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Comparative analysis of freshwater wetlands of Belarus and Portugal on the aspect of their present status, nature conservation performance and future perspectives

Lizaveta Sitkevich

Dissertação realizada para obtenção do Grau de Mestre em

Gestão Sustentável dos Espaços Rurais

Trabalho efetuado sob a orientação de:

Professora Doutora Carla Maria Rolo Antunes

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Declaração de autoria de trabalho

Declaro ser a autora deste trabalho, que é original e inédito. Autores e trabalhos consultados estão devidamente citados no texto e constam da listagem de referências incluída.

(Lizaveta Sitkevich)

Acknowledgements

Having graduated from the Belarusian State University as a Specialist in International Tourism Management and studied at the University of Algarve in the Master of Science in Sustainable Management of Rural Areas, I have managed to combine the knowledge I got with my personal interests in sustainability issues. In Belarus I concentrated on ecological tourism in our protected areas gradually turning from the 'tourism manager' view on it to 'nature conservationist' one. The Master programme helped me to get a broader view on sustainable management concept.

This thesis is a result of the author's continuous work and dedication which, however, could not be possible without support and contribution of many people.

First, I would like to thank my family and friends for their understanding, support and advice during all this time: my parents Sviatlana and Anatolij, my sister Kaciaryna and my Vova.

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RESUMO

O presente estudo incide na análise comparativa das zonas húmidas de água doce em dois países - Belarus (país de origem do autor) e Portugal (país onde o autor frequentou o curso de Mestrado), nomeadamente para determinar as semelhanças e diferenças nas abordagens de conservação de zonas húmidas e práticas seguidas nos referidos países e identificar os aspectos positivos e experiências que pudessem ser utilizadas no futuro. Foram seleccionadas 7 áreas de estudo – 3 turfeiras em Belarus e 4 zonas em Portugal (3 pauis e 1 turfeira).

A pesquisa centrou-se nos aspectos da conservação da natureza, uso atual de recursos de zonas húmidas e as perspectivas futuras de uso e conservação. Também foram realizados inquéritos, com o objectivo de avaliar o comportamento dos turistas quando visitam esta tipologia de espaço. Neste enquadramento, em ambos os países, o autor participou em dois projetos de conservação de zonas húmidas.

O trabalho tem a seguinte estrutura: 1 Introdução do estudo, onde são indicados os objetivos, a estrutura e a metodologia; 2 Estado da arte relativamente à visão das zonas húmidas de água doce de Belarus e de Portugal e as respectivas experiências de conservação; 3 Casos de estudo, onde são apresentadas as sete áreas de estudo e os dois projetos de conservação de zonas húmidas; 4 Resultados – análise comparativa do desempenho das áreas de estudo e da pesquisa sociológica; e por fim, 5. Conclusões.

A pesquisa realizada permitiu um profundo conhecimento e compreensão da evolução das características das áreas de estudo, seu desempenho atual em conservação da natureza, ecoturismo e educação ambiental. Os principais resultados obtidos mostram que as áreas de estudo de Belarus e de Portugal são áreas de alto valor de conservação. No entanto, as abordagens e objectivos de conservação são bastante diferentes nos dois países: as zonas húmidas belarusas estão muito melhor conservadas e ativamente envolvidas em práticas de conservação regulares que provam ser altamente eficientes; os objectivos prioritários para as áreas são a sua restauração através da pesquisa científica, conservação e uso sustentável que significa a proteção, o desenvolvimento do ecoturismo, práticas de educação ambiental e envolvimento da população local. As zonas portuguesas estão bastante alteradas e sujeitas a ações de conservação pontuais; os objectivos prioritários para estas áreas são a conservação através de medidas para a recuperação de espécies e habitats, sem o objectivo prioritário de restauração de ecossistemas, verificando-se algumas limitações do seu uso por status de proteção e regulação de práticas ilegais, controle de visitas e desenvolvimento da educação

ambiental e ecoturismo. O conceito de abordagem em Portugal revela-se pouco sustentável, pois não recorre a atividades de conservação regulares e as zonas húmidas funcionam ou de proteção formal e prevenção de sua futura utilização ou concentram-se na educação ambiental.

Os resultados da pesquisa sociológica também provam a maior eficiência do desempenho das áreas belarusas mostrando o maior nível de conhecimento sobre as áreas de estudo e as suas atividades.

Palavras Chave:

Conservação de zonas húmidas, análise comparativa, charco, paul, turfeira, projeto de conservação da natureza, ecoturismo, educação ambiental.

ABSTRACT

The present thesis is devoted to comparative study of freshwater wetland areas in 2 countries – Belarus (the country of the author's origin) and Portugal (the country of Master studies). 7 research sites were chosen – 3 mires in Belarus and 4 marshes in Portugal. The research was done in the field of their nature conservation performance, current use of wetland resources and future perspectives of use and conservation. Besides, the examples of the 2 successful wetland conservation projects in both countries, in which the author participated, were provided. Moreover, the sociological survey on assessing awareness of potential tourists about the research sites was conducted and its results presented. As a result, the comparative analysis was conducted to determine similarities and differences in wetland conservation approaches and practices in Belarus and Portugal and to identify the positive aspects and experience that could be used by each side in the future.

The work has the following structure: 1. Introduction of the study, its objectives, structure, methodology; 2. Issue background – overview of Belarusian and Portuguese freshwater wetlands and their conservation experience; 3. Research data – presentation of the 7 research sites and 2 wetland conservation projects; 4. Results – comparative analysis of the research sites' performance and analysis of the results of the sociological survey; 5. Conclusions

The thesis research has produced a deep knowledge and understanding of the past and present features of the research sites, their current performance in nature conservation, ecotourism and environmental education.

The main results obtained show that both Belarusian and Portuguese research sites are high conservation value areas. However, the conservation approaches and objectives are completely different in the countries: Belarusian wetland areas are much better conserved and actively involved in regular conservation practices which prove to be highly efficient; the priority objective set for the sites is their restoration through scientific research, conservation and sustainable use by protection, development of ecotourism, environmental education practices and involvement of local population. Portuguese sites are transformed to high extent and are subjected to unregular and inefficient conservation actions; the priority objective set for the sites is conservation of the sites through measures for recuperation of species and habitats without the objective of restoration of ecosystems, limitation of their use by protection status and regulation of illegal practices, visit control, and developing environmental education and ecotourism practices. In practice, the Portuguese concept proves

to be unsustainable: it does not imply regular conservation activities which causes further degradation of the landscapes and the sites either function for formal protection and prevention of their further use or concentrate on environmental education.

The results of the survey also prove the higher efficiency of Belarusian sites's performance showing higher level of awareness about the research sites and their activities.

Keywords:

Wetland conservation, comparative analysis, mire, bog, marsh, nature conservation project, ecotourism, environmental education.

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List of Abbreviations and Symbols

APB – Achova ptušak Baćkaúščyny

AW – Aquatic Warbler

AWCT – Aquatic Warbler Conservation Team

CIBIO – Centre for Investigation of Biodiversity and Genetic Resources of the University of Porto

CMS – Convention on Migratory Species

CTM – Mediterranean temporary ponds

DBC – Dniapro-Buh Canal

EC – European Commission

EU – European Union

GEF – Global Environment Facility

GEOTA - Grupo de Estudos de Ordenamento do Território e Ambiente

IBA – Important Bird Area

ICNF – Instituto da Conservação da Natureza e das Florestas

IUCN – International Union for Conservation of Nature

KfW Development Bank - Kreditanstalt für Wiederaufbau Development Bank

NAS – National Academy of Sciences

NGO – Non-governmental organization

NUT – Nomenclature of Territorial Units for Statistics

PATO – Associação de Defesa do Paul de Tornada

RSPB – Royal Society for the Protection of Birds

SGP – Small Grants Programme

UN – United Nations

UNDP – United Nations Development Programme

USAID – United States Agency for International Development

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1. Introduction

1.1. Scope and framework of the study

Nowadays wetland conservation is a topical issue since climate change leaves us fewer and fewer opportunities to survive and prosper on our planet. Conservation activities do not keep up with degradation processes, rising CO2 emissions, melting glaciers and dying coral reefs. Saving wetlands in this situation has become a potential solution since they carry out a crucial function – support of rich biodiversity, hydrological regulation, accumulation of CO2 in case of peatlands and other greenhouse gases which allow us to speed down global warming processes. Moreover, for Belarus it is highly useful since we plan to start selling carbon credits on account of existing and restored peatlands (Restoring Peatlands, 2011).

On the other hand, a great wetland potential is simultaneously constrained by the degradation processes and its "adverse to natural" effects: biodiversity loss, fires, water pollution (IPCC, 2014); degraded peatlands tend to produce greenhouse gas emissions due to decrease of groundwater level, peat fires and therefore contribute to climate change (Restoring Peatlands, 2010a).

What is more, climate change itself threatens wetlands since rising temperatures together with water run-off due to past drainage cause summer draughts and further loss of wetland functions. For instance, as Earth Peoples Blog, 2012 states, "warmer summer weather threatens to thaw the large peatland areas of Canada and Russia, causing them to decompose. There is also a risk that fossilised methane, stored under these areas, could be released".

It goes without saying that besides their air clearing capability, wetlands serve as habitats for unique species of flora and fauna.

Thus, wetland conservation on a global scale is a planet-saving tool and it is important to develop and support cooperation between countries and conservation organizations so that they could share their experience, develop joint projects since wetlands do not see any country borders, they belong to nature.

This thesis is meant to serve as an example of such cooperation, combination of knowledge and experience of two countries (Belarus and Portugal) so that efficient practices of each country could be studied on the examples of particular wetland sites and, perhaps, applied in the future in the other areas.

1.2. Objectives, structure and methodology of the research

The objective of the thesis is set to carry out a comparative analysis of conservation concepts and practices of Belarus and Portugal by exploring the particular protected wetland areas in both countries (in the scheme below), analyzing their present status, activities and conservation and development projects ongoing there and provide examples of 2 projects (one for each country) by participating in it personally and collecting the information needed.

The present master thesis has been divided into three parts: overview of wetlands in each country, analysis of the research sites and comparative analysis with conclusions.

As for the first part of the work, to conduct analysis of the research sites, it was decided to make an overview of Belarusian and Portuguese wetlands so that the research sites and their characteristics could be seen within the general concept of wetland conservation in each country. This overview has been based on the following points:

- historical context, area size and value;
- scientific research and conservation activities in recent years.

The second part of the work is devoted to analysis of the research sites (Table 1.1) including characterization of the 2 nature conservation projects – Aquatic Warbler Conservation project in Belarus and LIFE Trachemys in Portugal in which I participated and which are representative for the work since they reflect current issue in freshwater wetland conservation field in the two countries. The Belarusian project was carried out on 2 of the research sites. The Portuguese one was not carried out on the research sites but since it is one of the few current projects on wetland conservation in Portugal and the author participated in it, the project was included for analysis in the thesis.

Table 1.1 Research sites in Belarus and Portugal

Portugal	**Belarus**
Paul de Arzila – NW Portugal	Sporava mire - SW Belarus
Paul de Tornada – NW Portugal	Zvaniec fen mire – SW Belarus
Paul do Boquilobo – NW Portugal	
Lagoa de Dom João, Serra de Montemuro – N Portugal	Jelnia mire – N Belarus

In addition, water quality analysis was conducted for the 3 Portuguese sites and 1 Belarusian. Peat analysis results were obtained for 1 Portuguese and 3 Belarusian sites.

Wetland condition analysis was carried out for all the sites using the data of the National System of Information on Hydrological Resources and the results of the previous researches on water quality parameters in the study areas.

What is more, besides the analysis of the sites, the sociological survey was carried out to assess awareness of Belarusian and Portuguese people about wetlands in general and the research sites in particular and attractiveness of these sites for ecotourism. The results were further analyzed and included in the research data.

Finally, comparative analysis is conducted in the third part of the work and conclusions of the research made having proved the efficiency of the work done and brought about interesting results that can be applied further in wetland conservation management both in Belarus and Portugal.

Methodology

Full methodology of the work can be represented by the following fluxogram (Figure 1.1)

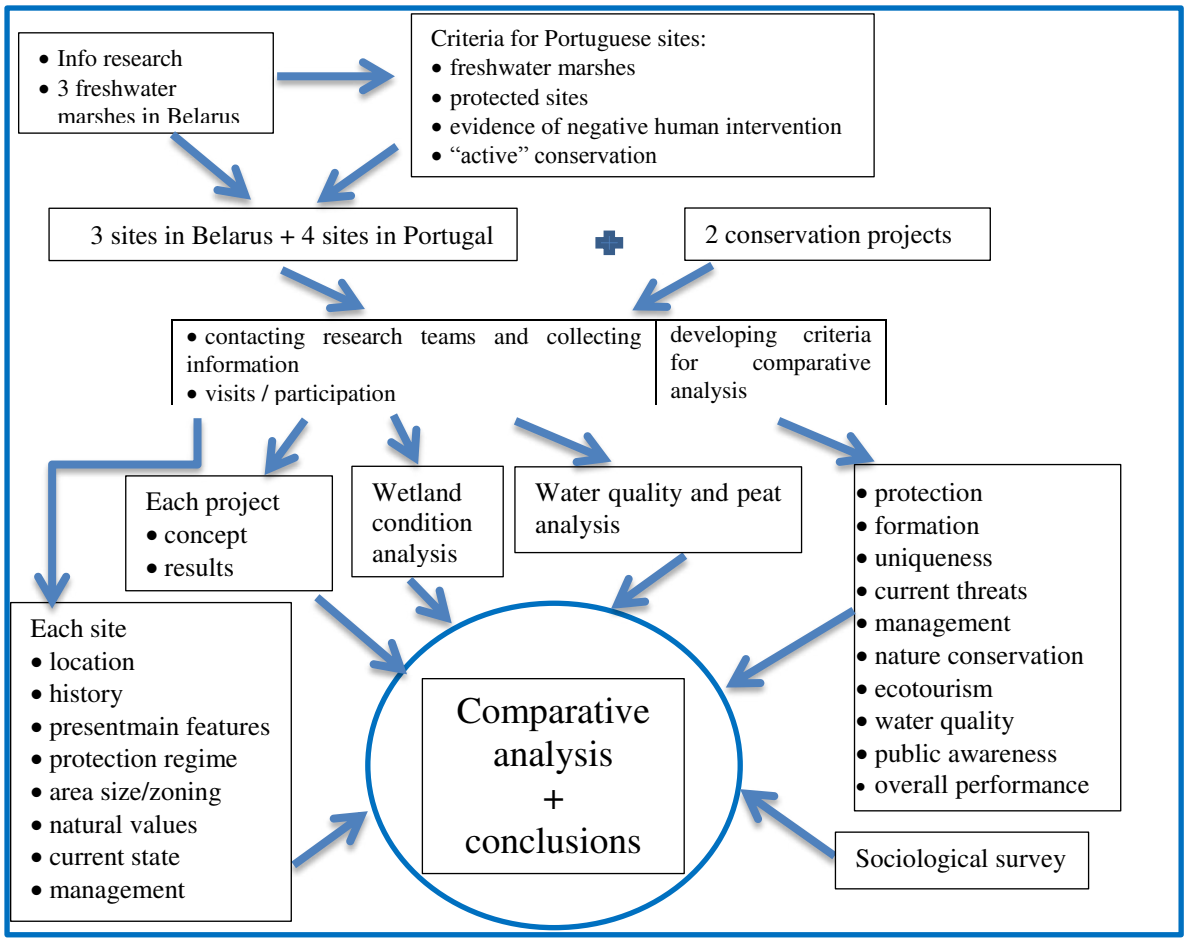


Figure 1.1 General scheme of the thesis

The basis of the work was choosing several protected areas in Belarus and Portugal. A deep information research was conducted so that the author could distinguish potential territories for research in the two countries since comparative analysis is efficient as long as it can provide useful results. This is only possible when the objects of research from the two sides have common or similar characteristics, problems and reasons for these problems. In this case the ways to tackle those problems (projects, development plans) by one side can be of great help for the other.

Thus, the criteria for choosing wetlands for my research were based on my knowledge of particular Belarusian protected wetland sites and their features – they are all freshwater marshes of 2 types – fen mires and peat bogs, all of them with the consequences of drainage and (or) intensive agricultural use in the 20th century. Such consequences are violation of hydrological regime, water and soil contamination, destruction of habitats of plants and animals. Most of the sites are protected and involved in active conservation actions on restoration of hydrological regime by vegetation management, renaturalisation of habitats through rewetting of drained territories, ecotourism and environmental education. So, knowing that Portugal possesses similar territories it was extremely interesting for me to conduct research so that I could find examples of efficient conservation work and use this experience in Belarus, and share our conservation practices. So, obviously, since I was searching for successful models of development and Belarusian sites showed active conservation and development status it was necessary for me to explore "active" wetlands in Portugal with the following characteristics:

- protected sites since they could provide conservation examples, unprotected ones, on the opposite, do not allow for getting enough information;
- those which hold scientific research, ecotourism activities, conservation projects, active and accessible research teams so that I could communicate with them and see the possibilities of efficient wetland use and conservation.

Having analysed general information on Portuguese wetlands I pointed out several criteria for choosing these or those territories:

- wetland type: I needed marshes with characteristics similar to Belarusian ones, freshwater, at least one with peat deposit since all the Belarusian research sites are peaty;
- conservation status and history (problems that caused the need for protection, in Belarus it is drainage and its effects);
- present activities in the area;

- present challenges and conservation projects;
- future plans;
- the number of chosen territories was also meaningful. It must have been enough to get real results, not too many.

So, there were 3 already chosen Belarusian sites – 2 fen mires and 1 peat bog.

As for Portugal, it turned out peaty areas are mostly found in the Azores (which was not the thesis case, since these are islands) and in the mountainous regions of continental Portugal (some peat marshes are natural, the other ones with the consequences of intensive agriculture and little conservation work). Thus, the latter ones were not suitable for comparison with Belarusian peatlands, situated on flatlands, big in size and suffered from drainage, now being restored and actively studied. Only one Portuguese peatland was chosen for the thesis, to give an example of undisturbed peatland landscape in the country, provide information on its historical formation and human use and check its current state.

The other 3 chosen Portuguese wetlands sites are mainly freshwater marshes, with similar to Belarus drainage consequences and current development scheme (so it seemed after the primary analysis). Of course, it was impossible to know for sure those sites would be suitable enough from the point of view of current conservation actions and their efficiency, this could only be known after visiting them. Fortunately, from the Belarusian side it was known our sites have shown positive results of their conservation activities. It would have been good if the Portuguese ones also had had.

So, I have finally chosen 3 sites from each side, and 1 additional in Portugal since it was a peat bog, the only one among the Portuguese research sites but not representative enough for description of nature conservation activities.

Analysis of the research sites implied visiting them, contacting research teams there and collecting all the necessary information, as well as developing criteria for comparative analysis.

Analysis of each site was carried out using the following analysis scheme: location, history and present main features, protection regime, area size and zoning, natural values, current state: threats, management: past and present, what needs to be done and what is planned.

Analysis of the 2 conservation projects was based on the information obtained from the project managers (Malashevich, 2013-2014 and CIBIO, 2013) and personal experience from participation in them.

Water quality and peat analysis of the Belarusian sites was based on the research data obtained from Bahadziazh (2010), Thiele et al. (2012), Tanavickaja (2013).

Water quality analysis of the Portuguese sites was based on the data from the Sistema Nacional de Informação de Recurcos Hídricos (2013) and the research studies of Brito and Mieiro (2000), Silva (2007).

The peat ph analysis at the peatbog of Lagoa de D. João was conducted with deionized water, a ph meter Hanna Combo (Figure A87, Appendix), KCL solutions. Samples were obtained at the 4 points of the bog (3 samples at each location). 40 cm^3 peat samples were mixed with 100 cm^3 1M KCL solutions. The ph meter was placed inside for 20-30 seconds. Analysis process and equipment are shown on Figure A88, Appendix.

Moreover, the von Post Decomposition Index has been assessed for the research site (Figure A89, Appendix) which implies assessement of distinctness of the structure of plant remains and colour, determined by squeezing wet peat in the hand.

Wetland condition analysis was carried out with the use of the method of Clarkson et al., (2003). Wetland Record Sheet was filled for each site and wetland condition index determined.

The survey was created with the SurveyMonkey service and was spread through emails, Facebook, V kontakte (Belarus) and word of mouth.

Each survey consisted of 10 questions (https://www.surveymonkey.com/s/999GRKN, https://www.surveymonkey.com/s/SLHYBV7), allowing to determine the type of persons's activity (work, hobby – connected/not connected with nature conservation, tourism, environmental education), evaluate their awareness about the wetlands (marshes, fens and bogs) and wetland protected sites of the country in general and knowledge about the particular wetland research sites of the thesis.

Comparative approach was further applied for the analysis of Belarusian and Portuguese research sites. The criteria were established taking into account the ones that were used for characterization of each protected area. Thus, they are as follows: protection status, historical aspect of wetlands' formation, uniqueness, current threats, management, nature conservation activities, ecotourism, water quality, public awareness, overall performance. It is also important to note that the 4th research site in Portugal (the peatbog in Lagoa do Dom João) will not be included into the analysis since it has been an example of Portuguese peaty marsh but completely natural and with no nature conservation management.

2. Issue background

2.1 Overview of Belarusian wetlands

2.1.1 Historical context, area size and value

Belarus has always been the land of wetlands. The world indicator for wetland areas percentage is 6 % (AAAS, 2014), for the marshes (mires, peatlands) – 3.4 % (Chichko, 2010) whereas in Belarus it is 7 % and 6.4 % respectively (Astapovich, 2011). It holds 17th place in the world by the peatland area (Fenchuk and Kazulin, 2012).

Furthermore, Belarus has 16 Ramsar sites with a surface area of 614 708 ha (Ramsar, 2013a), all of them being specially protected nature areas of a various state status: one national park and zakaznik (reserves). Besides, not only Ramsar sites but other wetlands are Important Bird Areas, Belarus has 49 such areas (Birdlife, 2014c). Among wetland types the dominant ones for Belarus are fen mires and peat bogs, the other ones being lakes.

In the 1960s wetlands covered 15% of the country whereas mires were spread on 14,2% (Chichko, 2010), almost half of that area suffered from massive drainage in the 1960-1990s. As a result the area of mires decreased to 6.4 % (Astapovich, 2011), the remaining area having been drained for the purpose of agriculture, forestry, and peat extraction.

All in all, Belarusian mires can be divided into 3 groups by their current state: natural ones with disrupted hydrology; drained and being used ones; abandoned drained peatlands being restored in the recent years. The natural ones with disrupted hydrology are in a natural state but are influenced by the surrounding drained areas, thus, have experienced disturbance of hydrological regime, water pollution, overgrowth with reeds. The main conservation measures are habitat and vegetation management. The drained peatlands which continue to be used for peat extraction, agriculture are out of the conservation measures. The abandoned drained peatlands are current restoration project sites that have recently been rewetted.

It should be noted that drained peatland sites have caused large CO2 releases due to peat decomposition whereas these areas are naturally meant to accumulate CO2 and thus reduce greenhouse gas emissions. These degraded wetland areas are the reason for Belarus being the 8th in the CO2 emissions list (IMCG, 2014).

Biodiversity value

According to BrantaTours, 2014, Belarusian wetlands are responsible for rich biodiversity being habitat for key rare and endangered plant species such as rare species of orchids, lichens, mosses, typical mire plant communities; rare bird species such as Greater Spotted Eagle, Aquatic Warbler, Common Crane, Corncrake, Short-eared Owl.

Bogs are a place to see Terek, Marsh and Green Sandpipers, Whimbrel, Curlew, Golden and Ringed Plovers, Black-tailed Godwit, Greenshank, Redshank, Snipe, Great Snipe, Redshank, Spotted Redshank, Great Grey Shrike, Meadow Pipit, Citrine and Yellow Wagtails, whilst the edges surrounding the pine bogs are typical breeding place for Osprey, Golden and Short-toed Eagles, Hobby and Merlin.

Open meadows and mires are hunting grounds for various birds-of-prey breeding in neighbouring floodplains and forests, such as White-tailed, Short-toed, Greater and Lesser Spotted Eagles, Honey Buzzard, Goshawk, Great Grey and Short-eared Owls.

Old floodplain forests feature Hazel Grouse, Capercaillie, Woodcock, Middle Spotted Woodpecker, Black Stork, Eagle Owl, Roller, Redwing and Azure Tit.

Besides birds, mammals are also encountered in the wetland areas and in the neighboring forests: Gray Wolf, Brown Bear, Wild Boar, Eurasian Lynx, Racoon Dog, Eurasian Elk, European Roe Deer, European Beaver, European Bison, European Mink.

Thus, the wetlands of Belarus are an interesting tourist attraction that is well-known within the bird watching community and is promoted in the country and for foreign visitors.

2.1.2 Scientific research and conservation activities in recent years

In the 1990-2000s foreign scientists stimulated arising interest in wetland conservation in Belarus, having developed several projects, the most important one was connected with the discovery of the globally threatened bird species of Aquatic Warbler on one of the Belarusian fen mires and further research on this bird dependency on suitable wetland conditions (Kozulin and Flade, 1999).

For the recent 25 years there has been done a lot in the area of wetland conservation. Here are one of the most significant actions implemented by APB-Birdlife Belarus, UNDP Belarus, various Ministries, local executive committees, local forestry entreprises, local population, volunteers with both national and foreign financial support (UNDP, GEF, European Union funds, USAID, Michael Otto foundation for environmental protection (Germany), Michael

Succow foundation (Germany), Royal Society for the protection of birds (UK), German KfW bank, Coca-Cola Beverages Belarus):

- **New protected areas created** on the wetland territories, now, with the already existed ones, comprising 1/3 of the overall wetland area in Belarus;
- **Restoration of hydrological regime of the Jeĺnia peatbog (1992-2002, 2008-2010) –** implemented by APB-Birdlife Belarus with the support of Coca-Cola Beverages Belarus, RSPB, UNDP-GEF: construction of 48 dams on the drainage canals which allowed to raise groundwater level and stimulate conditions for restoration of native flora/fauna (Shajkin and Levy, 2010; GEF-SGP, 2008c);
- **Management planning for conservation of fen mire biodiversity in Belarus (1999-2002)** – implemented by APB-BirdLife Belarus in cooperation with the Ministry of Natural Resources and Environmental Protection; financed by Michael Otto Foundation for Environmental Protection (Germany) and UNDP Belarus: development of Management Plans for Zvaniec, Sporava and Dzikoje fen mires (UNDP, 2002);
- **Implementation of urgent recommendations of the management plans for key biodiversity areas in Belarus (2002-2006)** – implemented by APB-BirdLife Belarus with the support of the RSPB (UK), UNDP, the Darwin Initiative for the Survival of Species (UK) and Michael Otto Foundation (Germany): hydrological regime stabilized at Zvaniec fen mire (7 sluices and dams constructed) and Dzikoje fen mire (5 dams constructed), monitoring of Aquatic Warbler population at 5 breeding sites, ringing of Aquatic Warbler at Zvaniec, Sporava and Dzikoje, water management regulations developed for the fishfarm near Sporava fen mire (UNDP, 2006b);
- **Conservation of Unique Biological Diversity of Turaú Meadow Through Sustainable Use (2006-2008) –** implemented by Turaú city council with the GEF-SGP support: establishment of site management structure, construction of a tourism trail, workshops with guides and agro-tourism providers, conservation actions against overgrowth with bushes and reeds, monitoring of bird populations (GEF-SGP, 2006a);
- **Conserving unique biological diversity of lowland mires through their sustainable use (2006-2009) –** implemented by APB-Birdlife Belarus, funded by GEF-SGP – vegetation management at 2 key Aquatic Warbler breeding sites – Sporava and Zvaniec – mowing and bush removal (GEF-SGP, 2006b);
- **Eco-tourist path setup and restoration of the natural hydrological regime of the marsh at the hydrological reserve "Vyhanaščanski" (2008-2009)** (GEF-SGP, 2008b)**;**

- **Restoration of the natural hydrological regime of the reserve "Dakudaúski" upset by peat extraction (2008-2010)** (GEF-SGP, 2008d);
- **Catalyzing sustainability of the wetland protected area system in Belarusian Palieśsie through increased management efficiency and realigned land use practices** (**2006-2011**) – coordinated by the Ministry of Natural Resources and Environmental Protection, with the support of APB-Birdlife Belarus, funded by UNDP-GEF and Ministry: 4 wetland reserves – Sporava, Zvaniec, Mid-Prypiać, Prastyr – implementation of Management Plans for Sporava and Zvaniec reserves, Management Plan development for Mid-Prypiać site, establishement of a cross-border (with Ukraine) Ramsar site "Upper Prypiać" (Ministry, 2006; UNDP, 2006a; 2010a; 2011a) (Figure A1, Appendix);
- **Peatland Project (2006-2011)** – Renaturalization and Sustainable Management of Peatlands in Belarus to Combat Land Degradation, Mitigate Climate Change, and Ensure Conservation of Globally Valuable Biodiversity implemented by the Ministry of Forestry and APB-Birdlife Belarus at 15 sites (Figure A2, Annex): approximately 28 000 ha of degraded peatlands rewetted and rehabilitated, their long-term protection secured, reduction of CO2 emissions by at least 300,000 tons annually, populations of threatened biodiversity species stabilized, risk of fires diminished significantly (UNDP, 2010b);
- **Restoring Peatlands and Applying Concepts for Sustainable Management in Belarus (2008-2012) –** implemented by APB-BirdLife Belarus and the Michael Succow Foundation in cooperation with RSPB and the Government of Belarus. The project is financed by German government through KfW bank. 10 designated sites – a large scale peatland investigation and rewetting programme: rewetting of ca 15 000 ha of degraded peatlands and calculation of greenhouse gas emission reductions to facilitate certification and sale of carbon credits on the voluntary market (Restoring peatlands, 2010b);
- **Creation of conditions for the development of eco-tourism at the Republican Biological Reserve "Sporaúski" (Biaroza district) with the minimal environmental impact (2008-2009) –** implemented by the local village council, funded by GEF-SGP: construction of ecological trails for tourists and schoolchildren, organization of environmental activities for raising public awareness, organization of open championship on hay mowing (GEF-SGP, 2008a);
- **Eight wetlands 2011-now** – web-project created to raise public awareness about the government decision on reduction of the area of 8 wetland reserves for using that land for peat extraction: as a result of public signing of the petitions and active media coverage of the

problem, one of the reserves has managed to be left without any changes in its area, the situation of the other ones has not been decided on yet (Eight Wetlands, 2011). This campaign has been doing a lot in raising public awareness about Belarusian wetlands and their present problems, widening the audience of indifferent people further than ecological community;

- **Aquatic Warbler (AW) conservation in Belarus project (2002 – up to now)** has been implemented by APB-BirdLife Belarus with support of RSPB. Belarus hosts 40% of this globally threatened species, mostly on 3 key breeding sites of Zvaniec, Sporava and Dzikoje; the bird serves as an indicator of wetland conservation state. What is done: habitat management, monitoring of Aquatic Warbler numbers and distribution, Aquatic Warbler counts in Sporava, Zvaniec and Dzikoje sites, study of migrations (Ministry, 2006; Malashevich, 2012). The AW counts project is fully described in chapter 3.1.4;
- **Sustainable scheme for peatland conservation and management developed**: transformation of the current approach to peatland use (balancing real income from peat extraction by hypothetical arguments of biodiversity conservation)to the new one (balancing real income from peat extraction by real income from peatland restoration and conservation) (Fenchuk and Kazulin, 2012):

Key elements of this scheme (Figure A3, Annex) are practical (how to reach maximum effect for climate and biodiversity during rewetting), scientific (how to estimate the amount of emission reductions and the effect on biodiversity), economical (how to ensure flow of funds for future managing rewetted peatlands and continuation of the work on restoration of degraded peatlands; how to balance real money from peat extraction by real money from peatland restoration and conservation) and political (how to ensure the recognition of the significance of mires/peatlands and their importance for climate balance).

Economical effect is planned to be reached through selling carbon emission reductions on the international carbon market (Fenchuk and Kazulin, 2012);

- **Secondary bogging of exhausted peat field "Choreúskaje" and "Astroŭúskaje" with the purpose CO2 emission reduction, prevention of peat fires and biodiversity protection (2009-2012) –** implemented by APB-Birdlife Belarus, Mijory and Pružany village councils, Pružany forestry entreprise, Jeĺnia reserve administration, with the support of the Ministry of Natural Resources and Environmental Protection, funded by GEF-SGP: waterlogging of the depleted part of peat bog, restoration of hydrological regime and peat ecosystem on the 2 lowland bogs in the aim of prevention of peat fires, reduction of CO2 emission, preservation of biodiversity (GEF-SGP and APB, 2009a);

- **Sustainable Management of Wetland Protected Areas of International Importance in Stolin district (2012-2013) –** implemented by the local village council, funded by GEF-SGP**:** creating condtions for development of ecotourism, environmental education in Mid-Prypiać reserve, upgrade of buildings of the reserve with energy-efficient technologies (SGP-GEF, 2012);
- **Clima East "Conservation and sustainable management of peatlands in Belarus to minimize carbon emissions and help ecosystems to adapt to climate change" (2014-2020)** – implemented by the Ministry of Natural Resources and Environmental Protection with the support of the National Academy of Sciences of Belarus, national reserves Zvaniec and Sporava, local authorities of the Drahičyn and Biaroza districts and APB-BirdLife Belarus, funded by UNDP-GEF: aimed at restoration of Sporava and Zvaniec fen mires by mechanized mowing and collecting and use of biomass for fuel briquette production (ClimaEast, 2014);
- **Berries of Stolin district (2014-2015) -** implemented by the local company, funded by GEF-SGP: the goal is to create conditions for reducing the degradation of peatlands in the western part of the Stolin district, through their involvement in agricultural use and setting up blueberry plantations; diversify agricultural production in private households of Stolin district by blueberry production development, including involvement of degraded peatlands (GEF-SGP, 2014)**;**

Thus, wetland, and mostly, peatland conservation in Belarus implies combination of 2 aspects – conservation and education&ecotourism. The conservation aspect involves conservation and scientific research, ensurance of formal protection of the areas, development of their management plans and creation of the administrations of the wetland reserves (the last measure was first implemented within the project, proved to be successful, was approved by legislation and now is practicedon the state level) (Malashevich, 2013-2014).

There are lots of bureaucratic barriers faced by the Belarusian environmental NGOs such as obligatory registration of the projects (only on condition of Letter of Support from the Ministry of Natural Resources and Environmental Protection), obligatory use of all the money during the project (no possibility of savings, only target use of funds) (Malashevich, 2013-2014), financial control of the organizations by the state, financial problems (only foreign funding which is often difficult to get), state management focused on getting only financial benefits, neglecting environmental aspect, lack of ecological awareness in the society caused by a short history of ecological movement in Belarus.

However, the wetland conservation community in Belarus is rather strong and not concentrated on science only, they also devote their work to people and raising their interest

in nature conservation. **For example, there are voluntary camps annually organized by APB-Birdlife Belarus within the Aquatic Warbler conservation project, dam construction on Jeĺnia peatbog; birds festival in Turaú, seasonal bird observations, public petitions on the Internet, infocampaigns through creation of commercials, videos, organization of educational activities in public places.**

Moreover, local communities play a significant role in saving traditional environments in their villages. The success of the past and present activities is in complex use of conservation instruments (State-NGO dialog, foreign funding, scientific community, public campaigns, local population involvement, enthusiasm and concern about saving nature and its elements).

2.2 Overview of Portuguese freshwater wetlands

2.2.1 Historical context, area size and value

Portuguese continental wetlands (both freshwater and saltwater) are located mostly along the coast of the country representing various wetland types, both natural and human-made: rivers, lakes, ponds, creeks, estuarine lagoons with extensive dune systems, mudflats and reedbeds, artificial salinas, alluvial plains; swamps, bogs, saltpans and saltmarshes, freshwater marshes with series of drainage canals surrounded by agricultural lands and forest, rice fields and fishfarms, peat bogs.

Agricultural development has led to drainage of marshes and meadows, afforestation of marginal lands during the 20th century which have caused disturbance of hydrological regime of the areas, soil erosion, increased water run-off, irregular river discharge, and transformation of the landscpaes due to overgrowth with invasive plant species. This has posed a threat to a lot of aquatic bird species which have always used the wetland areas as migrating stopovers, breeding and nesting sites.

Work on making inventory of the Portuguese wetlands started in 1975 but had not brought any real result until 1999 when the Institute for Nature Conservation and Forests started a project on conservation of wetlands having developed Action Strategy for the project focused on the need for National Inventory of Wetlands (ZHP, 2014).

Wetland conservation was set as a priority in the National Strategy for Conservation of Nature and Biodiversity in 2001 (ZHP, 2014).

There is no accurate information on the whole wetland cover in Portugal. As for now, there is information that there are 1302 wetland areas (ZHP, 2014) identified in Portugal, continental and island parts (the Azores and Madeira). Moreover, according to MedWet/WIS database there are 527 wetland sites covering 5.07 % of the overall number of Mediterranean wetlands (MedWet and Kapanidis, 2014).

The terms for the types of wetlands in Portuguese are various – estuário (estuary), sapal (saltmarsh), charco (swamp, bog, mire), paul (more or less close to marsh), lagoa (pond), lago (lake), ribeira (river), pantano (swamp), turfa (peatbog), which can be natural, artificial, permanent or temporary. The 3 research sites of the thesis (Paul de Arzila, Paul do Boquilobo, Paul da Tornada) are of the "paul" type which is closest to marsh in Belarus. The research peat site (Lagoa de D.João) is closest to peat bog in Belarus.

The Ramsar Convention on Wetlands came into force for Portugal in 1981. Portugal presently has 31 sites designated as Wetlands of International Importance, with a surface area of 132,487 hectares which is 1.44% of the whole country area (Ramsar, 2013b). See Table 2.1.

Analysis of the Ramsar list of Portugal allows us to classify the Ramsar sites according to their types.

Continental freshwater wetlands are 12 of 31 Ramsar sites, belonging to the "permanent freshwater marshes/pools, seasonal/intermittent streams/rivers, non-forested and forested peatlands" types (Ramsar classification).

The Azores possess 10 freshwater Ramsar wetlands – forested and non-forested peatlands, permanent/seasonal freshwater lakes/marshes/pools (Table 2.1).

Thus, Portugal on the whole has 22 internationally protected fully or partially freshwater wetlands covering almost 16% of the Ramsar areas of Portugal (Figure A4, Appendix). Calculations were made using the data on Ramsar sites of Portugal.

Table 2.1 Indicators of Portuguese Ramsar sites on the continent and the Azores (number, area, percentage) (Ramsar, 2013)

	Number of sites	Area, ha	%, of the country area
Ramsar sites	31	132 487	1.44
Cont Portugal	18	119 587	1.3
• freshwater marshes/lakes/peatlands	12	8290	0.09
• other	8	111 297	1.21
Azores	13	12900	0.14
• freshwater lakes/peatlands	10	12790	0.139
• other	3	110	0.001

Thus, Ramsar continental freshwater wetlands of Portugal cover 0.09 % of the country area or 6.3 % of the Portuguese Ramsar area (Table 2.2).

Table 2.2 Indicators of Portuguese Ramsar freshtwater wetlands (Ramsar, 2013)

	Number of sites	Area, ha	%, of the country area	%, of the Ramsar area
Freshwater wetlands among Ramsar sites	20	21080	0.23	15.9
• continental FW	12	8290	0.09	6.3
• Azores FW	10	12790	0.139	9.6

Moreover, these areas are all protected at the national or municipal level, having different state protection statuses: 5 natural parks, 8 natural reserves, 1 local natural reserve, part of 1

national ecological reserve, 1 protected landscape, 1 natural regional monument, Rede Natura 2000 sites, UNESCO Biosphere Reserves, Sites of Community Importance, Special Protection Areas (ICNF, 2014c) (Table A1, Annex). Besides, Portugal has designated 33 freshwater wetland areas as Important Bird Areas (Birdlife, 2014d).

Value

The Portuguese continental freshwater wetlands are important wintering and resting grounds for migratory aquatic bird species using the Eastern Atlantic flyway to Africa (Ramsar, 2013b). Moreover, many threatened species populations are supported thanks to the wetland areas as their breeding and nesting points: bird species (ducks, herons, flamingos, waders), mammal species (European otter, Wildcat), indigenous fish species (Iberian barbel), reptiles, amphibians.

What is more, the wetlands serve for regulation of the groundwater level, flood prevention, and human activities such as fishing, aquaculture, shellfish trade, traditional salt production.

Peatbogs situated in the Portuguese mountaineous areas, have an important function of CO2 storage.

2.2.2 Scientific research and conservation activities in recent years

Conservation of wetlands in Portugal is an important aspect of its conservation policy. Having ratified the Ramsar convention in 1981, the country has done a lot in designation of 31 wetland sites for conservation, development of Site Management Plans and promotion of aquatic bird protection and sustainable use of wetland resources. Conservation of freshwater wetlands is part of the wetland conservation policy, 22 Ramsar sites out of 31 being fully or partially freshwater ones.

However, freshwater wetlands, as it seen above in the text, cover a small percentage of the protected wetland areas; second, some of them have been seriously transformed by man and have lost their natural functions; third, the Portuguese conservation approach in some wetland protected areas (the thesis research sites are an example) does not imply recuperation of habitats with their primary functions but means their designation with conservation status and minimizing human impact on the area, work with local population, regulation of hunting, fishing which often turns out to be permission for further landscape transformation with rare conservation actions. On the other hand, there are freshwater wetland areas where

conservation and educational projects are actively developed and implemented and positive results obtained in both biodiversity conservation and rasing public awareness.

Conservation projects developed and implemented in Portugal are usually those in cooperation with the EU countries and with the EU funds support. Here are several projects brought to life in the recent 20 years in the freshwater wetlands of Portugal:

- multiple researches on various conservation aspects undertaken by groups of scientists from the universities, environmental organizations (for example, researches for Ramsar Site Management Plans, studies on expansive vegetation growth, evaluation of environmental quality in the wetland reserves made by the specialists of the Institute for Conservation of Nature and Forests, the University of Lisbon, Porto, Coimbra, Algarve);
- **MedWet1 (1992-1996)** – project of the Mediterranean Wetlands Initiative, aimed at developing conservation methods and tools that would be specific to the Mediterranean, initially involving 5 EU countries (Portugal, Spain, France, Italy and Greece) while also involving the countries of North Africa and the Middle East. The project was led initially by a Steering Committee chaired by the EC and then the Ramsar Bureau (MedWet, 2010a).

There were 5 sites participating in the project (one for each country). In Portugal it was Sado Estuary. The objectives set were as follows: to develop methods and tools specific to Mediterranean wetlands in five areas: inventory and monitoring, wetlands management, training, public awareness, research results and dissemination. As a result, the developed tools were applied to the research sites: 5 manuals for Inventory of Mediterranean Wetlands, methodological guide for monitoring, training modules for management and monitoring wetland vegetation;

- **SUDOE: Inventory, assessment and monitoring for wetland management (2003-2004)** – MedWet project implemented in 16 wetland sites of Portugal (7) and Spain (9) (among them Paul de Arzila Natural Reserve, one of the thesis research sites). The objectives were as follows: to provide the SUDOE region (Southwestern Europe) with a tool for the elaboration of management and monitoring plans for wetlands, to improve the MedWet inventory methodology for wetlands, to promote public awareness and participation, contribute to the institutional development of each partner through exchange of information and communication of results (MedWet, 2010b).

The results achieved: new datasheets added to the MedWet inventory methodology; cartographic conventions and data management with a GIS; seminars, training courses, contribution to management plans of the sites, habitat description system applied to the sites;

- **Charcos com Vida –** initiated by CIBIO in 2014: an educational campaign aimed at creation of inventory on charcos (wetland type) and raising public interest and awareness, focusing on the primary and secondary schoolchildren. The project suggests "adoption" of the charcos (taking responsibility for characterization, observation, investigation, maintenance of the area, organization of educational activities, spreading information about the intiative) or construction of the new charcos according to the techniques provided. This could be done by schools or other interested entities. Moreover, the project provides pedagogical materials on various aspects of the issue;

LIFE programme has been a successful initiative for Portugal, having funded multiple conservation projects. Since its launch in 1992, there have been 73 projects in the field of nature conservation in Portugal (EU, 2014). Below are the LIFE projects implemented and planned for implementation in the freshwater wetlands of Portugal:

- **LIFE Re-establishment of the Baixo Mondego marshes (1st phase, 1993-1995) –** coordinated by the National Service of Parks, Reserves and Nature Conservation**:** preservation the three wetlands of the Baixo Mondego marshes (Paul de Arzila, Paul da Madriz and Paul do Taipal) (EU, 1993): purchase of lands by state, innovative techniques in agriculture, creation of infrastructure for visits.
- **LIFE Porphyrio - Porphyrio project - Reintroduction of the Purple Gallinule in the Lower Mondego River Valley (1998-2001) –** implemented by the Institute of the Sea with the support of the Institute for Conservation of Nature and Forests in Paul de Arzila and Paul de Madriz reserves**:** restoring a viable population of purple gallinules in the lower Mondego by re-introducing birds from Spain (EU, 1998). This project was innovative in Portugal, for it was the first time that a soundly structured and monitored bird reintroduction plan was implemented.
- **LIFE Palustris - Palustris, Management of the Special Area of Conservation of the Marsh of Arzila (2001-2006) –** implemented by the Institute for Conservation of Nature and Forests and Paul de Arzila Nature Reserve (EU, 2001)**.**
- **LIFE Trachemys (2011-2013) –** EU funded project for Spain and Portugal on eradication of alien species of freshwater turtles thorugh their captures: the results are described in chapter 3.2.5 (EU, 2011).
- **LIFE Ecotone Management of riparian habitats towards the conservation of endangered invertebrates (2012-2016) – implemented by QUERCUS** (EU, 2012)**.**

This project is targeting the conservation of alder alluvial forests in two Portuguese rivers (Rio Paiva, Torgal stream in Costa Sudoeste), in order to increase the populations of three species of dragonfly. The project also sets out to improve the conservation status of two species of freshwater pearl mussels (EU, 2012a).

- **LIFE Charcos Conservation of Temporary Ponds in the Southwest Coast of Portugal (2013-2017) –** implemented by the League of Nature Conservation. Mediterranean temporary ponds (CTMs) are seasonal wetland habitats, subjected to extreme and unstable ecological conditions (EU, 2013). Due to their uniqueness and scientific value, they are listed as a priority habitat for conservation in Annex I of the EU Habitats Directive. The project's overall aim is to enhance the conservation status in southwest Portugal of Mediterranean temporary ponds (CTMs) (EU, 2013).

Expected results: The project's main expected result is to halt the loss of temporary ponds in the Costa do Sudoeste Natura 2000 site, reversing the declining trend observed in the past few years. Conservation and demonstration actions are planned for at least 16 temporary ponds, and in some of the ponds more than one type of conservation action will be applied simultaneously.

It can be seen from the information above that there have been various initiatives in the field of freshwater wetland conservation in Portugal. Some of them are implemented in the protected areas, the other ones concern the unprotected territories in need for conservation actions. The projects are funded from the EU funds (LIFE, joint country initiatives) and brought to life by Portuguese NGOs (Quercus, League for the Protection of Nature, etc) and governmental environmental entities (ICNF, administrations of the protected areas). However, it should be noted that funding for the project is difficult to obtain in Portugal, and the process of project implementation is often delayed or disturbed by bureaucratic barriers. The conservation initiatives are implemented more efficiently within the particular projects in the unprotected wetland areas and are sporadic under the management policy of the protected ones. The wetland conservation community in Portugal is devoted to their goals but lacks motivation and reliable sources for that: its members have faced so many obstacles on their way (both at the European, national and local level) that the low efficiency of their current work can be seen as a consequence of the previous processes.

3. Research data

3.1 Research sites: Belarus

3.1.1 Sporava mire

3.1.1.1 Location

Sporava mire is a fen mire (Europe's largest complex of natural floodplain fen mires) situated in Southwest Belarus, Brest region, in the area of 4 districts – Biaroza, Drahičyn, Ivanava and Ivaceviči, in the floodplain of the middle course of the Jasieĺda River, left affluent of the Prypiać River, Black Sea basin (NAS, 2009a) (Figure 3.1).

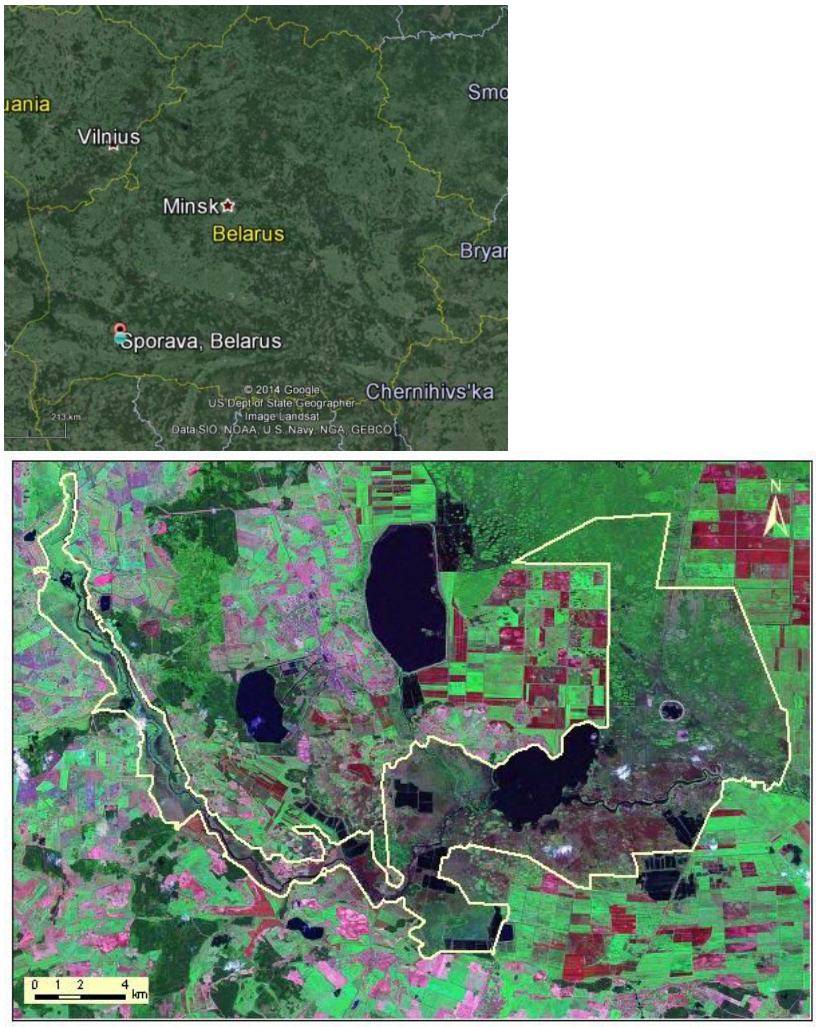


Figure 3.1 Location of Sporava mire (Google Earth; Malashevich, 2014a)

3.1.1.2 History and present main features

The area of the reserve is represented by the landscapes of ancient alluvial lowlands with wide and poorly drained floodplain and floodplain terraces complicated by lake and peat-filled depressions. First, there is a tectonic fracture in the area between such tectonic structures as Palieśsie depression in the east and Brest depression in the west which served as a pre-condition for wetland formation. Second, there is a lake-mire depression in the area of Lake Sporaúskaje formed in the postglacial period (NAS, 2009a). Thus, there are at least two factors which determined the conditions of excess wetting of the area.

The Jasieĺda floodplain, which is 0.5–2 km wide, is a typical fen mire. Lowland mires absolutely dominate the landscape occupying peaty or peaty-gleyed moderately acid soils (NAS, 2009a). A typical feature of Sporava mire is the layer of sapropel under peat which is a clear evidence of past existence of shallow lakes on this territory.

There has been developed the following scenario of Sporava mire formation:

- 13 thousand years ago the alluvial lowland was occupied by the rather stagnant shallow lake with the ongoing process of sapropel deposition. The process was rather slow due to cold weather conditions and poor mineral nutrition;
- 6.5 thousand years ago there was a blowout of the water from the lake which caused further formation of the Jasieĺda River. The ancient lake gradually became shallow and started to turn into the mire, whereas its former area turned into the Jaselda floodplain. Peat deposition has occurred since that in the floodplain (NAS, 2009a).

The mires within the reserve comprise a solid continuous tract (75% of the area) stretched along the Jasieĺda River for about 35 km (NAS, 2009a). The centre of the reserve is occupied by Lake Sporaúskaje which provides conditions for close proximity of ground water table to the soil surface.

Most of the site is covered by open fens and shrubs. There are numerous small hills and low mineral islands scattered across the mire. In the past, these mineral islands were covered by oak and pine woods. Eventually the forests were cut, and the islands were used as agricultural fields and pastures. Today most agricultural fields are abandoned and the natural vegetation is regenerating. Nowadays the hills are covered with oak, birch, black alder and ash.

Most of the site area appears to be in condition very close to the natural one, however, it is influenced by the surrounding areas which were drained for agricultural purposes and intensively used in the 1970-80s (NAS, 2009a). Around 20 years ago all the drainage system was turned off, however, the consequences of its construction continue to influence the mire.

As APB, 2009b states, before drainage the hydrological regime of the Jasieĺda River was typical of flatland rivers: every spring high floods would occur, followed by prolonged summer dry periods, regularly interrupted by rainfall. Sialiec fishfarm and a reservoir were constructed in the river floodplain (NAS, 2009a). They have seriously influenced the hydrological regime of the river. In the past, in spring the filling of the fishfarm's ponds was carried on, so spring floods were almost absent, but summer inundations have become common since in the summer the fishfarm let out the water intensively and high rains added to the flooding, thus, this caused increase in ground nesting birds' mortality. Disruptions in the hydrological regime have resulted in intense overgrowth of the river channel and the lake, severe annual inundation of the floodplain and catastrophic droughts and fires during the year. In 1991 the Sporava mire got a state protection status of a biological reserve and became 1st Ramsar site in Belarus in 1999 (NAS, 2009a).

3.1.1.3 Protection regimes

Sporava mire has the following national and international protection statuses:

- **National** – Sporaúski state biological reserve (zakaznik) established in 1991, renamed and expanded Sporaúski republican biological reserve established in 1999 (NAS, 2009a). Logo of the reserve is on Figure 3.2, showing the Aquatic Warbler as a key species;

Figure 3.2 Logo of the reserve (Wikimapia, 2014)

- **International** – Ramsar site established in 1999 (first in Belarus), Important Bird Area (IBA) established in 1998 (Ramsar, 2013a).

3.1.1.4 Area size and zoning

Sporaúski reserve has an area of 19 384 ha (NAS, 2009a). It represents a weakly disturbed part of flat Jasieĺda floodplain with ducts, oxbows and fen mires (Figure 3.3). It can be

divided into the following landscape parts: Jasieĺda floodplain, drainage canal system, Lake Sporaúskaje, open fen mires themselves.

More correct and logical zoning is division into two zones (NAS, 2009a):

- Narrow and heavily waterlogged Jasieĺda floodplain 25 km long, with the overgrown riverbed – sedges along the watercourse, further regularly flooded area of the floodplain, and typical fen mires 500-2000 m on each side of the river;
- Area of Lake Sporauskaje – greatly expanded Jasieĺda floodplain with open mires of various type and mineral islands (Figure 3.3).

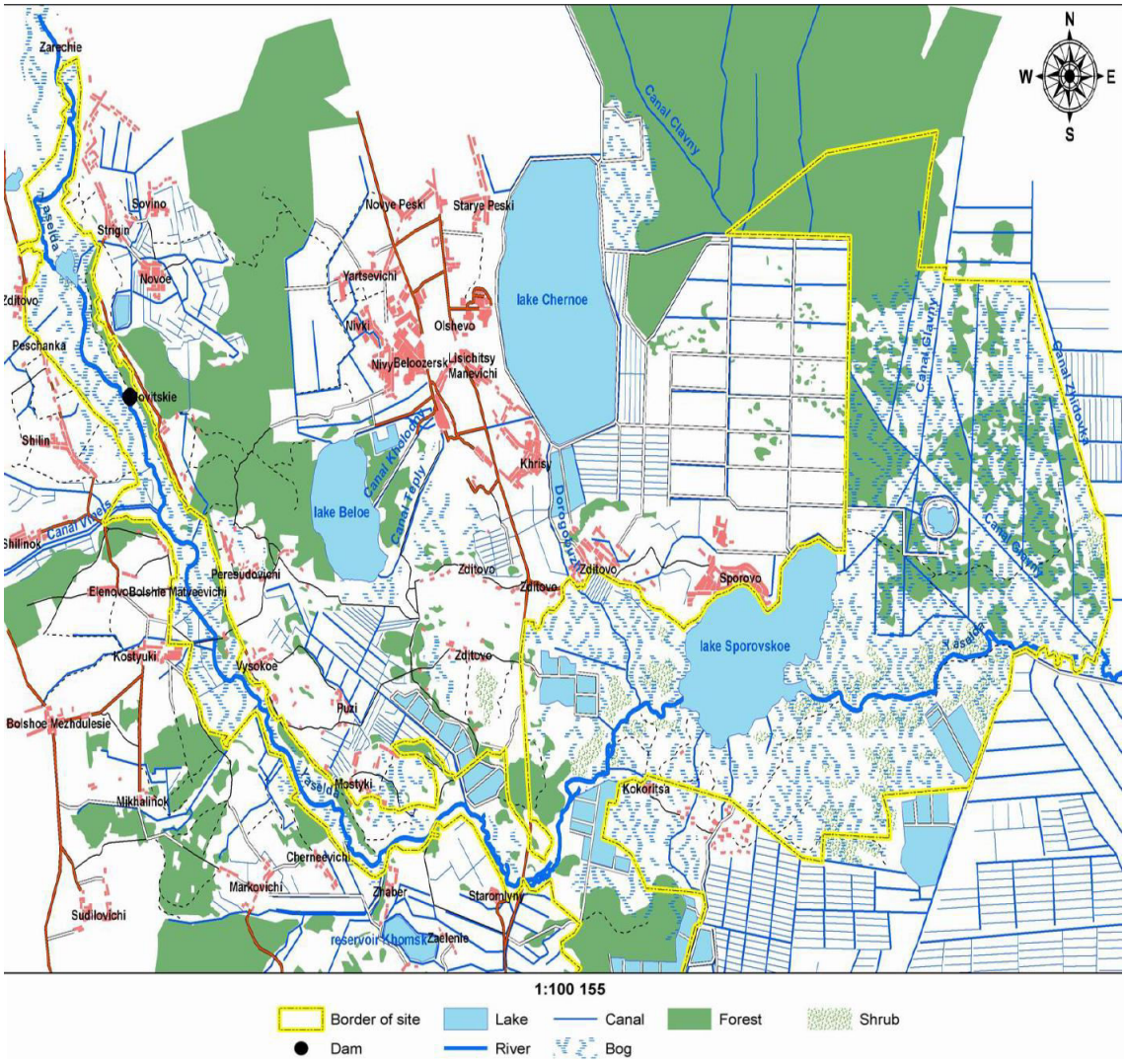


Figure 3.3 Location and boundaries of the Sporaúski reserve (Malashevich et al., 2008)

Overall area of weakly disturbed and natural ecosystem is 95 % of the reserve.

- 59.6 % of the area is covered with mires (open (40.8 %) and overgrown (18.8 %) ones);
- 24.7 % - lands covered with forest (21 %) and bushes (3.7 %);

- 4.9 % - mineral islands between mires;
- 8.9 % - underwater lands;
- 1.9 % - recultivated peat extraction (NAS, 2009a).

The open mire area has decreased by 21 % since 1955 and it is predicted that the area of open mires will decrease by 18 % by 2025 (NAS, 2009a). Full table on past and predicted transformation of landscape types is Table A2, Appendix.

Land plots and water bodies of the reserve belong to the state and are used by 27 agricultural entreprises and forestry enterprises (with the main part of the area used by the enterprises of Biaroza and Drahičyn districts (Figure A6, Appendix; NAS, 2009a).

3.1.1.5 Natural Values of Sporava mire

The main natural value of the site is represented by the fact that Sporava mire is one of the largest European habitats of the Aquatic Warbler *Acrocephalus paludicola* (Figure 3.4), a globally threatened bird species, hosting 5 % of its global population (Malashevich, 2013-2014).

Figure 3.4 Aquatic Warbler in Sporava mire (Tourist Kobrin, 2014)

Moreover, the site is unique for Europe in respect to its area and natural state of the landscapes – unique complex of mesotrophic and eutrophic fen mires characterized by high peat deposit, important function of CO2 regulation.

It is one of the largest lowland mires in Palieśsie region. It plays water regulatory role for the Jasieĺda purifying the effluents from the drained area and preventing flooding of the nearby villages and agricultural lands by water storage (NAS, 2009a).

Flora is determined by the fen mire landscape: dominant species are sedges (Acute Sedge *Carex acuta*, Tufted Sedge *Carex elata*), along the Jasieĺda watercourse there are reeds (Common Reed *Phragmites australis*) (NAS, 2009a);

Birches are dominant tree species, willows (*Salix sp*.) are also encountered in most places, both being indicators of mire overgrowth;

Rare species of orchids, e.g. *Cypripedium calceolus*, or a lady's-slipper orchid (Figure A8, Appendix), are encountered here (NAS, 2009a).

Fauna of the site is determined by the dominance of open fen mires:

- 123 bird species, among them, besides Aquatic Warbler, rare species of Corncrake *Crex Crex*, Great Snipe *Gallinago media*, Bittern *Botaurus stellaris*, Black Stork *Ciconia nigra*, Eurasian Curlew *Numenius arquata*, Short-Eared Owl *Asio flammeus*, Savi's Warlber *Locustella luscinoides*, Little Bittern *Ixobrychus minutus*, Short-toed Snake-eagle *Circaetus gallicus,* Hen Harrier *Circus cyaneus,* Lesser Spotted Eagle *Aquila pomarina,* Greater Spotted Eagle *Aquila clanga,* Black-tailed Godwit *Limosa limosa*;
- 20 mammal species, among them European Badger *Meles Meles,* Eurasian Elk *Alces Alces,* Euraisan Roe Deer *Capreolus Capreolus,* Wild Boar *Sus scrofa,* Red Fox *Vulpes vulpes,* European Hare *Lepus europaeus,* Short-tailed Weasel *Mustella erminea,* Eurasian Polecat *Mustella putorius,* European Otter *Lutra lutra,* Eurasian Beaver *Castor fiber,* Raccoon dog *Nyctereutes procyonoides.* Muskrat *Ondatra zibethica;*
- 34 fish species;
- 6 reptile species, rare European Pond Turtle *Emys orbicularis*, Sand Lizard *Lacerta agilis* and Grass Snake *Natrix Natrix* are common;
- 6 amphibian species, Moor Frog *Rana arvalis* and Common Frog *Rana temporaria* are most common (NAS, 2009a).

It is important to note that Sporava is a habitat for 48 species from the Red Data Book (NAS, 2009a).

***Cultural value of Sporava mire**

Sporava mire represents a traditional natural landscape with evidence of past life and activities of local people: earlier the typical feature of this region was "chutary" – the houses located far from each other on the mineral islands. Now the remains of these houses are traces of orchards and areas where houses were standing.

3.1.1.6 Current state: threats

As it was mentioned above, Sporava mire has suffered from drainage and intensive agricultural use of the surrounding area having caused nutrient pollution. The mire itself was not drained and represents an untouched landscape with the consequences of the actions on nearby territories which are as follows, according to UN, 2002; NAS, 2009a:

Overall change in hydrological regime of the river:

- canalization of the upper course of the Jasieĺda River from the source to the upper limits of the reserve (30% of the Jasieĺda catchment area has been drained);
- construction of the water reservoir and Sialiec fishfarm upstream of the reserve in 1977-1986 led to almost total absence of spring floods due to filling of fishfarm reservoirs, high summer inundations due to water discharge from the fishfarm, as a consequence – flooding of bird nesting sites, disappearance of rare plant species;

Table A3, Appendix shows a drastic increase of the Jasieĺda runoff before and after drainage of the 1970-80s.

Water pollution

- industrial waste and domestic sewage from Biaroza;
- agricultural affluents from cattle-breeding farms and drainage activities;
- chemical pollution from the Sialiec fishfarm;
- as a result – overgrowth of the riverbed and Lake Sporaúskaje;

Vegetation change on dry elevated hills due to ploughing and overgrazing in the past;

Overgrowth of open mires with bushes and trees (reeds, willows, birches) which results in unsuitability of these localities for Aquatic Warbler. Evidence of the indicated threats is on Figure 3.5.

Figure 3.5 Views of the mire (Malashevich, 2014b)

Vegetation burning – it needs careful planning since it can have adverse effects: when it is carried out in dry springs and upper peat layer is burnt, together with insects and plant seeds, vegetation will only regenerate in 2-3 years. On the other hand, when the areas are burnt in the winter, when there is an ice layer, only upper grassy vegetation layer burns, thus, contributing to vegetation control in the mire.

Illegal fishing and hunting (Kuklov and Dym, 2006)**.**

3.1.1.7 Management: past and present

Management of the reserve is under responsibility of Sporaúski republican biological reserve, state nature conservation enterprise created in 2005 (NAS, 2009a) as a unique result of efficient cooperation between district executive committees of Biaroza, Drahičyn, Ivacevičy, Ivanava, the Ministry of Natural Resources and Environmental Protection and APB-Birdlife Belarus non-governmental organization. 6 people now work in the administration of the reserve (Malashevich, 2013-2014).

The activities carried out in the reserve are habitat management and nature conservation, hunting, fishing, ecotourism and environmental education.

The first Management Plan was developed for 2002-2006 and efficiently implemented. The current Management Plan is for 2009-2013.

Conservation aspect

Scientific and public attention to Sporava mire was raised in 1995-1997 when Aquatic Warbler was discovered in the area by the Belarusian-German research team during their search for its nest places, with financial support of RSPB, Michael Otto Foundation (Germany) and UNDP Belarus (Kazulin and Flade, 1999). Breeding biology studies were carried out from 1998. Ringing of the Aquatic Warbler has been conducted along with this work. Since 1995 numerous studies on population development, habitat structure, breeding success, diet of the species have been conducted. It was concluded that Sporava mire was one of the 3 key breeding habitats for Aquatic Warbler in Belarus hosting 5% of its world population which at the same time was suffering a severe decline (by 90% within the last 30 years) (Kazulin and Flade, 1999) due to mire destruction by drainage and abandonment. During further research links and interactions between drainage measures and other alterations of the water regime, agricultural use, trophic level of the mires and vegetation succession were much better understood.

Since 1995 a number of projects have been implemented on on preparation of inventory on remaining sedge fen mires and AW populations in Belarus so that a fen monitoring system as well as a conservation strategy for the Prypiać floodplain could be developed. Further conservation projects have contributed to development and implementation of the reserve management plans:

- **Management planning for conservation of fen mire biodiversity in Belarus (1999-2002)** was financed by Michael Otto Foundation for Environmental Protection (Germany) and UNDP Belarus and implemented by APB-BirdLife Belarus in cooperation with the Ministry of Natural Resources and Environmental Protection – **development of Sporava Management Plan** (UNDP, 2002);

In the Management Plan all the threats were analysed and key necessary measures for the reserve set and prioritezed.

The main points of the plan 2002-2006 were as follows:

1. main objective is to establish and sustain the conditions for regeneration and support of the open mires, their vegetation and habitats of rare fauna species;
2. regeneration of hydrological regime of the mire (water regulation system on old drainage channels, control of water pollution levels);
3. development of actions for prevention of further open mire overgrowth (mechanized mowing);
4. organization of infrastructure and all the necessities for ecotourism development;
5. organization of monitoring system of water level and its quality, reserve ecosystems, density and breeding success of Aquatic Warbler;
6. raising awareness of local population on the activities conducted in the reserve, involving local people in their planning and realization, information distribution through printing materials, media;

The 2002-2006 Management Plan was implemented within **the Implementation of urgent recommendations of the management plans for key biodiversity areas in Belarus project** (UN, 2006b)**.** It is decscribed in the Habitat management section below.

- **Catalyzing sustainability of the wetland protected area system in Belarusian Palieśsie through increased management efficiency and realigned land use practices (2006-2011) – implementation of the 2006-2009 Management Plan for Sporava reserve:** construction of ecotourism facilities, rehabilitation of populations of rare and endangered species, organization of hay-mowing and bush cutting, reconstruction of ameliorative systems (Malashevich et al., 2008-2009; UNDP, 2006a; 2010a-2011a)**.**

Conservation activities within the developed management plans have been implemented in the field of complex study of mire ecosystems. This is a wide term uniting the following aspects:

- Habitat management (hydrological and vegetation management);

- Monitoring of AW numbers and distribution, breeding success and causes of nest mortality;
- Study of feeding and nutritive base evaluations;
- Study of migrations.

Each of these aspects will be analysed below by characterization of the projects carried out.

Habitat management

- ***Hydrological management***

Implementation of urgent recommendations of the management plans for key biodiversity areas in Belarus (2002-2006) (UNDP, 2006b).

According to Malashevich et al. (2008-2009); UN (2002); UNDP (2006b), the following aims were set and measures taken:

Aim 1. Optimisation of hydrological regime of the fen mire – construction of 1 sluice at Sporava mire, water operation regulations developed for Sialiec fishfarm;

Water operation regulations on water intake and discharge levels were approved in 2009. The main regimes of water use were established as follows:

- closure of reservoir sluices and accumulation of incoming water from the Jasieĺda in the reservoir only during high floods and high precipitation years to prevent floodplain flooding;
- limited letting of water from the reservoir into the floodplain in the years of low floods in April-May;
- in dry years and absence of spring floods there will be lack of water for the fishfarm and the reserve, so, plan construction of water regulation site on the river aimed at water level control and letting water into the river and the reserve through filtration of reservoir water;

Aim 2. Development of hydrological and species monitoring system to evaluate the effectiveness of taken measures – monitoring and ringing of the AW, the decline of the species was observed to have stopped even an increase in population as registered;

Aim 3. The establishment of management units for reserves – setting up Sporaúski reserve management office.

- ***Vegetation management: mowing***

20-30 years ago the mire was mown regularly by local people which has nearly stopped today. Mowing is highly important since it allows clearing the areas for new vegetation which serves as a habitat for a lot of species. However, it is impossible to restore the hand mowing tradition now, so, mechanized mowing has been implemented as an alternative within the following projects.

- **Conserving unique biological diversity of lowland mires through their sustainable use (2006-2009)** implemented by APB-Birdlife Belarus – **vegetation management at Sporava – mowing and bush removal with tractors** (Figure A10c; GEF-SGP, 2006b);

The results showed that mowing is technically possible and can be economically justified. According to Malashevich et al. (2008-2009), altogether 397 hectares of Sporava mire were mown and 30 hectares were cleared from bushes in 2006-2009. Monitoring works implemented showed positive effect of habitat management, leading to up to 3 times increase in the density of vocalizing males of the Aquatic Warbler.

- **Restoring Peatlands and Applying Concepts for Sustainable Management in Belarus – Climate Change Mitigation with Economic and Biodiversity Benefits (2008-2012) –** conducted by APB-BirdLife Belarus, RSPB, the Michael Succow Foundation in cooperation with the Government of Belarus and UNDP Belarus (Restoring peatlands, 2010b).

As Malashevich (2011) states, innovative and highly efficient caterpillar mowing device (ratrac) was specially adopted for working under mire conditions (Figure A9a, Appendix). The staff was hired and trained from the local population. Mowing has been conducted regularly since 2011, during suitable weather conditions, except for a nesting season. Since 2011 ca. 400 ha were mown (Malashevich, 2013-2014).

As Malashevichv (2013) states, due to mowing the habitat suitability improved, since a thick layer of dry vegetation was removed and the area was partially cleaned from bushes (Figure A9b, Appendix). Partial removal of bushes was caused by a technical problem with the mowing device. There was no increase in AW numbers registered in 2012 for all 3 mown localities. This goes in line with the recent study on habitat productivity performed in Biebrza National Park, Poland. Following the study, AW population increase was registered starting only with the second year after mowing.

Rare plant species rehabilitation

According to UNDP (2011b; 2006a), his measure was carried out within the project on **Catalyzing sustainability of the wetland protected area system in Belarusian Palieśsie through increased management efficiency and realigned land use practices (2006-2011).**

Lady Bell flower, or *Adenophora lilfolia* rehabilitation was performed by the staff of the Central Botanic Garden of the National Academy of Sciences of the Republic of Belarus. The seedlings were grown with the use of cellular engineering techniques and by genotype are identical to the plants of the species inhabiting the territory of Belarus. For Belarus this is an innovative experience on reintroduction of rare plant species with the objective to establish a

new sustainable population in natural habitats. Schoolers from the nearby Zdzitava village participated in planting of the around 1000 sprouts.

At present *Adenophora lilifolia* can be found in the Belarusian Palieśsie mainly in semi-open areas with sparse broad-leaved forest or in bushes with sparse growth of oak in floodplains of large rivers. The total number of *Adenophora lilifolia* is not more than 300 plants.

- ***Monitoring of AW numbers and distribution***

Aquatic Warbler monitoring in Belarus project (2002 – up to now) – habitat management, monitoring of Aquatic Warbler numbers and distribution, Aquatic Warbler counts in Sporava, Zvaniec and Dzikoje sites, study of migrations (Ministry, 2006; Malashevich, 2012). Research of Aquatic Warbler breeding habitats in Belarus started in 1995. Since then monitoring of breeding mechanisms, distribution and optimal water level for breeding was conducted. The project will be described in detail in Chapter 3.1.4 of the dissertation.

- ***Sporava Caretakers' Network***

The project "Creation of caretakers' network on the key Belarusian wetlands" was initiated by APB-Birdlife Belarus with the help of its members and financial support of foreign partners (APB, 2010a). The network of the caretakers is a voluntary community of local people responsible for monitoring of Important Bird Areas, their state and reporting to the nature conservation entities (APB, regional branches of the Ministry of Natural Resources and Environmental Protection) about threats, change in numbers of key bird species, their habitats, environmental education of local population (APB, 2014).

Sporava's caretakers have produced a lot of efficient results: participation in Aquatic Warbler counts, reporting about the threats for the mire.

Development aspect (education, tourism)

Tourism and environmental education are seen as priorities for future reserve development. The following facilities and events already exist (Tourisitc Brest, 2014a; Biaroza, 2014):

- visitor centre next to the mire itself with accommodation facilities (9 places) including facilities for the disabled, maps of the reserve routes, printed materials for visitors (maps, booklets) (Figure A11, Appendix);
- accommodation facilities at the nearby agricultural farmsteads;
- equipped pedestrian trail with 2 observation points next to the visitor centre, a campsite next to the Jasieĺda River, ferry crossing (Figure A12, Appendix);

- 4 more ecological trails (water, pedestrian, bike and mixed ones) developed and planned to be equipped (Figures A7, A13, Appendix);
- organization of various excursions;
- rental of boats, bikes, tourist equipment (tents, sleeping bags).

These actions were brought to life within the following projects:

- **Creation of conditions for the development of eco-tourism at the Republican Biological Reserve "Sporaúski" (Biaroza district) with the minimal environmental impact (2008-2009) –** construction of ecological trails for tourists and schoolchildren, organization of environmental activities for raising public awareness, organization of open championship on hay mowing (GEF-SGP, 2008a);
- **Catalyzing sustainability of the wetland protected area system in Belarusian Palieśsie through increased management efficiency and realigned land use practices (2006-2011)** – construction of ecotourism facilities, documentary shooting (UNDP, 2010a-2011a).

However, the timetable of the centre requires prebooking of the visit and does not guarantee the centre will be opened when the visitors come which decreases attractiveness of Sporaúski. Furthermore, there is a lack of direction posts for visitors. Moreover, there is not a web-site of the reserve although there is much information on the Internet (in particular, on the web-sites of Brest region executive committee, Biaroza local executive committee, Brest region touristm web-site, free of charge deal.by) since the reserve is known because of the AW conservation and promoted in the mass media reports. Belarusian and foreign scientists, birdwatchers, students visit Sporava for their research, participation in the volunteer camps on AW counts. There are school excursions and various educational activities for local schools organized in the reserve. Still, the information on Sporava for foreign tourists is almost absent on the Internet. Those foreigners who come to the reserve are either from nature conservation field or birdwatchers who got information from their friends in this field. However, the author encountered 3 links to the British sites on organization of bird tours where Sporava mire was included as a visit site (Naturalist and Limosa, 2014). The number of visitors (both national and foreign) of Sporava mire is growing judging by the 2011-2013 results shown in Table 3.1:

Table 3.1 Number of visitors of Sporaúski reserve (2011-2013) (Malashevich, 2013-2014)

Number of visitors/excursions	2011	2012	2013
Belarusian	1104	1798	2138
Foreign	121	196	189
Total	1225	1994	2327

It is important to note that a visit to the reserve can be combined with cultural tourism activities: destinations nearby – museums of traditional arts in the villages fortress remains, remains of the monastery.

Unfortunately, among all the services offered, the reserve can also organize foreign hunting tours which is seen as an unacceptable service type for the reserve. Moreover, the consequences of these hunting tours often show that these activities are done without any environmental analysis.

Raising awareness about the unique fen mire habitats through environmental education and tourism

- to raise public awareness about the necessity for conservation of Sporava mire and prevention of open mire overgrowth, in 2007 there was organized a national hand mowing championship called "Sporaúskija sienakosy" (Sporaúskija haymakings) which is now held annually attracting lots of participants and visitors (Figure A14, Appendix). The winner participates in the European hand mowing championship in Poland (Biebrzha National Park) (Brovach, 2013);
- there is an annual festival in the Sporava village called Sporaúskiaja žarty, meaning Sporava jokes, a festival of traditional local humour (Figure A15, Appendix; Viachorka, 2013).

Local people are enthusiastic and represent a good basis for sustainable development of their villages and the reserve.

3.1.1.8 What needs to be done and what is planned

Sporaúski reserve has shown a good progress in the recent years both in conservation and development field. The initiatives planned for the future are as follows:

- already launched **Clima East project "Conservation and sustainable management of peatlands in Belarus to minimize carbon emissions and help ecosystems to adapt to climate change" (2014-2020) –** aimed at restoration of Sporava fen mire by mechanized mowing and collecting and use of biomass for fuel briquette production (BELTA, 2013: ClimaEast, 2014;)
- pedestrian trail next to the visitor centre is being equipped for the disabled, the number of visitors is planned to be increased by this measure;

- 4 ecological trails to be equipped for visitors, direction posts to be set, map of the routes will be provided for visitors;
- there is a plan to be further developed an existing cycling route around 3 lakes so that the bikes could be rented and returned at any specially equipped point of the route;
- the accommodation part of the visitor centre is being reconstructed for 5 rooms/8 visitors;
- photoelectrical station is to be constructed in 2014 so that the reserve could provide itself with energy and get revenues from its sale for nature conservation activities (implemented within the project of SGP/GEF and local environmental fund) (Viachorka,2014);
- creation of a training centre on bioresources and alternative energy within the above mentioned project (Viachorka, 2014);
- continuation of mechanized mowing.

What is good, cooperation between the reserve administration, local executive committees, APB-Birdlife Belarus, UNDP Belarus, foreign partners has been established thoroughly and is to be continued with success.

3.1.1.9 Water quality and peat analysis

Data and detailed reults of the water quality and peat analysis are in Chapter 3.1.1 of Appendix.

Elevated values of the nutrients in the Jasieĺda River near Sporava mire, high levels of sewage discharge into the river. Peat ph values are in the normal range for fen mires (5.6). Peat is weakly decomposed (von Post decomposition index is h4).

3.1.1.10 Wetland condition analysis

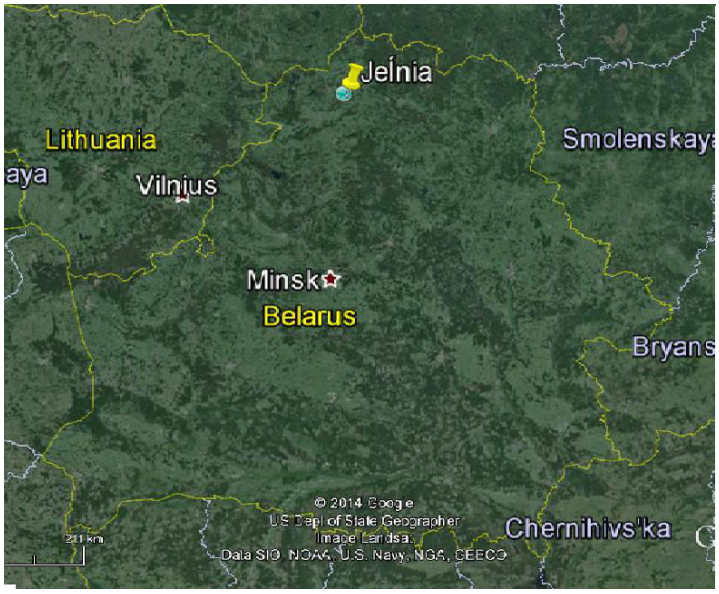
The table of evaluation is located in Chapter 3.1.1 of Appendix. The overall result obtained for Sporava mire is 19.33 out of 25 which is a rather high value and evidence of close-to-natural state of the mire with the consequences of drainage of the surrounding areas.

3.1.2 Jeĺnia bog

3.1.2.1 Location

One of the largest peat bogs in a state close-to-natural in Belarus and Europe, with multiple lakes (around 100).

Jeĺnia is situated in Northwest Belarus, in Viciebsk region, the districts of Mijory and Šarkaúščyna (Figure 3.6). The nearest point is the city of Mijory. The bog belongs to the basin of the Western Dźvina River, Baltic Sea basin (Kozulin et al., 2012).



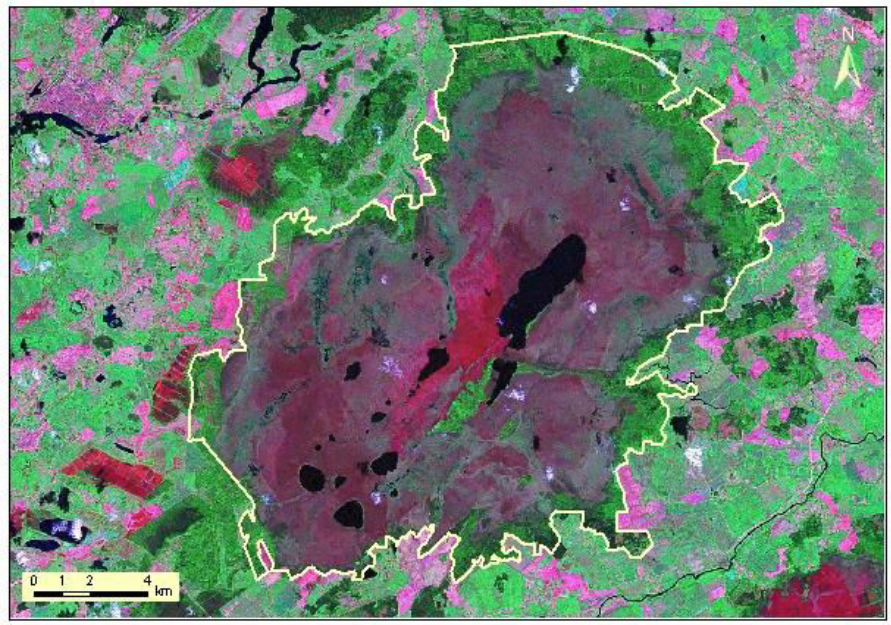


Figure 3.6 Location of Jeĺnia bog (Google Earth; Malashevich, 2014a)

3.1.2.2 History and present main features

As Kozulin et al., 2012 states, Jeĺnia peatbog was formed in the lowest part of Polack lowland (a result of postglacier lake existence here) with the basis of clay, rainwater gathering in the narrow hollows and forming shallow lakes which then caused start of moss layer formation and deposit of moss peat. Wetland formation process began to cover larger and larger areas of dry lands of coniferous forest. Frequent forest fires contributed to the process. Moreover, poor mineral nutrition determined mainly rainwater feeding of the area, thus, the bog formation. The process has taken 8200-9000 years (Kozulin et al., 2012), thus, it started a long time ago.

The Western Dźvina River provides substantial part of the bog drainage through the system of its affluents. Lakes of the bog are connected with the basin by the drainage canals system and the small rivers.

The water level regime of raised bogs depends on: the precipitation regime, evaporation of water, water runoff from the bog, mire type, composition, and relief. Raised bog landscapes are characterized by: the spring maximum level coinciding with the maximum snowmelt; the summer minimum level resulting from increased evaporation from the bog surface; the fall increase of the level as a result of higher precipitation and lower evaporation; and the winter gradual decline of the level over the period between fall and spring owing to water runoff from the mire and lack of water inflow due to precipitation.

Most of the bog is overgrown with low pines, but there are also significant open spaces with multiple small lakes and open water bodies. The core of the bog is a peat deposit covering 90 % of the reserve (Table A4, Appendix). Peat layer depth is 3.8 m on average, maximum of 8.3 m (Kozulin et al., 2012).

There are multiple mineral islands in the area of the bog covered with fir-trees and small-leaved forest. The Jeĺnia bog has traditionally been used by local people to gather cranberries *Oxycoccus palustris* (Figure A18, Appendix).

In 1957–1959, before the establishment of the reserve, a network of drainage canals and ditches was constructed in the eastern part of the bog (Kozulin et al., 2012). It was constructed to facilitate peat extraction. Despite the fact that no peat extraction was subsequently carried out here, the drainage network was causing a significant negative influence on the site. By now the canals and ditches have overgrown with vegetation, but they continue to impact the mire in a negative way.

The drainage implied straightening of the Jeĺnia rivers and construction of the channels which caused serious disturbance of the hydrological regime of the raised bog: canal system started

in the centre of the bog and went further through the lakes to the peripheral zones where the water was further processed into the drainage system. As a result, water table fell up to 1m below the ground, dry peats started to mineralize and produce CO2 emissions. Hydrological characteristics of peat have changed: water did not accumulate in peat, it just flowed away. Moreover, the site became prone to fires, occurring regularly, with the most destructive ones in 1998 and 2002, with almost 70 % of the bog suffered (Figure A17, Appendix).

The consequences are clearly visible: vegetation transformation – Pine *Pinus sylvestris* disappearance in exchange for spread of European White Birch *Betula pubescens*, Silver birch *Betula pendula* and Aspen *Populus tremula*, Common heather *Calluna vulgaris* domination among shrubs, cranberries endangered (Figure A16, Appendix). What is more, decrease of the groundwater level has been observed but, thanks to the dam construction projects since 2002, it has regenerated to a great extent. The groundwater level typical of the bog and set as the aim to be reached is next to the surface level with small seasonal differences (Thiele, 2013).

According to Tanavickaja, 2012b, the most disturbed areas are the ones in the centre and in the south of the bog, in the areas of drainage canals and lakes. Natural peat bogs cover mostly northern part of the bog and do not need any conservation measures (Figure A20, Appendix). The reserve was established here in 1968 with the status of the republican hydrological reserve and transformed into the landscape one in 2007 (Kozulin et al., 2012).

3.1.2.3 Protection regimes

Jeĺnia bog has the following national and international protection statuses:

- **National** – Republican landscape reserve, established in 1968 as a hydrological reserve, transformed in 2007 (Kozulin et al., 2012);

The logo of the reserve (Figure 3.7) has the Arctic Loon on it, only 2 pairs of this rare bird are encountered in the bog.

Figure 3.7 Logo of the reserve (Jeĺnia reserve, 2014)

- **International** – Ramsar site established in 2002, Important Bird Area established in 1998, Important botanical site established in 2005 (Kozulin et al., 2012).

3.1.2.4 Area size and zoning

According to Kozulin et al. (2012), Jeĺnia reserve has an area of 25301 ha (Figure 3.8).

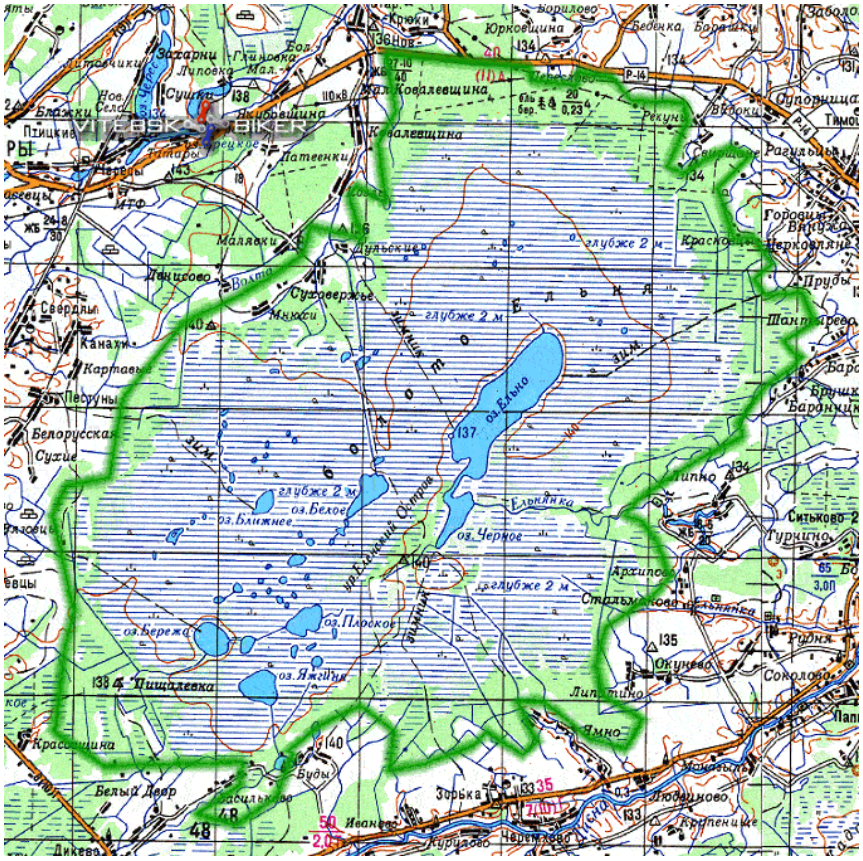


Figure 3.8 Map of the bog (Viciebskbiker, 2014)

The bogs cover 66 % of the reserve area, 24 % - forested lands, 6 % - low forests and shrubs. It is important to note that 50% of the reserve is covered with bogs which suffered from fires (Kozulin et al., 2012). See Table A5, Appendix on transformation of landscape types of the bog.

The land plots and water bodies of the reserve belong to the state: the user of land plots and water bodies is Dzisna forestry entreprise (Mijory, Dzisna, Hiermanaviči forestry sections), the tenants are Šarkaúščyna and Mijory district divisions of the Belarusian Society of Hunters and Fishermen, Absterna Ltd (Figures A19, Appendix; Kozulin et al., 2012).

3.1.2.5 Natural Values of Jeĺnia peatbog

First of all, Jeĺnia is one of the largest near-natural raised bogs in Europe (views of the bog are on Figure A25, Appendix)**.**

Second, the bog is an important stop-over site for semi-aquatic bird species, such as Cranes (around 4000) and Geese (9000-12000 annually) (Figure A21-A22, Appendix), globally threatened species of Lesser White-fronted Goose *Anser erythropus* breeds here (40-50 pairs in Europe), only 2 pairs of Arctic Loon *Gavia arctica* (Figure A23, Appendix) (Kozulin et al., 2012).

The bog is an IBA due to 150-200 pairs of Black Grouse *Tetrao tetrix*, 60 pairs of Common Crane *Grus grus*, and 50 pairs of Short-Eared Owl *Asio flammeus* (Kozulin et al., 2012).

What is more, Jeĺnia is known for its unique paludal plant communities of a south taiga type (upland oak communities, ash, linden formations, old aspen and alder formations, open bogs, cranberries and cowberries communities) and rare and endangered flora species (Dwarf Birch *Betula nana*, Small-fruited Cranberry *Oxicoccus microcarpus*, Blushing Bog-moss *Sphagnum molle*, Cloudberry *Rubus chamaemorus*, Swamp Willow *Salix myrtilloides* etc.) (Kozulin et al., 2012).

Flora is dominated by 11 species of Sphagnum and Common Sundew *Drosera rotundifolia* (Figure A24, Appendix), and now well spread "thanks" to the drainage species of Birch *Betula sp*, Willow *Salix sp,* Sheathed Cottonsedge *Eriophorum vaginatum*, Common Heather *Calluna vulgaris* (Kozulin et al., 2012).

Common Cranberry *Oxycoccus palustris* has seriously suffered as a result of forest fires but now is regenerating.

Fauna:

- 31 mammal species, Wild Boar *Sus scrofa*, Eurasian Elk *Alces alces*, European Red Fox *Vulpes vulpes*, European Otter *Lutra lutra*, European Beaver *Castor fiber*, European Badger *Meles meles*, European Hare *Lepus europaeus,* Short-tailed Weasel *Mustella erminea,* Raccoon dog *Nyctereutes procyonoides,* Snow Hare *Lepus timidus*;
- 150 bird species, nesting site for Arctic Loon *Gavia arctica*, Willow Grouse *Lagopus lagopus* (Figure A26, Appendix), European Golden Plover *Pluvialis apricaria*, Jack Snipe *Lymnocryptes minimus*, Whimbrel *Numenius phaeopus*, Common Greenshank *Tringa nebularia*, Black Stork *Ciconia nigra*, White-Tailed Eagle *Haliaeetus albicilla*, Short-toed Snake-eagle *Circaetus gallicus*, Black Kite *Milvus Migrans*, Osprey *Pandion haliaetus*, Golden Eagle *Aquila chrysaetos*, Lesser Spotted Eagle *Aquila pomarina*;
- 5 reptile species, large population of Common European Viper *Vipera berus* (Figure A27, Appendix);
- 7 amphibian species (Kozulin et al., 2012).

3.1.2.6 Current state: threats

There can be indicated the following disturbing factors which currently act as threats to the bog;

- unregulated harvesting of wild berries and mushrooms as a disturbance factor;
- intensive hunting and fishing: hunting for waterfowl species is prohibited during spring nesting and breeding season, but during the rest of the year the birds are disturbed;

Recently there has been made a series of photos compiled in one Facebook post on fishing attractiveness in the reserve. It could be more efficient to promote the site from the point of view of unique biodiversity;

- unsustainable forest management – cutting of indigenous communities of pines, fir-trees, their replacement by birches and willows;
- use of cross-country vehicles which destroy vegetation and upper layer delicate peat soils;
- local pollution with household waste from the nearby villages.

Views of the bog are shown on Figure 3.9.

Figure 3.9 Views of the bog (Malashevich, 2014b)

3.1.2.7 Management: past and present

Management of the reserve is a responisiblity of the Jeĺnia nature conservation state enterprise created in 2006 with a team of 3 people, Šarkaúščyna and Mijory district executive committees who work in cooperation with various nature conservation entities (Kozulin et al., 2012; Malashevich, 2013-2014).

The first Management Plan was developed in 2008 for a 5-year period by the National Academy of Sciences of Belarus (Kozulin, 2008). The current Management Plan is for 2012-2016 (Kozulin et al., 2012).

Main priorities of the plan are as follows (Kozulin et al., 2012):

- restoration of hydrological regime of the bog;
- organization of forest management aimed at biodiversity conservation;
- preparation of recommendations on optimizing amateur fishing in the reserve to minimize the impact of the disturbance factor on nesting birds;
- organization of ecological tourism and environmental education: developing tours of the reserve and surrounding areas taking into account biodiversity inventory data; developing and building special causeways for mechanical vehicles (cross-country vehicles) for tourist and other (scientific, fire fighting, and monitoring) purposes; creating the infrastructure for ecotourism development;
- organize an awareness-raising campaign to inform the population about the nature conservation value of the reserve, its conservation and use regimes;

- preparation of proposals on organizing sustainable use of the major bog resource, i.e. cranberries, and its processing in the district;
- putting in place a system of monitoring water levels and quality on the territory of the reserve, its flora and plant communities, biotopes, bird population, and entomofauna to assess the status of bog ecosystems and efficiency of the Management Plan implementation.

Conservation aspect

Scientific research on the Jeĺnia bog has been conducted for the last 20 years by various institutions. Since 1999 there have been a number of conservation projects on dam construction implemented in the reserve.

- **Restoration of hydrological regime of the Jeĺnia peatbog (1992-2002, 2008-2012)** (GEF-SGP, 2008c) **-** construction of 48 dams (Levy, 2010) on the drainage canals which allowed to raise groundwater level, stimulate conditions for restoration of native flora/fauna, prevent the bog from fires, and even stop decrease of Black Grouse populations. The project was implemented with the help of foreign and Belarusian volunteers, local community members during "Let's save Jeĺnia together" volunteer camps organized for this objective, and by Mijory construction service. Simple design and local materials (burnt tree trunks, peat) have been used for construction which made the process easy and low-cost (Figures A28-A30, Appendix; Shajkin and Levy, 2010). First, in 1999-2002, 17 dams were constructed in the peripheral part of the bog which still could not decrease the water level in the centre of the bog. In 2007-2009 the dams were built in the central part to block the canals there (Levy, 2010).

What is more, several sensors for measurement of groundwater level, water quality characteristics (mineralization, temperature, acidity, dissolved oxygen) have been located in the bog and provide a lot of useful information for monitoring its regime (Tanavickaja, 2012a).

The constructed dams have been checked for their efficiency in spring 2012 (Tanavickaja, 2012a). The process of bog restoration is very slow and needs time. There are already positive results of the dam construction judging by the survey of all the dams functioning conducted in May 2012:

- ✓ canals have started covering with Sphagnum moss;
- ✓ water has started accumulating and its level has raised 30-50 cm up;
- ✓ 40 dams carry out their function to greater or lesser extent;

- ✓ 8 dams have been damaged or formed new watercourses (Tanavickaja, 2012a).

As a result of a more than 10-year experience of dam construction on the Jeĺnia bog and the latest analysis of dams there were made the following conclusions on the construction techniques that could be used in the future (Tanavickaja, 2012a):

- ✓ dams should be constructed so that their level could be 30 cm higher than maximum level of spring floods;
- ✓ managed wrapping should be planned so that washout of additional watercourse is prevented;
- ✓ planning of soil dams built with excavators so that runoff is completely blocked;
- ✓ monitoring of the restoration processes is needed, the main expected effects are Sphagnum moss growth along the canals, peat adaptation to natural conditions again and restoration of its CO2 accumulation function.

- **Support to the development of a comprehensive framework for international environmental cooperation in the Republic of Belarus (2011-2014):**
  - ✓ the management plan of 2008 was reviewed and updated in 2012, mainly in the section concerning the hydrological regime restoration;
  - ✓ habitat analysis was conducted and new habitats of rare species found;
  - ✓ in May 2012 the reserve was supplied with cross-country vehicles, water monitoring set for inspecting of the bog and monitoring of its hydrological regime, fauna and flora (Figure A31, Appendix; UNDP, 2013).

- **Jeĺnia Caretakers' network**

Jeĺnia Caretakers' network was planned to be for monitoring the changes brought about by the dam construction, evaluating state of the dams, watching the activities carried out in the reserve with the aim of reporting in case of illegal hunting, fishing, or other negative human actions. Seminars and workshops were developed for the caretakers so that they could be well-informed about the current environmental legislation, strategies and plans for nature conservation field in Belarus.

According to UNDP, 2014, the caretakers of the Jeĺnia mire participate in the restoration of hydrological regime of the mire, monitor the state of dams and if necessary perform their routine repairs. Not less than a half of volunteers, engaged in construction of dams, are local citizens. In addition to that, 6 caretakers from Mijory and Šarkaŭščyna districts have become public inspectors, which has institutionalized their connection with territorial bodies (Inspections) of the Ministry of Natural Resources and Environmental Protection.

The initiatives supported by the caretakers on the Jeĺnia bog are annual counts of Common Crane, dam construction (APB, 2014), installation of information boards in the reserve (Figure A32, Appendix; APB, 2010a), assigning public inspectors for nature conservation from the caretakers' network (APB, 2010b), cooperation with the reserve administration in reporting about threats and illegal actions.

- **Counts of Black Grouse and Willow Grouse in 2012** (Lundyshev, 2012)

Counts (166-469 Black Grouse and 85 Willow Grouse) and analysis of these 2 species distribution in the Jeĺnia bog have shown that they both face a number of problems caused both by the change in the hydrological regime of the bog and by unregulated human activities (fishing): the species of Raccoon dog and Red Fox have decreased their population, disturbance of the birds in the period of cranberries harvest and fishing activities with dogs, winters without snow and Willow Grouse deaths due to this factor.

Development aspect

From the point of view of ecotourism potential Jeĺnia bog has a limited access for tourists (bad roads, few villages and cities nearby, forests difficult to access, areas suffered from fires) and a low level of maximum acceptable concentration of visitors since bog landscape conservation requires regulation of disturbance level. Thus, ecotourism activities in the reserve can not be aimed at mass tourism. Fortunately, ecotourism itself is a concept which requires limited number of tourist visits. The reserve has gone through successful improvements in ecotourism development, thanks to the EU/UNDP project and the festival "Cranes and cranberries of Mijory land" (UNDP, 2013) organized in 2012. All these factors increased the visitors interest in the reserve. Accommodation services in the Mijory city and agricultural farmsteads have seen a rise in their profits.

The number of visitors of the reserve in 2008-2014 is shown in Table 3.2.

Table 3.2 Number of visitors of the Jeĺnia reserve in 2008-2013 (Borok, 2012-2014)

Number of visitors	2008	2009	2010	2011	2012	2013	2014 jan-april
Belarusian	78	60	53	65	76	289	202
Foreign	22	14	15	2	10	62	17
Total	100	74	68	67	86	351	219

The numbers show the ongoing rise of the reserve popularity among both Belarusian and foreign tourists. Two big tourist groups from Germany and Finland visited the reserve in 2013.

According to Dobrovolskij and Markevich, 2013, within the project on **Support to the development of a comprehensive framework for international environmental cooperation in the Republic of Belarus (2011-2013)** there have been completed the following tasks in the area of ecotourism development*:*

- ecological visit-centre in the reserve opened in September 2013, its specific feature is its distant location from the bog itself which requires proper planning of its functions for visitors: interactive information boards are set in the centre, in Belarusian, English and Russian (Figures A34-A35, Appendix);
- tourist equipment has been provided: tents, sleeping bags, boats, bikes, skis, snowshoes, binoculars, compasses, it all can be rented at a very low price;
- ecological trail Azieraúki started to be constructed and equipped for tourists: 1.5 km, a pedestrian trail with a wooden flooring, 2 hours' walk, mostly through the bog (Figure A36, Appendix);

So far, 500 m of the trail has been constructed (Natural Pearls, 2013a);

- information boards provided, observation point and observation platforms constructed (Figures A37-A38, Appendix);
- promotional videos have been shot in English, Belarusian and Russian (Chapter 3.1.2, Appendix);
- there has been efficient promotion of the reserve on its Facebook page: descriptive photos are placed there regularly (Jeĺnia, 2014);
- as Matvejeva, 2013 states, starting from September 2012, there has been annualy organized an ecological festival called "Cranes and cranberries of Mijory land" which concentrates on culinary part of various dishes based on cranberries, traditionally collected in the area (drinks, pastry, sausages). Observations of migrating Cranes are also carried out during the festival. The festival became a good promotional event for the reserve (Figure A39, Appendix);
- ecological festivals, seminars held regularly and devoted to various events, e.g. World Wetlands Day 2014 festival fo school pupils, Felting souvenirs seminar (Natural Pearls, 2013b; Jeĺnia reserve, 2014);

- starting from 2013 one agricultural farmstead near the reserve offers photo shooting of the Common Crane *Grus Grus* from specially equipped hiding places (Figure A40, Appendix; Kozlovskij, 2013);
- there was developed a business-plan of the new company on collecting and processing of wild berries and mushrooms (mainly cranberries, blueberries, and mushrooms), the company called Mijorskija jahady (Mijory berries) was registered in October 2012: aimed at sustainable use of local resources by involving local people and getting economic profit from abundant local resources.

Among the tourist facilities of the reserve the following ones can be noted:

- in May 2013 there was tested a new service of "Through the bog on snowshoes": snowshoes are an equipment for the bog visit, there is a possibility of excursions prebooking and participation in planned visits (Figure A41, Appendix; Natural Pearls, 2013c);
- guide services, prebooked, cost 1 euro per person per hour for Belarusian tourists, and 2.5 euros for foreigners. Excursions can be pedestrian (along the trail), on the snowshoes, skis (Natural Pearls, 2014);
- 5 enthomological routes developed in the reserve (Natural Pearls, 2014);
- there are recommendations of RSPB specialists on organization of school excursions and visitor groups division (Chapter 3.1.2, Appendix; Cooper, 2012);
- accommodation is not provided by the reserve but there are good options of accommodation in the city of Mijory (2 hotels), Dzisna (1 hotel), however, they are located far from the destination, catering is not provided on a regular basis, the restaurants and cafes may be closed at the time of arrival;
- there is a web-page of the reserve on the web-site of Viciebsk region reserves, both in Russian and in English, but the English version is incomplete;
- there is a possibility for foreign tourists to find the reserve on the Internet (English version of the news, Facebook page).

Environmental education is also a priority for the Jeĺnia reserve: organization of key events for adults and schoolers – International Migratory Bird Day, the above mentioned festival Cranes and Cranberries of Mijory land, World Wetlands Day (Natural Pearls, 2013b);

Thus, there are many positive trends about the reserve activities, whereas, there are negative aspects – possibility of all the activities being at stake after the end of the funding project, insufficient promotion of the site among national ad international tourists, lack of infrastructure.

3.1.2.8 What needs to be done and what is planned

What needs to be done

The following measures need to be taken to improve the nature conservation and ecotourism/education performance of the Jeĺnia reserve:

- promotion of the reserve both for Belarusian and foreign tourists. Although information about the site is spread through the word of mouth in the birdwatching and nature conservation community, the reserve can be promoted among the general ecotourism travelers on the Internet;
- promotion through the commercial in English and a short movie since now they are not easily to find on the Internet;
- plan of ecotourism development and plan of work with visitors needs to be developed;
- a series of information boards have been developed, each devoted to a certain aspect: Cranberry – bog berry, Dragonflies of the bog, Birds of the bog, Do you know trees, Sphagnum and its characteristics. Judging by the design already planned, they seem to be very modern from the point of view of environmental education. There are also planned interactive games with both children and adults: Why we need bogs, Willow grouse and goshawk (Lundyshev, 2012);
- there is a possibility and potential in combining Jeĺnia ecotourism resources and routes with other protected areas (Braslavy Lakes, Bielaviežskaja Pušča) so that complex tours could be possible. What is more, ecological tourism can be combined with cultural heritage of the area.

What is planned

The future plans are listed below in Table 3.3, according to the current Management Plan 2012-2016 and other sources (Kozulin et al., 2012; Jeĺnia reserve, 2014).

Table 3.3 Plans of the reserve

Conservation	**Development**
installation of man-made bird boxes and regulation of the number of certain species (Raccoon dog, American mink)	finishing the Azeraúki ecological trail; a second ecological trail to be constructed
Project on fire prevention – construction of 20 artificial reservoirs is planned on the peripheral	webcams installation – live version of the reserve, shooting a movie as a result

part of the bog so that water could be transported fast in case of fire, repairs of 60 km of roads, construction of 20 km of new ones (Mshar, 2012)	
additional activities to restore the hydrological regime of the Jeĺnia bog	improvement of infrastructure for ecotourism development (tourist trails, watch towers, special causeways, buying equipment, programs and a promotion plan)
forest management by *Dzisna Forestry Enterprise* in accordance with the new Regulations on the Jeĺnia reserve	preparing and publishing brochures, postcards, guidebooks, calendars, etc
start of the cranberry's company work	installing signs giving directions and other information, billboards
ensuring sustainable hunting (regulating fall hunting at sites of day stop-over and feeding of migratory birds, optimization of no-take zones)	organization of tracking animals as ecotourism activity
setting amateur fishing regimes at certain lakes	
preparation of plant/animal habitat certificates and transferring them to land users for conservation	
comprehensive monitoring of the ecosystems	

3.1.2.9 Water quality and peat analysis

Tha data and detailed results of thewater quality and peat analysis are located in Chapter 3.1.2, Appendix.

Hydrochemical parameters are in the normal range typical of Belarusian bogs (low mineralization, low conductivity, strongly acidic). Water ph values are their highest limit.

Groundwater levels have increased to normal levels on the edges of the bog and are gradually increasing in the centre.

Peat ph values are in the normal range for bogs (2.99). Von Post Decomposition Index is H1 (undecomposed peat) for the undisturbed parts of the bog, H4-H5 for the disturtbed ones which is still a normal result.

3.1.2.10 Wetland condition analysis

The Table of evaluation is located in Appendix. The overall result obtained for the Jeĺnia bog is 19.67 out of 25 which is a rather high value showing the high percentage of natural bog areas and efficient work on restoration of the hydrological regime.

3.1.3 Zvaniec mire

3.1.3.1 Location

Zvaniec mire is the largest European mesotrophic fen mire, diversified by small mineral islands scattered over the area and covered by forests and shrubs. Located in southwestern Belarus, Brest region, Drahičyn and Kobryn districts, 17 km south-east of Drahičyn, to the south of the Dniapro-Buh canal, Black Sea basin (Figure 3.10). The site borders the Dniapro-Buh Canal (DBC) in the North, Bielaaziorsk Canal in the East, bypass canals of the Arechaúski and Krasny Partyzan agricultural entreprises' drainage systems in the South, Arechaúski Canal in the West (NAS, 2009b).

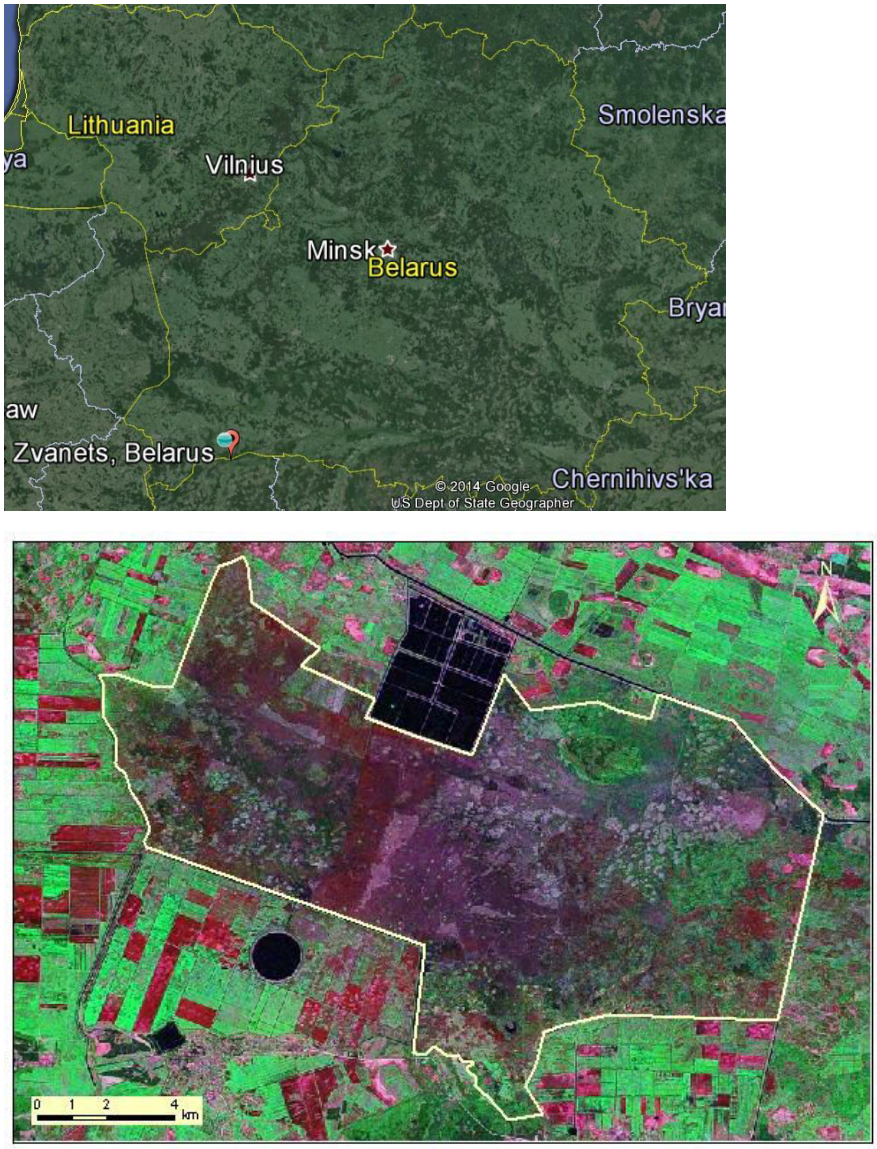


Figure 3.10 Location of Zvaniec mire (Google Earth; Malashevich, 2014a)

3.1.3.2 History and present main features

As NAS, 2009b states, Zvaniec mire, lake-alluvial plain, part of Palieśsie lowland, started to form 4.5 thousand years ago as a result of melting of the Dniepr glacier and erosion processes caused by icy water flows. The resulting depression was getting filled with water. Further warming up of the climate made sedimentation with silty and sandy matter a regular process. Glacier retreat caused water outflow, the former lake was gradually getting filled with rich matter brought by rivers from the plain, its size was shrinking and it continued its existence only as a waterlogged plain. Thanks to closeness and abundance of groundwater layer, waterlogging and peat accumulation started in the deepest depressions, the area covering with hypnum moss, reeds and sedge peat. Peat layer at present is 0.5-1 m.

Thus there existed so called Halaúščyckaje mire, a vast waterlogged complex. Zvaniec was the eastern part of that complex. During 1960-80 drainage campaigns most fens were drained for agricultural purposes, forestry and peat extraction. Only six large fens were left in natural state in Europe. Zvaniec is the largest of them.

According to NAS, 2009b, Zvaniec mire is located in the interfluve of the Dniapro-Buh Canal (DBC), constructed in 1775-1783 and its tributaries, Bielaaziorsk and Arechaúski Canals, constructed in the beginning of the 20th century for navigation purposes. In the 18th century the DBC was used only during spring floods, only later in 1837-1867 the regulation dams were constructed. All the canals seriously changed the regime of the mire.

The main recharge source of the mire is ground water. Atmospheric recharge is significant only in autumn and spring.

The surface flow is directed both to the east and to the west. The northern part of the mire is partly drained by DBC. The hydrological regime of the area is also influenced by amelioration polder systems (7) and drainage canals, and fishfarm Navasiolki. Central and southern parts are least disturbed (NAS, 2009b).

Almost annually the summer and fall no-flood period is interrupted by rainfall floods. The height and duration of summer floods are significantly lower than the same parameters of the spring floods. However, in some years (1984, 1993) the summer rain flood water levels surpassed those of the spring melt floods (NAS, 2009b).

In especially dry years the groundwater table can drop up to 0.5 m below surface (NAS, 2009b). As it was noted above the hydrological regime of the mire is influenced by amelioration polder systems, drainage canals and ditches. Their exploitation defines the groundwater table on the mire. Incorrect operation of the polders and drainage canals often

results in unexpected inundations, draughts, and catastrophic fires on the site causing significant damages to the biological diversity.

Open sedge fen parts of the mire are natural habitats for many species under minimal anthropogenic pressure. They can serve as reference mires in planning for management of fens, as well as for rehabilitation of wetlands.

3.1.3.3 Protection regimes

Zvaniec mire has the following national and international protection statuses:

- **National** – Republican Landscape Reserve established in 1996 (NAS, 2009b);

Logo of the reserve shows the Aquatic Warbler as a key species for the site (Figure 3.11).

Figure 3.11 Logo of the reserve (Malashevich, 2014a)

- **International** – Ramsar site established in 2002, Important Botanical Site (1998), Important Bird Area (2005) (NAS, 2009b).

3.2.3.4 Area size and zoning

Accordin to NAS, 2009b, the total area of Zvaniec reserve is 16 227 ha. Open fens dominate the area covering 77.4 % of the reserve. The area of forests and shrubs, which are mainly found on the mineral islands, is 18.1 %. Agricultural lands – 2.1 % - parts of the islands used for ploughing (159 ha), mowing (47 ha), and pastures (147 ha). 0.2 % of the reserve is covered with water (see Table A6, Appendix). It is important to note that open fen areas has decreased by 11% since 1955 (Malashevich et al., 2008).

Depending on the landscape features, geographic location, level and type of anthropogenic load the area can be divided into several parts: the western part, the central and the southern part together, the northern and the eastern parts (Figure 3.12).

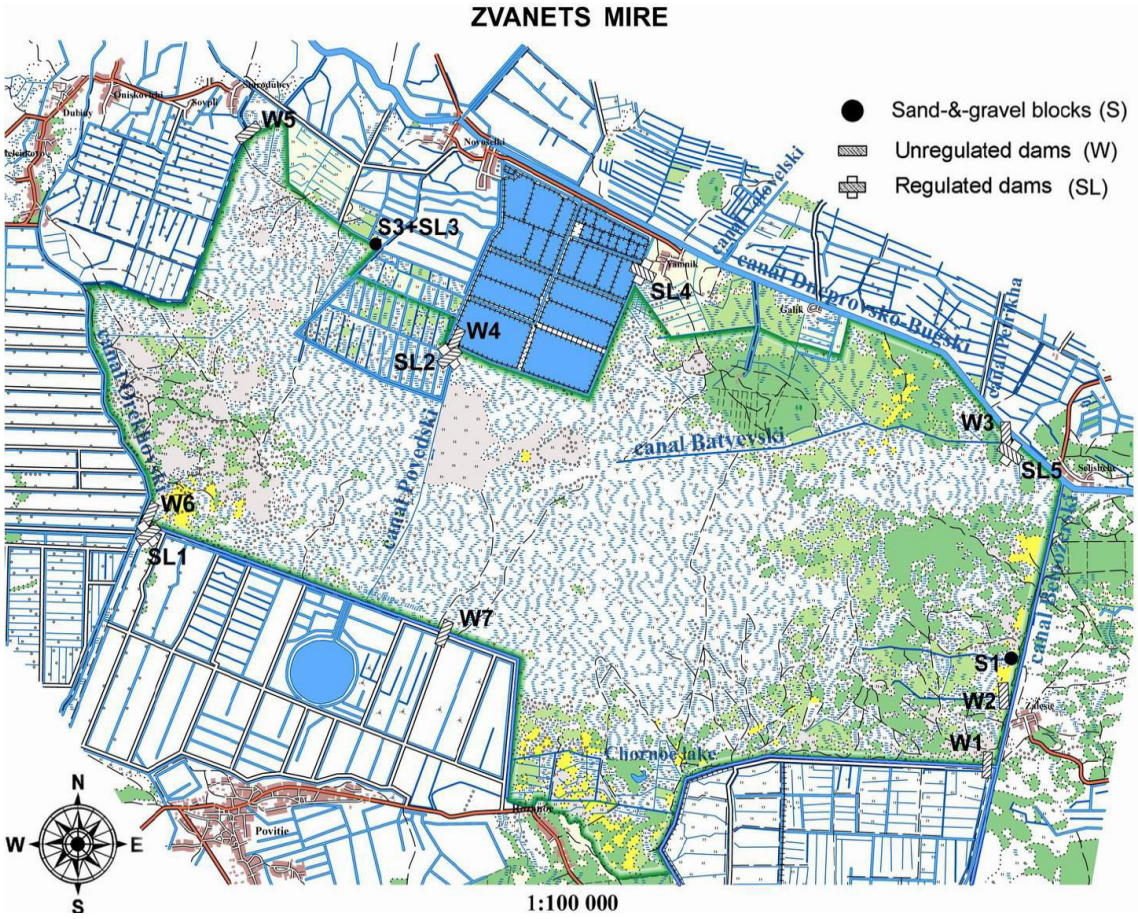


Figure 3.12 Map of the Zvaniec mire (Malashevich et al., 2008)

The western part is characterized by abundance of mineral islands with sedge fen mires overgrown with shrubs. The islands are characterized by high degree of transformation due to past arable farming activities.

The central and southern parts of the mire are dominated by open fen mires with shrubs covering about 10-30% (NAS, 2009b). Mineral islands are scattered all over the mire complex, but their area is small (0.2 to 1 ha) (NAS, 2009b). Mineral islands in this part of the mire are the least transformed as they were used by people only as hay-making fields. These small mineral islands are used by a number of rare bird species for nesting.

Mineral islands dominate in the eastern part of the site. Natural forest vegetation here forms narrow strips along the slopes of the islands. Most of the island area was used for arable farming by local population, mainly to grow potatoes. Fen mires located between the islands are severely overgrown with shrubs. Here the largest Zvaniec island is located, alsmot fully covered with forests.

The northern part of the site is greatly impacted by the presence of the DBC. The share of open fens here is the lowest. Willow shrub proportion is the highest here, the area being

strongly waterlogged. Most of the islands in this part were previously used for ploughing and hay-making.

Open water surfaces are represented by one lake and a network of canals and ditches. The site is owned by the state. As it can be seen on Figure A42, Appendix, most part of the site's lands is not used (83%). The land is leased to Radastoúski agricultural entreprise and Drahičyn forestry (12% of the site) (NAS, 2009b).

3.2.3.5 Natural Values of Zvaniec mire

Zvaniec mire is characterized by the following features that confirm its uniqueness and biodiversity richness:

- a particularly good representative example of sedge-hypnum fen mires typical of the Palieśsie biogeographic district;
- hosts 2 globally threatened species of birds – at least 2 pairs of Greater Spotted Eagle *Aquila clanga*, and the largest population of the Aquatic Warbler *Acrocephalus paludicola* (3000-5500 singing males, 30 % of the European population) (NAS, 2009b; Malashevich, 2013);
- the site is a "hotspot" for conservation of biological diversity of Eastern Europe biogeographic region. It supports particular elements of biological diversity (species, habitat types) of fen mires. The Zvaniec mire contains a significant proportion of species adapted to special environmental condition (mesotrophic open fen mire) (NAS, 2009b):

29 plant species were discovered to be rare and disappearing within the region of Palieśsie;

10 vegetation communities formerly widespread across Palieśsie fen mires, now rare for Belarus and Europe, are found here.

Bird species composition of Zvanec is not very rich but includes some typical fen mire species (125): Greater Bittern *Botaurus stellaris*, Short-toed Eagle *Circaetus gallicus*, Lesser Spotted Eagle *Aquila pomarina*, Greater Spotted Eagle *Aquila clanga*, Common Kestrel *Falco tinnunculus*, Hobby *Falco subbuteo*, Little Crake *Porzana parva*, Crane *Grus grus*, Curlew *Numenius arquata*, Short-eared Owl *Asio flammeus*, Savi's Warbler *Locustella luscinioides*, Aquatic Warbler *Acrocephalus paludicola*, Penduline Tit *Remiz pendulinus*, Great Grey Shrike *Lanius excubitor*;

- 29 mammal species, including 2 Red Data Book Species – European Badger *Meles Meles*, Eurasian Lynx *Felis linx*;

- 9 amphibian species, dominating Moor Frog *Rana arvalis*;
- 5 reptile species, rare species of the European Pond Turtle *Emys orbicularis* (NAS, 2009b).

***Social and cultural value of the Zvaniec mire**

Despite their negative influence on the mire, the Dniapro-Buh Canal (DBC) and the Belaaziorsk Canal represent certain historic value.

According to NAS, 2009b, the DBC was constructed in 1775-1783, the Bielaaziorsk Canal in 1905-1910. Ancient embanking facilities from oak, and parts of old sluices have remained on some parts of the canals. These are examples of hydrotechnical facilities dated late 19 – early 20th century.

What is more, some of the existing economic activities are also a part of the traditional culture. Up to the late 1950s there were many so-called one-house villages on mineral islands in the western and southern part of the now protected area. At present there are practically no such villages on the site, but arable farming on mineral islands for domestic purposes is sometimes practiced by the inheritors of the former land-owners. Horticulture is another traditional type of economic activities. Bee-houses were mounted on large ancient oaks, the latter representing significant historic, esthetic, and scientific value.

What is more, historic and ethnographic sites are also found close to the site. Jamnik village, especially its southern part has retained almost all historic features typical for the Palieśsie region: reed-roofs, traditional hedges, shadoofs, nests of white storks on old trees and house roofs (NAS, 2009b).

3.1.3.6 Current state: threats

There can be indicated the following disturbing factors which currently act as threats to the mire:

- **Exploitation of the adjacent amelioration systems.** The amelioration systems are all drainage polder-type systems, i.e. they are separated from the external catchment by embankments. Excess water is pumped out of the polders by pump stations and is supplied to the ditches which form the southern boundary of the Zvaniec mire. When in operation, the pump stations of these systems lead to the excessive waterlogging of the mire and high amount of nutrients from agricultural fields (UN, 2002);

Amelioration systems: some of them in need of repairs, some do not function, the other ones still influence the water regime of Zvaniec causing either inundations in the south (during

summer floods and water inflow from the canals) or droughts (too rapid water outflow after spring floods);

- **As a consequence of the first factor, speeding up of the vegetation succession -** mire tracts with a lowered groundwater table have higher cover of reeds which results in changes in the species composition of plants and animals. The tracts with a lowered groundwater table (especially close to the boundaries of the mire) are characterized by spread of shrubs and forests.

Evidence of the above indicated threats and general views of the mire can be seen on Figure 3.13.

Figure 3.13 Views of the mire (Malashevich, 2014b)

- **Disruption of hydrological regime of the mire – elevation or decline of the groundwater level.** The main reason for that – lack of coordination of the rules and procedures for exploitation of the Dniepr-Buh canal with the need for conservation of the Zvaniec mire. Fortunately, now all the canals of water outflow into the Dniepr-Buh canal are closed, thus, do not influence the area any more;
- **Abandonment of traditional land use**. Recent decades have seen a rapid decline in the amount of haymaking on the mire. Some 20 years ago, about 70% of the mire was mown by the local population. Today less than 10% of the mire is cut: most hay-making is now performed on more accessible fields which emerged as a result of drainage. Hence, many mire tracts get overgrown with shrubs and reeds (NAS, 2009b);
- **Forest logging**. The islands were formerly occupied by nemoral oak forests, which created a positive environment for a number of rare plants and served as breeding sites for many birds

of prey. Nowadays, the islands have retained only scattered fragments of those forests. Forest logging continues to negatively impact the mire because most of the mire's forests are under jurisdiction of agricultural enterprises, which use forests without limitations, that would be impossible if the forests, for example, were under the jurisdiction of forestries;

- **Biological pollution.** This is present on all mineral islands of the mire and in many of the forests in the north of the site. This is in most cases related to the dissemination of weeds and forest-steppe species imported from numerous agricultural fields and pastures located of the mineral islands representing a threat to local flora;
- **Use of poisonous seeds.** The use of poisonous seeds on fields adjoining the site has frequently resulted in mass killing of black grouses, partridges and cranes, the latter species being a nationally protected one;
- **Climate change**. Changes in the amount of winter precipitation in the last years have resulted in years with either no spring floods or – the opposite – with a very high spring floods. Summer rainfall floods have also become more frequent. Absence of flood or prolonged inundation of the floodplain during the vegetation season results in serious changes in the "operational mechanics" of the mire ecosystem, exemplified by temporary replacements of vegetation associations, changes in species composition, distribution and density of birds, flooding of nests and as a result mass killing of nestlings;
- **Operation of the Navasiolki fish-farm**. The Navasiolki fish-farm is located in the northern part of the mire. It is supplied from the DBC, but the recharge is also partly carried out with water pumped out of the mire (UN, 2002).

3.1.3.7 Management: past and present

Management of the reserve is carried out by the state nature conservation entreprise Zvaniec Republican Biological Reserve with a team of 5 people, and Drahičyn and Kobryn district executive committes (NAS, 2009b) in cooperation with APB-Birdlife Belarus.

Lands of Drahičyn forestry are use as follows: arable farming is conducted on 94 ha, 36 ha are used for hay-making, 149 ha for cattle pasturing (NAS, 2009b).

Mineral islands are partially used by the local population for ploughing and subsequent growing of arable crops, mainly potatoes. The western part of the mire is used most intensively. This part has not yet been included in the protected area. The eastern part of the mire adjoining the Bielaaziorsk Canal is also used quite intensively.

The area of the mire is also used as a large reservoir to store water pumped out of the ameliorated (poldered) areas in rainy periods and supply water for drained tracts during dry periods. Large canals are used by local population for non-commercial fishing.

Horticulture has always been popular among local population and the traditions of this household craft are still alive here. However, the actively used areas cover only 12% of the reserve (NAS, 2009b).

In 2001 a management plan for the Zvaniec reserve was elaborated in the framework of an international project on Management Planning for Key Fen Mire Biodiversity in Belarus**.** It was further implemented (NAS, 2009b). The present Management Plan is for 2009-2013. Its main priorities were set as follows (NAS, 2009b):

- hydrological regime management and vegetation management – mowing, vegetation use for briquette production, managed vegetation burning;
- review and update of borders and regimes of use of the reserve with the area extension to 16227 ha and increase in the number of land users;
- ecotourism organization and sustainable development – repairs and opening of an information centre, ecological trail and observation point construction, website development, business plan on promotion of Zvaniec within the domestic and inbound tourism market;
- establishment of a hunting unit in order to manage the hunting activities and reduce the number of poaching cases;
- environmental education, cooperation with local people.

Conservation aspect

Kozulin and Flade (1999) state that scientific surveys of the site started in the 1950s. In 1995–1997 a study of the distribution and ecology of the Aquatic Warbler in Belarus was carried out, assisted by the Michel Otto Foundation (Germany) and the Royal Society for the Protection of Birds (UK). The study discovered that the Zvaniec mire supported the world's largest populations of this bird. Thus, the research outcome clearly indicated a need for a Management Plan for this area.

According to Ramsar (2002) in 1997, a permanent monitoring plot was established in the southern part of Zvaniec, enabling annual studies of the dynamics of the mire flora and fauna. In 2001–2002 a number of projects on study and description of Zvaniec as a potential Ramsar site were implemented, e.g. **Number and Distribution of Snipe and Great Snipe; Social**

and Cultural Value of the Site; Study of Possibilities for Recreation and Tourism at the Site.

- **Management planning for conservation of fen mire biodiversity in Belarus (1999-2002)** - development of Management Plan for Zvaniec fen mire (UNDP, 2002b);
- **Implementation of urgent recommendations of the management plans for key biodiversity areas in Belarus** (**2002-2006)** – setting of management administration of the reserve, hydrological regime stabilized (7 sluices constructed), monitoring of Aquatic Warbler population, ringing of Aquatic Warbler (UNDP, 2006b);

As a result of the 2003-2008 plan realization, the following conservation measures were taken (NAS, 2009b):

- ✓ borders of the reserve changed and newly established;
- ✓ all the canals of water outflow into the Dniapro-Buh canal are closed, thus, do not influence the area any more;
- ✓ water regulation systems (sluices, dams) were constructed in 2004 in order to limit water outflow through the canals and amelioration systems or its inflow during summer floods. These systems proved their efficiency having caused increase in water level in the reserve and prevention from summer floods in the central part of the mire;
- ✓ regulation dam was constructed in the area of Navasiolki fishfarm to decrease its influence on the reserve;
- ✓ monitoring of groundwater levels has been conducted regularly.

- **Conserving unique biological diversity of lowland mires through their sustainable use (2006-2009)** implemented by APB-Birdlife Belarus – vegetation management at the key Aquatic Warbler breeding site – mowing and bush removal with tractors (GEF-SGP, 2006b);
- **Catalyzing sustainability of the wetland protected area system in Belarusian Palieśsie through increased management efficiency and realigned land use practices 2006-2011**– implementation of the Management Plan of the Zvaniec reserve, establishement of a cross-border Ramsar site "Upper Prypiać" which includes Zvaniec and Prastyr (Belarus) and Upper Prypiać and Prypiać-Stochid (Ukraine), engineering project on optimisation of hydrological regime (UNDP, 2006a; 2010a; 2011a);
- **Aquatic Warbler monitoring in Belarus project (2002 – up to now)** – annual Aquatic Warbler counts, monitoring of AW numbers and distribution, ringing (Malashevich, 2012), the project is described in Chapter 3.1.4;

- **Zvaniec Caretakers' Network**. According to UNDP, 2014, at the Zvaniec mire the caretakers monitor hydrological regime: take measurements of the ground water level and monitor the overflow situation. One of the caretakers took active participation in the development of the project application for rewetting of drained peatland withdrawn from agriculture in the vicinity of the mire. By the caretakers' efforts the census of cranes is organized and performed at the Zvaniec mire annually.

Development aspect

Zvaniec reserve possesses the following ecotourism and environmental education facilities:

- the information centre was opened in 2010 in the village of Haravica, Drahičyn district, 7 places for accommodation of visitors, rental of bikes, tents etc (Figure A45, Appendix; Touristic Brest, 2014b). However, visit to the centre and the reserve requires prebooking, otherwise, the visitors would face a closed office although it is officially open during all the week except for the weekend. There are no routes developed for tourists, although the funding was provided for that;
- there is no web-site of the reserve, there is some information, not much of a tourist type, on the web-sites of Brest tourism, Drahičyn district;
- the tourist routes along Bielaaziorsk and DB canals were developed for pedestrians and bike tours but not equipped so far (Figure A43, Appendix);
- ecological education activities have been organized with the local pupils, school excursions;
- excursions for foreign groups are organized (1-2 per year);
- meetings with locals are held sporadically.

Table 3.4 demostrates low numbers of visitors in 2011-2013 which is an evidence of lack of promotion and infrastructure for visits.

Table 3.4 The number of visitors of Zvaniec reserve, 2011-2013 (Malashevich, 2013-2014)

Number of visitors	2011	2012	2013
Belarusian	53	58	55
Foreign	17	0	13
Total	70	58	68

3.1.3.8 What needs to be done and what is planned

What needs to be done

The following measures need to be taken to improve the nature conservation and ecotourism/education performance of the reserve:

- hydrological and vegetation management: further implementation of the regulation measures;
- promotion of the reserve through mass media, Internet, social networks, events, provision of information for foreign visitors on the Internet;
- installation of infoboards, direction signs, equipment of the tourist trails;
- organization of environmental education activities;
- collaboration with Sporava reserve on organizing joint excursions.

What is planned

Among the plans of the reserve is the already launched **Clima East project on Conservation and sustainable management of peatlands in Belarus to minimize carbon emissions and help ecosystems to adapt to climate change (2014-2020) –** aimed at restoration of Zvaniec fen mire by mechanized mowing and collecting and use of biomass for fuel briquette production: purchase of 2 tractors and other equipment for mowing of 40% of the mire area. Processing of biomass for briquette production (Sadovksaja, 2013).

3.1.3.9 Peat analysis

Data and results of peat analysis are located in Chapter 3.1.3, Appendix. The ph values obtained are in the normal range for fen mires (5.73) and show that the peat in Zvaniec mire is weakly acidic which does not serve as any evidence of drainage consequences and disturbance of hydrological regime of the mire. This means that the ecosystem has had the resources to protect itself and prevent severe degradation.
Von Post Decomposition Index is H4 (weakly decomposed peat) which is a normal value.

3.1.3.10 Wetland condition analysis

The Table of evaluation is located in Appendix. The overall result obtained for Zvaniec mire is 19.58 out of 25 which is a rather high value meaning that although the mire has suffered from drainage the big part of has remained weakly disturbed and the conservation activities carried out are highly efficient.

3.1.4 Aquaric Warbler conservation project

3.1.4.1 Overview of Aquatic Warbler conservation concept

The Aquatic Warbler *Acrocephalus paludicola* is the rarest and the only globally threatened passerine bird found in mainland Europe. According to AWCT (2014); Birdlife (2014b), the species is classified as Vulnerable at the global level and is listed as Vulnerable in the IUCN Red List of Threatened Species. At the European level it is classified as Endangered. It is also included into Annex I of the EU Wild Birds Directive, in Appendix II of the Bern Convention and in Appendix I of the Bonn Convention.

Once widespread and numerous in fen mires and wet meadows throughout Europe, the Aquatic Warbler has disappeared from most of its former range. As AWCT (2014) states, nowadays, its world population is confined to fewer than 40 regular sites in only six European countries, with four sites supporting over 80 % of the global population (Poland, Belarus, Ukraine, Lithuania).

History of decline

According to Birdlife (2014a), since 1970, the Aquatic Warbler species has declined significantly as a result of the destruction of 80-90% of its habitat in the river systems of the upper Prypiać, Jasieĺda (Belarus) and Biebrza/Narew (Poland). These systems hold approximately 75% of the European population. It formerly bred in France, Belgium, Netherlands, former West Germany, former Czechoslovakia, former Yugoslavia, Austria and Italy. As Flade (2013) states, whereas the Central European population seems still to be more or less stable (probably increasing in East Poland, declining in Belarus, unknown in Ukraine), the peripheral populations are threatened by extinction or have already disappeared. Whilst the current status of the West Siberian population is unknown (latest breeding season records from the year 2000), the Hungarian population has completely vanished (700 males in 2001, no breeding occurrence after 2011). The Baltic population is steeply declining (from 290–330 in 2004 to less than 100 males in 2013). The Pomeranian population is threatened by extinction: decline from c. 200 males in 1999 to c.100 males in 2006 to less than 20 in 2013.

Population, breeding sites, migration routes

According to Flade (2013), the global population size of the Aquatic Warbler (AW) is estimated at between 9 500 and 13 700 singing males during the period 2009–2013 and confined to fewer than 40 sites in 5 countries.

Aquatic Warbler distribution of male population among the countries is the following: **Poland** 2,670-3,850; **Belarus** 2900-5500 (Kozulin and Malashevich, 2013); **Ukraine** 4,000-4,900 (Poluda, 2013); **Lithuania** cerca 100 (Flade, 2013), **Germany**, fewer than 25 (Birdlife, 2014a).

Thus, the Aquatic Warbler regularly breeds in Belarus, Poland, Ukraine, Lithuania, with major populations in Belarus, Ukraine, and Poland (AWCT, 2014).

It breeds in large open lowland marsh habitats with low grassy vegetation (mostly sedge fen mires) with water mostly less than 10 cm deep. It winters in similar habitats (the grassy saline marshes of the Senegal and Niger deltas) and, on migration, favours coastal habitats with low stands of sedge and reed near open water (Portugal, France) (Birdlife, 2014a).

On migration, it has been recorded in 15 European countries, mainly in the west and southwest of the continent. It winters in the Sahelian belt of sub-Saharan West Africa, mainly along the lower Senegal River, where it was discovered in January 2007, within and to the north of Djoudj National Park, and in 2011 found in smaller wetlands in south-west Mauritania and at the inner Niger Delta in Mali. Two-thirds of the known population have been discovered since 1995 (Birdlife, 2014a).

Threats

According to Birdlife (2014a), the most important threats for the species are:

- loss of breeding habitat owing to drainage for agriculture and peat extraction, damming of floodplains, unfavourable water management and the canalisation of rivers. Habitat degradation is widespread where traditional fen management has ceased allowing succession to unsuitable overgrown reedbed, shrub or woodland, decrease of the groundwater level;
- uncontrolled fires in spring and summer pose a direct threat to birds and nests, since they can burn out the upper peat layer of fens;
- in the wintering grounds, agricultural cultivation and irrigation (creation of rice and sugar cane plantations), drought, wetland drainage, intensive grazing, succession to scrub, desertification and salinisation of irrigated soils are all existing threats.

Conservation policy

As Birdlife, 2014a states, Aquatic Warlber is legally protected in all countries of its breeding range. All key breeding sites in Belarus, Germany and Poland are located within protected areas. Habitat is actively managed in Poland, Belarus, Ukraine, Lithuania and Germany. All breeding range states except for Russia have monitoring programmes.

First, there exists the Birdlife International Aquatic Warbler Conservation Team which is responsible for research, development and implementation of conservation actions and cooperation between the countries of the breeding range.

According to CMS, 2014, the Aquatic Warbler Memorandum of Understanding (MOU) was concluded in Belarus, under the auspices of the Convention on Migratory Species (CMS) and became effective in 2003. The MOU applies to 22 countries where the Aquatic Warbler breeds, rests on migration or winters. It calls for cooperation among national authorities to promote the conservation of the species and requires the strict protection of the species and the maintenance and restoration of its habitat.

Moreover, in 2010 there was adopted a new International Species Action Plan for the Aquatic Warbler, prepared by CMS's partner BirdLife International on behalf of the European Union. The main objective of the Action Plan is to maintain the Aquatic Warbler throughout its range and, in the medium to long term, promote the expansion of the breeding population to other suitable areas. Priority conservation actions to be taken by the Signatories can be summarized as follows: legislative measures to ensure the species' and habitat protection, conservation of all existing sites, increase of the area of suitable habitat at existing sites and restoration of additional sites, monitoring and research, and the establishment of a public awareness strategy (CMS, 2014).

The following researches have been carried out in Europe and Africa recently:

- the first wintering site discovered in 2007 in the Djoudj National Park in Northwest Senegal. Later on three more sites were discovered, they are located in southern Mauritania and in the Niger River delta in Mali (CMS, 2014): ringing of the species and data analysis;
- habitat restoration has been conducted on the breeding grounds;
- AW counts are held regularly in Belarus, Ukraine, Lithuania.

3.1.4.2 Belarus

Kozulin and Flade, 1999 state that studies on Aquatic Warbler distribution in Belarus started in the 1990s by the joint international team hade by the German wetland scientist Martin Flade who came up with the idea to study Belarusian fen mires after he found one of his Dad's photos during World War II which was shot in Belarus and showed the mire landscape. The scientist decided there could be large numbers of Aquatic Warbler in Belarus if the mires were in a good condition. It needed studying since in Germany the birds were in decline due to habitat destruction.

Since then, lots of studies have been carried out, several projects developed and brought to life by the conservation team of APB-Birdlife Belarus, German scientists with the financial support of the Royal Society for the Protection of Birds (UK), the Secretariat for the Bonn Convention (CMS) and the A.G. Leventis Foundation (Germany).

Key breeding sites

The main Belarusian AW breeding sites are all located within the protected areas and are Sporava fen mire, Dzikoje mire, and Zvaniec mire.

All the other regularly occupied breeding sites are under the protection regime (Figure 3.14).

Figure 3.14 Location of the AW breeding sites in Belarus, 2013 (Malashevich, 2013)

According to Kozulin and Malashevich, 2013, before the massive drainage of mires in the 1960s, Aquatic Warbler was nearly continuously distributed in the central part of its breeding range, in the Paliessian lowland. There were cerca 99 big fen mires (each of 1 000 ha and more) covering a total area of more than 900 000 ha. The mires were either adjacent to each other, or were located in a distance of 20-40 km. For that period the number of Aquatic Warblers is estimated at about 450 000 singing males.

Conservation policy

According to Malashevich and Fenchuk (2008), the AW conservation policy includes the following aspects:

- maintaining existing habitats;
- restoring abandoned habitats;
- regular monitoring of AW numbers and distribution – Aquatic Warbler counts, ringing of the birds, search for new sites.

Monitoring of AW numbers and distribution: AW counts

AW counts will be analysed on the basis of 2013 counts' results at 3 key breeding sites, and results from the 2010-2013 results at some sites presented by Malashevich, 2013.
In general, the counts have been held regularly since 1995. Usually the key breeding sites (Zvaniec, Sporava and Dzikoje mires) were taken as the research sites.
The AW counts are carried out according to the international AW monitoring scheme developed within the framework LIFE-Nature project (Poland and Germany). They are organized as volunteer camps for all the people interested.
The counts start one hour before sunset and last for maximum 2 hours – the period of the highest singing activity of males. This period is enough to cover a monitoring route up to 2 km. Counts are usually not conducted in rainy or windy weather.
Counts are simultaneously conducted by 2-5 people on each monitoring route. Teams move in rows with GPS and map the birds in their lists. Each bird has to be registered by at least 2 counters before it is mapped. This allows for receiving reliable data from volunteers with different level of knowledge and experience; moreover, volunteers are previously provided with basic information on GPS use and bird counting and mapping by the camp coordinator.

Depending on the site size and availability of volunteers the following methods are used for the counts:

- counts on the sample plots;
- full counts.

Aquatic Warbler counts 2013 were carried out at 3 most important AW breeding sites: Zvaniec (end of May, beginning of July), Sporava (end of June) and Dzikoje mires. Double counts were carried out at 18 sample plots in Zvaniec (central part), plus survey and full counts at all suitable habitats in western and eastern parts (the most detailed counts ever carried out at this mire).

Full counts were executed at c. 40% of the known localities in Sporava. Full counts at a major part of suitable habitat were performed in Dzikoje mire. Full counts were also carried out at some small sites. The detailed results are presented in Table A46, Appendix.

Main conclusions of the AW counts 2010-2013 are as follows:

According to Kozulin and Malashevich, 2013, at present there are only 3 key Aquatic Warbler breeding sites (Zvaniec, Sporava and Dzikoje) left in Palieśsie region, holding c. 2 750 - 5 200 singing males (years 2010-2013). The rest of the national population breeds at 5 permanent sites with low numbers (Dzivin, Prostyr, Ščara, Servač and Svislač) resulting in 100 - 200 males and at 7 suboptimal sites holding 50-100 males in total.

So, altogether **15 breeding sites** were hosting **2 900-5 500** singing males in the years 2010-2013. Most of Belarusian breeding sites located at considerable distance (50-260 km) from each other. Such remoteness creates barriers for exchanges of birds between the sites.

At the key sites Zvaniec, Sporava and Dzikoje the species rapidly declines due to overgrowth of open fens with reeds and bushes. Comparison population estimates in late 1990-s and recent monitoring data from the years 2010-2013, Aquatic Warbler numbers decreased for Zvaniec from 3000-8000 until 2100-4400, for Sporava from 700-2100 until 500-600, for Dzikoje from c. 1500 until 150-200 (Kozulin and Malashevich, 2013). These figures reflect population decline due to habitat loss. However it should be emphasized that these numbers also reflect a more detailed level of survey implemented in recent years.

As Malashevich, 2013 states, some sites (Dzikoje, Siervač, AĺmanyandŽadzien) are transforming from fens into bogs.

Aquatic Warbler numbers might be stabilized and even increased if there was a network of key sites located not far from each other. It might be achieved through both securing optimal habitat conditions at existing sites (Zvaniec, Sporava, Dzikoje, Siervač) and restoring new big

fen mires (Vyhanaščanskaje, Hryčyna-Starobinskaje and Dakudaŭskaje) (Malashevich, 2013). It will secure fast population increase at the key sites until their maximum ecological capacity, and considerable increase of both distance and numbers of fledglings disseminating to new areas within breeding range (including suboptimal sites) during their post nuptial dispersion. The network of key and suboptimal biotopes will allow exchanging individuals between the sites. This will stabilize population numbers even under conditions of negative processes at some sites.

Aquatic Warbler counts is an interesting scientific event and volunteer camp, allowing to expand the number of people aware of the nature conservation problems at Belarusian mire sites, get those people involved and give them an extremely useful experience of bringing their own contribution to mires' conservation, getting to know new interesting people and widening their knowledge of Belarusian nature.

Habitat management

Although the AW numbers are declining, the work that has been done in the recent 15 years in the field of AW and its habitat conservation is very efficient and goes far beyond the AW counts but also involves the conservation measures taken at the key breeding sites:

- development of the sites' inventories, ensurance of protection regimes;
- regular mechanized mowing at Sporava mire since 2011 has proved its efficiency, allowing to decrease overgrowth with reeds, birches and willows at Sporava mire, provide habitat restoration for the inhabitants of the mire. 400 ha were mown overall (Malashevich, 2013-2014);
- hydrological model developed for Zvaniec mire (Malashevich, 2013-2014);
- mowing scheme is developed for Zvaniec also and is to be implemented within the Clima East project (ClimaEast, 2014).

3.2. Research sites: Portugal

3.2.1 Paul de Arzila

3.2.1.1 Location

Paul de Arzila is a freshwater marsh located in the region of Centre (NUT II sub-division - EU geocode standard for referencing the subdivisions of countries for statistical purposes (Eurostat, 2014)), the sub-region of Baixo Mondego (Lower Mondego, NUT III sub-division (Eurostat, 2014)), on the left bank of the Mondego river (on the River Cernache affluent), part of the Coimbra district, three municipality councils (Coimbra, Condeixa-a-Nova and Montemor-o-Velho) and three parishes (Arzila, Pereira and Anobra) (Leitão, 2013b). The paul is most closely located to the village of Arzila (Figure 3.15).

Figure 3.15 Location of Paul de Arzila (Google Earth)

3.2.1.2 History and present main features

The paul was formed in the valley of the River Cernache, the left affluent of the River Mondego, having represented one of the freshwater marshes in the valley of the Low Mondego River which once was a giant wetland (Leitão, 2013b). Judging by the words of the people working in the area, in the old times, before humans started their intervention, the wetland was covered with True Bulrush *Scirpus lacustris* (Bunho in Portuguese) and Rushes *Juncus sp* which local people regularly cut for weaving and making mats and various handicraft objects (Leitão, 2013a). Besides, for many centuries agriculture was the main source of income for Arzila village and nearby locations; fishing and hunting were practiced

here. However, regularization and drainage were maintained at biological equilibrium, until in the 1950s agricultural practices were intensified by the fact that 2 ditches were opened in the valley – Vala dos Moinhos in the east, Vala da Costa in the west which were supposed to drain the water from the nearby hills, later the third ditch (Vala do Meio) was opened in between the two previous ones to drain the rest of the water and use the land for rice and corn cultivation (ICNF, 2003-2004). Localization of the ditches is shown on Figure A49, Appendix.

These are considered to be the most destructive measures ever taken in the area which seriously changed the hydrological regime of the Paul. The so-called regularization of water regime functions as follows: waterflow path gets rectilinear, completely unnatural, groundwater levels diminish, the distance flown by water in the river diminishes as well, its flow speed rises, thus, the river channel deepens which causes and speeds up soil erosion. Furthermore, summer dissecation and diminution of fish flow in the paul are also the consequences. What is more, the paul is a terminal part of the hydrographic basin of the River Cernache and is close to the meeting point with the river (Leitão, 2013b), so, it gets most pollutants flow, influencing not only the surrounding area but the whole river basin. As a result, the area of the paul has become overgrown with Common Reed *Phragmites australis* and Willows *Salix sp.*

Moreover, the growth of the surrounding urban areas rose interest of the villagers in Coimbra vacancies and abandonment of agriculture as a principal activity, decrease in agricultural areas. What is more, nearby polluting industries (malfunction of wastewater treatment plants, factory on transformation of animal products, agroindustries (ICNF, 2003-2004; Flumm, 2006; Leitão, 2013a)) played its part in deterioration of the water quality in the paul.

3.2.1.3 Protection regimes

Paul de Arzila has the following national, European and international protection statuses:

- **National** – Nature Reserve (Reserva Natural) designated in 1988 (Leitão, 2013b);

The logo of the reserve shows Purple Heron as a key species (Figure 3.16).

Figure 3.16 Logo of the reserve (ICNF, 2014d)

- **European** – Special Protection Area (ZPE – Zona de Protecção Especial, 1988), Site of Community Importance (Sítio de Importância Comunitária, 1997), Rede Natura 2000, Biogenetic Reserve of the Council of Europe (1990) (Leitão, 2013b);
- **International** – Biotope CORINE (1987), Important Bird Area (IBA), Ramsar site designated in 1996 (ICNF, 2003-2004; Wetlands International, 2014).

Paul de Arzila is an important part of a network of 3 wetlands in the Mondego valley, including 2 other IBAs – Paul do Taipal and Paul de Madriz.

3.2.1.4 Area size and zoning

The nature reserve was established in 1988. According to Leitão, 2013b, the territory of the reserve has an area of 585 ha (the area of the paul itself is about 150 ha) which is distinctly divided into two parts:

- the central part representing an alluvial plain with an extensive reedbed, areas of permanent submersion, and agricultural area, main vegetation is marshy one with Common Reed *Phragmites australis*, True Bulrush *Scirpus lacustris*, Common Cattail *Typha latifolia*, Rushes *Juncus sp.*, and also tree species of Grey Willow *Salix atrocinerea*, Black Alder *Alnus glutinosa*, examples of Narrow-leafed Ash *Fraxinus angustifolia*, Elm *Ulmus sp*., Black Poplar *Populus nigra* (Figure A47-A48, Appendix);
- the second part is an area bordered by the hills of the river valley and covered mainly with forest and agricultural territories next to urban areas, main vegetation are tree species of Maritime Pine *Pinus pinaster*, Blue Gum *Eucalyptus globulus*, Portuguese Oak *Quercus faginea*, English Oak *Quercus robur*.

The official zoning of Paul de Arzila (ICNF, 2004) defines 3 protection zones – Total Protection Area, Partial Protection Area, and Complementary Protection Area. What is more, two more protection levels are established: Partial Protection Zone has Area of Specific Intervention for Conservation of Natural Values, and Complementary Protection Zone has

Area of Specific Intervention for Public Use. Finally, there is an area not subjected to protection which corresponds with Urban Area (Figure 3.17).

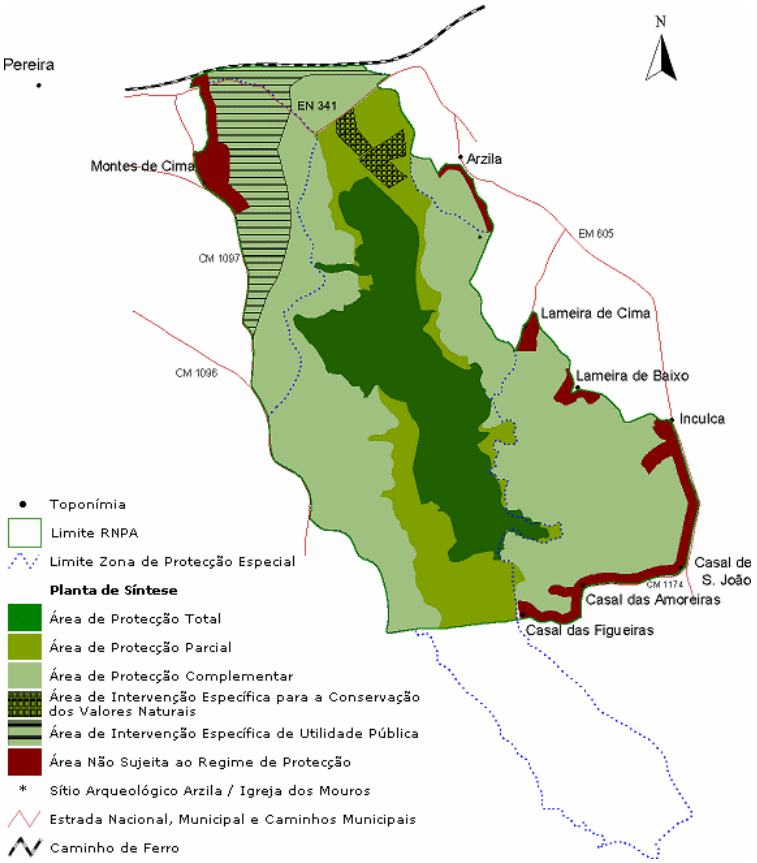


Figure 3.17 Paul de Arzila zoning (ICNF, 2004)

Total Protection Area – 114,12 ha (Leitão, 2013b) – includes alluvial and riparian formations, oak woods, reedbeds and bulrush beds, ditches, lakes and ponds.

Partial Protection Area – 85,50 ha (Leitão, 2013b) – includes flatland agricultural lands of the type 'rice fields'.

Area of Specific Intervention for Conservation of Natural Values was defined within this zone as an area of high interest of conservation of its biodiversity. There was defined a problem within this zone which is about agricultural production systems of intensive type (rice and corn cultivation based on irrigation). These practices have to be in compliance with the objectives of the natural reserve.

Complementary Protection Area – 384,16 ha (Leitão, 2013b) – includes forests and bushes, agricultural lands on the hills. The problems of this zone are said to arise from using traditional policultural systems in agriculture and existence of fast-growing tree species potentially threatening the other ones.

There is an Area of Specific Intervention for Public Use defined in this zone was created to permit the implementation of reconstruction of N341/347 road on the Alfarelos/Taveiro plot (Leitão, 2013b).

Urban Area – 23,10 ha (Leitão, 2013b) – a territory without any strong need of conservation natural values (as it was defined in the zoning document (ICNF, 2004)) which corresponds with the parts of villages next to the paul – Monte da Cima, Arzila, Lameira de Cima, Lameira de Baixo, Caneira, Casal de S.João, Casal das Amoreiras, Casal das Figueiras.

By the landscape type and activities carried out there are distinguished 3 areas – *areas with agricultural activities, forests and semi natural areas, wetlands* (Leitão, 2013b). This can be seen on Figure A50-A51, Table A7-A9 in Appendix.

Agricultural areas are divided into two parts – the part on the hills occupied with olive trees, vineyards, orchards, arable rainfed lands, and the part of the valley occupied with irrigated arable lands.

Wetlands (ca. 150 ha, 21 % of the reserve area (Leitão, 2013b)) also are represented in 3 forms– *freshwater marshes (permanent or lakes), seasonally inundated agricultural lands and canals*.

Freshwater marshes (permanent or lakes) are occupied with Common Reed, True Bulrush, Grey Willow. This zone has the biggest area out of all the 3 ones.

Seasonally inundated agricultural lands are represented by rice fields.

The area of *canals* is very important for certain fish, amphibian species, European Otter *Lutra lutra*.

3.2.1.5 Natural Values of Paul de Arzila

Paul de Arzila possesses the following fauna species and carries out the following functions (Leitão, 2013b;):

- 126 bird species, including vulnerable species of Purple Heron *Ardea purpurea*, Goshawk *Accipiter gentilis*, Savi's Warbler *Lacustella luscinioides*, White Stork *Cigonia Cigonia*, Marsh Harrier *Circus aeruginosus* (2 pairs);
- nesting site for Little Bittern *Ixobrychus minutus*, its number increased from 2 pairs in 2003 to 6-13 pairs thanks to the LIFE project in 2005, Black-crowned Night Heron *Nycticorax nycticorax*, Cetti's Warbler *Cettia Cetti*, Savi's Warbler *Lacustella luscinioides*, Common Reed Bunting *Emberiza schoeniclus*, a stable population of 5-6 pairs of reintroduced Purple Gallinule *Porhpyrio porphyrio*;

- wintering ground for Common Teal *Anas crecca*, Mallard *Anas platyrhynchos*, Cattle Egret *Bubulcus ibis*, Little Egret *Egretta Garzetta*;
- migratory stop-point for Sedge Warbler *Acrocephalus schoenobaenus*, Eurasian Reed Warbler *Acrocephalus scirpaceus*, Great Reed Warbler *Acrocephalus arundinaceus*, Melodious Warbler *Hippolais polyglotta*, Willow Warbler *Phylloscopus trochilus*, Bluethroat *Luscinia svecica*;
- 21 mammal species, including Iberian Shrew *Sorex granarius*, Western Mediterranean Mouse *Mus spretus*, Otter *Lutra Lutra*, Wildcat *Felix silvestris*;
- >200 species of invertebrates;
- 15 fish species, including an American one introduced to control mosquitoes (prevention of malaria) which is now common in the paul; Iberian endemics Iberian Barbel *Barbus bocagei*, Iberian Nase *Chondrostoma polylepis*, Lusitanian endemic species of Ruivaco *Rutilus macrolepidotus*;
- 11 reptilian species;
- 8 amphibian species, but 2 frog species in decline due to predation from non-native Louisiana Crayfish, or Red Crawfish, which appeared in the surrounding area in the 1960s (Figure A53a, Appendix). One of the frogs, *Discoglossus galgamoi*, is now thought to be extinct in the paul and only survives in ponds on higher ground, the other one, *Rana perezi*, is also in decline; endemics Iberian Triton *Triturus boscai*, Schreiber's Green Lizard *Lacerta schreiberi*;

What is interesting, during the visit to the area, the great number of these crayfishes was the first thing to be noticed, to be more precise, the remains of them on the ground. Later, dozens of alive ones were seen in the gutter, which was quite surprising.

It was said that after the 2001 big floods the number of Crayfish drastically increased but in recent years a decrease was observed (it is believed, crayfishes have become otter's prey), so the otter population has increased. In 2013, the floods reached the almost 2001 level, so, the Crayfish population has seriously increased again.

However, it would not be true to say that during the visit the author has observed rich biodiversity and pointed a lot of animal species. It could be because of the season (end of October), or due to the conditions in the paul are not suitable for hosting the above mentioned species anymore.

3.2.1.6 Current state: threats

As it has already been mentioned above, Paul de Arzila represents a lot of negative consequences of improper, inappropriately planned human use. The main problems which are obvious now are the following (ICNF, 2003-2004):

- reedbed overgrowth causing almost full displacement of naturally growing bulrush, typical of the area (Figure 3.18);
- willow overgrowth, also having taken the territory of True Bulrush (Figure 3.18);
- *Phragmites australis* and *Salix sp*. cover about 75 % of the total wetland area; current estimates are *Phragmites australis* cover >90 % of the wetland area, open water <5 %, wet reedbed <10 %;
- Watermifoil *Myriophyllum spp* invasion which caused eutrophication, water stagnation, decrease of oxygen and retention of organic compost;
- non-native species of Crayfish having caused nearly extinction of 2 species of frogs;
- absence of priority species chosen for conservation management;
- absence of promotion of the paul as an ecotourism destination, few activities of the environmental centre;
- ageing population of the surrounding villages, major employment of Arzila and Pereira population in the tertiary sector (mainly in Coimbra and 2 hospitals in the area, railway services), Anobra inhabitants also employed in the secondary sector (nearby industries of Condeixa-a-Nova) – there is a tendency of increase in the area of forests and uncultivated lands and decrease in agricultural lands.

Figure 3.18 Views of Paul de Arzila (Malashevich, 2014b)

Moreover, there are problems coming from the outside of the paul:

- domestic pollution – there are only 3 wastewater treatment plants working in the area – ones of Arzila, Anobra and Vila Pouca villages, the other villages/towns neglecting the pollution of the River Cernache affluents;

There are at least 5 ETAR with direct influence on the paul (Leitão, 2013c).

- industrial pollution – 3 sources – ceramic production (already closed (Leitão, 2013c)), factory on transformation of animal products, the one on extraction and washing of aggregates, and two agroindustries (mills). Only the first two have the wastewater treatment plants in operation, although not functioning properly sometimes;

- diffuse pollution – intensification of agriculture in the form of use of fertilizers and other chemicals in corn and rice production – as a consequence we get degradation of living conditions for animals as well as contamination of alimentation for people.

As for now: agricultural practices tend to disappear, only small properties are left, they do not use any chemicals, only natural fertilizers and herbicides to a small extent. So, degradation of animal habitats is more a past consequence.

- two hunting zones next to the area of the Paul de Arzila and a training camp for hunting inside the reserve, still existing but it is said they are not used (Leitão, 2013c);
- reconstruction of the road N341/347 on the Alfarelos/Taveiro plot. Part of Taveiro-Arzila has been constructed, part Arzila-Granja de Ulmeiro is left (Leitão, 2013b);

In the process of Management Plan development, there were diagnosed the existing negative factors for the reserve. Some of them have been listed above and are showed on Figure A52, Appendix.

- there is a need to adjust the Municipal Management Plans (MMPs) to the concept of the Paul in its Management Plan since there are misleading paragraphs in MMPs of the three municipalities which may cause management contradictions in the future, e.g. the characterization of the wetland regime as restriction of public use of soils.

It is important to understand the hierarchy of the Management Plan of Paul de Arzila and Municipal Plans that are also related to the area. In Portugal the Wetland Management Plan is called Special Management Plan on territorial management of national scope, whereas Municipal ones are regarded as Municipal Management Plans on territorial management of municipal scope. Thus, Special Management Plans are superior to Municipal ones (ICNF, 2004).

- the need to adjust the Paul Management Plan to the Regional Plan of the Centro Litoral since the latter appears superior to the former (ICNF, 2004).

3.2.1.7 Management: past and present

The major part of the paul is in private property of various owners, 65 ha is a state property which was bought from the private owners in 2003-2005 (Leitão, 2013b; EU, 2007).

The objective to develop the first Management Plan was established in 2001. The information was collected and prepared in the form of diagnostic and synthesis reports in 2003 (ICNF, 2003-2004), they have been used by the author for this work since these materials are

available on the site of ICNF. The first Paul Management Plan was approved in 2004. At the moment there is no new Management plan of the wetland, there is a draft version but not finally approved. It has been taking already a long time to do that (Leitão, 2013a). No information could be given to me from the draft version or on the question of priority objectives set in the new plan. Only the questions on the changes of any points of the previous plan in the last 20 years were answered. There planned to be organized a meeting of the Parties involved – local community representatives, local municipality, ministry of environmental affairs, centre itself etc to decide on function division in the management of the area (Leitão, 2013a).

Past management of the Paul de Arzila is characterized by setting the management objectives for the Paul zones and 3 LIFE projects which will be described below.

The objectives set for **the Total Protection Area** were the following (ICNF; 2004):

- the zone being the untouched area for preservation of natural processes and habitats, unique flora and fauna features, but implying intervention into habitats in the form of control of reedbed expansion, promotion of bulrush growth and expansion, opening of the lakes (open pools that were created by the LIFE 2001-2006 project), ecological recuperation of the ditches, monitoring of alluvial plains, control of natural succession and selection and elimination of alien to oak species;

What is really done: the area has been untouched except for the LIFE projects in 2001-2006 described below.

The objectives for **the Partial Protection Area** were set as follows:

- area for conservation of natural values of rice cultivation fields and agricultural lands;
- the rice field biotope was given the status of Area of Specific Intervention for Conservation of Natural Values since it has rich fauna and simultaneously suffers from intensive agricultural system;
- area plan had to be elaborated in order to establish the maximum possible levels of fertilizers' use, control the groundwater level in the process of cultivation, control of overflow, drainage systems, introduction of a culture to be grown on the fields in the midperiod of Autumn-Winter;
- agricultural lands were said to be in need of reconsidering agricultural practices by respecting the Code of Good Agricultural Practices;.

What is really done: traditional agriculture continues but without fertilizers' use and substantially decreased in its area.

The Complementary Protection Area has been designed to preserve forest biotope together with agricultural lands on the hills next to the paul and serve as a buffer zone for Total Protection Area. The Area of Specific Intervention for Public Use was created to permit the implementation of reconstruction of N341/347 road on the Alfarelos/Taveiro plot.

- the biotope of forests – measures for prevention of overgrowth of fast-growing exotic tree species and their planting, as well as encouraging local forest owners to plant native tree species in the area;
- the biotope of agricultural lands – promoting respect for the Code of Good Agricultural Practices and development and application of the Zone Plan to the environmentally aggressive practices.

What is really done: the area was created as a buffer zone for conservation of Total Protection Area, forest management measures are implemented here.

Overall, Portuguese officially protected areas and their environmental centers are said to have the objectives of working with local communities, prevention of illegal hunting etc. In reality they do very few things out of those objectives due to various reasons – lack of funding sources and difficulty to get it, bureucaracy and neglection of nature conservation issues by the authorities. Current management can be described from 2 sides – conservation and development aspects.

Conservation aspect

The following conservation measures and projects have been brought to life in Paul de Arzila:

- the administration of the nature reserve managed to acquire 20 ha of the privately owned land in the 1990s;
- **LIFE Re-establishment of the Baixo Mondego marshes (1st phase) (1993-1995)** (EU, 1993). The objectives and results are in Table 3.5.

Table 3.5 Objectives and results of the project (EU, 1993)

Objectives	**Results**
key areas would be safeguarded from degradation by land purchase and subsequent management	acquisition of 12 ha of land to help safeguard the freshwater marshes from degradation
disturbance of the sites would be brought under control through surveillance by rangers	rotational organic farming of rice and corn was started and the controlled use of herbicides and pesticides investigated under the biotope management

• development of sustainable alternatives to intensive land use, such as organic farming and eco tourism, would also be promoted – including the construction of nature trails and information centres; • inform the general public on the district's ecology and natural heritage.	• nature trails were developed and guided visits / nature walks with wardens organized; • an information centre was built.

- **LIFE Porphyrio-Porhyrio project (1998-2001) –** Reintroduction of the Purple Gallinule in the Lower Mondego River Valley project – birds were brought from the research centre in Valencia, Spain; there was conducted reproduction in the wild in Coimbra and then the birds were released in the pauls (Arzila, Madriz, Taipal) (EU, 1998). The objectives and results are in Table 3.6.

Table 3.6 Objectives and results of LIFE Porhyrio-Porphyrio (EU, 1998)

Objectives	**Results**
establish a free breeding population in Arzila through the reintroduction of at least 30 animals	• reintroduction and captive breeding of the *Purple Gallinule* in the Mondego valley was achieved with success; • contribution to preparation of the EU *Purple Gallinule* Action Plan
achieve captive breeding for reinforcement of the areas subject to reintroduction	a new expanding population of the target species in Portugal was achieved and due to this, its status according to the Portuguese Red Data Book was reviewed to be changed from "threatened" to "vulnerable"
improve the habitat quality for the target species	aquatic bird fauna in general benefited from the habitat improvement measures undertaken by the project
raise the awareness of the population	awareness raised among students, the one aimed at the local adult population was weak in some areas, which may be partially explained by thepopulation, traditionally unaware of nature conservation issues
develop and apply a monitoring technique based on the identification of individual vocalisations.	developed and applied

- **LIFE Palustris – Palustris (2001-2006) –** Management of the Special Area of Conservation of the Marsh of Arzila: 34 ha acquired for state property, open water pools created, reduction of the reedbed by 40%, all the canals recovered, construction of a ringing station, construction of a macrophyte wastewater treatment plant, monitoring of species (EU, 2001; 2007). The objectives and results are in Table 3.7.

Table 3.7 Objectives and results of the LIFE Palustris-Palustris (EU, 2001; 2007)

Objectives	**Results**
draw up and partially implement a Paul de Arzila management plan to increase habitat diversity and the breeding population of target species;	habitat diversity of the marsh increased with consequent benefits to the vulnerable species;
increase all target habitats by at least 30% and see greater numbers of key species (particular targets included seeing a 20% increase in the population of ruivaco and around 3 more nesting couples of each of the Western marsh harrier and the purple heron);	the reproductive population of the Purple Heron *Ardea purpurea* doubled;
purchase 68 ha of marsh ecosystem;	33.3 ha of targeted marshland purchased from 175 land owners to be managed exclusively for conservation purposes. This extended the total area of protected marshland in Arzila to 65 ha;
reduction of the reedbank, creation of open water areas and removal of excessive sediments from the marshes;	40% of the reedbed cleared, 2 ha of open water areas created. Key vegetation types spread, sediment removed from 22 ha of marshland;
• set up facilities to treat wastewater by plants, monitor water quality and hydrology, and carry out surveillance of target species populations; • achieve a 60% decrease in organic pollution and a 40% decrease in chemical pollution;	• a total of 15 km of ditches restored in four different areas of the reserve - Vala do Meio, Vala da Costa, Ponte do Passo and Vala dos Moinhos - allowing a better control of the water levels inside the project implementation areas; • a tertiary treatment process introduced into a facility for treatment of wastewater by plants;
increase local awareness of the importance of this wetland and build an observation tower.	a 7-meter high observation tower and an elevated 60-meter pathway through the reedbed constructed.

- the area of bulrush has been gradually declining due to reedbed *Phragmites australis* overgrowth, thus, only a small part remains, and only 1 local person does the cutting nowadays;
- little has been done in the area of reedbed management. At the current stage of its growth, *Phragmites australis* needs regular cutting;

However, it is important to note that in Portugal the problem of reedbed overgrowth on wetlands is not taken as seriously as it is in Belarus, for example, since there it really threatens the huge areas of natural mires. In Portugal *Phragmites* is not a common plant species, it serves for nesting of several important bird species, such as Reed Bunting, Purple Heron, Marsh Harrier, Great Reed Warbler, so, reedbed in this case plays a significant role in habitat support.

Moreover, rice fields are perceived and they really are feeding areas for birds, so, they are also seen as a "necessary for conservation" landscape.

- the problem of White Willow *Salix alba* overgrowth has never been addressed which has been causing the transformation of the northern part of the paul into the forest (Flumm, 2006);
- water quality assessment was conducted under the ICNF supervision (Brito and Mieiro, 2006).

In 2006, a sewage treatment plant started its work at the northern edge of the paul to tackle sewage coming from the surrounding villages. It has primary, secondary and tertiary treatment phases and discharges away from the wetland (EU, 2007).

Development aspect

Paul de Arzila has the following ecotourism and environmental education facilities:

- there is an Interpretation Centre of the Paul de Arzila which has 4 employees (constructed within LIFE 1993-1995 project). Currently, little is being done by the centre due to lack of investment and initiative. What exists in the reserve is the results of the 1990s work and LIFE projects:

1. exposition of bulrush use in artisanate inside the centre (Figure A53b, Appendix);
2. bulletins, brochures and booklets from the 1990s, in Portuguese only. What is more, there is no objective to make the new ones at the moment. Absence of materials in English is not seen as a problem. Since, it is said, "we do not aim at mass tourism here, more at conservation activities" unfortunately, conservation activities are also not noticed at the moment;
3. information board near the centre with a zone division of the paul and explanation of the pedestrian route which is not easily-understandable (Figure A54, Appendix);
4. pedestrian trail – path, bridge, observation points, one of them open, two other ones closed (constructed within 2001-2006 LIFE Palustris-Palustris (EU, 2007)). See Figure A53de, Appendix;

- there is little promotion of the area: on the site of the ICNF, municipalities, VisitPortugal.com (Turismo de Portugal, 2014), some birdwatching sites, but mainly in Portuguese. Portuguese people are not interested in birdwatching that much, birdwatchers are mainly from the UK, Germany, the Netherlands, Scandinavian region, so it would be useful to focus on this group of potential visitors;
- there is no local community involvement in the process of planning and development. What is said is that young part of local community of Arzila village mostly does not know about the existence of the wetland, only if they get to know that on the school visits. What is more, local people have never regarded this area as the one in need for conservation, they just used it for their own purposes, which means a rather low level of environmental awareness from the point of view of the modern green society.

On the other hand, it is difficult to blame the people since locals are closer to nature more than anyone else, they did what they did in the past for their own good but the problem is that now the area is not used either for active agriculture or for artisanate due its degradation. It is

important to note that locals are even opposed to the management of the reserve since the establishment of the reserve set regulations of land use that deprived the people of their agricultural lands without any discussion with them and did not offer any alternative (Reis, 2008). What remains is the area itself with all its biodiversity and negative consequences of human use having a great potential for conservation projects (which need funding), promotion and use for environmental education and ecological tourism purposes, moreover, bringing income to local community and conserving the area for future generations.

The employees of the interpretation centre say they have had 2 alternatives – either stand for complete recuperation of the wetland which they did not support since human use was a natural element in the process, so the area got its new features due to that, both negative and positive ones (Leitão, 2013a). Thus, they have chosen the second alternative, to allow the wetland to develop naturally but try to slow down the degradation processes, so to say, take away negative factors and see what remains. It is a rather understandable and logical position but on condition of completing the mission of erasing negative factors – reed and willow overgrowth, non-native species of fish and crayfish, local community passiveness and deprivation of lands, lack of investment, lack of initiative on the side of the centre team.

3.2.1.8 What needs to be done and what is planned

What needs to be done

The measures that need to be taken to improve the nature conservation and ecotourism/education performance of Paul de Arzila reserve are shown in Table 3.8.

Table 3.8 Measures necessary for implementation in Paul de Arzila (Flumm, 2006)

Habitat management	**Hydrological management**	**Tourism and environmental education management**
• regular reedbed cutting in the summer. Purple Heron nesting sites are to be avoided in the process of reedcutting; • increasing the areas covered with True Bulrush and Common Cattail for Purple Gallinules by spreading these plants within the reserve;	water level control – water gauge boards installation in order to measure water levels throughout the year, dry and wet reedbed areas in the summer;	local community involvement in the management of the reserve and activities carried out;
• underwater reedcutting with an amphibious vehicle in the winter; • willow removal;	construction of sluce-weir on at least one of the 3 ditches.	info promotion of the Paul, creation of a web-site, updated leaflets in Portuguese and English.
choosing a priority species for conservation management and reed cutting, in particular. These		

are assumed to be Purple Heron, Purple Gallinule and perhaps Marsh Harrier;		
eradication of alien species by constructing isolated pools on higher grounds and attracting frogs to them in order to divide the territories of crayfishes and threatened species;		
updating maps, including constructed pools, determination % of open water cover, *Phragmites australis* reedbed, *Typha latifolia* and *Scirpus lacustris* beds.		

What is planned

Plans for the future development of the reserve are listed below:

- there planned to be organized a meeting of the Parties involved in management of the paul – representatives of the local community, the municipalities, the Ministry of Environment Spatial Planning and Energy, the interpretation centre itself to decide on function division in the management of the area;
- the new Management Plan is to be approved soon, it contains the future plans of the reserve administration. As for now, information about them was not given to me;
- construction of the other part of the road N341/347 Arzila-Granja de Ulmeiro (Leitão, 2013a; 2013c).

3.2.1.9 Water quality analysis

Water quality analysis data are located in Chapter 3.2.1, Appendix.

The main conclusion from the research data is as follows: the results of 1999 and 2011 have shown water deterioration inside the paul. Although ph, O2 saturation, conductivity levels have not reflected drastic increases or decreases, the values of the nutrient parameters for the paul have equaled or even got higher than the level of those at the points close to the pollution sources. This has been caused by the effect of the wetland since water pollutants do not accumulate in the river, their values just reflect their real amount. For the wetland it is the other process: nutrients accumulate with time and only after a certain time period they can be really diagnosed and confirmed to be present. This time seems to be actually now, negative consequences of human activities are now seen in the paul not only in the form of extensive vegetation growth or poor biodiversity, but also in the values of water quality parameters.

3.2.1.10 Wetland condition analysis

The table of evaluation is located in Chapter 3.2.2, Appendix. The overall result obtained for Paul de Arzila is 15.51 out of 25 which is a medium, closer to low result showing lack of conservation actions for the areas and its gradual degradation.

3.2.2 Paul da Tornada

3.2.2.1 Location

Paul da Tornada is a freshwater permanently flooded marsh located in the region of Centre (NUT II sub-division (Eurostat, 2014)), the sub-region of Oeste (West, NUT III sub-division (Eurostat, 2014)), part of the district of Leiria, the municipality council of Caldas da Rainha, the parish of Tornada village (ICNF, 2014a). The paul is situated right in the centre of Tornada village (Figure 3.19).

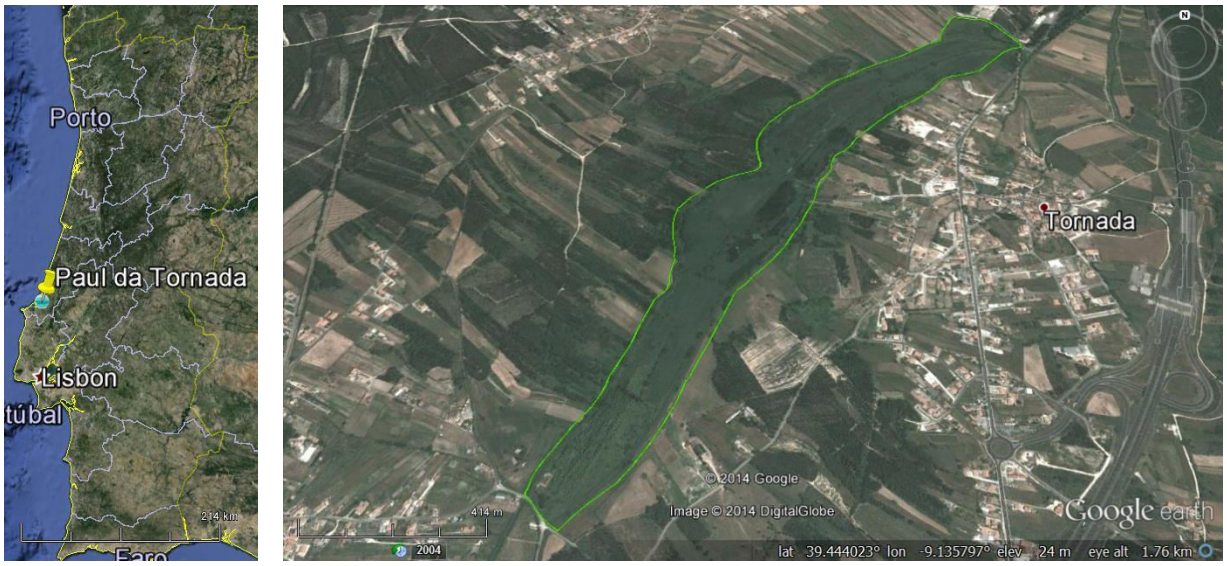


Figure 3.19 Location of Paul da Tornada (Google Earth)

3.2.2.2 History and present main features

The oldest historical references to the Tornada Marsh are associated with the creation of the city of Caldas da Rainha and the foundation of its Thermal Hospital, by the Queen Leonor de Lencastre in the end of the 15th century. The paul already existed at that time but with the name of Cornaga which then was changed in the 17th century (Lemos, 2013b).

The Tornada marsh is part of a set of lowlands created as a result of a range of sea arms that entered into the bay of São Martinho do Porto and covered the area of the paul and surrounding zones. A few centuries ago a true inland sea existed in the region, surrounded by substantial human settlements (Lemos, 2013b). The area was formed in a small alluvial plain included in a typhonic valley with extensive reedbeds and a lot of aquatic openings (Figure A68, Appendix). Geologically, due to its sea formation the valley is surrounded by the

structures of mudslides and beach sands, argillaceous sandstones, lignites and dolomites, sand dunes and limestones (Figure A67, Appendix). Hydrographically, Paul da Tornada receives the waterflow from the superficial sub-basin of Vala Real which then is connected with the Tornada River basin (Figure A69, Appendix).

With sea retreat, the area gradually got its present hydrographic regime: the central zone stayed flooded most of the year, encircled by land covered with water only during the winter. Approximately in the 13th century the margins of the area started to be used for agriculture, later cultivated for the needs of the Thermal Hospital. The ditches are supposed to have been opened in the 16th century (Lemos, 2013b). Various owners have followed one another.

The next references about the paul are only in the 1960s when the margins of the paul started to be used for vineyards and rice cultivation. Moreover, there existed species of bamboo collected for making mats.

In the next decades the paul has gone through degradation due to the nearby industries, unregulated livestock farms, sewage from Caldas da Rainha. There is evidence that in the dry periods of the 1980s the pollutant discharges could be seen and a lot of animals were dead (Lemos, 2013b). Later the area had been abandoned until non-governmentla organizations Association PATO (A Associação de Defesa do Paul de Tornada) and GEOTA took preservation and recuperation measures in 1988 (PATO, 2014). Since 1992 the site has been rented by GEOTA. In 2001 the area became a Ramsar site (Wetlands International, 2014). In 2009 Paul da Tornada received the status of Local Natural Reserve (ICNF, 2014).

So the marsh now represents a central permanently inundated part of 25 ha divided in the middle by the drainage ditch of Vala de Meio and limited in the east and the west by two drainage canals (Vala de Guarda Mato, Vala de Palhagueira), coming from small streams at the south end of the marsh (Lemos, 2013b). In this flat zone the canals run until the northeast end of the wetland where they join. The system of ditches goes further to the north where the waterflow converges into the Tornada River and further flows into the bay of São Martinho do Porto. The permanent inundation of the Paul is explained by the fact that the groundwater level is very high due to the existence of the aquifier. The surrounding area gets inundated in the rainy season although the area of the paul has the fewest amount of precipitation in the region (Lemos, 2013b).

3.2.2.3 Protection regimes

Paul da Tornada has the following national, European and international protection statuses:

- **National** – Local Nature Reserve (Reserva Natural Local, established in 2009), part of Reserva Ecológica Natural, Reserva Agrícola Nacional (2008), National Network of Protected Areas (Rede Nacional das Áreas Protegidas, 2009), "natural areas" by Caldas da Rainha municipality (2002) (Lemos, 2013b);

Logo of the reserve (Figure 3.20) shows European Otter *Lutra lutra* as a key species.

Figure 3.20 Logo of the reserve (ICNF, 2014a)

- **International** – Ramsar Site established in 2001 (Wetlands International, 2014).

3.2.2.4 Area size and zoning

Tornada Marsh has an area of 50 ha, out of which 25 ha are permanently inundated and form a central zone: part of it is open water area with deeper zones representing small lakes.

Localization of the paul is shown on Figure 3.21.

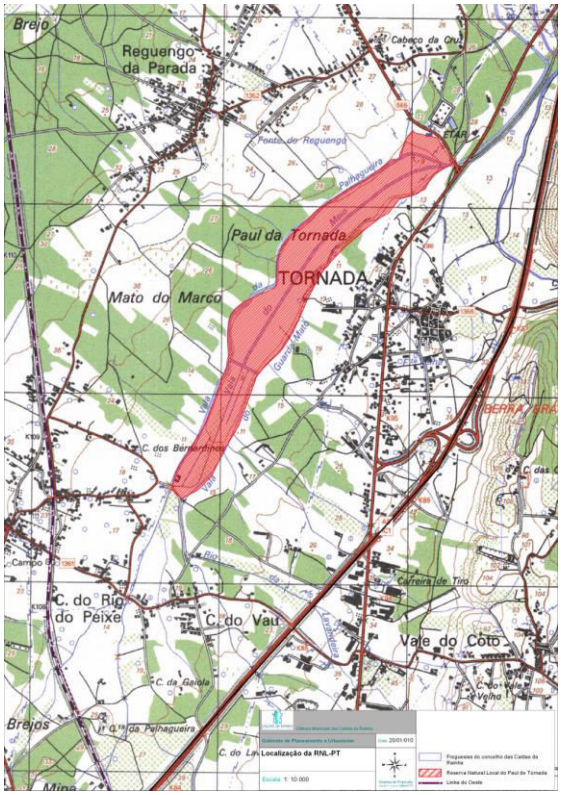


Figure 3.21 Localization of Paul da Tornada on the physical map (Lemos, 2013b)

Dominant vegetation is Water Smartweed *Polygonum amphibium L.*, Rigid Hornwort *Ceratophyllum demersum L.*; True Bulrush *Scirpus lacustris* on the margins of the central zone (Lemos, 2013b).

- semi-inundated area is mostly covered with Common Reed *Phragmites australis*. There are also other plant species forming "carpets" on the water surface, and trees like Grey Willow *Salix atrocinerea* and Black Poplar *Populus nigra* around the paul (Lemos, 2013b);
- areas to the west and south of the paul, inundated only in the winter used for agriculture to a small extent due to the hardly suitable conditions: April/May – planting of tomatoes, potatoes, corn, wheat, oat, pumpkin, cabbage, alface; between the inundated areas and the southern point of connection of 3 ditches – zone of corn and hybrid sargo growing in the summer;
- the surrounding forested areas are mostly covered with Maritime Pine *Pinus pinaster* and some Tasmanian Blue Gum *Eucalyptus globulus* (Lemos, 2013b).

The zoning described above is reflected on the map of landscape units from the Management Plan (Figure A70, Appendix). Reed beds dominate the paul area.

3.2.2.5 Natural values of Paul da Tornada

According to Lemos (2013b), the paul possesses rare fauna species as well as carries out multiple functions for them:

- 145 bird species;
- 1 critically endangered species – Whiskered Tern *Chlidonias Hybrida*, 3 endangered species – Black-Crowned Night Heron *Nycticorax nycticorax*, Aquatic Warbler *Acrocephalus paludicola*, Purple Heron *Ardea puprurea*;
- major importance for migrating birds as wintering areas: Northern Shoveler *Anas clypeata,* Eurasian Teal *Anas crecca,* Gadwall *Anas strepera,* Grey Heron *Ardea cinere,* Common Pochard *Aythya ferina,* Common Snipe *Gallinago gallinago,* Spotted Crake *Porzana porzana,* Goldcrest *Regulus regulus*;
- important for some migratory species that stay a few days resting and feeding before finishing their journey: Sedge Warbler *Acrocephalus schoenobaenus,* Eurasian Wigeon *Anas Penelope,* Garganey *Anas querquedula,* Bluethroat *Luscinia svecica*;
- breeding site for some species that are threatened in most parts of their own biogeographical area: Eurasian Reed Warbler *Acrocepalus scirpaceus,* Great Reed Warbler

Acrocephaalus arundinaceus, Purple Swamp-Hen *Porphyrio Porphyrio*, Purple Heron *Ardea purpurea,* Squacco Heron *Ardeola ralloides,* Black-winged Stilt *Himantopus himantopus,* Little Bittern *Ixobrychus minutus,* Savi's Warbler *Locustella luscinioides;*
or to species that breed in this region and feed on the wetland or on the surroundings: Common Swift *Apus apus,* Alpine Swift *Apus melba,* Rock Dove *Columba livia,* Common Wood Pigeon *Columba palumbus,* Common Cuckoo *Cuculus canorus*;

- important for some fishes such as Conger-eels *Anguilla anguilla*, a migratory species threatened by water pollution and illegal fishing;
- 18 species of mammals, habitat for some threatened mammals such as iberian endemics Iberian Shrew *Sorex granarius,* Western Meditteranean Mouse *Mus spretus;* Greater White-Toothed Shrew *Crocidura russula,* Least Weasel *Mustela nivalis,* European Badger *Meles meles,* European Otter *Lutra lutra*;
- 12 species of reptiles such as European Pond Turle *Emys orbicularis,* Mediterranean Turtle *Mauremys leprosa,* iberian endemic of Schreiber's Green Lizard *Lacerta Schreiberi*;
- 8 species of amphibians, 2 iberian endemics Bosca's Newt *Triturus boscai,* Portuguese Painted Frog *Discoglossus galganoi*;

3.2.2.6 Current state: threats

During the Preparation of the Management Plan SWOT analysis (Table 3.9) was conducted and the matrix developed with strong and weak points of the paul performance and opportunities and threats for its development (Lemos, 2013b).

Table 3.9 SWOT-analysis of Paul da Tornada (Lemos, 2013b)

Strengths	**Weaknesses**
• biodiversity; • species with high status of conservation; • environmental NGO working in the area; • localization; • existence of the Interpretation Centre; • activities on environmental education; • birds monitoring; • knowledge about the area; • being Local Natural Reserve; • being Ramsar Site; • existence of technical support; • proper management of the site	• little promotion; • hardly an attractive environment; • infesting exotic species; • unattractive or absent trails; • lack of infrastructure for visits; • lack of parking; • absence of information boards, signs; • domestic and industrial pollution; • urban pressure; • localization; • weak demand; • lack of retaining strips to prevent fires on the margins of the ditches; • lack of investment; • energetically unsustainable building of the centre;

	• lack of marking of the reserve boundaries; • lack of room for exhibitions, café, restaurant
Opportunities	**Threats**
• possibility to function in the network with the other wetland sites; • organization of better access to the area; • integration into the programmes of study visits; • can be a recreation area; • possibility to get community funds; • rise in ecotourism; • change of consumption habits; • increase in activities of birdwatching; • promotion of higher environmental awareness and social responisibility of the entreprises; • rise in the number of qualified specialists (more employment); • social networks on the Internet (promotion); • thematic promotion of visits; • promotion of internships; • creation of restaurant, tourism facilities; • organization of camps; • deeper cooperation with universities; • use of renewable energies; • local development; • rural tourism development	• lack of guarantees of long-term funding; • illegal hunting; • illegal capture of birds; • possibility to exceed loading capacity of the site; • landscape planning and urban pressure; • maintenance of pollution cases in the paul basin; • increase in the number of industries in the paul basin; • increase in vandalism cases

Analysis of the SWOT matrix shows that the strengths of the reserve performance result from its biodiversity, localization and successful conservation initiatives carried out within the past projects.

The weaknesses reduce the integral use of the site potential, they mainly result from the inadequate measures on provision of sustainable and regulated visits in the past.

The opprotunities listed guarantee that the reserve can turn into the area of conservation, recreation, study and collective learning.

Below the views of the paul are shown indicating current state of the site (Figure 3.22).

Figure 3.22 Views of Paul da Tornada (Lemos, 2013b; Malashevich, 2014b)

3.2.2.7 Management: past and present

The complete wetland area is a private property. Currently it is rented by GEOTA (an environmental national NGO), together with PATO (self-funding) and receiving some financial support from the ICNF and the Municipal Council (Câmara Municipal de Caldas da Rainha) (Lemos, 2013b).

The first Management Plan (Plano de Gestão) of the reserve was developed in 2010 (Lemos, 2013b). That one has been revised and given to the author for analysis. It must be noted that management concept of Paul da Tornada is completely different from the other research sites in Portugal, the approach is modern and practically oriented. The main features and priorities of the Plan are set as follows (Lemos, 2013b):

- the Management Plan has been the result of cooperation between central administration (ICNF), local administration (municipality of Caldas da Rainha) and NGOs of PATO and GEOTA;
- there has been applied the concept of proactive territorial management with the mission to conserve, valorize and promote the natural heritage of Paul da Tornada through its research and interpretation, sustainable use, and connection with the community as an area for education and recreation;
- priorities:

1. maintain, enhance and promote natural values of the site;

2. boost the site development as a platform for education on sustainable development, in cooperation with civil society, regional and local entities;

3. develop an innovative model of the site operational management;

The actions in the plan were developed within the 3 priority goals for various time periods within 2010-2016. Among these actions the key ones are as follows (Table 3.10):

Table 3.10 Key actions of the Management Plan (Lemos, 2013b) and their fulfillment

2010	Fulfillment
Elaboration of candidature for community funds receipt "Active management of protected and classified areas"	Fulfilled
Identify exotic infesting species	Fulfilled
Facilitate elimination of sewage discharge	Fulfilled, protocols with the involved entities
Sign collaboration protocols with investigation centres	Fulfilled
Create a web-site of the reserve	Fulfilled in 2011
Maintain the station for monitoring paludal and aquatic bird species	Fulfilled
Plan the system of trails for visits with information boards, signs	Fulfilled in 2011
Develop a model implementation and revision of the Plan	Fulfilled
Plan the work group and their responsibilities for on-time implementation of each action of the Plan	Fulfilled
Organize annual meetings of the Strategic Council and meetings with members of various entities involved in the Plan implementation	Fulfilled regularly
2011	
Develop a programme on reed management and implement actions on its cutting	Fulfilled and done regularly
Maintain the roads necessary for fire prevention	Regular control
Remove infesting exotic species of plants	Fulfilled
Plant trees and bushes of riparian galleries (ash,willows, common cattail, true bulrush)	Fulfilled
Conduct a research on pollution sources of the paul basin and monitor water quality	Research conducted, regular monitoring
Inventory and monitoring of ducks, otter, bats, turtles, dragonflies and butterflies, fish and amphibians	Conducted regularly during the year
Replan and rebuild the interpretation centre	Fulfilled
Organization of guided visits, cooperation with tourism entreprises	Fulfilled, regular visits
Employ a professional intern, attract student interns for projects	Fulfilled
Participate in public events	Fulfilled
Develop a database on flora, fauna, habitats and conservation measures in the reserve	Not fulfilled, in the process
Purchase lab equipment	Fulfilled
Submit an application of a candidature for community funds receipt	Fulfilled
2012	
Plan creation of the system of the paul basin for mitigation of urban pressure	Not fulfilled
Construct the trails and set inforboards, signs	Not fulfilled

Develop a booklet for visitors	Fulfilled
Improve access to the centre	Fulfilled
Organize a technical seminar about the reserve	Fulfilled

The information showed above is an evidence of a rather efficient work of the reserve in the recent 5 years. A lot of planned measures were implemented although there are a lot of them to still plan and bring to life.

Conservation aspect

Conservation work in Paul da Tornada has been led in the following directions:

- there are some scientific projects in collaboration with the Universities (Faculdade de Ciências da Universidade de Lisboa; Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa; Faculdade de Ciências da Universidade de Coimbra) and ICNF (Lemos, 2013a);
- under the Management Plan the following measures were planned (Table 3.11), they were mostly implemented in 2010-2012 or are being implemented regularly in the reserve.

Table 3.11 Conservation actions of the Plan (Lemos, 2013b)

Identify exotic infesting species
Facilitate elimination of sewage discharge
Sign collaboration protocols with investigation centres
Maintain the station for monitoring paludal and aquatic bird species
Develop a programme on reed management and implement actions on its cutting
Maintain the roads necessary for fire prevention
Remove infesting exotic species of plants
Plant trees and bushes of riparian galleries (ash,willows, common cattail, true bulrush)
Conduct a research on pollution sources of the paul basin and monitor water quality
Inventory and monitoring of ducks, otter, bats, turtles, dragonflies and butterflies, fish and amphibians
Develop a database on flora, fauna, habitats and conservation measures in the reserve
Purchase lab equipment Plan creation of the system of the paul basin for mitigation of urban pressure

However, the measures on reed cutting taken in 2010-2012 are of a very small scope and have not contributed to the overgrowth prevention. Cutting must be carried out urgently for the bigger areas.

All the other actions are also implemented to a small extent. This can not stop landscape degradation if time management is not replanned.

Development aspect

The following measures were planned and partially fulfilled within the Managemetnt Plan (Table 3.12).

Table 3.12 Development actions of the Plan (Lemos, 2013b)

Create a web-site of the reserve
Plan the system of trails for visits with information boards, signs
Replan and rebuild the interpretation centre
Organization of guided visits, cooperation with tourism entreprises
Employ a professional intern, attract student interns for projects
Participate in public events
Construct the trails and set inforboards, signs
Develop a booklet for visitors
Improve access to the centre

As a result, the reserve now has the following conditions for ecotourism and environmental education activities:

- CEEPTA, ecological and educational centre of the paul opened in 2000 (Figure A71, Appendix; PATO, 2014), which is responsible for organization of various activities and ecotourism facilities such as: pedestrian trails in the paul, educational workshops on recycling, construction of nests and feeding platforms, aromatic and medical plants, organization of exhibitions, meetings, commemoration of environmental events;
- there is an information kit for teachers, booklets for visitors in Portuguese (the new one is being prepared with an English version inclusively (Lemos, 2013c));
- there is an unequipped pedestrian trail (Figure A72, Appendix);
- visitors are mostly school children, there are sometimes foreign tourists but very rarely (Figure 7A2, Appendix) (Lemos, 2013a), promotion is very low;

There is no stats on the number of visitors in the recent years but the approximate number annually is 3000-5000 people (Lemos, 2013c), most part of them being schoolchildren on the organized visits.

- rudimentary laboratory has been created to allow scientific research for nature conservation on the site, there are sleeping places on the 2nd floor of the centre, together with binoculars and spotting scope for visitors (Lemos, 2013b);
- guided visits are offered to public if booked previously to visit (Lemos, 2013a).

3.2.2.8 What needs to be done and what is planned

What needs to be done

The following measures need to be taken to improve the nature conservation and ecotourism/education performance of the reserve:

- search for long-term investment;
- habitat management – reedcutting, removal of bushes, for both conservation and attractiveness purposes;
- more active promotion of the site among potential tourists;
- basic tourist facilities, e.g. possibility of use of the 2nd floor of the centre for accommodation of tourists, not only researchers, information boards, trails, observation points;
- involvement of local community members in the activities carried out by the reserve.

What is planned

Paul da Tornada has the following plans for the future:

- there planned to be constructed 2 observation towers and a short wooden trail with an information board about birds of the paul. A small area of reeds and trees has been cut and cleaned for this future construction, edges of he marsh are to be cleaned for better visibility;
- updated booklet in Portuguese and English is to be published;
- revised actions of Management Plant to be implemented further (Lemos, 2013a).

3.2.2.9 Water quality analysis

The data for evaluation of water quality at Paul da Tornada are located in Chapter 3.2.2, Appendix. The results of the analysis clearly indicate ongoing pollution in the paul by the high levels of nitrates, phopsphates and ammonia. The measures already taken by the administration of the reserve do not seem to influence the problem since there has not been registered any decrease in the nutrients' level. However, the regular assessment of the water quality in the future could determine the efficiency of the conservation actions since the improvement of conditions in the paul needs time to be reflected in the water quality parameters.

3.2.2.10 Wetland condition analysis

The table of evaluation is located in Chapter 3.2.2, Appendix. The overall result obtained for Paul da Tornada is 17 out of 25 which is a medium value showing that the paul is polluted with nutrients, suffers from drainage in the past being severely overgrown and is involved in few conservation actions.

3.2.3 Paul do Boquilobo

3.2.3.1 Location

Paul do Boquilobo is a freshwater marsh located in the region of Alentejo (NUT II sub-division (Eurostat, 2014)), the sub-region of Lezíria do Tejo (NUT III sub-division (Eurostat, 2014)), on the right bank of the Tagus river (in the hydrographic basin of the River Almonda), part of the district of Santarem, the two municipality councils (Golegã and Torres Novas) and the parish of Azinhaga village (Pereira, 2013b). Location is shown on Figure 3.23.

Figure 3.23 Location of Paul do Boquilobo (Google Earth)

3.2.3.2 History and present main features

Paul do Boquilobo was formed in the transition zone between alluvial plain (corresponding mostly with Total Protection Zone) and fluvial terraces (the other Areas, zoning is described further in the text) (Pereira, 2013b).

The alluvial plain was once an area of the River Almonda itself and surrounding seasonally inundated lands, now it is an area of the River Almonda, riparian galleries with willows and ashes, drainage ditches. So, the area has been in agricultural use (rice cultivation with Poplar surrounding the fields) for a long time, supported by the drainage procedures of the 20th century (Pereira, 2013b). As a result, the hydrographic basin of the river was drastically changed by the network of multiple ditches.

With the establishment of the reserve in 1980 part of the area has gone through the regeneration process, the other one has continued to be used in agricultural practices. The research data (Pereira, 2013b) show consequent abandonment of lands by 1999.

The hydrographic system of the paul as an agricultural area has functioned in the following way: floods from the Tagus River naturally inundate the site starting from October-November and part of it subsequently dries out when the water table is mechanically lowered in spring to create larger areas for cultivation. The site may also act as a flooding buffer zone contributing to increased protection of adjoining farmland areas against erosion caused by winter floods. For many years this wetland has been a valuable sink for alluvial particles carried in by the Tagus River creating rich cultivated areas, which have contributed to the economic wealth of the area (see Figure A80, Appendix).

Fluvial terraces in the western part of the reserve were traditionally covered with cork oaks, rice fields and olive trees, later fig trees, irrigated crops cultivation appeared. By the 1980s there had started transition to planting sunflower, tomatoes, melon, irrigated corn, beet, vineyards, land use for pastures, cork oaks with irrigated corn having become the dominant culture.

In the last 50 years, the area of the reserve was the property of 3 farm estates - Quinta do Paul do Boquilobo, Quinta de Mato Miranda and Quinta da Broa, the first one once belonged to the Knights Templar and the Order of Christ (Pereira, 2013b).

Before reserve creation the paul was an area belonging to Quinta do Paul do Boquilobo as a hunting area. Now it is still belongs to the same family. What is left are 3 families of farmers and their houses (earlier there were 13 families), a church, and a farming area of olive trees, cork oaks where there are still 5 tractor drivers and 1 guard (Pereira, 2013b).

In the area of Quinta de Mato Miranda there was a vineyard, olive trees grown in the 1920s, then added cork oaks, wheat (did not grow well), then corn and sunflower in the 60s, and experiments on animal farming (cows and pigs) (Pereira, 2013b).

Now the use of land is much less intensive. Land use regimes can be seen on Figure A83, Appendix. However, the drainage and intensive agriculture in the past have led to overgrowth of ditches with reeds, bulrushes, sedges and willows.

3.2.3.3 Protection regimes

Paul do Boquilobo has the following national, European and international protection statuses:

- **National** – Nature Reserve (Reserva Natural, established in 1980 (ICNF, 2008));

Logo of the reserve (Figure 3.24) shows Purple Heron as a key species.

Figure 3.24 Logo of the reserve (ICNF, 2014e)

- **European** – Special Protection Area, Rede Natura 2000 (ICNF, 2014b);
- **International** – Biosphere Reserve (the only Portuguese protected area in the World Network of Biosphere Reserves of UNESCO) (ICNF, 2014a), Ramsar site established in 1996 (Wetlands International, 2014), Important Bird Area (ICNF, 2014b).

3.2.3.4 Area size and zoning

The reserve has an area of 817 ha (ICNF, 2014b) which, as it has already been mentioned, is a transition zone between alluvial plain and fluvial terraces.

By the reclassification of 2008 the reserve got its new division system into Total Protection Area, Partial Protection Area, Complementary Protection Area and Area of Specific Intervention. The state has bought almost the whole area of Total Protection Zone which allows for protection of the central core of the paul from the direct human disturbance. According to ICNF, 2008 and ICNF, 2014b, the paul is divided into the following zones (Figure 3.25):

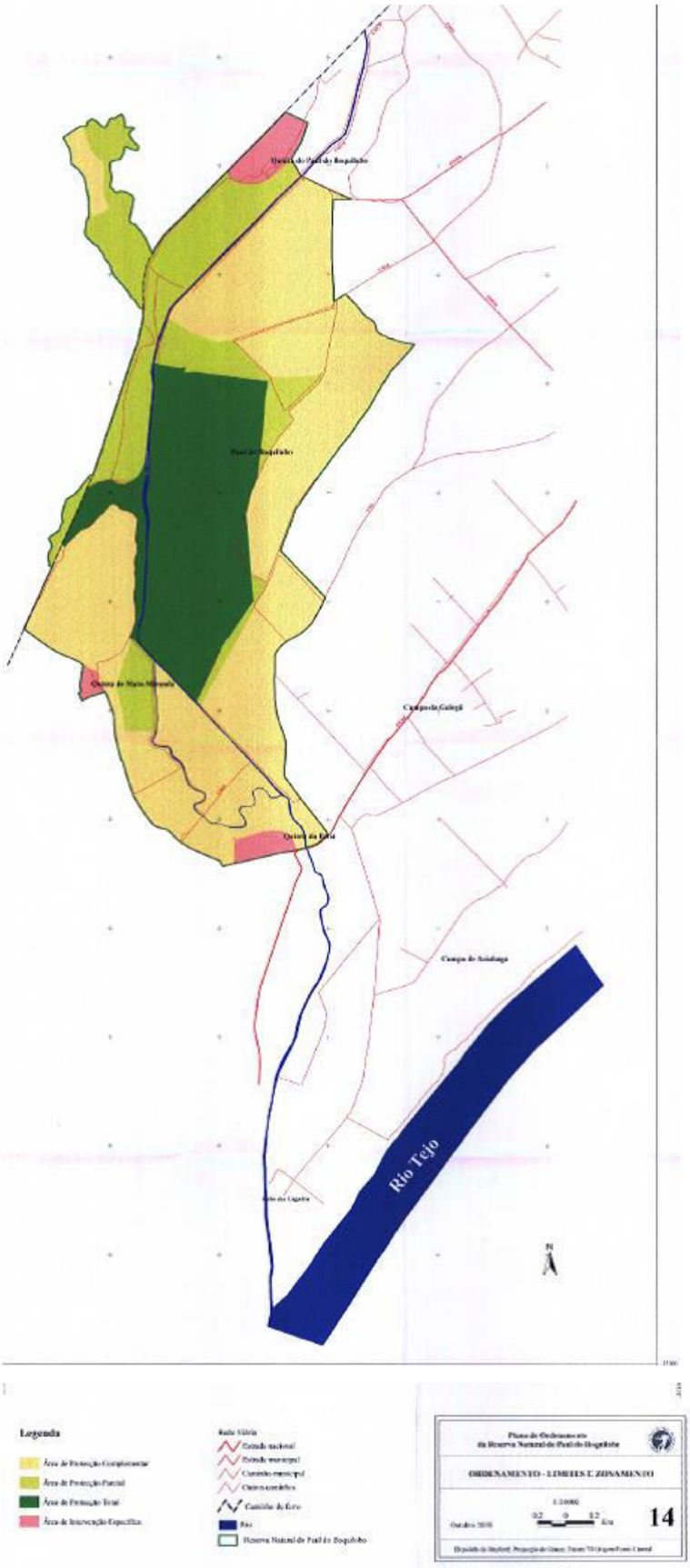


Figure 3.25 Zoning of the paul (Pereira, 2013b)

Total Protection Area 189 ha – permanently inundated areas, with limited access only for conservation obectives;

Partial Protection Area 167 ha – temporarily inundated or not inundated areas, used for pastures, fishing and conservation activities;

Complementary Protection Area 436 ha – agricultural lands, with requirements for sustainable use of natural resources for well-being of the former 2 areas;

Area of Specific Intervention 25 ha – estates, buildings associated with history of the paul, above mentioned quintas.

The main part of the reserve area is covered with the wetland area, further by percentage of cover go agricultural lands, water areas, and forest lands. The distribution of lands among various landscapes and activities is shown on Figure A82-A83, Appendix.

3.2.3.5 Natural values of Paul do Boquilobo

According to ICNF (2014b) and Pereira (2013b), the site possesses the following unique features and fauna species:

- important wetland site with excellent conditions for wintering, nesting and support of migratory routes of many aquatic bird species especially such as Herons (*Bulbucus ibis, Egretta garzetta, Nycticorax nycticorax, Ardea purpurea, Ardea cinerea, Ixobrychus minutus* e *Ardeola ralloides*) and Eurasian Spoonbill *Platalea leucorodia*. During nesting season they form the biggest concentrations in the country;
- during winter season the paul is a gathering site for ducks, Purple Swamphens, Coots, representing 47 % of national winter population of Northern Pintail *Anas acuta*, 35 % of Common Pochard *Aythya ferina*, 12 % of Shoveler *Anas clypeata*;
- threatened species like Aquatic Warbler *Acrocephalus paludicola*, Water Pipit *Anthus spinoletta* and Bluethroat *Luscinia svecica* can be seen here;
- important role in regulation of hydrological system and improvement of water quality, absorbing excess water during rainy season and feeding groundwater during dry periods.

Overall there were identified the following numbers of various species in the paul:

- 16 fish species, including 2 lusitanian endemic species Boga portuguesa *Chondrostoma lusitanicum* and *Rutilus macrolepidotus*;
- 11 reptile species;

- 13 amphibian species, including 4 iberian endemics Iberian Newt *Triturus boscai*, Iberian Frog *Rana iberica*, Iberian midwife toad *Alytes cisternasii*, Iberian Painted Frog *Discoglossus galganoi*;
- 27 mammal species, among them European Otter, European Polecat;
- 226 bird species.

3.2.3.6 Current state: threats

According to Pereira (2013b):

- the problems in the area are caused by the drainage canals constructed up the River Almonda stream to the north of the reserve and in the paul itself which disturbed the natural hydrographic system of the area and waterflow from the Rivers Tagus and Almonda, in particular. The paul gets water renovation from them only during high floods which are not regular, the water it gets regularly is of poor quality and from secondary sources;
- fishing and hunting practices allowed in the big part of the reserve – 2 hunting and 2 fishing zones within the forest and water area inside and outside the paul;
- there is an exotic invasive species of Louisiana Crayfish that has already been mentioned in the Paul de Arzila characteristic. There have not been any researches on that in Paul do Boquilobo;
- there is an American plant species of Water Hyacinth introduced in the 1970s that has invaded the area (which is an indicator of its water pollution and excess of nutrients) and threatens the whole ecosystem forming vast patches on the water that decrease oxygen accessibility and harm potential biodiversity;
- urban and industrial pollution from the villages of Riachos, Entroncamento and Golegã (pig farms) with pollutants reaching the western part of the reserve (nesting sites of lots of bird species), agricultural pollution (nutrients and plastic).

It is important to note that all the pollution sources, except for agriculture, are located outside the reserve. The problem here is malfunctioning of sanitation system in the Almonda basin;

- lack of activities at the interpretation centre of the paul, lack of promotion of the reserve as an ecotourism destination.

The views of the paul at present are shown below (Figure 3.26).

Figure 3.26 Views of Paul do Boquilobo (Malashevich, 2014b)

3.2.3.7 Management: past and present

The reserve is managed by its administration, with the help of the municipalities. A big part of the lands have been bought from the various landowners by the state (177 ha, 150 ha of which is Total Protection Area (ICNF, 2014b).

The main agricultural users for now are 3 above mentioned estates, the agriculturers of Golegã and Azinhaga to the east of the paul, the ones of Riachos and Golegã to the north. To the west of the reserve are pastures (goats, sheep) of people from Brogueira and Alcorochel. Fishers are mostly people from Azinhaga village (Pereira, 2013b).

The Paul Management Plan was approved in 2008.

The development strategy of the paul aims first of all, at (ICNF, 2008):

- conservation of natural values (herons colony, palearctic birds' wintering sites) of the central part of the paul with permanently inundated lands;
- maintenance of the sesoanlly inundated lands and areas of extensive use between the central part and peripheral part of intensive agricultural use;
- reestablishment of water connections with the Tagus and Almonda Rivers and clearing of the ditches to widen the inundated areas and stop the ongoing reduction of the wetland;
- recuperation of riparian galleries;
- sustainable management of resources for adequate agricultural, fishing, forestry practices and land use for pastures;
- proper management of area use by public visitors, its recreational use for educational purposes, its use as a laboratory for research.

To achieve this, the reserve has been in collaboration with the organisations working in agriculture, farming, research and education, and also in a permanent dialogue with the authorities (Pereira, 2013a).

Conservation aspect

There were planned the following measures in the reserve by the 2008 Management Plan (ICNF, 2008; Pereira, 2013b):

Total Protection Area:

- establishment of Additional Water Treatment Station for supplemental purification after ETAR, and construction of dam system in the Almonda basin for providing water supply in periods of high floods;
- reconstruction of an old ditch which connects Total Protection Area with Valado da Estrema in Várzea do Canto dos Trancos;
- construction of a new ditch to create a protection zone between agricultural lands and Total Protection Area;

Partial Protection Area:

- creation of a pedestrian trail which exists in the unequipped form, the other route for observation of habitats, and organization of camping places;
- construction of the gate for management of ETAR effluents and their redirection into the River Almonda in case of accident of malfunction – this measure is hard to understand, obvious is the fact that it is taken for protection of agricultural fields and not for improvement of water quality;
- regeneration of connection between the Tagus and the paul through the system of alvercas of Golegã, using existing ditches, which will allow water renovation both in the paul and alvercas not depending on flood season;

What is being done:

- control of water level in the paul is continued to be done through the existing system of ditches using the following rules: upon the start of rainy season the gates are kept open for water renovation until the water level is 1.5 m or a bit higher, the gates are kept closed as long as the water level is 1.5 m;
- permanent monitoring of fauna (especially avifauna) in the form of regular bird counts by the paul employees (Pereira, 2013a);
- there exist agreements with various educational institutions of secondary and polytechnic level on monitoring environmental conditions in the paul, water and soil quality in particular;
- as a result of 2 previous points – rich photo database on the evolution of the area (Pereira, 2013a);
- there have been the bird conservation projects, e.g. the one on placing nests at particular points to enhance nesting of certain bird species (Pereira, 2013a);
- there is currently a project on conservation of a rare plant species *Narcissus fernandesii,* aimed at its establishment on the new lands acquired by state (Pereira, 2013a);

- there has been a permanent collaboration dialogue with Torres Novas municipality within which there is a current project with community funds on improvement of sanitation conditions in the municipality which would resolve the pollution problem in the reserve also (Pereira, 2013a);
- the efforts to tackle the negative consequences of drainage ditches construction have been faced with lack of human and financial resources.

Development aspect

The paul possesses the following facilities for ecotourism and environmental education:

- the paul is open to visitors (tourists, scientists, students) supporting the main objective of nature conservation (Pereira, 2013a). There is a partially equipped pedestrian trail that can be done independently by visitors (Figure A84, Appendix), with information boards, observation tower (Figure A85, Appendix) which is hard to find due to overgrowth with bushes. Requests for guided visits are also accepted (Pereira, 2013a);
- there is an Interpretation Centre with an exhibition on the paul. However, the timetable of the paul centre is rather irregular;
- there are no updated booklets (only the old ones in Portuguese), little promotion (sites of ICNF, municipalities, birdwatching sites, with information mainly in Portuguese) and no web-site;
- there are 2 enterprises licensed to organize pedestrian walks in the reserve (Pereira, 2013a).

3.2.3.8 What needs to be done

There is no information on future plans of the reserve. So, the necessary measures are listed below:

- renovation of the proper connection with the Rivers Tagus and Almonda;
- elimination of pollution sources, cooperation with the entities involved in the problem;
- research and plan for elimination of invasive plant and animal species;
- more active promotion of the site, development of the strategy on working with visitors, creation of a web-site;
- clearing of certain areas accessible for visitors from the bushes and trees;
- installation of infoboards, plan on organization of accommodation, other tourism facilities;

- development of a new booklet in English and Portuguese;
- revision of the Management Plan and proper management of its implementation, distribution of responsibilities among the administration members;
- regular control of the actions implemented within the Management Plan.

3.2.3.9 Water quality analysis

The research data and results are located in Chapter 3.2.3, Appendix. The results of the analysis give a clear evidence of the ongoing penetration of the pollutants into the paul. Though the nutrients' values are not in the critical range for the paul itself, their values outside the site show high pollution levels. Moreover, the data for the analysis point inside the site were available only till 2005 which increase the possibility of the current values being much higher. The exact information could be obtained in case of conducting present analysis at the 2 points and comparing the results.

3.2.3.10 Wetland condition analysis

The Table of evaluation is located in Chapter 3.2.3, Appendix. The overall result obtained for Paul do Boquilobo is 16.66 out of 25 which is a medium value showing that the paul suffers from the ongoing pollution, drainage and intensive agricultural use consequences and lack of conservation actions.

3.2.4 Peatbog in Lagoa de D. João

The peat bog in Lagoa do Dom João is part of the mountainous range of Serra de Montemuro in the north of Portugal, however, no management regulations are applied to it, no nature conservation and tourism activities carried out, few factors threatening its well-being (fires, cattle). The site is completely natural and almost untouched. The reason for its including into the research list was stated in Introduction. The characteristic of this peat bog does not provide information on efficient wetland management since its location and use have guaranteed its conservation. However, it is important as the only peat marsh among the Portuguese research sites and peat ph analysis can serve as a confirmation of its high conservation status.

3.2.4.1 Location

The peat bog is situated in the north of Portugal, the mountainous region of Serra de Montemuro, the region of Norte (NUT II sub-division) (Eurostat, 2014), the sub-region of Tâmega (NUT III sub-division), the district of Viseu, the council of Resende, the parishes of Panchorra and Feirão (Profico Ambiente, 2006**).** Location is shown on Figure 3.27.

Figure 3.27 Location of the bog (Google Earth)

3.2.4.2 History and present main features

Serra de Montemuro, where the peat bog is situated, is bounded by the River Douro on the north and by the River Paiva in the south and southwest (Espírito de Aventura, 2013). It is a

very important site for conservation of species such as wolf and water-mole. The dominated flora is English oak *Quercus robur* and Maritime pine *Pinus pinaster* (Turismo de Portugal, 2014b). Serra de Montemuro is known for its granitic valleys with stones scattered around the mountain areas.

The peat bog in Lagoa do D. João is a typical one for the Portuguese mountains. Such peatbogs form on the mountain platforms with lowland parts which were part of marine areas in the past (Terra Nossa, 2006): the geological conditions were created, rainwater was gradually collected in the shallow lakes where Sphagnum moss grows easily, organic matter accumulates and decomposes turning into peat.

Mountain peat bogs are formations of high importance because they are used as pastures by locals. However, it is necessary to note that most areas are used rather sustainably due to a small number of cattle and a low level of their disturbance since they are far from any mass tourist route. However, some of the peatbogs reflect the consequences of intensive agriculture and fires (Serra da Freita) (RTP, 2005).

The peat bog in Lagoa de D. João was formed in the same way as it was described above. It represents a lake of 3 ha and an adjacent 10 ha area of peat bog at 1110 m elevation with characteristic bog vegetation (*Sphagnum spp., Juncus aquarossus, Carex spp., Drosera rotundifolia*), water level of 0.15 m approximately.

Next to the site there is the Eolic park of D. João and Feirão which posed a threat to the peatbog in 2005 when its planning was discussed with the authorities and there was an intention to construct a trail for better access to the wind turbines which would cross the peatbog. Fortunately, this was prevented and the site was left untouched (Profico Ambiente, 2006).

Granitic stones are represented here scattered around the mountain slopes on one side and gathered into fences for cattle on the other. The site has been used for pastures and forestry, now these activities are continued. Moreover, there have been fires in the recent 40-50 years from which he peatbog suffered (Monteiro-Henriques, 2014). Anyway, like it was said above, the site looks natural and weakly disturbed, it is too far from the main tourist routes, sometimes there can be visitors but few of them, so, nature conservation and tourism at the site are not developed. Moreover, there is no need in nature conservation activities since the bog has always developed naturally.

The views of the bog are shown on Figure 3.28 below.

Figure 3.28 Views of the bog (Malashevich, 2014b)

It must be noted that the other areas of Serra de Montemuro are said to suffer the consequences of human activities: deforestation, overgrowth with bushes and shrubs due to active use of the lands for pastures. The research peat bog is least suffered of the area in this case.

What concerns tourism, it must be said, there are some tourist routes passing next to the peat bog but not directly through it (Turismo de Portugal, 2014b).

3.2.4.3 Protection regimes

The peatbog has the following national and European protection statuses:

- **National** – being part of Serra de Montemuro, it belongs to Reserva Agrícola Nacional, Reserva Ecológia Nacional, Biotope CORINE Montemuro/Bigorne (Turismo Centro de Portugal, 2014);
- **European** – part of the 1st phase of the National List of Rede Natura 2000 (Turismo Centro de Portugal, 2014).

3.2.4.4 Peat ph analysis

Ph analysis of peat at Lagoa do Dom João was carried out on 30 October, 2013. Samples were taken at 4 locations (3 samples per each location) since the peat layer depth was not exactly known.

The samples from the first 3 locations turned out to be more "earth" than "peat", so only the 4th location´s results are supposed to show the real peat ph values. Average values were then obtained (Table 3.13).

Table 3.13 Results of peat ph analysis

Location	Ph Sample 4
1	4.07
2	4.05
3	4.05
4	**4.057**

The peat ph results at the 4th location demonstrate the strongly acidic character of peat (low values of ph) which is typical of a natural peat bog.

The value of the von Post Decomposition Index is 3 which means "very slightly decomposed peat which, when squeezed, releases muddy brown water, but from which no peat passes between the fingers. Plant remains still identifiable, and no amorphous material present" (von Post Decomposition Index Figure A89, Appendix).

So, the analysis turns out to confirm the almost unchanged character of the site and its natural development. However, fires and further area use for pastures pose threats to future well-being of the bog.

There is no point and perspective for tourism development here. Those interested in discovering Portuguese peat bogs will find information about them. However, this part could be much better organized since there is not much database information about the Portuguese "turfeiras" on the Internet.

3.2.4.5 Wetland condition analysis

The Table of evaluation is located in Appendix. The overall result obtained for the site is 24.17 out of 25 which shows natural state of the bog and few disturbing factors with no need for active conservation actions.

3.2.5 LIFE+TRACHEMYS (Portugal)

3.2.5.1 When, where and why

The LIFE+Trachemys project on Demonstration strategy and techniques for the eradication of invasive freshwater turtles was implemented in Portugal (Algarve) and Spain (Valencia) in 2011-2013 under the LIFE+Biodiversity initiative (CIBIO, 2013a).

LIFE+ programme is a financial instrument for nature protection and conservation in the European Union which co-finances environmental initiatives in Member countries. The LIFE+Trachemys is included in the LIFE+Biodiversity section which is set to develop innovative techniques for the EU aim of "stopping biodiversity loss" (Generalitat Valenciana, 2013).

The main aim of the project, accoding to CIBIO, 2013a, was to address the issue of introduction of invasive exotic species, in particular, the negative environmental impacts on wetland environments and native freshwater turtle species of the European Pond Turtle *Emys orbicularis* and the Mediterranean turtle *Mauremys leprosa* from alien exotic turtle species, particularly the Red-eared slider *Trachemys scripta elegans* in the Mediterranean region, Spain and Portugal in particular (characterization of native and exotic species is in Chapter 3.2.5, Appendix). These impacts have been as follows (CIBIO, 2013b):

- Loss of aquatic biodiversity due to aggressive behavior of exotic turtle species (exotic turtle species are predators);
- Fast breeding mechanism and aggressive behavior towards native turtle species;
- Distribution of diseases in the aquatic habitats.

The pet turtle trade began in 1970 when the first *Trachemys scripta* were caught to reproduce in captivity. At the same time the Ninja Turtles movie was shown on TV (1987-1996) which brought pet turtle sales to its maximum. The trade has led to a large number of specimens being maintained in captivity. It is estimated 26 million individuals were sold around the world in 1989-1994. The pets were often released unthinkingly or even escaped by themselves into the wild. This could be caused by the lack of good conditions for keeping them (big size to which they can grow, aggressiveness, noise) or simply by annoyance from keeping animals for a long time since they can live for 40-50 years. Due to these releases, now *Trachemys scripta* can be encountered in rivers, lakes, parks and public gardens of Portugal as well as other European countries. Nowadays, *Trachemys scripta* is considered to

be a non-indigenous species with ecological risk in Portugal and one of the 100 most dangerous invasive exotic species in the world by the International Union for Conservation of Nature. In Portugal import of *Trachemys scripta* was forbiddem by Law in 1996, in 1999 commercialization of the species was forbidden. However, the Law lacks measures of control and application of regulations which explains the fact that turtle trade and release are still a common practice in Portugal (CIBIO, 2013b).

3.2.5.2 Project sites and institutions involved

According to CIBIO (2013a), the project included 13 areas of action in Valencia and 4 areas in Portugal. The Portuguese sites were in Algarve – 4 lakes of Ria Formosa. Below the Portuguese project sites are shown (Figure 3.29).

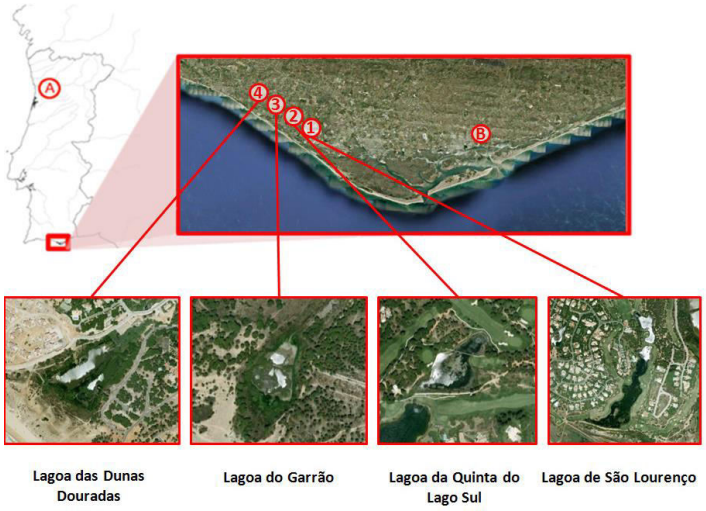


Figure 3.29 Project sites in Portugal: A – CIBIO and Biological park of Gaia, reception centre for the exotic turtles, B – RIAS, reception centre for the exotic turtles, 1, 2, 3, 4 – areas of action defined by the LIFE+ Trachemys project (CIBIO, 2013a)

The institutions involved (CIBIO, 2013a):

- **The University of Porto and CIBIO-IETA**, Centre of Investigation of Biodiversity and Genetic Resources belonging to the university, Institute of Agricultural and Food Sciences and Technologies, an NGO financing university research;
- **ALDEIA-RIAS** – ALDEIA is an NGO working for sustainable development and nature conservation, with two centres of reception and recuperation of wild animals – CERVAS in Serra de Estrela Natural Park and RIAS in Ria Formosa Natural Park. The latter was one of the LIFE Trachemys reception centres;

- **Biological park of Gaia** (Parque Biológico de GAIA) – a permanent centre of environmental education with the centres for recuperation of injured wild animals or those suffered from illegal captures;
- **Generalitat Valenciana*** - Department of Infrastructure, Territory and Environment of the Valencia Community Government, Ministry of Equipment, Planning and Environment – public institutions responsible for nature conservation issues, management of protected areas of Valencia;

*various self-governmnet institutions under which the Spanish autonomous community of Valencia is politically organized;

- **VAERSA** – public entreprise of the Generalitat Valenciana carrying out studies on various environmental aspects, including the study on the autochthonous freshwater turtle species.

3.2.5.3 What was planned to do: To develop a strategy in order to preserve aquatic endangered species of endemic fish and autochthonous freshwater turtles in Valencia and Algarve by eradicating wild populations of exotic invasive freshwater turtles, and then test efficiency of new methods of control and eradication of invasive species, reinforcement and conservation of native turtles (EU, 2011).

The expected results for the project were set as follows, according to EU (2011):

- development of standardized protocol methods and techniques for the eradication of exotic invasive freshwater turtle populations in wetlands;
- implementation of the protocol in pilot areas (natural wetlands in Spain and Portugal);
- demonstration of the viability and feasibility of new techniques for detecting nesting areas of exotic invasive freshwater turtle populations in wetlands;
- collection of individual exotic turtles (mainly T. scripta) from 17 wetlands of Valencia and Portugal;
- eradication of eggs of exotic turtles (mainly T. scripta) from 11 wetlands of Valencia and Portugal;
- eradication of wild populations of exotic invasive freshwater turtles from 17 natural wetlands in Spain and Portugal;
- production of a handbook about the eradication of exotic invasive freshwater turtle populations in wetlands;

- reinforcement of 10 populations of indigenous endangered freshwater turtles in Valencia and Portugal;
- holding of an international seminar about the control of invasive exotic fauna in wetlands.

3.2.5.4 Materials and methodology

Trapping techniques and localization of traps

During captures both passive (nasas with or without baits and fluctuating traps) and active (hand capture, collection with a shrimp catcher (camaroeiro in Portuguese)) techniques were used (CIBIO, 2013b). See Figures A93-A95, Appendix.

As CIBIO (2013b) states, nasas were located next to the margins of the lakes with difficult access and low visibility to prevent robberies.

Fluctuating traps were located in the deepest zones of the lakes where the biggest number of individuals was observed during rest and thermoregulation or where there were few places for that (Figure A96, Appendix).

During the active working periods the nasas were checked every 2-3 days, the fluctuating traps – every week whereas in the winter it was done every 15 days. Hand capture and collection with a shrimp catcher were used in every possible case. All the project sites were regularly checked for nests of exotic species. If found, they were registered, opened, eggs and neonates removed from them.

3.2.5.5 Management of captured individuals

All the captured animals were identified and given a number. Natives were separated from exotic ones. Various measurements were made: length, width, weight, sex, maturity and other physical characteristics. Afterwards natives were released back into the wild in the places they were captured. Exotics, in case of Portugal, were transported to the reception centre of RIAS in Olhão and further transported to the Zoological Park KrazyWorld in Algoz (Parque Zoológico de Algoz) (CIBIO, 2013b).

3.2.5.6 What was done

The results of the project including the captures will be represented for the Portuguese project sites. According to CIBIO (2013 a; b):

- various capture methods were developed: different kinds of traps applied on the project sites, training of dogs for nest search carried out;
- captures were performed not only on the project sites but also in public gardens thanks to the information spread.

Field work was carried out by the team of 2 people regularly joined by volunteers who helped at the different stages. Besides, there was fruitful cooperation with the members of the above mentioned institutions and the ones responsible for management of the areas of action.

- evaluation and monitoring of native freshwater turtle population;
- epidemiological and molecular analysis of native species so that the situation at the national level could be understood and better conservation measures developed;
- diverse environmental education activities carried out mainly in the areas next to the project sites in order to raise public awareness and prevent more releases of exotic turtle species into the wild;
- International symposium on freshwater turtle conservation held in Vila Nova de Gaia, Portugal in May 2013.

3.2.5.7 Results of captures: overall

All in all, 299 individuals of exotic species and 6594 individuals of native species were captured during 3 years of the project. Nasas turned out to be the most efficient technique in native species capture whereas in exotic species capture hand capture was also very resultative (CIBIO, 2013 a; b).

The results of the captures for each trapping technique are shown in Table ….

Table 3.14 Results of captures for each trapping technique (CIBIO, 2013b)

Capture method	Captures of exotics			Captures of natives		
	2011	2012	2013	2011	2012	2013
Nasa	29	42	51	2473	1862	1809
Fluctuating trap	26	15	15	137	100	2
Hand capture	44	24	7	28	75	57
Shrimp catcher capture	16	18	12	7	4	0
Total	**115**	**99**	**85**	**2645**	**2041**	**1868**

Results of captures: Exotic species

According to CIBIO (2013b), 299 individuals of exotic species were captured on the project sites and in the public gardens: 94 % of them are *Trachmeys scripta,* 6 % - all the other exotic species (Figures A97-A98, Appendix).

The most efficient methods of capture of exotics were the passive ones (60% of the captures, nasas – 41%, fluctuating traps – 19%). Hand capture – 25% of out-of-water individuals and collection with a shrimp catcher – 15% which was mostly used in the public gardens. It is important to note that hand capture has been extremely efficient to a big extent thanks to spread of information about the project and involvement of people from various organizations since there were a lot of cases when people brought the captured exotics to the field team.

10 nests with 127 eggs were found in the area of Lagoa de São Lourenço.

It should be noted that the numbers of captures of exotic species during 3 years, high in the 1st year and equally lower in the next ones, could be an evidence of ongoing eradication. What is more, the adults captured in 2012 and 2013 were mostly non-reproductive, the number of juveniles and neonates was also gradually decreasing.

Furthermore, the captures and analysis helped to correct the area of *Trachemys* distribution which was adopted at the beginning of the project. It was revealed that a rather big part of its population is encountered in the surrounding areas of the project sites.

The biggest number of captures of exotics was observed at Lagoa de São Lourenço (63,9%) which is an evidence of the fact that the lake was a point of introduction of exotic turtles and establishment of their population here. From here they spread to the adjacent areas which are proved by the high numbers of captures at Lagoa Quinta do Lago Sul.

As a result of the project, it is said the exotic turtle species have been eradicated from the lakes of the project and adjacent areas. Moreover, their numbers have substantially decreased in Lagoa de São Lourenço and Lagoa Quinta do Lago Sul although the species are still observed there (Figures A99-A100, Appendix). These 2 sites are the most difficult at the task of complete eradication of the exotics since they are daily visited by people and can not be efficiently controlled.

21 neonates and pregnant females found at the 2 lakes are a clear evidence of the fact that invasion of *Trachemys scripta* has been stopped. Further measures of control of nesting should be taken in the marginal zones of the lakes.

Results of captures: Native species

- **European Pond Turtle *Emys orbicularis***

As CIBIO (2013a) states, 342 individuals of *Emys orbicularis* were caught at the 4 project sites, 49 of which were pregnant females that were further transported to the installations of reproduction in captivity in RIAS and Biological Park of Gaia.

Number of captures: The biggest numbers of captures are at Lagoa de São Lourenço and Lagoa da Quinta do Lago Sul where presence of exotic turtle species is more evident (Table A12, Appendix). Moreover, they are of a big size, with permanent character of water regime, constant abundance of alimentation and refuge which raises their capacity of being a suitable habitat for bigger numbers of turtle species.

Proportion of sexes: Sex rate represents disequilibrium, with 1:0.80 male-female rate although the species is polygamy, so it would be more preferable and logical to have more female individuals.

Age groups: Determination of age is a difficult task, thus, approximation by the dorsal longitude and weight is made. It is considered neonates are <40mm and <20gr, juveniles >40mm <100mm, adults >100mm.

Adults are dominant in the structure of captures (76.8%), juveniles – 16.7%, neonates – 6.5%.

It is important to note that the used type of traps (floating traps) complicates capture of neonates, so mostly all of them were caught by hand on the margins of the lakes. Their presence indicates that the species reproduces successfully.

The results of captures per each lake are presented in Chapter 3.2.5, Appendix.

- **Mediterranean turtle *Mauremys leprosa***

It was known that this species' populations are extremely high in coastal Algarve lakes (CIBIO, 2013a).

The results show high population density of *Mauremys leprosa* in the 4 action areas which confirms the above mentioned information. The biggest concentration is noticed in Lagoa das Dunas Douradas. Together with Lagoa do Garrão these locations show the smallest numbers of the exotic turtle species (Table A13, Appendix). So, there may be some connection

between the elevated number of *Mauremys leprosa* and the reduced number of *Trachemys scripta.*

Moreover, numbers of males and females are in quite equilibrium, as well as numbers of adults and juveniles (CIBIO, 2013a).

All in all, the results demonstrate that the species represents stable and healthy populations which guarantees their well-being at a short term. It can be concluded that effects of invasive exotic turtle species on the Mediterranean turtle are hardly seen or can not be felt yet.

Discussion

During the project it was seen, as expected, that the populations of *Emys orbicularis* are in a rather preoccupying situation, showing low density, ageing and fragmented character of distribution.

In case of *Mauremys leprosa,* although the situation is much better and stable, there is still preoccupation about the influence of the exotic species on its populations. More informative conclusions could be obtained with long-term monitoring of the situation.

It is important to understand that the data obtained are the first detailed description of real situation of native turtles´ populations in Portugal. Moreover, Algarve is one of the most favorable areas for both species. So, these data serve as a useful instrument and evidence of necessity for the conservation actions that could be taken in the future.

All in all, the project has been not only a scientific initiative but a public environmental campaign. Besides efficient eradication actions in the Algarve freshwater lakes and analysis of the native turtles´ situation, the population has been educated on the issue of consequences of releases of the exotic species and opportunities of cooperation with the project centres (through communication with the research team, information borads set next to the project sites, tv news on the project). The project has been important for future research and conservation actions planned in the areas involved.

3.3 Sociological survey "Awareness about the wetland protected sites and their attractiveness for potential tourists"

Goals of the survey

The survey was carried out in Belarus and Portugal with the aim to evaluate the level of people's awareness about wetland protected sites and their attractiveness for the participants as potential tourists. The data taken for evaluation were as follows:

- general knowledge about the wetland protected sites;
- awareness about wetlands (their various types: marshes, fens and bogs) as ecosystems and understanding of their functions, value;
- knowledge about wetland protected sites, their role for nature and people, negative and positive aspects of their natur
- e conservation and tourism activities;
- knowledge about the thesis research sites (Sporava fen mire, Jeĺnia bog, Zvaniec fen mire, Paul de Arzila, Paul da Tornada, Paul do Boquilobo) and their activities; opinions on their nature conservation and tourism performance.

The results of the survey are described in Chapter 4.1.

4 Results

4.1 Sociological survey: Analysis of the results

Participants of the survey – 51 Belarusians, 40 Portuguese; this number turned out to be sufficient for obtaining efficient results.

1. By the type of activity among both countries' participants prevail those not connected with nature conservation, tourism or environmental education (Figure 4.1). This was a desirable result since it provides a high possibility of getting the indicators of real awareness level about the research issues;

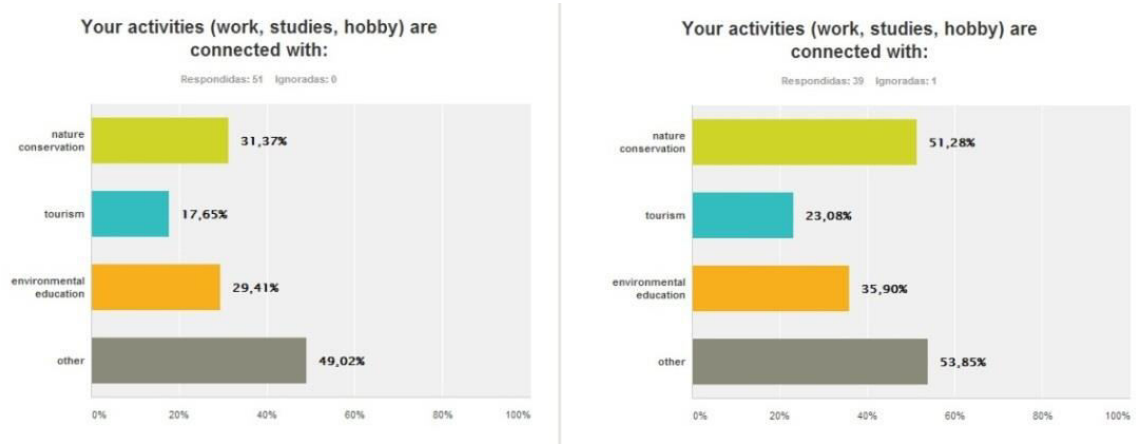


Figure 4.1 Distribution of participants by the type of activity: a – Belarus, b – Portugal

2. The question of the Belarusian survey "which protected areas would you advise for a visit to see Belarusian nature and which ones have you visited by yourself" has showed the knowledge about 23 protected areas.

The most frequently mentioned areas are Bielavežskaja pušča (the most ancient Belarusian and European forests), Biarezinski biosphere reserve, the research sites of Jeĺnia and Sporaúski.

The similar question but focusing on the wetlands in the Portuguese survey "which wetlands do you know in Portugal" has produced 33 mentioned wetland protected areas.

The most frequently mentioned are Ria Formosa, Tagus Estuary, Ria de Aveiro.

The research sites Paul de Arzila, Paul da Tornada, Paul do Boquilobo are very rarely mentioned.

Due to difference in the focus of the questions, it is difficult to compare the results quantitavely. However, the mention frequency of the research sites can be easily assessed (Figures A105-A106, Appendix).

Responses to a series of questions on territorial distribution of the country's wetlands and their role and functions for nature and people have brought about the following results: for both Belarus and Portugal identical values of 58% aware and 42% not aware of the facts stated (Figure 4.2).

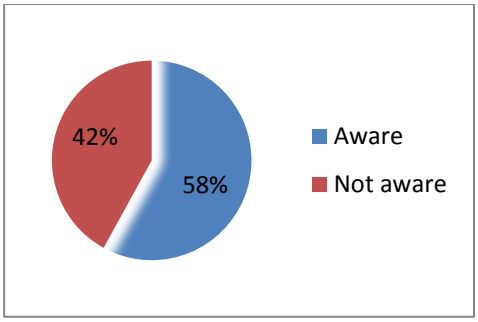


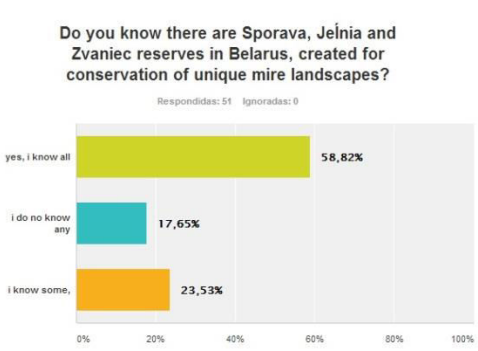
Figure 4.2 Awareness of both Belarusian and Portuguese respondents about the territorial distribution of wetlands, their role and functions for nature and people

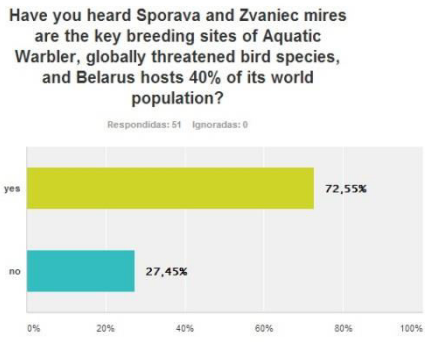
All in all, the awareness level in this case can be generalized to being 50/50 in both countries which is a good result.

3. The level of awareness about the thesis research sites and activities (nature conservation, tourism, educational) organized on them has been reflected in the following results:

Belarus

Figures 4.3-4.5 show answers to the series of questions on the knowledge about the sites, their features and events organized:





a b

Figure 4.3 Awareness of the Belarusian respondents about a. Sporava, Jeĺnia, Zvaniec reserves; b. Aquatic Warbler uniqueness for the world and Belarus

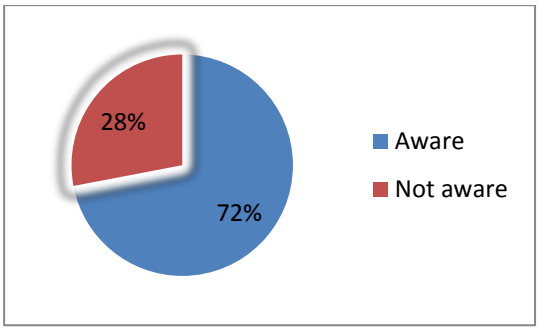
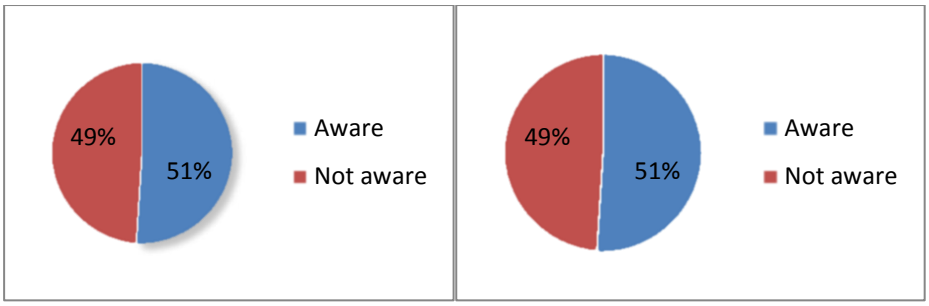


Figure 4.4 Awareness of the Belarusian respondents about organization of volunteer camps on Aquatic Warbler counts in Sporava and Zvaniec and dam construction on Jeĺnia



a b

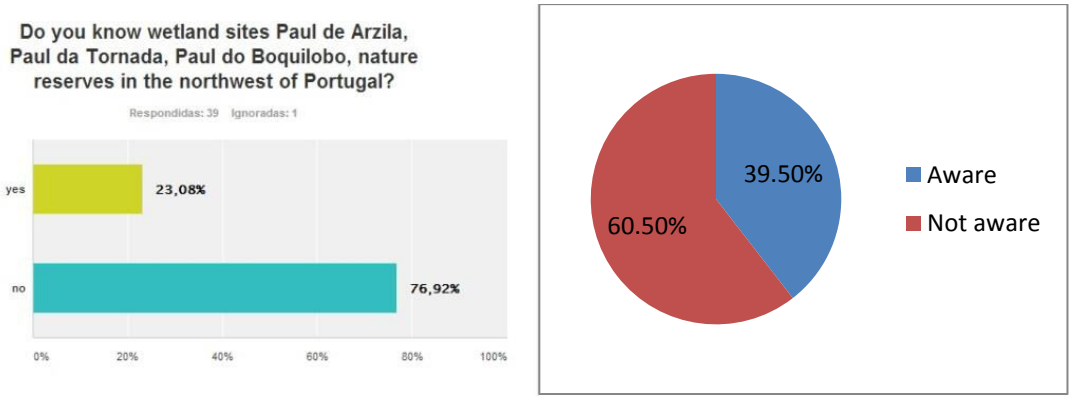
Figure 4.5 Awareness of the Belarusian respondents about organization of festivals in the reserves: a – Sporaúskija senakosy (hand mowing championship) in Sporava, b – Cranes and cranberries of Mijory land on Jeĺnia

To sum up the data from the above located figures, it must be said awareness about the research sites and activities organized is very high (average of 68%), Sporava and Jeĺnia being more known for the respondents than Zvaniec.

Moreover, it is worth noting that among those not informed about Sporaúskija senakosy (hand mowing championship) in Sporava, Cranes and cranberries of Mijory land on Jeĺnia 80% and 64% respectively would like to visit the events, thus, can be regarded as potential visitors of the research sites.

Portugal

Figure 4.6 shows the answers to the series of questions on the awareness about the sites, their characteristics and events organized:



a b

Figure 4.6 Awareness of the Portuguese respondents about a. the research sites´ existence; b. LIFE Trachemys project on eradication of invasive freshwater turtle species implemented in Ria Formosa Natural Park

The average Portuguese awareness level about the research sites and conservation activities together is 32% which is a very low indicator.

To compare, the Belarusian level of awareness about the research sites only is very high (82 %, Sporava and Jeĺnia are the most known) which is almost equal to the Portuguese level of unawareness (77 %, Portuguese research sites are equally little known). Moreover, Belarusian responses have shown a high knowledge of the activities organized in the reserves.

4. Final part of the results – responses to the questions on positive and negative aspects of the research sites´ activities (conservation, tourism, education), reasons and suggestions for improvement of their performance. In addition to the 3 Portuguese reserves, the same question was asked about the most frequently mentioned wetland site of Ria Formosa with expectation of more active responses. The results are shown in Table 4.1.

Table 4.1 Positive and negative aspects of the research sites' activities and suggestions for imrpovements by the respondents

Protected wetland site	+	-	Suggestions
Sporaúski	• biodiversity, beauty of the landscape; • good opportunities for recreation, visits to the mire; • inforcentre, trail, guest house; • active administration; • mowing	•overgrowth of the Jasieĺda floodplain; •unregular work regime of the inforcentre; •low interest of local authorities (is not fully true); •low ecotourism development; •biting insects	•more mowers at the Sporaúskija senakosy hand mowing championship
Zvaniec	• scale (size) of the mire, biodiversity, rare species of plants and birds ; • visits to the mire;	•passiveness of the reserve administration; •long walk/road to the mire; •overgrowth with bushes;	

	• islands in the middle of the mire	•low ecotourism development	
Jeĺnia	• beauty and scale of the landscape, biodiversity; • water purity, lake; • visits to the bog; • active members of the reserve administration; • visit-centre, ecotrail, cross-country vehicle; • project on Jeĺnia conservation; • «how the earth moves under the feet, eat overwintered cranberries»	•long and difficult access to the bog; •use of the cross-country vehicles on the bog damages plants and upper soil layer; •lack of locals' awareness; •frequent traces of human (rubbish); •lack of accommodation services; •fires	
Paul de Arzila		•lack of infrastructure	•urgent management measures
Paul da Tornada		•lack of infrastructure	•urgent management measures
Paul do Boquilobo	• biodiversity	•lack of infrastructure	•urgent management measures
Ria Formosa	• biodiversity, possibilities of birdwatching	•pollution by human activities; •low accessibility; •lack of promotion; •lack investment; •illegal fishing	•water quality control; •ecosystem observation; •infrastructure improvement (there is no direct road from Faro, although it exists); •prohibition of agricultural activities, wastewater discharge; •more efficient info promotion about the events and projects; •more infoboards with maps; •improving organization of visits, trails; •increase of ecological awareness and information provision of tourism business representatives

Additionally, there was a question of the Portuguese survey about all the continental Ramsar wetlands, whether know/visited or not, what respondents know about them and what would like to improve (Table 4.2). This can not be compared with any results of the Belarusian survey, so the information is given separately.

Table 4.2 Responses about the Ramsar wetlands of Portugal (aware or not, notes)

Wetland site	Number of the respondents aware of its existence, nv/nr	Notes
Ria de Alvor	19/32	• infrastructure improved in the recent years; • pollution evidence; • needs more research and investment; • more information for tourists; • more efficient protection
Tagus Estuary	27/32	• pollution evidence; • lack of ecotourism, recreation promotion; • overexploration of area; • needs more research and investment; • more river (as a habitat) conservation measures;
Sado Estuary	21/31	• more information; • more research and investment; • better planning; • prevention of pollution which is seen

Sapais de Castro Marim	22/31	• difficult access, lack of information; • lack of infrastructure; • polluted waters; • needs more resources (research, investment); • needs protection from urban expansion; • better planning of human activities (infrastructure, tourism, access); • needs more events on environmental education;
Bertiandos e S. Pedro d´Arcos	3/28	• needs more research and investment
Pateira de Fermentelos	4/29	• needs more research and investment
Lagoa de Albufeira	21/31	• needs more research and investment; • needs proper planning and organization; • focus on ecotourism, the one practiced now is not sustainable; • organization of sports activities as a means of promotion
Lagoa de St.André e Lagoa de Sancha	18/31	• needs more research, resources and conservation measures; • more information for tourists

It is important to note that the question for the Portuguese respondents about their opinion on the reasons for lack of conservation and educational projects in the wetland protected areas, lack of infrastructure, little information in English (both on the Internet and in the reserves) has shown the following responses:

- lack of investment and difficulties of getting it;
- bureaucracy in the country;
- neglect of nature conservation and environmental education issues by the governmental authorities;
- lack of environmental education projects for general population, schools, universities;
- lack of involvement of students into nature conservation within their studies;
- low level of people's interest, motivation;
- mentality.

4.2 Comparative analysis of the Belarusian and Portuguese research sites

The information collected about the research sites and presented in the chapters of the thesis allowed to finally conduct a comparative analysis which was set as an objective of the work. The results are represented in Table 4.3.

Table 4.3 Comparative analysis of the Belarusian and Portuguese research sites

Criteria	Belarus	Portugal
Protection status	All the 3 protected wetland areas have a status of "zakaznik" (reserve).	3 of the protected wetlands areas have a status of "reserva natural" (nature reserve).
	Declared for the restoration, preservation and (or) reproduction of natural complexes and objects, natural resources of one or more species with restricted use of other natural resources	Declared based on the natural characteristics, protection of which will result in future benefits of use and appreciation the area's resources. Such areas should remain unaltered by human activity during a prolonged period of time.
	No zoning applied to the reserves.	Zoning applied to the reserves (Total, Partial and Complementary Protection Areas).
	The objectives of a management unit of zakaznik are as follows: • ensuring compliance with the established regime of protection and use of the reserve; • organization of implementation of nature conservation measures; • organization of environmental monitoring; • organization and promotion of scientific research; • participation in development and implementation of positive environmental practices; • environmental education and promotion of environmental protection; • organization of tourism, recreation, and other activities in accordance with the protection regime.	The objectives of reserve natural are set as follows: • implementation of measures necessary for maintenance and recuperation of species, habitats, and geosites of favourable conservation status; • system of visitation control in order to minimize disturbance of the natural environment; • limitation of the use of resources, allowing for maintenance of natural features of the protected area.
Historical aspect: wetlands' formation and use	All the 3 sites were formed as a result of postglacier shallow lakes existence and their filling with organic matter which then was gradually turning into peat. Later, in the 1950-80s the sites and (or) surrounding areas went through drainage (for agriculture, forestry and peat exctraction) and its further consequences.	All the 3 sites were formed in the alluvial plains either representing remains of the past giant wetlands in the Mondego and Almonda floodplains (Paul de Arzila, Boquilobo) or former part of the sea covering the area (Paul da Tornada). In the 19-20th century all the 3 marshes went through drainage for agricultural puproses and its further consequences.
Uniqueness	• The biggest remaining in Europe complexes of mesotrophic and euthrophic fen mires (Sporava, Zvaniec) and raised peat bogs (Jenia) in a state close-to-natural; • Sporava, Zvaniec – key breeding sites of the globally threatened bird species of Aquatic Warbler (35% of the world population); • Jeĺnia – migrating stop-over for thousands of Cranes and Geese annually;	• Important nesting sites for rare bird species such as Purple Heron, Iberian endemic species of amphibians; • Important wintering grounds, migrating stop-overs for a lot of bird species; • Important function of hydrological regulation for the surrounding areas and wetland landscape itself

	• All 3 sites – rare bird species, plant communities; • Important function of CO2 regulation	
Current threats	• Disturbance of the hydrological regime by the drainage canals and fishfarms; • Decrease of the groundwater level and overgrowth with trees and bushes (birches, willows, reeds); • Water pollution (agricultural, domestic, industrial); • Fires	• Disturbance of the hydrological regime, disruption of water flow and its renovation; • Overgrowth with trees and bushes (willows and reeds) and displacement of natural vegetation; • Negative influence of invasive animal, plant species; • Domestic, industrial pollution; • Often unregulated fishing, hunting practices; • Absence of priority species for management; • Lack of conservation measures; • Lack of promotion of the sites for tourism
Management	• Management units of the sites created for administration of the reserves; • Management Plans developed in the reserves since 2000s and regularly revised; • Administrations of the reserves responsible for management plan implementation; • Complex management concept: scientific research, vegetation and hydrological management (with an aim of restoration), ecotourism and environmental education as priorities for conservation actions; • Cooperation with local authorities, government, NGOs, volunteers, locals	• Management Plans developed for each reserve: some of them regularly revised (Paul da Tornada), the other ones in the process of revision (Paul de Arzila); • Administrations of the reserves responsible for management plan implementation; • Paul da Tornada is managed by an environmental NGO and represents a positive example of NGO cooperation with local and regional authorities; • Conservation of natural values of the reserves but without an aim of habitat and hydrological regime restoration; • Tourism is not seen as a priority action (Paul de Azrila, Paul do Boquilobo); • Complex management concept: conservation of natural values, proper planning, conditions for ecotourism and environmental education (Paul da Tornada) • Cooperation with local authorities, NGOs, most efficient at Paul da Tornada; • Neglect of conservation issues by the government, lack of investment
Nature conservation activities	• Active conservation measures implemented since 1995: • Restoration of hydrological regime on Jeĺnia, Sporava and Zvaniec; • Habitat restoration / vegetation management in Sporava mire; • Biodiversity monitoring at all the sites; • Caretakers' network functioning at the 3 sites; • Use of best practices and international expert support in the projects, participation of volunteers (educational part); • Evidence of projects' efficiency judging by the results: stop of fires on Jeĺnia, stop of draughts on Zvaniec, development of fishfarm regulations that take into acoount requirements of the Sporava reserve, restoration of the groundwater level, restoration of habitats and slowing down overgrowth with bushes and trees	• Few conservation measures taken: Paul de Arzila • Bush removal, creation of open pools, reintroduction of Purple Gallinule in the 1990s; Paul do Boquilobo • Bird conservation projects in the past, current rare plant conservation project; water level control, soil analysis within cooperation with various educational institutions; • Permanent monitoring of fauna; • Current pollution problem resolvation within cooperation with Torres Novas municipality; Paul da Tornada • Reed cutting since 2011, monitoring of species, management of invasive species; • Scientific researches within cooperation with universities, enhancing internships for research; • Poor evidence of efficiency of conservation measures: the threats remain the same

Ecotourism	• Tourism facilities provided: infocentre (all 3), accommodation (Sporava and Zvaniec), trails and observation towers (Sporava – well-equipped, Jeĺnia – observation tower, trail under construction, Zvaniec - none), infoboards, booklets; • Educational part - excursions for schools; • Involvement of local population (caretakers); • Annual festivals (Jeĺnia, Sporava), volunteer camps (all 3); • Not active but increasing promotion of the sites for ecotourism mainly through birdwatching community, conservation projects; • Lack of information for foreigners on the Internet, no booklets in English; • Lack of signs within the reserve	• Tourism facilities provided to a small extent: infocentres (all 3), trails (Paul de Arzila, Paul do Boquilobo – observation tower and trail equipped, Paul da Tornada – none, in the process of planning), information boards; • Excursions for schools; • Lack of awareness and involvement of local population; • Poor promotion of the sites, without any plan to increase it (Paul de Arzila, Paul do Boquilobo); • Active position in ecotourism promotion at Paul da Tornada (not many efficient results for now but good performance in planning); • Little information for foreigners, no booklets in English; • Lack of informative infoboards
Water and peat quality	• Water quality analysis (Jeĺnia, Sporava) has shown positive results for Jeĺnia and pollution evidence at Sporava (not exactly inside the mire, but around it); • Peat analysis has revealed normal ph values for the mires and bog which is the indicator of good conservation state of the landscapes.	• Water quality analysis (all 3) has shown rather high pollution levels in the reserves resulting from the industrial, domestic pollution sources and lack of conservation measures; • There is a clear evidence of the ongoing penetration of pollutants into the marshes causing vegetation change due to overgrowth and landscape degradation.
Public awareness	average Belarusian level of awareness about the research sites is very high (82 %, Sporava and Jeĺnia are the most known)	average Portuguese awareness level about the research sites and conservation activities together is 32% which is a very low indicator
Overall performance	All the 3 reserves show a positive nature conservation and tourism development performance: • researches have been done for determination of the most serious threats and their causes; • a complex approach to management has been applied (administrations of the reserves are the first result of productive cooperation between state and non-state entities, there were set aims of restoration of habitats and hydrological regime); • active conservation measures implemented regularly and efficient results reached; • conditions for ecotourism provided and improved regularly; • local population is involved; • promotion of the sites is carried out, public, educational, conservation events are held in the reserves regularly; • cooperation with NGOs, universities, local authorities and government has been established. Thus, there is a tendency of stable	The 2 reserves (Paul de Arzila, Paul do Boquilobo) show a poor nature conservation and tourism development performance: • researches have been done for determination of necessary actions which were stated in the Management Plans; • an approach of conservation of natural values but without aim of restoration was taken as a basis; • due to lack of investment and neglect by the government few conservation measures have been implemented in the recent 20 years; • low sustainability of the projects implemented earlier, continuation of landscape degradation; • some conditions for ecotourism provided but not improved with the time; • local population is not involved; • promotion of the sites is almost absent, tourism is not seen as a priority; • cooperation with NGOs, universities, local authorities, but low. Paul da Tornada has shown a positive performance in various aspects such as development of modern management concept and proper planning of actions: • conservation measures taken, monitoring of habitats planned but not conducted; • tourism facilities improved with time;

	progressive development of the reserves as both centres of landscape conservation and ecotourism destinations. Moreover, efficient contacts have been built with various organisations. However, the reserves rely financially on foreign funds which makes them dependent on this type of funding and does not allow to plan for a long-term.	• priorities of both conservation and ecotourism/education set; • regular control of the work done and actions revised but slow process of plan implementation; • lack of long-term investment; • low visible efficiency of the measures implemented by now. Thus, there is a tendency of stagnant development of the 2 reserves as both centres of landscape conservation and ecotourism destinations (Paul de Arzila, Paul do Boquilobo). However, there is a positive tendency of progressive but slow and difficult to foresee development of Paul da Tornada reserve. All the reserves face lack of governmental interest and financial support resulting in lack of people's motivation for active work.

The information obtained for each criteria can also be represented from the point of view of similarities/differences between the research sites of 2 countries. This allows to obtain a clearer view on the results of the research. The information is shown in Table 4.4.

Table 4.4 Points of similarities/differences between the Belarusian and Portuguese sites

Criteria	Similarities	Differences
Protection status	• objectives of creation and development	• principle of unalteration by humans in Portugal; • ecotourism and environmental education are priorities together with scientific research and conservation in Belarus; • zoning in Portugal/no zoning in Belarus;
Historical aspect: wetlands' formation	all the sites and (or) their surrounding areas went through drainage and its consequences	formation history is different;
Uniqueness	all the sites are important for biodiversity, water and CO2 regulation	Belarusian sites show richer biodiversity due to their preservation through active conservation measures
Current threats	Disturbance of hydrological regime, overgrowth with bushes and trees, loss of biodiversity, illegal hunting and fishing practices, water pollution	**Portugal** • absence of priority species for management, lack of conservation measures; • lack of promotion of the sites for tourism
Management	• administrations – management units; • Paul da Tornada - exception in Portugal, similar to Belarusian complex management concept, development of environmental education; • cooperation with local authorities, NGOs	• regular revision of the Management Plans in Belarus; • complex management concept in Belarus; • conservation without active conservation actions in Portugal, ecotourism and environmental education are not priorities; • cooperation with local people in Belarus
Nature conservation activities		• active conservation policy and its high efficiency at the Belarusian sites • lack of conservation actions in Portugal
Ecotourism	• lack of information and promotion for foreigners; • lack of signs and infoboards	• well-equipped tourism facilities in Belarus; medium level in Portugal • promotion for the locals (events) in Belarus

		• involvement of local people in Belarus
Water and peat quality		• high pollution levels in Portugal • medium pollution levels in Belarus
Public awareness		Much higher in Belarus (82% in comparison to 32% in Portugal)
Overall performance	• lack of governmental interest • lack of financial support/reliance on foreign funds - instability	• positive evaluation for Belarus • poor evaluation for 2 sites in Portugal, the 3rd one is positive in planning / medium in implementation

5. Discussion and Conclusion

A multilateral research on the issue was carried out in the process of writing the thesis. Methodology was developed to conduct the analysis of each research site. The objectives set at the beginning of the work were met. Both theoretical and practical aspects of the wetland sites performance were studied. All the sites were visited personally and contacts with the administration members were established to get the information on current development of the reserves from the direct source.

The characterization of the research sites was complex and balanced and served as a reliable basis for the consequent comparative analysis. It allowed to evaluate their nature conservation performance rather efficiently. However, the author understands that the information analysed and the results obtained can only partially reflect the realities of the site since it is hard to make a really thruthful evaluation of the 7 wetland sites from the point of view of the student researcher and after a seven-month work. Moreover, biological aspects of the wetland development were especially difficult to describe since the author does not have a degree in this field, that is why studies, instructions and opinions of various experts were often used for the work, detailed questions were posed to the administration members of the reserves. The work was planned not as a biological research but as a multilateral analysis of various aspects of nature conservation performance of the research sites.

What is more, positive experience of the Portuguese sites was meant to be obtained for the Belarusian practices in wetland conservation. This aim has been partially implemented since Belarusian examples turned out to be more successful than the Portuguese ones by their long-term efficiency. However, the information obtained during the research served for the understanding of both countries' realities in the field of wetland conservation and analysis of various approaches that can be applied to the research sites.

To sum up, general level of awareness about the wetland protected areas among Belarusian and Portuguese participants of the survey can be assessed as 50/50 which is a rather positive indicator.

However, awareness about the wetland research sites of the thesis, their value and projects/activities organised is rather high in Belarus and very low in Portugal. This can be explained by the fact that mire (fens and bogs) conservation in Belarus has been a priority for the recent 20 years, is very active and efficient at the level on nature conservation, education and tourism, whereas in Portugal the level of investment and focus on such areas is much lower.

The survey has shown drawbacks of the reserves' performance in both countries: lack of infrastructure, lack of investment (Portugal), inefficient information distribution and promotion, landscape degradation and lack of conservation projects (Portugal), passiveness of the reserves' administration and neglect by local and state authorities.

*The survey can be assessed as efficient judging by its results but in the process of the analysis it was observed that a more precise form of the questions and their goals is needed to receive better results. This could be corrected in the further work and possibly the conduct of the second more detailed survey on the issue.

The comparative analysis conducted as a result of the work on each wetland site brought about the following conclusions:

- the history of wetlands' formation has been different but further history of their use, disturbance by man and the consequences is rather similar;
- protection statuses of "zakaznik" and "reserva" are similar by the objectives of their creation and development but the Belarusian one poses fewer limitations, thus providing space for active nature conservation activities. The Portuguese regulations for the reserve focus on complete limitation of the use of resources and human intervention of any type through zoning which is not present in Belarus;
- by the factor of uniqueness, the Belarusian sites show more outstanding features whereas the Portuguese ones turn out to be less attractive by their natural values due to their progressive degradation, loss of unique flora and fauna, and passive conservation and tourism development (difficult access to observation points);
- by the threats, the reserves have shown similar biological factors of disturbance which result from the past human alteration but their influence and scope are different, much less in Belarus due to active conservation measures taken, whereas in Portugal these factors have progressed further to the negative side;
- by management Belarusian sites are characterized by a complex management concept based on sustainability principles (management units created in the reserves, nature conservation, involvement of local people, cooperation with local and governmental authorities, NGO). Although in Portugal all the sites are also under control of their administrtions, 1 site (Paul da Tornada) has shown the complex approach to management focused on environmental education and 2 other sites are characterized by the lack of high quality management, especially in the field of nature conservation activities;

- by nature conservation and ecotourism activities, the Belarusian sites have shown activeness and efficient results in the recent 20 years (restoration of habitats, hydrological regime, raising public awareness and attractiveness for potential tourists) whereas in Portugal the 2 sites do not show efficient results of conservation or restoration due to lack of conservation measures and neglect of ecotourism potential, and 1 site with environmental NGO administration has shown positive planning of both conservation and ecotourism/education actions and their slow but progressive implementation;
- however, there were observed similar problems in ecotourism development such as lack of promotion, information borads and signs in the reserves of both countries;
- by the level of public awareness about the wetlands in general and the research sites in particular, Belarus has shown a much higher result than Portugal which can be explained by the active conservation and ecotourism development practices and their promotion in Belarus in the recent 20 years, and lack of public informing and involvement in the reserves' initiatives nd plans;
- approaches to freshwater wetland conservation in Belarus and Portugal have turned out to be different by their priority aims: restoration of habitats and hydrological regime, ecotourism promotion in Belarus and conservation of natural values without obligatory restoration of habitats and hydrological regime, just prevention from further degradation in Portugal;
- the Belarusian wetlands have shown a much better performance both in nature conservation and separately in ecotourism development if to judge from the point of the Belarusian approach to wetland conservation. Even judging from the Portuguese one, the Portuguese sites have not succeded in prevention of landscape degradation but 2 of them have shown stangnancy and passiveness in their development, 1 site has done proper analysis and planning of actions which are slowly implemented by the environmental NGO.

The focus of the problem in Portugal is usually put on lack of investment which is difficult to get but, from the author's point of view, motivation and interest of the authorities, both local and governmental, and employees of the protected areas play a significant role. What is more, local initiatives of sites' administrations that do not require a lot of funds are also a solution.

Belarusian research sites also face lack of governmental interest and dependency on foreign financial support but motivation and enthusiasm of the people involved, and properly planned management schemes are key factors of ongoing progress which allow to get over the bureaucratic and financial barriers.

However, the author clearly understands that the difference in the performance of the wetland sites in 2 countries has been caused not only by the above mentioned factors but by the general economic conditions and governmental policies of the countries as well as by the historical preconditions of the current approaches to wetland conservation.

Thus, the present thesis has allowed the author to get valuable experience in the research of wetland sites of Belarus and Portugal, expand the view on wetland conservation methods, participate in the ongoing conservation projects and present the results of the comparative analysis in the work.

References

AAAS Atlas of Population and Environment (2014) *Freshwater wetlands* [online]. American Association for the Advancement of Science. Available from: http://atlas.aaas.org/index.php?part=2&sec=eco&sub=wetlands [Accessed 13 March 2014]

APB-Birdlife Belarus (2009a) *Second life of Astroúskaje bog* [online]. APB-Birdlife Belarus. Available from: http://www.ptushki.org/info/press/item/1432.html [Accessed 16 December 2013]

APB-Birdlife Belarus (2009b) *Sporava mire* [online]. Available from: http://www.ptushki.org/en/what_we_do/ibas/sporava_mire.html [Accessed 13 October 2013]

APB-Birdlife Belarus (2010a) *Information boards were installed in the reserves* [online]. 20 October 2013. Available from: http://www.ptushki.org/info/press/item/4916.html [Accessed 15 February 2014]

APB-Birdlife Belarus (2010b) *The public inspectors assigned for the Jeĺnia reserve* [online]. 20 October 2010. Available from: http://www.ptushki.org/info/press/item/4906.html [Accessed 15 December 2013]

APB-Birdlife Belarus – monitoring of IBAs (2014) *IBA caretakers – results* [online]. Available from: http://iba.ptushki.org/be/results [Accessed 20 April 2014]

Astapovich, O. (2011) *Mires with a special role* [online]. 19 October 2011, Narodnaja hazeta newspaper. Available from: http://www.ng.by/ru/issues?art_id=60930 [Accessed 10 January 2014]

AWCT (2014) *Species of Aquatic Warbler* [online]. Available from: http://www.aquaticwarbler.net/taw/ [Accessed 14 February 2014]

Bahadziazh, A. (2010) *Transboundry River Basins in Belarus*. [pdf] Central Research Institute for Complex Use of Water Resources, Minsk, Belarus. Available from: http://www.unece.org/fileadmin/DAM/env/water/meetings/Assessment/Kiev%20workshop/Presentations/basin%20presentations/Presentation_2ndAssessment_Kiev_BasinsInBelarus_Bahadziazh_BY.pdf [Accessed 20 November 2013]

BELTA (2013) *UNDP brings to life a new project on conservation of Belarusian mires* [online]. 12 October 2013, BELTA. Available from: http://www.belta.by/ru/all_news/society/PROON-realizuet-novyj-proekt-po-soxraneniju-belorusskix-bolot_i_648928.html [Accessed 13 November 2013]

Biaroza district executive committee (2014) *Ecotrail "On the land of Aquatic Warbler"* [online]. Available from: http://bereza.gov.by/new_page_14_98/ [Accessed 13 March 2014]

Birdlife International (2014a) *Aquatic Warbler* [online]. Available from: http://www.birdlife.org/datazone/speciesfactsheet.php?id=7597 [Accessed 13 November 2013]

Birdlife International (2014b) *Aquatic Warbler Protection Status* [online]. Available from: http://www.birdlife.org/datazone/speciesfactsheet.php?id=7597&m=1 [Accessed 13 November 2013]

Birdlife International (2014c) *Important Bird Areas on Wetlands – Belarus* [online]. Available from: http://www.birdlife.org/datazone/sitesearchresults.php?reg=7&cty=20&sn=&fc=&cri=&fam=0&gen=0&spc=&cmn=&hab=5+&thr=&bir=&mar=N&aze=N [Accessed 2 September 2013]

Birdlife International (2014d) *Important Bird Areas on Wetlands – Portugal* [online]. Available from: http://www.birdlife.org/datazone/sitesearchresults.php?reg=7&cty=170&sn=&fc=&cri=&fam=0&gen=0&spc=&cmn=&hab=5+5+&thr=&bir=&mar=N&aze=N [Accessed 19 March 2014]

Borok, I. (2012-2014) *Interview: number of the reserve visitors.* Interviewed by Ulazdimir Malashevich

Branta Tours (2014) *Belarus – the most intact natural area in Europe* [online]. Available from: http://www.branta-tours.com/eightdays.php [Accessed 21 January 2014]

Brito, C., Mieiro, V.R. (2000) *Comunidades Vegetais Paludícolas: Controlo de Vegetação Expansiva nos Pauis do Baixo Mondego. Melhoramento e Gestão do Habitat para Aves Aquáticas no Paul de Arzila*. [pdf] ICN. Available from: https://www.yumpu.com/pt/document/view/14445040/rnpa-vegetacao-expansiva-controlo-2000pdf [Accessed 14 November 2013]

Brovach, O. (2013) *Sporaúskija sienakosy festival in Sporava* [online]. 4 August 2013, ej.by. Available from: http://www.rest.ej.by/activities/2013/08/04/na_brestchine_proshel_festival_sporovskie_senokosy.html [Accessed 06 October 2013]

Chichko, M. (2010) *2010 – International Year of Biodiversity* [online]. №18-21, 10 February 2010, Niasvižskija naviny newspaper. Available from: http://nesvizh-news.by/arhiv/2010/02/18-21-(9971-9974)/2010-god-%E2%80%94-mezhdunarodnij-god-biologicheskogo-raznoobraziya.aspx [Accessed 12 February 2014]

CIBIO bruno_herlander@hotmail.com (2013a) *Monitorização e seguimento das populações de cágados autóctones em Portugal*. [email: pdf] Message to L. Sitkevich (goslowtrevis@gmail.com). Sent 1 February 2014: 18:54. Available from: https://mail.google.com/mail/u/0/#search/bruno_herlander%40hotmail.com/143ba46675043ec4 [Accessed 1 February 2014]

CIBIO bruno_herlander@hotmail.com (2013b) *Resultados da campanha de erradicação de cágados exóticos em Portugal*. [email: pdf] Message to L. Sitkevich (goslowtrevis@gmail.com). Sent 1 February 2014: 18:54. Available from: https://mail.google.com/mail/u/0/#search/bruno_herlander%40hotmail.com/143ba46675043ec4 [Accessed 1 February 2014]

CIBIO (2014) *Charcos com Vida* [online]. Porto: CIBIO. Available from: http://www.charcoscomvida.org/como-participar/regulamento [Accessed 20 November 2013]

Clarkson, B., Sorrell, B., Reeves, P., Champion, P., Partridge, T., Clarkson, B. (2003) *Handbook for monitoring wetland condition.* [pdf] Revised in 2004. Available from: http://www.landcareresearch.co.nz/publications/researchpubs/handbook_wetland_condition.pdf [Accessed 16 September 2013]

ClimaEast (2014) *Clima East – Belarus* [online]. EU Climate Policy. Available from: http://www.climaeast.eu/clima-east-activities/pilot-projects/pilots-project-in-belarus [Accessed 20 January 2014]

CMS (2014) *Aquatic Warbler* [online]. UNEP/CMS Secretariat. Available from: http://www.cms.int/node/15 [Accessed 13 April 2014]

Cooper, B. (2012) *Plan of the nature interpretation in the Jeĺnia reserve* [pdf]. Available from: http://greenlogic.by/content/files/Elnya/Rus_combine_report_Cooper_.pdf [Accessed 13 December 2013]

Dobrovolskij, P., Markevich, P. (2013) *Visit-centre of the Jeĺnia reserve opened in Mijory*, Ej.by [online].30 September, 2013, Intersmith news site. Available from: http://www.rest.ej.by/rest-belarus/2013/09/30/v_miorah_otkrylsya_vizit-tsentr_zakaznika_el_nya.html [Accessed 16 March 2014]

Earth Peoples Blog (2012) *Stop destroying peatlands* [online]. 1 November 2012. Available from: http://earthpeoples.org/blog/?p=2590 [Accessed 12 March 2014]

Eight wetlands (2011) *Public campaign on the wetlands protection from drainage* [online]. Available from: http://www.eightwetlands.by/index [Accessed 23 December 2013]

Espírito de Aventura (2013) *Serra de Montemuro* [online]. Available from: http://www.espirito-de-aventura.iblogger.org/Serras/Montemuro/Montemuro.html [Accessed 13 March 2014]

European Commission (1993) *Reestablishment of the Baixo Mondego marshes (1st phase)* [online]. Available from: http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=209 [Accessed 23 November 2013]

European Commission (1998) *Porphyrio - Porphyrio project - Reintroduction of the Purple Gallinule in the Lower Mondego River Valley* [online]. Available from: http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=313 [Accessed 15 November 2013]

European Commission (2001) *Palustris - Palustris, Management of the Special Area of Conservation of the Marsh of Arzila*. [online]. Available from: http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=1721 [Accessed 20 November 2013]

European Commission (2007) *Layman's report.* [pdf] Coimbra. Available from: http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFile&rep=file&fil=LIFE00_NAT_P_007085_LAYMAN.pdf [Accessed 07 April 2014]

European Commission (2011) *Life Trachemys* [pdf]. Available from: http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=3821&docType=pdf [Accessed 13 January 2014]

European Commission (2012) *ECOTONE – Management of riparian habitats towards the conservation of endangered invertebrates* [pdf]. Available from: http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=4036&docType=pdf [Accessed 24 February 2014]

European Commission (2013) *LIFE Charcos - Conservation of Temporary Ponds in the Southwest Coast of Portugal* [online]. Available from: http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=4746 [Accessed 25 December 2013]

European Commission (2014) *LIFE Portugal* [online]. Available from: http://ec.europa.eu/environment/life/countries/portugal.html [Accessed 12 March 2014]

Eurostat (2014) *NUTS nomenclature for Portugal* [online]. European Commission. Available from: http://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL&StrNom=NUTS_22&StrLanguageCode=EN&IntPcKey=30641073&StrLayoutCode=HIERARCHIC [Accessed 25 October 2013]

Fenchuk, V., Kazulin, A. (2012) *Peatland restoration and conservation in Belarus,* 11th Conference of Parties, Bucharest, Romania, 6-13 July 2012. [pdf] Wetlands International. Available from: http://south-asia.wetlands.org/Portals/0/publications/Presentations/03-Fenchuk_CoP11-peatlands_Belarus.pdf [Accessed 13 October 2013]

Flade, M. skype "uladzimir malashevich" (2013) *Overview on the Aquatic Warbler global population dynamics, occurring challenges and successes for its conservation.* Book of Abstracts, the International Conference on Aquatic Warbler Conservation. 14-15 November, 2013. Vilnius, Lithuania [doc]. Message to skype "chygunka". Sent 22 April 2014: 18:55.

Flumm, D. (2006) *Visit to Paul de Arzila site*. [pdf] IBAS in Portugal SPEA. Available from: http://ibas-terrestres.spea.pt/fotos/editor2/pauldearzilareportdavidflumm.pdf [Accessed 18 December 2013]

Generalitat Valenciana (2013) *Life Trachemys* [online]. Available from: http://www.cma.gva.es/web/indice.aspx?nodo=72095&idioma=C [Accessed 14 January 2014]

IMCG (2014) *IMCG Symposium 2014, Belarus* [pdf]. IMCG Bulletin, January 2014. Available from: http://www.imcg.net/media/2014/imcg_bulletin_1401.pdf [Accessed 15 March 2014]

Instituto da Conservação da Natureza e das Florestas (2003-2004) *Paul de Arzila documentos de gestão. Relatório Diagnóstico* [pdf] ICNF. Available from: http://www.icnf.pt/portal/naturaclas/ordgest/poap/pornpa/pornpa-doc [Accessed 15 March 2014]

Instituto da Conservação da Natureza e das Florestas (2004) *Paul de Arzila Plano de Ordenamento.* [pdf] ICNF. Available from: http://dre.pt/pdf1sdip/2004/06/143B00/37303736.pdf [Accessed 13 October 2013]

Instituto da Conservação da Natureza e das Florestas (2008) *Paul do Boquilobo Plano de Ordenamento.* [pdf] ICNF. Available from: http://dre.pt/pdf1sdip/2008/03/05600/0161201619.pdf [Accessed 13 October 2013]

Instituto da Conservação da Natureza e das Florestas (2014a) *Paul da Tornada Information* [online]. Available from: http://www.icnf.pt/portal/naturaclas/ap/amb-reg-loc/rn-loc-paul-tornada [Accessed 13 October 2013]

Instituto da Conservação da Natureza e das Florestas (2014b) *Paul do Boquilobo Characterization* [online]. Available from: http://www.icnf.pt/portal/naturaclas/ap/r-nat/rnpb/class-carac [Accessed 14 October 2013]

Instituto da Conservação da Natureza e das Florestas (2014c) *Sistema Nacional de Áreas Classificiadas* [online]. Available from: http://www.icnf.pt/portal/naturaclas/snac [Accessed 13 January 2014]

Instituto da Conservação da Natureza e das Florestas (2014d) *Paul de Arzila Logo* [image online]. Available from: http://www.icnf.pt/portal/turnatur/visit-ap/rn/rnpa [Accessed 13 March 2014]

Instituto da Conservação da Natureza e das Florestas (2014e) *Paul do Boquilobo* [image online]. Available from: http://www.icnf.pt/portal/turnatur/visit-ap/rn/rnpb [Accessed 29 March 2014]

International Panel on Climate Change (2014) *The IPCC Fifth Assessment Report Climate Change 2014: Impacts, Adaptation, and Vulnerability.* [pdf] 28 October 2014, IPCC, Ch.4, pp. 43-45. Available from: http://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Chap4_FGDall.pdf [Accessed 07 April 2014]

Jeĺnia reserve (2014) *Facebook page of the Jeĺnia reserve* [online]. Available from: https://www.facebook.com/yelnya.reserve [Accessed 15 February 2014]

Kapanidis, Y. (2014) *Statistics on wetlands stored in the MedWet Web information system.* [pdf] Greece: Mediterranean Wetlands Initiative. Available from: http://www.medwetlands-obs.org/sites/default/files/Annexe%201_Statistics%20on%20wetlands.pdf [Accessed 20 January 2014]

Kozlovskij, V. (2013) *Phototours on Cranes* [online]. 19 June 2013. Available from: http://www.wildlife.by/node/24274 [Accessed19 April 2014]

Kozulin, A. (2008) *Jeĺnia reserve: 2008 Management Plan* [online]. Available from: http://greenlogic.by/accomplishment_p_5.html [Accessed 14 October 2013]

Kozulin, A., Flade, M. (1999) *Breeding habitat, abundance and conservation status of the Aquatic Warbler in Belarus* [pdf]. Available from: http://www.aquaticwarbler.net/download/vw99_belarus.pdf [Accessed 02 December 2013]

Kozulin, A., Malashevich, U. skype "uladzimir malashevich" (2013) *The strategy of Aquatic Warbler conservation under conditions of habitat degradation and fragmentation in Belarus.* [email: doc]. Message to skype "chygunka". Sent 22 April 2014: 18:55.

Kozulin, A., Tanovickaja, N., Grummo, D., Lundyshev, D. (2012) *Jeĺnia reserve: Updated Management Plan* [online]. Available from: http://greenlogic.by/accomplishment_p_5.html [Accessed 14 October 2013]

Kuklov, V., Dym, N. (2006) *How the things in Sporava reserve are,* Narodnaja gazeta newspaper [online]. 22 October 2006. Available from: http://www.ng.by/ru/issues?art_id=10224 [Accessed 15 January 2014]

Leitão, L. (2013a) Interview at Paul de Arzila. Interviewed by Lizaveta Sitkevich, 30 October 2013.

Leitão, L. rnpa@icnf.pt (2013b) *Uma contribuição para o plano de gestão de Paul de Arzila*. [email: pdf] Message to L. Sitkevich (goslowtrevis@gmail.com). Sent 26 November 2013: 16:35. Available from: https://mail.google.com/mail/u/0/#search/rnpa%40icnf.pt/141c6050420c4e0e [Accessed 26 November 2013]

Leitão, L., rnpa@icnf.pt (2013c) *Questions about Paul de Arzila.* [email] Message to L.Sitkevich (goslowtrevis@gmail.com). Sent 26 November 2013: 16:35. Available from: https://mail.google.com/mail/u/0/#search/rnpa%40icnf.pt/141c6050420c4e0e [Accessed 26 November 2013]

Lemos, T. (2013a) *Interview at Paul da Tornada*. Interviewed by Lizaveta Stikevich, 28 October 2013.

Lemos, T., ceept.geota@gmail.com (2013b) *Management Plan.* [email: pdf] Message to L. Sitkevich (goslowtrevis@gmail.com). Sent 18 March 2014: 12:54. Available from: https://mail.google.com/mail/u/0/#search/associacaopato%40gmail.com/144bc499dcf06508 [Accessed 13 March 2014]

Lemos, T., ceept.geota@gmail.com (2013c) *Questions about Paul da Tornada* [email] Message to L. Sitkevich (goslowtrevis@gmail.com). Sent 13 March 2014: 16:32. Available from: https://mail.google.com/mail/u/0/#search/associacaopato%40gmail.com/144bc499dcf06508 [Accessed 13 March 2014]

Levy (2010) *Restoration of hydrological regime of the Jeĺnia peatbog* [pdf]. Available from: http://greenlogic.by/content/files/Elnya/Seminar/Levy_vosstanovlenie_hidroregime_Elnya.pdf [Accessed 29 November 2013]

Limosa Holidays (2014) *Belarus: Spring Birding in 'White Russia'*. Available from: http://www.limosaholidays.co.uk/bird-watching-tours-Belarus/Spring-Birding-in-White-Russia/Northern-Eastern-Europe/?StartDate=04-05-2014&EndDate=11-05-2014&CFID=4964339&CFTOKEN=902d4d412861050b-98FFAB5B-5254-00BC-8BA6ABE2D48245E4#0 [Accessed 13 April 2014]

Lundyshev, D. (2012) *Report on implementation of the Jeĺnia Management Plan in biodiversity and ecotourism issues* [pdf]. Minsk: EU/UNDP project. Available from: http://www.greenlogic.by/content/files/Elnya/Documents/Lundishev_report_May_2012_final.pdf [Accessed 10 January 2014]

Malashevich, U. (2009) *Winter mowing started in Sporava mire this January* [online]. Aquatic Warbler Conservation Team. Available from: http://www.aquaticwarbler.net/news/2009_01_Sporava_mowing.html [Accessed 13 November 2013]

Malashevich, U. (2011) *The ray of hope raised for Sporava mire* [online]. Aquatic Warbler Conservation Team. Available from: http://www.aquaticwarbler.net/news/2011_10_Sporava_mowing.html [Accessed 13 November 2013]

Malashevich, U. (2012) *Report on monitoring of Aquatic Warbler in Sporava mire and potential sites survey* [online]. Aquatic Warbler Conservation Team. Available from: http://www.aquaticwarbler.net/download/Monitoring_reports/Belarus_2012_AW_monitoring_report_final.pdf [Accessed 13 November 2013]

Malashevich, U. (2013) *Report on estimation of the Aquatic Warbler population in Belarus* [online]. Aquatic Warbler Conservation Team. Available from: http://www.aquaticwarbler.net/download/Monitoring_reports/Belarus_2012_AW_monitoring_report_final.pdf [Accessed 13 November 2013]

Malashevich, U. (2013-2014) *Interview on Aquatic Warbler conservation actions*. Interviewed by L.Sitkevich.

Malashevich, U., malashevich@ptushki.org (2014a) *Photos of the protected areas* [email: images] Message to L.Sitkevich (goslowtrevis@gmail.com). Sent 3 May 2014: 17:00. Available from: https://mail.google.com/mail/u/0/#inbox/14594e715254788f [Accessed 3 May 2014]

Malashevich, U., spadarmalash@gmail.com (2014b) *Views of the protected areas* [email: images] Message to L.Sitkevich (goslowtrevis@gmail.com). Sent 3 May 2014: 20:21. Available from: https://mail.google.com/mail/u/0/#inbox/145c388e119b0007 [Accessed 3 May 2014]

Malashevich, U., Fenchuk, V. (2008) *Management of Aquatic Warbler breeding habitats in Belarus* [pdf]. OTOP, Poland. Available from: http://www.otop.org.pl/bindata/documents/DOC33fbad65f73323c17480af3b1ddd4fd5.pdf [Accessed 13 November 2013]

Malashevich, U., Kozulin, A., Fenchuk, V. (2008) *Management of Aquatic Warbler breeding habitats in Belarus* [pdf]. Conservation of the Migratory Stopover Points for the Aquatic Warbler. Quimper, France, 11-13 September 2008. Aquatic Warbler Conservation Team. Available from: http://www.aquaticwarbler.net/download/Pub_conferences/2008_Quimper_LIFE_Conf/Malashevich-Kozulin_Management_of_AW_habitats_in_BY.pdf [Accessed 13 November 2013]

Matvejeva, T. (2013) *Cranes, cranberries and journalists* [online]. 30 September 2013, tut.by. Available from: http://news.tut.by/society/368389.html [Accessed 15 December 2013]

Mediterranean Wetlands Initiative (2010a) *MedWet1* [online]. Available from: http://medwet.org/2010/03/medwet1/ [Accessed 16 January 2014]

Mediterranean Wetlands Initiative (2010b) *SUDOE: Inventory, assessment and monitoring for wetland management* [online]. Available from: http://medwet.org/2010/03/sudoe-inventory-assesment-and-monitoring-for-wetland-management/ [Accessed 16 January 2014]

MedWet (2014) *Site Module: Portugal* [online]. MedWet Web Information System. Available from: http://www.wetlandwis.net/ [Accessed 13 January 2014]

Ministry of Natural Resources and Environmental Protection (2006) *National Report for the Aquatic Warbler Mou and Action Plan, Belarus*. [pdf] Bonn: UNEP/CMS Secretariat. Available from: http://www.cms.int/en/document/national-reports-signatories-belarus [Accessed 12 December 2013]

Monteiro-Henriques, T., tmh@isa.ulisboa.pt (2014) *Questions about the peatbog* [email]. Message to L.Sitkevich (goslowtrevis@gmail.com). Sent 5 May 2014: 18:27. Available from: https://mail.google.com/mail/u/0/#inbox/14598a3f4c11c272 [Accessed 5 May 2014]

Mshar, R. (2012) *New face of Jeĺnia,* Lesgazeta.info [online]. Available from: http://www.lesgazeta.info/new-face-elyni.html [Accessed 15 January 2013]

NAS, Scientific-practical centre of the National Academy of Sciences of Belarus (2009a) *Sporaúski reserve management plan 2009-2013*. Minsk: National Academy of Sciences of Belarus

NAS, scientific-practical centre of the National Academy of Sciences of Belarus (2009b) *Zvaniec reserve management plan 2009-2013*. Minsk: National Academy of Sciences of Belarus

Natural Pearls of Viciebsk region (2013a) *Construction of ecotrail in the Jeĺnia bog started* [online]. 25 March 2013. Available from: http://www.zakazniki.priroda-vitebsk.by/marshruty/zakaznik-elnya-/articles/nachato-stroitelstvo-ekologicheskoi-tropy-ozeravki-elnya-/ [Accessed 17 January 2014]

Natural Pearls of Viciebsk region (2013b) *Jeĺnia's 45th anniversary* [online]. 11 December 2013. Available from: http://www.zakazniki.priroda-vitebsk.by/marshruty/zakaznik-elnya-/articles/zakazniku-elnya-45-let-/ [Accessed 17 January 2014]

Natural Pearls of Viciebsk region (2013c) *On snowshoes around the bog* [online]. 06 June 2013. Available from: http://www.zakazniki.priroda-vitebsk.by/marshruty/zakaznik-elnya-/articles/-na-snegostupah-po-bolotu-/ [Accessed 17 January 2014]

Natural Pearls of Viciebsk region (2014) Jeĺnia reserve [online]. Available from: http://www.zakazniki.priroda-vitebsk.by/marshruty/zakaznik-elnya-/ [Accessed 17 November 2013]

Naturalist (2014) *Belarus: Fabled marshes and primeval forests.* Available from: https://www.naturalist.co.uk/tours/belarus2.php [Accessed 13 April 2014]

PATO (2014) *Paul da Tornada* [online]. Available from: http://www.associacao-pato.org/paul-de-tornada.html [Accessed 13 October 2013]

Pereira, F., FernandoJ.Pereira@icnf.pt (2013a) *Questions about Paul do Boquilobo*. [email] Message to L.Sitkevich (goslowtrevis@gmail.com). Sent 20 November 2013: 10:57. Available from: [Accessed 20 November 2013]

Pereira, F., FernandoJ.Pereira@icnf.pt (2013b) *Reports.* [email: pdf] Message to L.Sitkevich (goslowtrevis@gmail.com). Sent 20 November 2013: 10:57. Available from: [Accessed 20 November 2013]

Poluda, A. skype "uladzimir malashevich" (2013) *Aquatic Warbler peripheral populations dynamics and its possible reasons in Ukraine*. Book of Abstracts, the International Conference on Aquatic Warbler Conservation. 14-15 November, 2013. Vilnius, Lithuania [doc]. Message to skype "chygunka". Sent 22 April 2014: 18:55.

Profico Ambiente (2006) *Parque Eólico de D. João e Feirão: Relatório.* [pdf] Profico Ambiente, June 2006. Available from: http://aia.apambiente.pt/IPAMB_DPP/docs/SE174.pdf [Accessed 14 November 2013]

Ramsar (2002) *Information Sheet on Ramsar Wetlands: Belarus.* [pdf] Available from: http://sites.wetlands.org/reports/ris/3BY007en.pdf [Accessed 28 November 2013]

Ramsar (2013a) *The Annotated Ramsar List: Belarus* [online]. Available from: http://www.ramsar.org/cda/en/ramsar-documents-list-anno-belarus/main/ramsar/1-31-218%5E16728_4000_0__ [Accessed 14 October 2013]

Ramsar (2013b) *The Annotated Ramsar List: Portugal* [online]. Available from: http://www.ramsar.org/cda/en/ramsar-documents-list-anno-portugal/main/ramsar/1-31-218%5E16081_4000_0__ [Accessed 14 October 2013]

Reis, P.M. (2008) *Reacções e Oposições à Reserva Natural do Paul de Arzila: (ou a consciência da ineficácia na proteção do ambiente em Portugal).* [pdf] Associação Portuguesa da Sociologia. Available from: http://www.aps.pt/cms/docs_prv/docs/DPR4926fa623f7b6_1.pdf [Accessed 14 March 2014]

Restoring peatlands (2010a) *Peatlands in Belarus* [online]. Available from: http://www.restoringpeatlands.org/index.php?option=com_content&view=article&id=51&Itemid=37&lang=en [Accessed 13 March 2014]

Restoring peatlands (2010b) *Restoring peatlands and applying concepts for sustainable management in Belarus – climate change mitigation with economic and biodiversity benefits* [online]. Restoring peatlands. Available from: http://restoringpeatlands.org/index.php?option=com_content&view=article&id=47&Itmid=28&lang=en [Accessed 20 December 2013]

Restoring peatlands (2011) *National carbon market is created in Belarus* [online]. 21 March 2011, Restoring peatlands. Available from: http://restoringpeatlands.org/index.php?option=com_content&view=article&id=103:the-verified-carbon-standard-marks-a-new-stage-of-development-for-peatlands-rewetting-projects&catid=35:news-belarus&Itemid=61&lang=en [Accessed 13 March 2014]

RTP (2005) *Quercus entregam compensação para proteger turfeira da Freita* [online]. 6 April 2005. Available from: http://www.rtp.pt/noticias/index.php?article=8233&tm=8&layout=121&visual=49 [Accessed 13 April 2014]

Sadovskaja, E. (2013) *A new technology of sustainable use will be launched in Zvaniec reserve* [online]. 13 January 2013, Wildlife.by. Available from: http://bezbolot.net/2013/01/13/%D0%B2-%D0%B7%D0%B0%D0%BA%D0%B0%D0%B7%D0%BD%D0%B8%D0%BA%D0%B5-%D0%B7%D0%B2%D0%B0%D0%BD%D0%B5%D1%86-%D0%BE%D1%82%D0%BA%D0%B0%D1%82%D0%B0%D1%8E%D1%82-%D0%BD%D0%BE%D0%B2%D1%83/ [Accessed 14 February 2014]

SGP the GEF Small Grants Programme (2006a) *Conservation of Unique Biodiversity of Turaú Meadow through Sustainable Use* [online]. SGP the GEF Small Grants Programme. Available from: https://sgp.undp.org/index.php?option=com_sgpprojects&view=projectdetail&id=10324&Itemid=205 [Accessed 12 December 2013]

SGP the GEF Small Grants Programme (2006b) *Conserving unique biological diversity of lowland mires through their sustainable use* [online]. Available from: https://sgp.undp.org/index.php?option=com_sgpprojects&view=projectdetail&id=9837&Itemid=205 [Accessed 15 October 2013]

SGP the GEF Small Grants Programme (2008a) *Creation of Conditions for the Development of Ecotourism at Sporaúski Reserve with the Minimal Environmental Impact* [online]. SGP the GEF Small Grants Programme. Available from: https://sgp.undp.org/index.php?option=com_sgpprojects&view=projectdetail&id=13531&Itemid=205 [Accessed 12 December 2013]

SGP the GEF Small Grants Programme (2008b) *Eco-tourist path setup and restoration of the natural hydrological regime of the marsh at the hydrological reserve "Vyhanaščanski"* [online]. SGP the GEF Small Grants Programme. Available from: https://sgp.undp.org/index.php?option=com_sgpprojects&view=projectdetail&id=12883&Itemid=205 [Accessed 12 December 2013]

SGP the GEF Small Grants Programme (2008c) *Jeĺnia restoration project* [online]. SGP the GEF Small Grants Programme. Available from: https://sgp.undp.org/index.php?option=com_sgpprojects&view=projectdetail&id=12075&Itemid=205 [Accessed 12 December 2013]

SGP the GEF Small Grants Programme (2008d) *Restoration of the natural hydrological regime of the reserve "Dakudaúski"* [online]. Available from: https://sgp.undp.org/index.php?option=com_sgpprojects&view=projectdetail&id=12884&Itemid=205 [Accessed 12 December 2013]

SGP the GEF Small Grants Programme (2009) *Secondary bogging of Hareúskaje exhausted peatfield* [online]. SGP the GEF Small Grants Programme. Available from: https://sgp.undp.org/index.php?option=com_sgpprojects&view=projectdetail&id=14872&Itemid=205 [Accessed 12 December 2013]

SGP the GEF Small Grants Programme (2012) *Sustainable Management of the Wetland Protected Area of International Importance in Stolin District* [online]. SGP the GEF Small Grants Programme. Available from: https://sgp.undp.org/index.php?option=com_sgpprojects&view=projectdetail&id=17727&Itemid=205 [Accessed 12 December 2013]

SGP the GEF Small Grants Programme (2014) *Berries of Stolin District* [online]. SGP the GEF Small Grants Programme. Available from: https://sgp.undp.org/index.php?option=com_sgpprojects&view=projectdetail&id=2147&Itemid=205 [Accessed 12 December 2013]

Shajkin, R. (2010) *The largest peatbog in Belarus will be restored* [online]. 2 February 2010, APB-Birdlife Belarus. Available from: http://www.ptushki.org/info/press/item/2862.html [Accessed 03 November 2013]

Silva, M.M.R (2007) *Avaliação do Estado da Qualidade Ambiental Terrestre e Aquática na Reserva Natural do Paul do Boquilobo, Portugal*. [pdf] Universidade de Lisboa. Available from: http://www.cesam.ua.pt/files/Silva%20M.%20Tese%20mestrado.pdf [Accessed 13 December 2013]

Sistema Nacional de Informação de Recurcos Hídricos (2014) *Water quality parameters: Portugal* [online]. Available from: http://snirh.pt/index.php?idMain=1&idItem=1.5&idISubtem=ANUARIO_MAISESTACOES [Accessed 12 December 2013]

Tanavickaja, N.I. (2012a) *Report on Current State of Water Regulation Dams for Restoration of Hydrological Regime of the Jenia bog.* [pdf] Minsk: EU/UNDP Project. Available from: http://greenlogic.by/content/files/Elnya/Documents/full_report_May_2012.pdf [Accessed 10 October 2013]

Tanavickaja, N.I. (2012b) *Report on Development of Map Scheme of the Relief of the Jeĺnia bog, its Buffer Zone and Territorial Distribution of Groundwater Monitoring Devices.* [pdf] Minsk: EU/UNDP Project. Available from: http://greenlogic.by/content/files/Elnya/Documents/Report_Tanavitskaya_October_2012_web_site.pdf [Accessed 16 February 2014]

Tanavickaja, N.I. (2013) *Results of the 1st phase of monitoring of the hydrological regime of* the *Jeĺnia bog, analysis of the groundwater level change.* [pdf] Minsk, Belarus. Available from: http://greenlogic.by/content/files/Elnya/Documents/Otchet_gidrologiya_Elnya.pdf [Accessed 29 November 2013]

Terra Nossa (2006*) Turfeira da Serra da Freita* [online]. 11 May 2006. Available from: http://planetaverde.blogspot.pt/2006/05/trufeira-da-serra-da-freita.html [Accessed 15 April 2014]

Thiele, A. (2013) *3-year monitoring of the groundwater level on the Jeĺnia bog: research results (2009-2012)* [pdf]. Available from: http://greenlogic.by/content/files/Elnya/Seminar/UNDP_Jelnia_seminar2013_end.pdf [Accessed 3 March 2014]

Thiele, A., Liashchynskaya, N., Broska, T., Bärisch, S. Skuratovich, A., Dubovik, D. Stepanovich, J., Ermolenko, G., Sozinov, O. & Sakovich, A. (2012) *Belarus Peatland Restoration Project Database, In: Dengler, J., Oldeland, J., Jansen, F., Chytrý, M., Ewald, J., Finckh, M., Glöckler, F., Lopez-Gonzalez, G., Peet, R.K., Schaminée, J.H.J.* (2012) [Eds.]: Vegetation databases for the 21st century. – Biodiversity & Ecology 4: 335–336.

Touristic Brest (2014a) *Sporava reserve* [online]. Available from: http://tour.brest.by/turobj/naturalob/999.html [Accessed 29 November 2013]

Touristic Brest (2014b) *Zvaniec reserve* [image online]. Tourism in Brest region. Available from: http://tour.brest.by/turobj/naturalob/359.html [Accessed 13 October 2013]

Tourist Kobrin (2014) *Aquatic Warbler* [image online]. Available from: http://ikobrin.ru/kobgmir21.php [Accessed 14 February 2014]

Turismo Centro de Portugal (2014) *Serra de Montemuro* [online]. Available from: http://www.turismodocentro.pt/pt/produtos_.4/serra_de_montemuro_.a229.html [Accessed 14 March 2014]

Turismo de Portugal (2014a) Paul de Arzila [online]. Turismo de Portugal. Available from: http://www.visitportugal.com/en/NR/exeres/01CF441A-0C0D-40D4-BED5-17BA8ED6F589 [Accessed 13 October 2013]

Turismo de Portugal (2014b) *Serra de Montemuro* [online]. Available from: http://www.nichoverde.pt/index.php?route=product/product&path=37&product_id=53 [Accessed 14 February 2014]

UNDP Belarus (2002) *Management planning for conservation of fen mire biodiversity in Belarus* [online]. Available from: http://undp.by/en/undp/db/BYE-99-003.html [Accessed 16 November 2013]

UNDP Belarus (2006a) *Catalyzing sustainability of the wetland protected area system in Belarusian Palieśsie through increased management efficiency and realigned land use practices*. [pdf] United Nations Office in Belarus. Available from: http://un.by/pdf/PD_48429e.pdf [Accessed 13 November 2013]

UNDP Belarus (2006b) *Implementation of urgent recommendations of the management plans for key biodiversity areas in Belarus* [online]. Available from: http://un.by/en/undp/db/00011736.html [Accessed 16 November 2013]

UNDP Belarus (2010a) *Catalyzing sustainability of the wetland protected area system in Belarusian Palieśsie* [online]. United Nations Office in Belarus. Available from: http://undp.by/en/undp/doc/65db7b2864f2b.html [Accessed 07 December 2013]

UNDP Belarus (2010b) *Renaturalization and Sustainable Management of Peatlands in Belarus to Combat Land Degradation, Ensure Conservation of Globally Valuable Biodiversity and Mitigate Climate Change* [online]. United Nations Office in Belarus. Available from: http://undp.by/en/undp/doc/49d0e6c70134b.html [Accessed 07 December 2013]

UNDP Belarus (2011a) *Catalyzing sustainability of the wetland protected area system in Belarusian Palieśsie* [online]. United Nations Office in Belarus. Available from: http://undp.by/en/undp/doc/pr-48429-12-e.html [Accessed 07 December 2013]

UNDP Belarus (2011b) *UNDP/GEF Project Brings Back a Rare Flower* [online]. United Nations Office in Belarus. Available from: http://undp.by/en/undp/news/belarus/23-10-2011-n1.html [Accessed 14 November 2013]

UNDP Belarus (2013) *Support to the development of a comprehensive framework for international environmental cooperation in the Republic of Belarus* [online]. United Nations Office in Belarus. Available from: http://undp.by/en/undp/doc/pr-76991-2013.html [Accessed 28 November 2013]

UNDP Belarus skype "uladzimir malashevich" (2014) Terms of Reference for the Caretakers' Network [email: doc]. Message to skype "chygunka". Sent 22 April 2014: 18:55.

United Nations Office in Belarus (2002) *Implementation of the first measures of the Management Plans of key fen mires of Palieśsie for biodiversity conservation* [pdf]. Available from: http://un.by/pdf/PD11736Russian.pdf [Accessed 13 February 2014]

Viachorka, S. (2013) *5th Sporaúskija zharty festival is held on July 13-14, 2013,* News.21.by [online]. 13 July 2013. Available from: http://news.21.by/regional-news/2013/07/13/792317.html [Accessed 15 November 2013]

Viachorka, S. (2014) *Photoelectric station to be launched in Sporava rerseve,* Belport [online]. 10 January 2014. Available from: http://belport.by/obschestvo/50761-fotoelektricheskaya-stanciya-budet-postroena-v-zakaznike-sporovskiy-v-2014-godu.html [Accessed 17 January 2014]

Viciebskbiker (2014) *Jeĺnia reserve* [image online]. Available from: http://vitebskbiker.info/guide/protected_areas/elnja [Accessed 13 February 2014]

Wetlands International (2014) *Ramsar Infosheets* [online]. Available from: http://ramsar.wetlands.org/Database/SearchforRamsarsites/tabid/765/Default.aspx [Accessed 03 October 2013]

Wikimapia (2014) *Sporava reserve* [image online]. Available from: http://wikimapia.org/18658393/ru/%D0%91%D0%B8%D0%BE%D0%BB%D0%BE%D0%B3%D0%B8%D1%87%D0%B5%D1%81%D0%BA%D0%B8%D0%B9-%D0%B7%D0%B0%D0%BA%D0%B0%D0%B7%D0%BD%D0%B8%D0%BA-%C2%AB%D0%A1%D0%BF%D0%BE%D1%80%D0%BE%D0%B2%D1%81%D0%BA%D0%B8%D0%B9%C2%BB [Accessed 12 March 2014]

ZHP (2014) *Inventário de zonas húmidas* [online]. Available from: http://zonashumidasportugal.weebly.com/inventaacuterio.html [Accessed 15 November 2013]

APPENDIX

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Chapter 3.2.4

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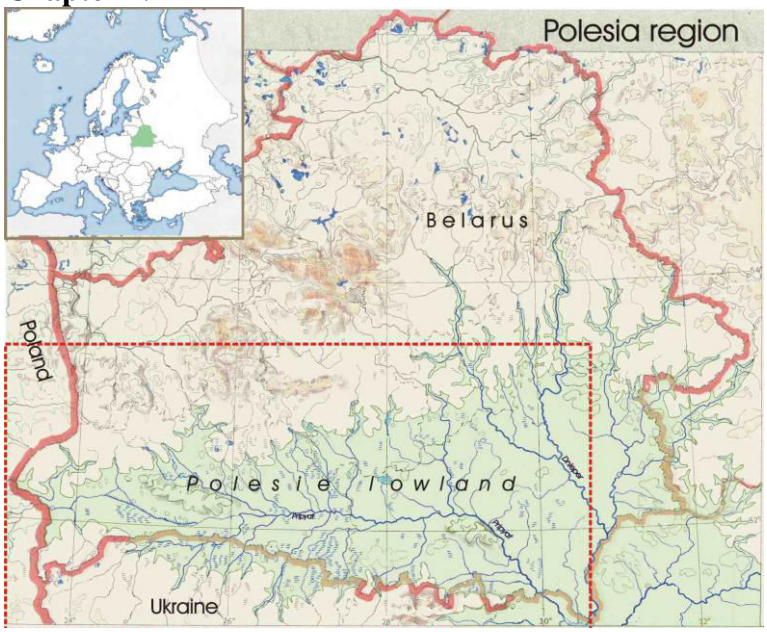


Figure A1. Project area of UNDP-GEF Palieśsie Project (Fenchuk and Kazulin, 2006)

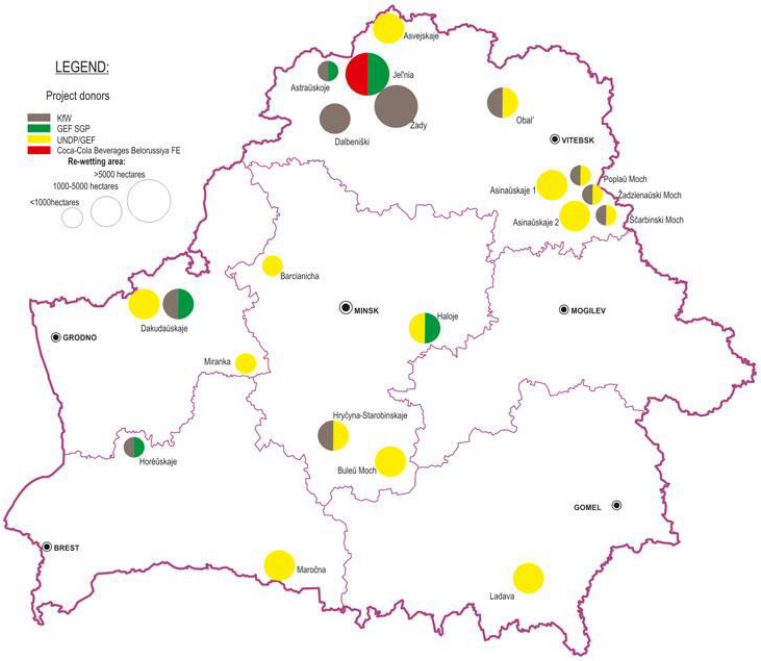


Figure A2. Project sites for UNDP-GEF Peatland project, GEF-SGP project and Restoring peatlands project (Restoring peatlands, 2010)

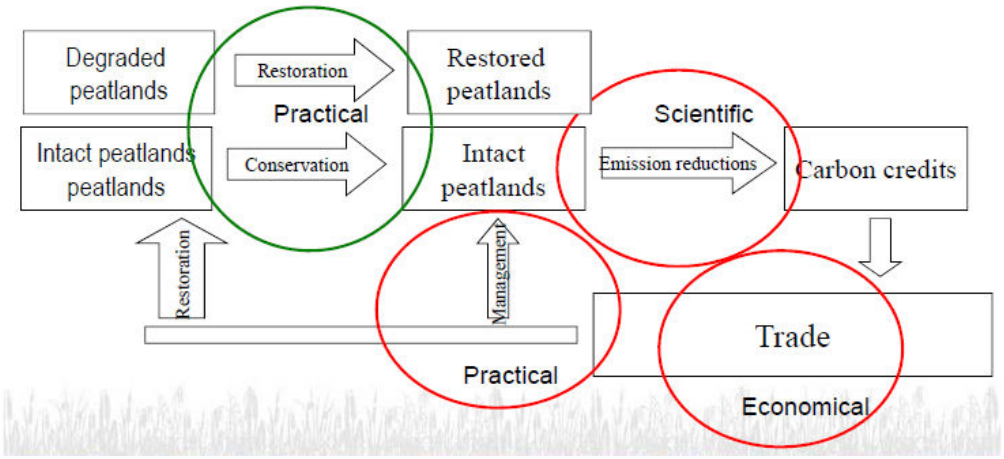


Figure A3. Sustainable scheme for wetland conservation and management (Fenchuk and Kazulin, 2012)

Chapter 2.2

Table A1. Ramsar sites and freshwater wetlands distribution in continental Portugal and the Azores according to the national system of classified protected areas (ICN, 2014)

	Ramsar sites	
	By the national system of classified protected areas	Freshwater Ramsar sites
Continental Portugal	parts or whole areas of 4 natural parks (Ria Formosa, Serra de Estrela, Guadiana Valley Natural Park, Serra de Aire e Candeeiros); 6 nature reserves (among them the thesis research sites Paul de Arzila, Paul do Boquilobo); 1 protected landscape; 1 local nature reserve (Paul da Tornada research site); 12 Special Protection Areas; 7 Sites of Community Importance; 1 biosphere reserve	12
Azores	1 regional nature park; 2 nature reserves; 1 regional natural monument; 1 protected landscape; 2 UNESCO biosphere reserves; 7 Sites of Community Importance	10

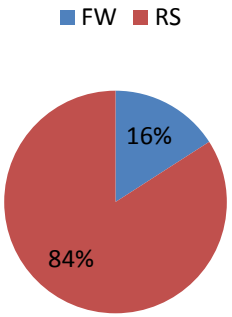


Figure A4. Freshwater wetlands percentage within the Ramsar sites of Portugal: FW – freshwater wetlands; RS – Ramsar sites area

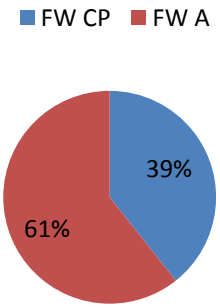


Figure A5. Freshwater wetlands of Portugal: FW CP – freshwater wetlands of continental Portugal; FW A – freshwater wetlands of the Azores

Chapter 3.1.1

Table A2. Landscape types and their transformation (past and future) in the Sporava mire (NAS, 2009)

Landscape type	2006		Evolution in comparison with 1955, %	Forecast for 2025, %
	ha	%		
Open fen mire	**7918**	**40.8**	-20.9	-18 to overgrown fen mire
Overgrown fen mire	**3637**	**18.8**	+6.8	+28 from open fen mire
Mineral islands	959	4.9	-0.8	-7 to bushes
Forest	4068	21	+10.5	+5 from overgrown fen mire
Bushes	719	3.7	+1.8	+54 from mineral isl, overgrown fen mire. peat extraction
Under water	1723	8.9	+1.8	+12 from peat extraction
Recultivated peat extraction	360	1.9	+0.8	-100 154 into bushes 206 – underwater
Overall	19384	100	-	19384

Table A3. Changes in the Jasieĺda runoff due to the drainage procedures (NAS, 2009)

Periods	Jasieĺda River – Biaroza, annually	Rudaúka River – Rudnia village, annually
1964-1973	147 mm	152 mm
1977-1983	210 mm	191 mm

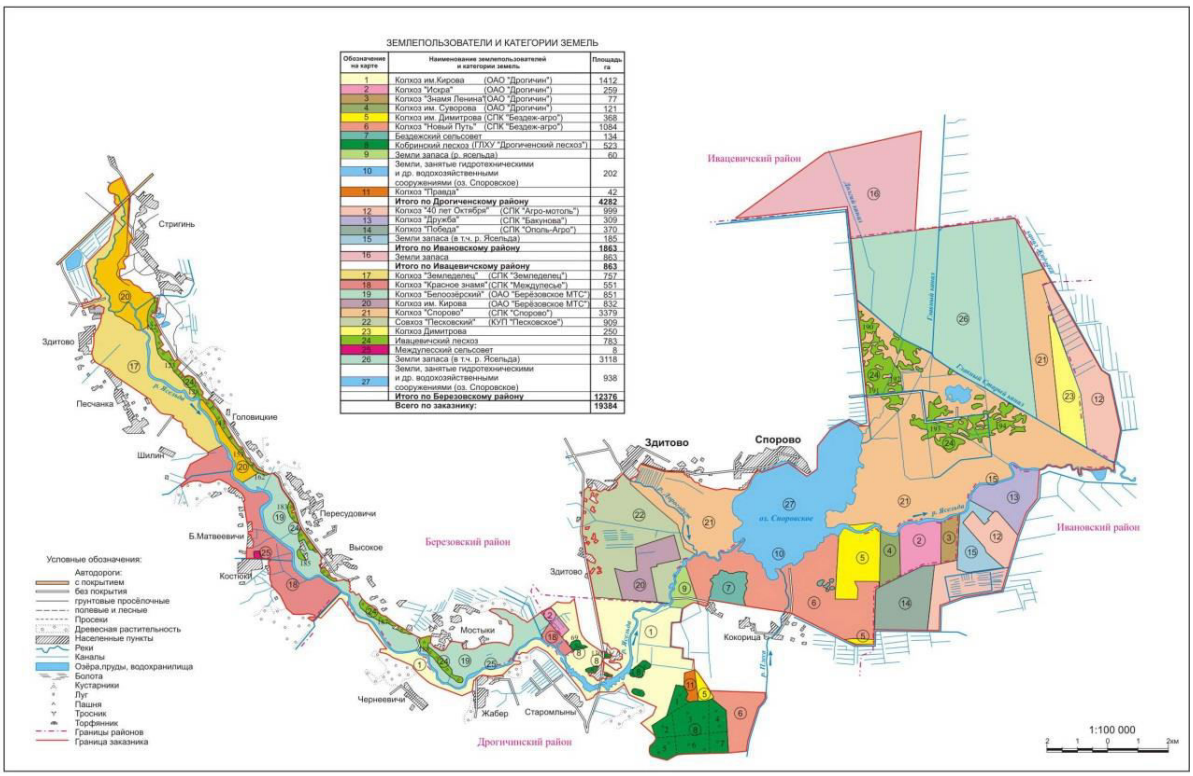


Рисунок 1.2 - Размещение пользователей земельных участков и водных объектов на территории заказника "Споровский"

Figure A6. Users of land plots and water bodies of the Sporaúski reserve (NAS, 2009)

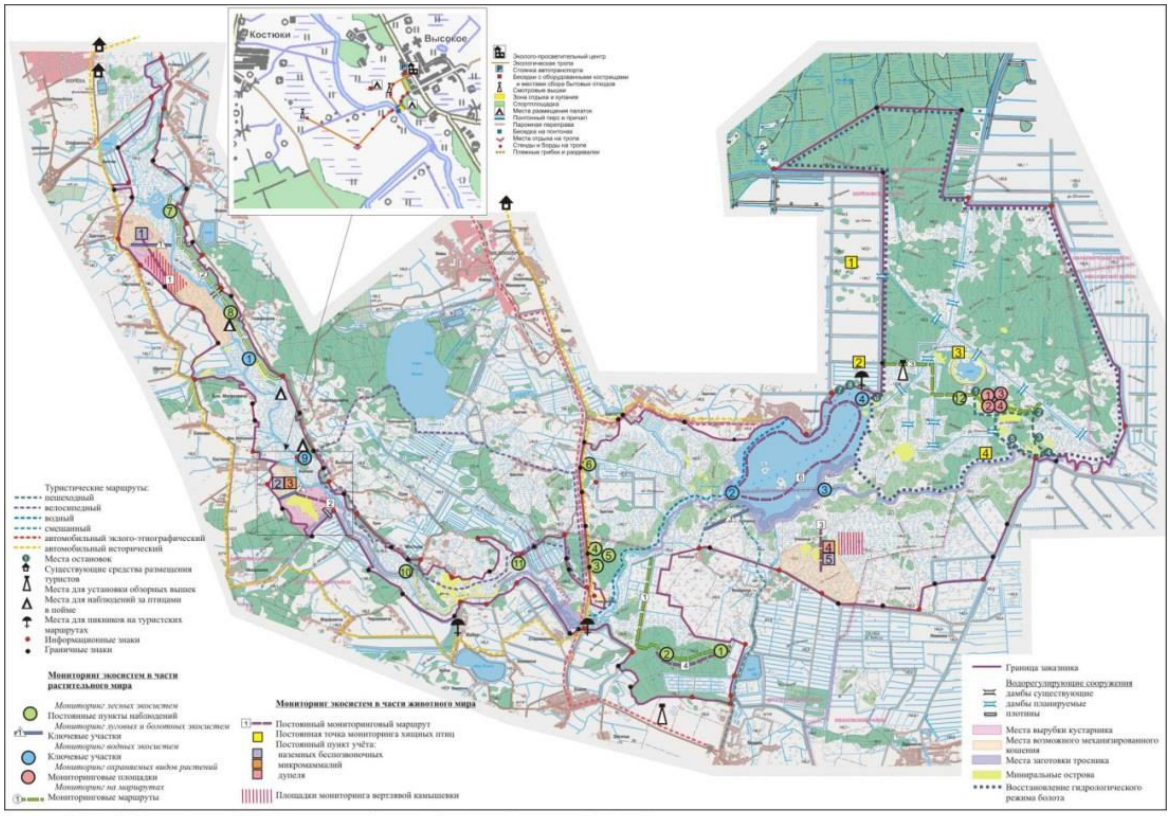


Рисунок 7.1. Схема мероприятий плана управления республиканским биологический заказником «Споровский»

Figure A7. Map of actions within the Management Plan of the Sporaúski reserve (NAS, 2009)

Figure A8. Lady's slippers orchid (Tourist Kobrin, 2014)

Figure A9. Sporava mire in a state of overgrowth before the start of mechanized mowing

a

 b

Figure A10. a. Innovative machinery (ratrac) mowing Sporava mire; b. Results of habitat restoration in Sporava mire (Sadovskaja, 2011); c. Mowing in 2006-2009

Figure A11. Visitor centre from the inside (Biaroza district executive committee, 2014)

Figure A12. Pedestrial trail with an observation point and campsite by the river

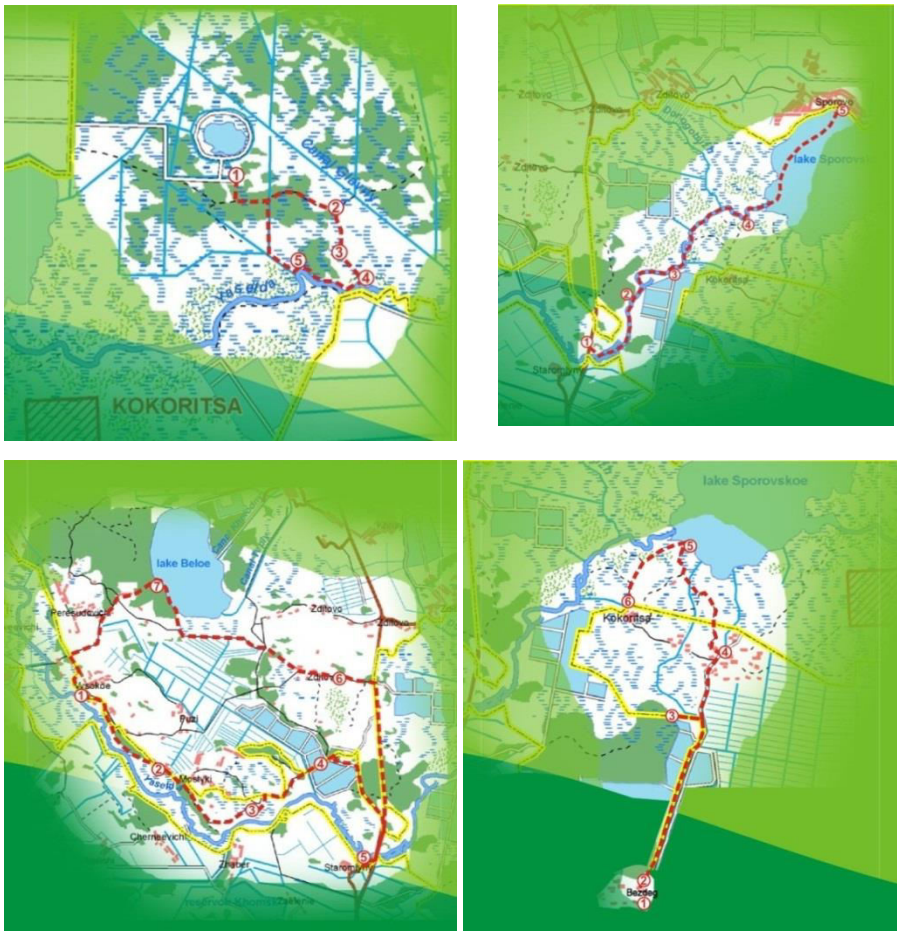


Figure A13. Maps for 4 ecological routes (Biaroza district executive committee, 2014)

Figure A14. Sporaúskija sienakosy festival

Figure A15. Sporaúskiaja žarty festival

Water quality analysis

Water is said to be seriously polluted in the Jasieĺda River and, thus, in the area of Sporava mire due to industrial and domestic sewage from Biaroza and previous pollution from Sialiec fishfarm which is now regulated.
There has been no information on water quality indicators exactly for the Sporava mire. However, there is information on the water quality analysis of the Prypiać and its affluents made in 2010.
So, there were observed elevated values of phosphorus-phosphates (P-PO5) and nitrogen-ammonia (N-NH4) in the area of the Jasieĺda River near Sporava mire. Moreover, N-NH4 have increased by 14.5% and 31% respectively since 2006. The values obtained in 2008 were 1.2-2.9 MAC for NH4, 1.1-3.6 for N-NO2, MAC – maximum acceptable concentration. This is an evidence of permanent pollution in the past and present which has severe consequences for the Sporava mire as a landscape and habitat.
What is more, the Jasieĺda River gets 10 thousand m3 of sewage every day which 90% of the regional indicator. Wastewater treatment plant in the area of the mire does not yet function properly although construction and repair works have been conducted for a long period of time.

Peat analysis

Analysis of peat was made through analysis of peat ph values from 2010 research data and assessment of von Post Decomposition Index.
Peat ph in Sporava mire, since it is a fen mire, must be weakly acidic, neutral or weakly alkaline: it gets minerals (N, K, P) from the groundwater and is nutrient-rich, its ph is usually 5.5-8.
The 2010 research data results show the 3 following ph values for peat: 5.51, 5.72, 5.56 with an average of 5.60.
The values obtained are in the normal range for fen mires showing that peat is weakly acidic which means it does not reflect any eutrophication processes caused by drainage and discharge of pollutants into the Jasieĺda River. This can further mean that either peat will show more “alkaline” values in the future due to ongoing accumulation or the pollution levels are very low.

Von Post Decomposition Index is H4 – weakly decomposed: plant structure still distinct, yields strongly turbid water, no peat substance passes between fingers, residue rather mushy.

Wetland condition analysis

Wetland name: Sporava fen mire
Region: Brest region, Biaroza, Ivanava, Ivacevičy and Drahičyn districts, Belarus
Date: 30.03.12

Classification: I System	**IA Subsystem**	**II Wetland Class**	**II Wetland Form**
Palustrine	Permanent	Fen	Floodplain

Indicator	**Indicator Components**	**Specify and Comment**	**Score 0-5**	**Mean Score**
Change in hydrological integrity	Impact of manmade structures	Drainage conducted in the 1970-80s. Drainage canals directly in the mire. Disturbance of the hydrological regime: decrease of the groundwater level, overgrowth with shrubs and trees. Around 70 % of the mire is disturbed, 31% of the reserve area is overgrown, the other part is open mires.	2	3
	Water table depth	Water table regenerating to normal levels.	4	
	Dryland plant invasion	Transformation of vegetation with birches, willows, overgrowth with reeds. 31% of the mire area is overgrown. A big part of the mire has been mowed in 2011-2013, so, the invasion of dryland plant species is partially stopped.	3	
Change in physicochemical parameters	Fire damage	<25% of the mire suffered and now in the process of recovery.	4	3.50
	Degree of sedimentation/erosion	None.	5	
	Nutrient levels	Water quality analysis shows high levels of domestic, agricultural pollution. Vegetation transformation (overgrowth with reeds, birches and willows along the drainage canals, near the central lake) as an evidence of euthrofication.	2	
	von Post index	4: plant structure becoming indistinct, yields brown water, some peat escapes between fingers	3	
Change in ecosystem intactness	Loss in area of original wetland	Open fen mires area has decreased by 21% since 1955, whereas overgown mire part has increased by 7%.	4	4
	Connectivity barriers	<25% of the connection (upstream and downstream) have been lost, althouth the disturbance is felt by almost 70% of the mire.	4	
Change in browsing, predation and harvesting regimes	Damage by domestic or feral animals	Light or localized browsing throughout the mire. Pastures were mainly o nthe mineral islands.	4	4.33
	Introduced predator impacts on wildlife	None	5	
	Harvesting levels	Disturbance by illegal hunting/fishing. Agriculture has been abandoned.	4	
Change in dominance of native plants	Introduced plant canopy cover	31% of the mire area has been overgrown with birches, willows and reeds	4	4.5
	Introduced plant understorey cover	None	5	
Total wetland condition index 19.33 / 25				

Degree of modification assigned as follows: 5=very low/none, 4=low, 3=medium, 2=high, 1=very high, 0=extreme

Chapter 3.1.2

Table A4. Carbon and carbon dioxide stockpile at the Jeĺnia peat deposit (Joint EU/UNDP project, 2008)

Area (ha)	Deposit type	Peat stockpile ('000 ton)	C ('000 ton)	CO_2 ('000 ton)
19,384	raised	93,325	49,968	183,385

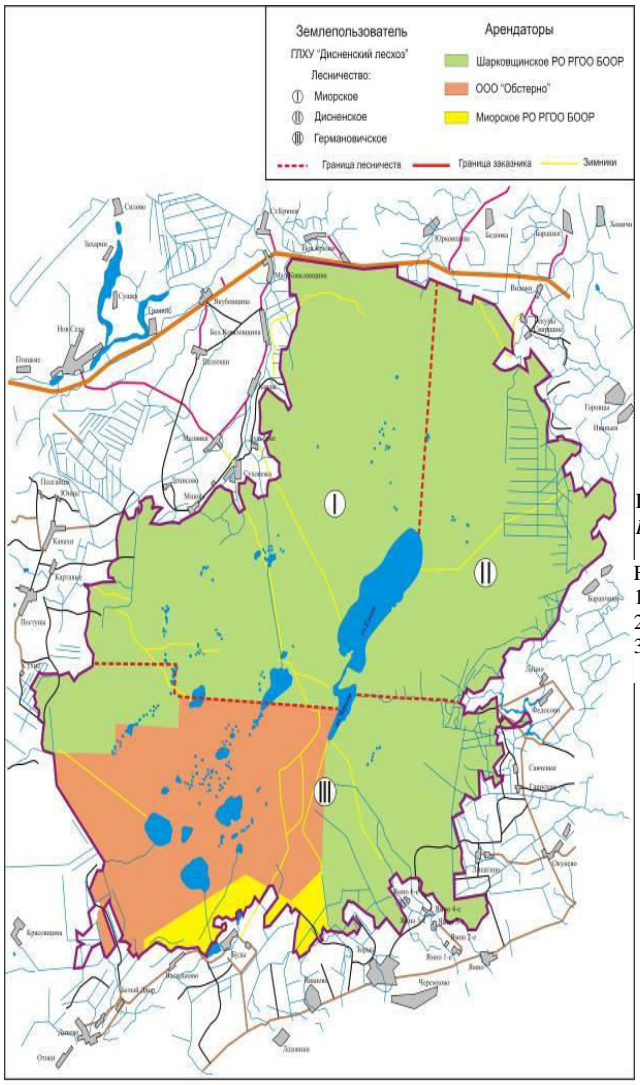
Figure A16. Effects of drainage on the bog

Figure A17. Severe fires on the bog in the past

Table A5. Transformation of landscape types in the Jeĺnia bog (EU-UNDP, 2008)

Landscape type	1990s, %	2012, %
Bogs	75.6	16
Bogs suffered from fires		49.7
Forested lands	22.1	24
Low forests and shrubs		5.8
Water	2.4	
Other lands		4.5

Figure A18. Cranberries (Gradziushka)



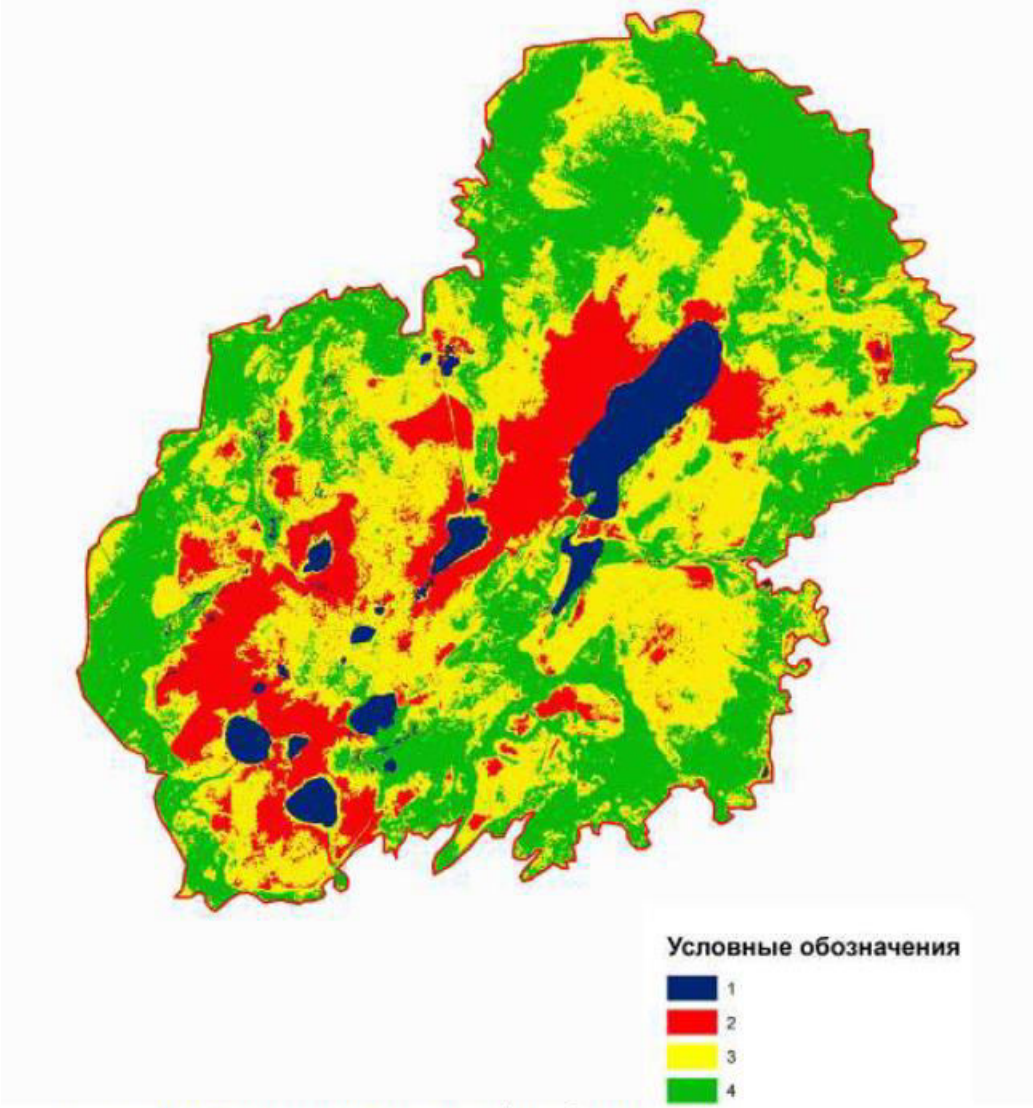
Land user:
Dzisna Forestry Enterprise

Forestry Sections:
1. Mijory forestry section
2. Dzisna forestry section
3. Hermanavičy forestry section

Tenants

Šarkaúščyna d.divsion *Bel Society of Hunters and Fishermen*
Absterna Ltd
Miory d.division *Belarusian Society of Hunters and Fishermen*

Figure A19. Users of land plots and water bodies and tenants of the the Jeĺnia reserve (Joint EU/UNDP project, 2008)



1 – открытая водная поверхность (озера) -1048, 2 га;
2 – территория сильно нарушенного гидрологического режима -2953,3 га;
3 – территория нарушенного гидрологического режима -8240 га;
4 – естественное верховое болото -8263 га.

Figure A20. Distribution of natural and disturbed landscape

Figure A21. Geese in the spring

Figure A22. Cranes in the bog

Figure A23. Arctic Loon in the bog

Figure A24. *Drosera rotundifolia* and *Ledum palustre* in the Jeĺnia bog

Figure A25. Views of the bog

Figure A26. Willow Grouse

Figure A27. Common Viper *Vipera berus*

Figure A28. Dam construction process

Figure A29. One of the dams on the Jeĺnia bog

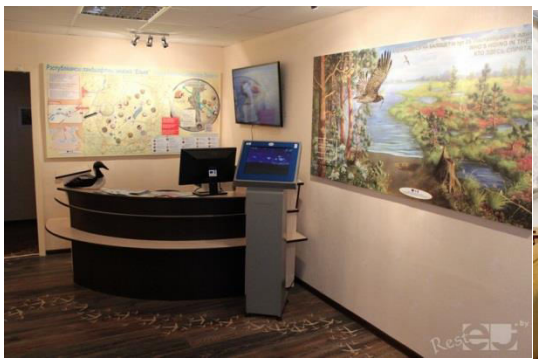
Figure A30. The dam a year after construction

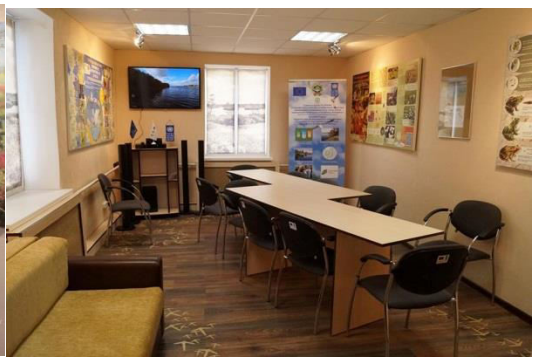
Figure A31. Cross-country vehicle for monitoring the bog

Figure A32. Information board in the reserve

Figure A33. Promotional board of the reserve

Figure A34. Visit-centre of the reserve





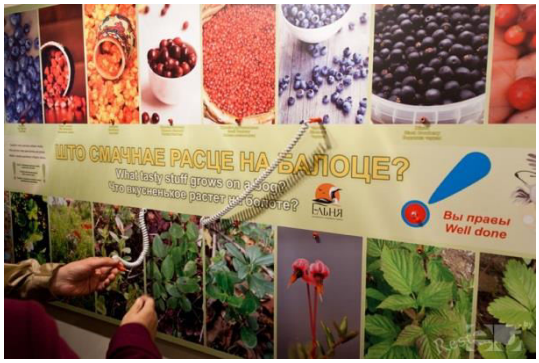


Figure A35. Visit-centre from the inside

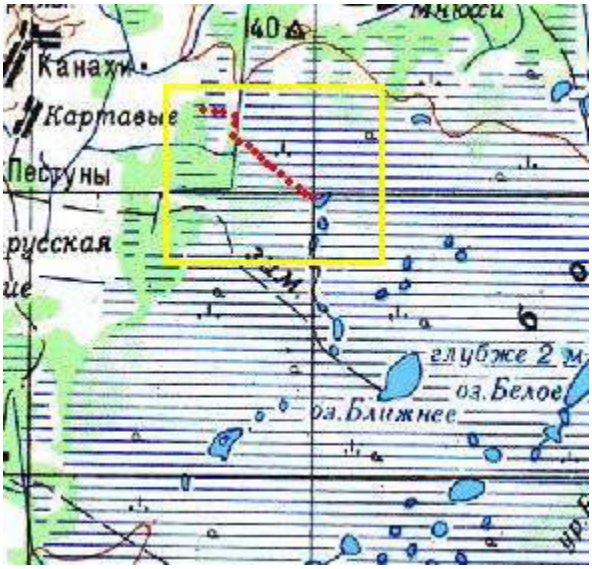


Figure A36. Construction of the Azeraúki ecological trail

Figure A37. Information board next to the visit-centre

Figure A38. Observation tower in the reserve

Figure A39. Cranes and cranberries of Mijory land in 2013

Figure A40. Shelters for shooting

Figure A41. Snowshoes for visiting the bog

The hyperlinks for commercials and videos on the reserve:

http://www.youtube.com/watch?v=Z9IBHh90KT0,

http://www.youtube.com/watch?v=aa8Rr559yjI,

http://www.youtube.com/watch?v=kbiJR4FioL8,

http://www.youtube.com/watch?v=UA_sfN9z5OI&feature=youtu.be

Visitor target groups

1. special visitors:

- scientists of different profiles (biologists, ecologists, geographers, geologists, etc.);
- participants of ecology oriented academic conferences;
- teachers, professors of biology and geography;
- students majoring in corresponding disciplines;

2. "enthusiastic" visitors:

- organized amateur tourists (ecotourists, including birdwatchers – bird

observing tourists, regional ethnographers), for whom trail use is one of the major goals of their voyage;

- members of school associations of ecological and similar profiles;

3. general visitors:

- secondary-school students coming for specialized lessons of nature study, biology, and geography;
- families, campers, orthodox pilgrims organized into tour groups;
- excursionists, tourists showing no specific interest in natural sites, arriving rather occasionally than purposefully, wishing mostly to hike and take the air.

Every tour should be available at for the three categories of visitors, whereas tours for school students should be adjusted depending on the students' age.

Water quality analysis

In June 2013 there were conducted field measurements of chemical characteristics of water by taking water samples near 10 previously installed sensors. The research was conducted after the period of high precipitation, thus, for the accuracy of the results, it makes sense to repeat the measurements in the midperiod of average precipitation.
The following parameters were measured during the research:

- Conductivity;
- Ph;
- Groundwater level,
- Mineralization;
- Oxidability;

These are the obtained research results for 11 research points:

Water quality indicators

Sensor №	Mineralization, mg/l	Conductivity, ms/cm	Redox potential, mV	Temp, ºC	Acidity, Ph	Acids, mg/l	GWL, cm
1	2615	30	0,07	+280	23	3,54	1,1	-10
2	2656	30	0,07	+279	23	3,52	1,2	-15
3	2597	30	0,06	+238	16	3,54	1,3	-15
4	2582	10	0,03	+283	22	3,81	1,3	0
5	2593	10	0,03	+259	22	3,80	1,3	0
6	2698	30	0,07	+250	15	3,64	0,8	-13
7	2561	20	0,04	+247	18	3,72	0,6	-5
8	2965	20	0,04	+295	21	3,70	0,5	-5
9	2567	20	0,06	+299	28	3,64	1,4	-15
10	2604	20	0,07	+227	27	3,68	1,6	-10

The values obtained allow us to make the following conclusions:

- Hydrochemical parameters are in the normal range typical of Belarusian bogs (low mineralization, low conductivity, strongly acidic);
- The highest values of mineralization are for points 1, 2, 3 which correspond with the disturbed parts of the Duĺski canal, and for point 6 in the south of the reserve;
- Ph values are at their highest limit for bogs;
- Oxidability is the highest at the bog edges which is explained by the fact that there is a higher water flow in those areas.

The analysis of groundwater level at various locations proves that there are areas that show a rather high level of disturbance (-10, -15 cm on average) which is a clear evidence of negative consequences of the past human activities. However, dam construction contributed to rise of the groundwater level and restoration of the hydrological regime of the bog.

Peat analysis

Analysis of peat was made through analysis of peat ph values from 2010 research data and assessment of von Post Decomposition Index.
Peat ph in Jeĺnia bog, since it is a raised bog, must be strongly acidic: absence of alkaline components from the organic material, precipitation prevails over evaporation,

anthropogenic factors (deposition of acidic pollutants from the atmosphere), peat is nutrient-poor, its ph is usually 3-4.
The 2010 research data results show the 3 following ph values for peat: 3.0, 2.9, 3.07 with an average of 2.99.
The values obtained are in the normal range for bogs which means peat is very acidic and does not reflect any evidence of its deterioration due to disturbance of hydrological regime.

Von Post Decomposition Index is has been measured for 3 locations:

- Lake Bielaje – H5 – moderately decomposed: plant structure still clear but becoming indistinct, yields much turbid brown water, some peat escapes between fingers, residue very mushy;
- 300 m from the drainage canal – H4 – weakly decomposed: plant structure distinct, yields strongly tubid water, no peat passes between fingers, residue rather mushy;
- Lake Kurhanistaje (between the tussocks) – H1 – undecomposed: plant structure unaltered, yields only clear colourless water.

Wetland condition analysis

Wetland name: Jeĺnia raised bog
Region: Viciebsk region, Mijory and Šarkaúščyna districts, Belarus
Date: 25.03.12

Classification: I System	IA Subsystem	II Wetland Class	II Wetland Form
Palustrine	Permanent	Bog	Floodplain

Indicator	Indicator Components	Specify and Comment	Score 0-5	Mean Score
Change in hydrological integrity	Impact of manmade structures	Drainage conducted in the 1960s. Canals mostly in the central and eastern part of the bog. Disturbance of the hydrological regime: decrease of the groundwater level, frequent fires, overgrowth with shrubs and trees. Around 54 % of the bog is disturbed, 14 % is seriously disturbed	3	3
	Water table depth	Only 40 % of the bog has a natural bog groundwater level. The other part has suffered form a severe decline of water table.	2	
	Dryland plant invasion	Low. Confined to margins of drainage canals, lakes	4	
Change in physicochemical parameters	Fire damage	Vegetation almost recovered from the devastating 1998 and 2002 fires which destroyed 70 % of the *Sphagnum* moss area	4	4
	Degree of sedimentation/erosion	None.	5	
	Nutrient levels	No evidence of increased levels of nutrients has been obtained during water quality analysis. Vegetation transformation (overgrowth with bushes and trees along the drainage canals, near lakes) as an evidence of euthrofication.	3	
	von Post index	3: distinct plant structure, yields brown water	4	
Change in ecosystem intactness	Loss in area of original wetland	Around 15% severely disturbed Central and southern parts of the bog have been severely disturbed by drainage.	4	3.5
	Connectivity barriers	54 % of the bog severely disturbed by drainage canals, most seriously – 14 %	3	
Change in browsing, predation and harvesting regimes	Damage by domestic or feral animals	None	5	4.67
	Introduced predator impacts on wildlife	None	5	
	Harvesting levels	Annual cranberries gathering, fishing by locals: low influence by formation of trails, animal disturbance	4	
Change in dominance of native plants	Introduced plant canopy cover	Confined to margins of the drainage canals, lakes	4	4.5
	Introduced plant understorey cover	None	5	
Total wetland condition index 19.67 / 25				

Degree of modification assigned as follows: 5=very low/none, 4=low, 3=medium, 2=high, 1=very high, 0=extreme

Chapter 3.1.3

Table A6. Distribution of landscapes in the Zvaniec mire (NAS, 2009b)

Landscape type	%
Open fens	77.4
Forests and shrubs	18.1
Agricultural lands	2.1
Water	0.2

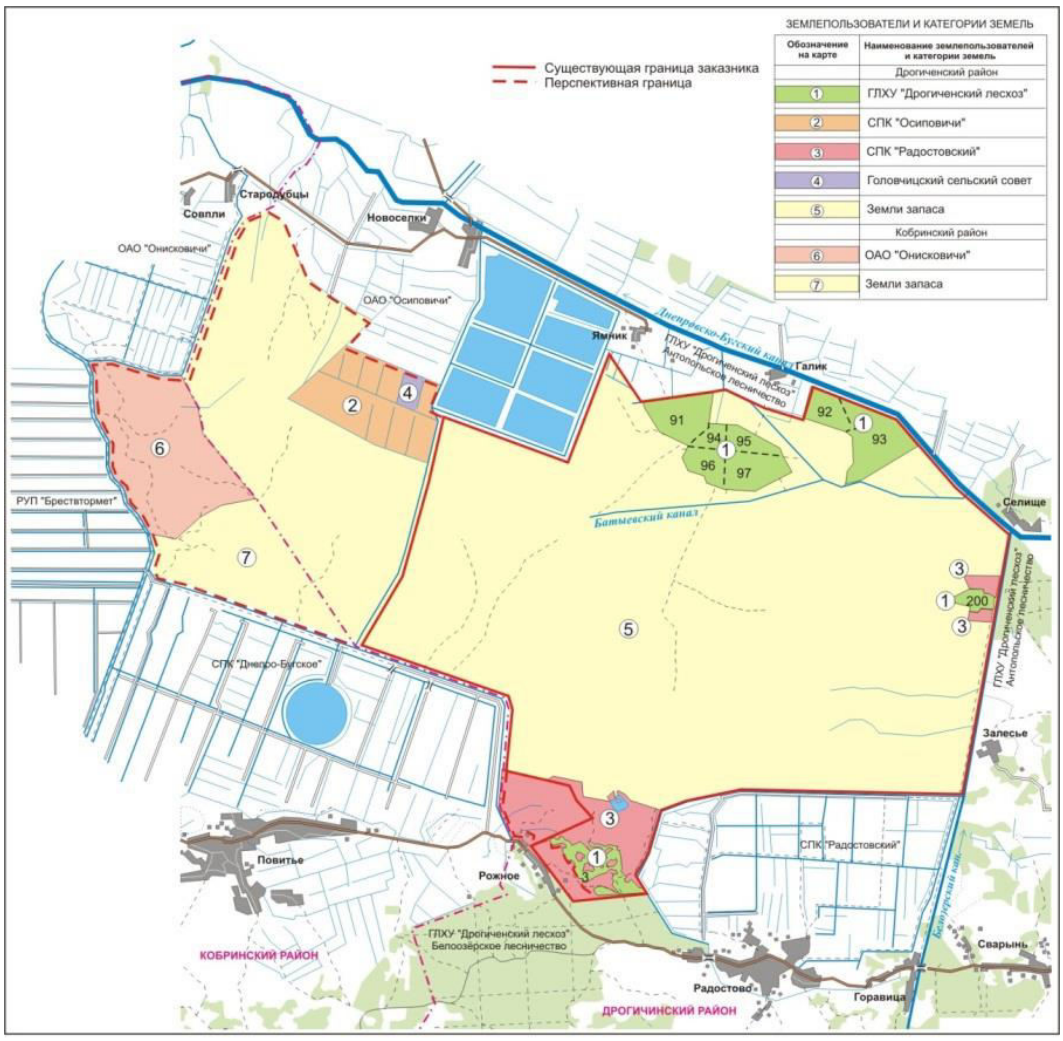


Рисунок 1.2 - Размещение землепользователей земельных участков на территории заказника "Званец"

Figure A42. Land users in the Zvaniec reserve (National Academy of Sciences, 2009)

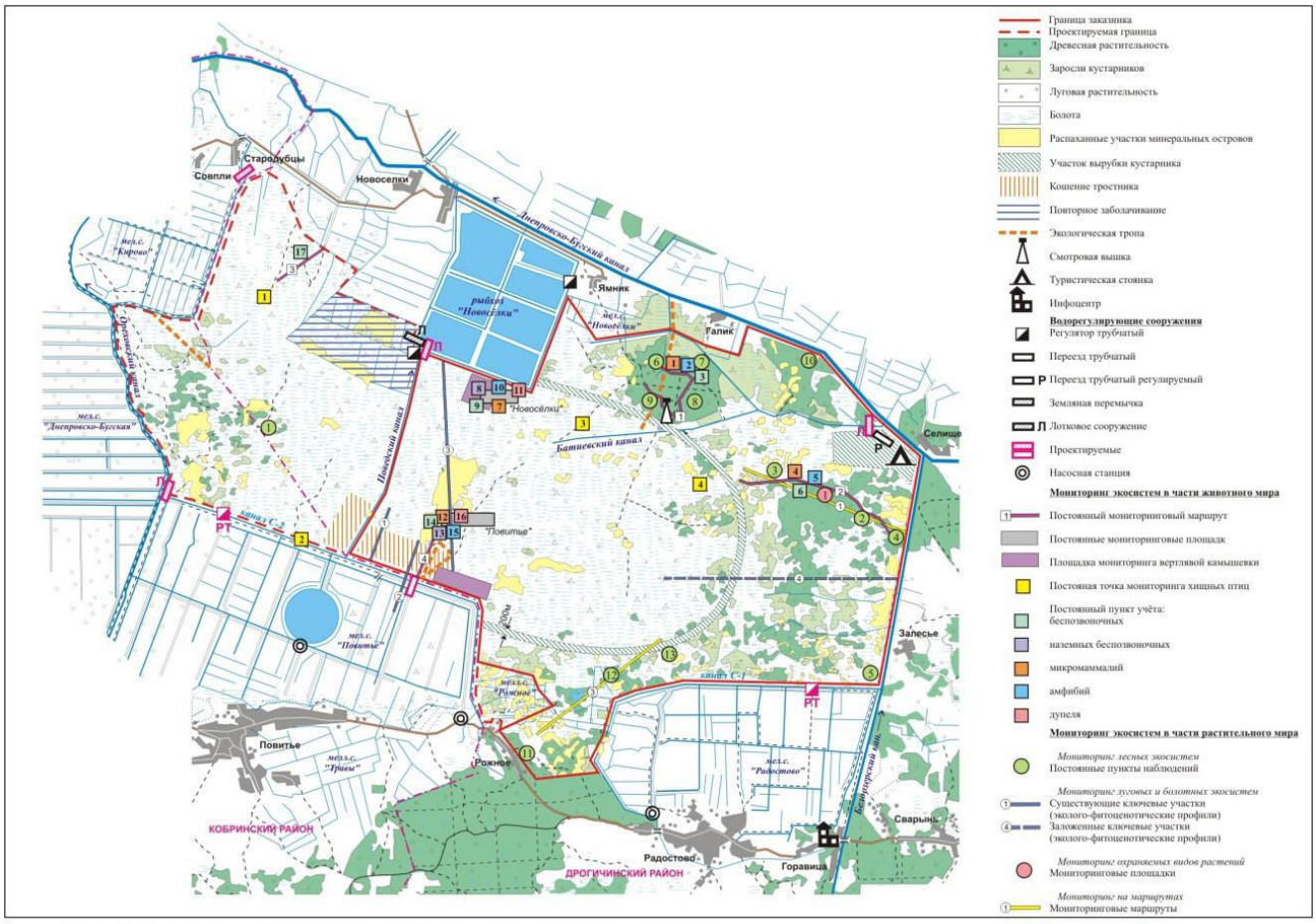


Рисунок 7.1 - Схема мероприятий плана управления республиканским биологическим заказником "Званец"

Figure A43. Scheme of the planned activities in the Zvaniec reserve (National Academy of Sciences, 2009)

Figure A44. Views of the mire

Figure A45. Visitor centre

Peat analysis

Analysis of peat was made through analysis of peat ph values from 2009 research data and assessment of von Post Decomposition Index.
Peat ph in Zvaniec mire, since it is a fen mire, must be weakly acidic, neutral or weakly alkaline: it gets minerals (N, K, P) from the groundwater and is nutrient-rich, its ph is usually 5.5-8.
The 2009 research data results show the 3 following ph values for peat: 5.80, 5.70, 5.70 with an average of 5.73.
The values obtained are in the normal range for fen mires and show that the peat in Zvaniec mire is weakly acidic which does not serve as any evidence of drainage consequences and disturbance of hydrological regime of the mire. This means that the ecosystem has had the resources to protect itself and prevent severe degradation.

Von Post Decomposition Index is H4 – weakly decomposed: plant structure distinct, yields strongly turbid water, no peat substance passes between fingers, residue rather mushy.

Wetland condition analysis

Wetland name: Zvaniec fen mire
Region: Brest region, Kobryn and Drahičyn districts, Belarus
Date: 25.04.12

Classification: I System	IA Subsystem	II Wetland Class	II Wetland Form
Palustrine	Permanent	Fen mire	Floodplain

Indicator	Indicator Components	Specify and Comment	Score 0-5	Mean Score
Change in hydrological integrity	Impact of manmade structures	Drainage conducted in the 19-20th centuries. No drainage canals in the mire itself, only around it. Disturbance of the hydrological regime: rises and falls of the groundwater level, frequent fires, overgrowth with shrubs and trees. Around 50% of the bog (northern and eastern parts) are affected by the human activities	3	3
	Water table depth	Sudden inundations or droughts due to improper use of amelioration systems, using of a mire part as a reservoir for the fishfarm and amelioration systems. Big interval between max and min groundwater level and between different years.	2	
	Dryland plant invasion	Low. Tracts with a lowered groundwater table along the mire boundaries are overgrown with shrubs and trees	4	
Change in physicochemical parameters	Fire damage	Unexpected fires in the recent years in <25% of the mire, vegetation recovering from the older fires	4	3,75
	Degree of sedimentation/erosion	None.	5	
	Nutrient levels	Use of poisonous seeds on the nearby agricultural lands which caused eaths of various birds in the past. Vegetation transformation on mineral islands, along the tracts as an evidence of euthrofication.	3	
	von Post index	4: plant structure becoming indistinct, yields born water with some peat escaping between fingers	3	
Change in ecosystem intactness	Loss in area of original wetland	No loss, one of the 6 large fens left untouched with drainage and peat extraction. Just disturbance by human activities around the mire	5	4
	Connectivity barriers	Around 50 % of the mire (especially northern and eastern parts) disturbed by amelioration systems and the fishfarm	3	
Change in browsing, predation and harvesting regimes	Damage by domestic or feral animals	None	5	4.33
	Introduced predator impacts on wildlife	None	5	
	Harvesting levels	Land ploughing for agriculture on mineral islands, forest logging	3	
Change in dominance of native plants	Introduced plant canopy cover	Tracts with lowered groundwater table – birches, willows, reeds	4	4.5
	Introduced plant understorey cover	None	5	
Total wetland condition index 19.58 / 25				

Degree of modification assigned as follows: 5=very low/none, 4=low, 3=medium, 2=high, 1=very high, 0=extreme

Chapter 3.1.4

	Name of site / locality	Year	Coordinator	Number of counts	Type of counts	Accuracy	Area, ha**	Population on site, males	
								min	max
1	**Zvaniec**						**4,660**	**2,149**	**4,459**
	Zvaniec East (Selišča)	*2013*	*UM*	*1*	*full*	*good(obs)*	*140*	*34*	*34*
	Zvaniec Central	*2013*	*UM*	*2*	*reg. plots*	*good(est)*	*4,520*	*2,115*	*4,425*
	Zvaniec West	*2013*	*UM*	*1*	*full*	*good(obs)*	*0*	*0*	*0*
2	**Dzivin**						**175**	**12**	**12**
	Dzivin-Chabovičy	*2011*	*UM*	*1*	*full*	*good(obs)*	*28*	*3*	*3*
	Dzivin-Lipava	*2013*	*UM*	*1*	*full*	*good(obs)*	*17*	*0*	*0*
	Dzivin-Liubań	*2011*	*UM*	*1*	*full*	*good(obs)*	*63*	*0*	*0*
	Dzivin-Rudziec	*2010*	*UM*	*1*	*full*	*good(obs)*	*67*	*9*	*9*
3	**Sporava**						**1,426**	**492**	**667**
	31 localities (within PA)	*2013*	*UM*	*1*	*full/est*	*good(est)*	1,358	475	650
	Bielaje (in a buffer zone)	*2012*	*UM*	*1*	*full*	*good(obs)*	55	14	14
	Vysokaje East (buffer zone)	*2013*	*VP*	*1*	*full*	*good(obs)*	13	3	3
4	**Dzikoje**						**1,563**	**174**	**209**
	Dzikoje	*2013*	*UM*	*1*	*full/est*	*good(est)*	*1,155*	*170*	*194*
	Hlybokaje	*2006*	*MC*	*1*	*full/est*	*good(est)*	*35*	*2*	*5*
	Lomaŭka	*2006*	*MC*	*1*	*full*	*good(obs)*	*139*	*0*	*0*
	Naraŭ	*1996-2005*	*MC*	*1*	*full/est*	*good(est)*	*234*	*2*	*10*
5	**Ščara**						**411**	**16**	**16**
	Babrovickaje	*2010*	*DL*	*1*	*full*	*good(obs)*	*3*	*0*	*0*
	Dabromysĺ	*2013*	*SL*	*1*	*full*	*good(obs)*	*123*	*0*	*0*
	Końki	*2010*	*DL*	*1*	*full*	*good(obs)*	*12*	*3*	*3*
	*Rahačy****	*2012*	*UM*	*1*	*full*	*good(obs)*	*200*	*5*	*5*
	Tuchaviči	*2010*	*DL*	*1*	*full*	*good(obs)*	*71*	*8*	*8*
	Vyganaščanskaje	*2010*	*DL*	*1*	*full*	*good(obs)*	*2*	*0*	*0*
6	**Servač**						**493**	**30**	**30**
	Dzierkaŭščyna	*2012*	*VL*	*1*	*full*	*good(obs)*	*444*	*8*	*8*
	Prachody	*2010*	*VL*	*1*	*full*	*good(obs)*		*20*	*20*
	Šantaraŭščyna	*2012*	*VL*	*1*	*full*	*good(obs)*	*49*	*2*	*2*
7	**Svislač**						**202**	**37**	**37**
	Hrajna	*2010*	*DV*	*1*	*full*	*good(obs)*	*153*	*35*	*35*
	Rahačy	*2010*	*DV*	*1*	*full*	*good(obs)*	*49*	*2*	*2*
8	**Middle Prypiac**						**647**	**26**	**26**
	Jasieĺda	*2011*	*VL*	*2*	*full*	*good(obs)*	*42*	*0*	*0*
	Korabje	*2011*	*SL*	*1*	*full*	*good(obs)*	*67*	*1*	*1*
	Mikaševičy	*2011*	*VL*	*1*	*full*	*good(obs)*	*23*	*1*	*1*
	Styr	*2010*	*MD*	*2*	*full*	*good(obs)*	*515*	*24*	*24*
9	**Prostyr**						**800**	**10**	**50**

	Prostyr	*2010*	*DZ*	*-*	*guess*	*poor(susp)*	**500*	*10*	*50*
	Zarelišča	*2010*	*DL*	*1*	*full*	*good(obs)*	*300*	*0*	*0*
10	**Aĺmany**	2010	MD	1	estimate	med(est)	***1,500**	**0**	**0**
11	**Dzitva**	2010	DL	1	full	good(obs)	**31**	**2**	**2**
12	**Hajna**	2010	SL	1	full	good(obs)	**711**	**0**	**0**
13	**Lieĺčyckaja Ubarć**	2010	PP	-	guess	poor(susp)	***600**	**0**	**0**
14	**Stary Žadzien**	2006	VF	1	estimate	med(est)	***600**	**20**	**40**
15	**Upper Pcič**	2013	UM	1	full	good(obs)	**36**	**0**	**0**
	TOTAL						**13,855**	**2,968**	**5,548**

* The sites are not sufficiently surveyed. The area of suitable habitat is considerably overestimated due to mosaic structure of site. Further surveys are needed to refine (reduce) these numbers.
** Area of suitable habitat
*** New locality discovered in 2012

Type of counts
Full = full counts covered the whole site.
Full/est = full counts were executed for the most part of the site and minimum figure corresponds to the number of counted males, an estimation resulting in a maximum figure was produced for the rest of the site.
Reg. plots = counts were implemented at sample plots located regularly.

Accuracy
Good (Observed) = based on reliable or representative quantitative data derived from complete counts.
Good (Estimated) = based on reliable or representative quantitative data derived from sampling or interpolation.
Medium (Estimated) = based on incomplete quantitative data derived from sampling or interpolation.
Poor (Suspected) = based on no quantitative data, but guesses derived from circumstantial evidence.

Coordinators
DL Dzianis Lundyshau
DZ Dzima Zhurauliou
MC Mikalaj Cherkas
MD Maryna Dzmitrynok
PP Pavel Pinchuk
SL Siamion Lievy
UM Uladzimir Malashevich
VF Viktar Fienchuk
VL Volha Lukshyc
VP Vadzim Pratasievich

Figure A46. Results of AW counts 1996-2013

Chapter 3.2.1

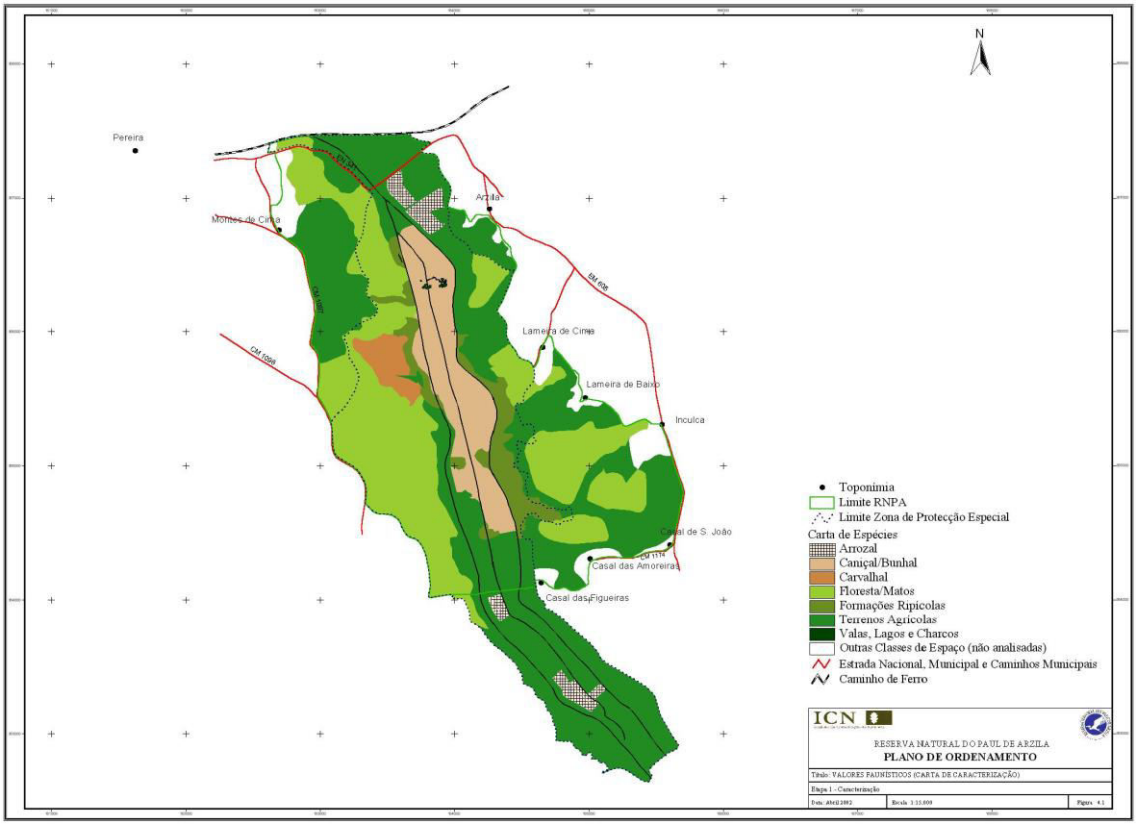


Figure A47. Vegetation landscapes within the protection zones

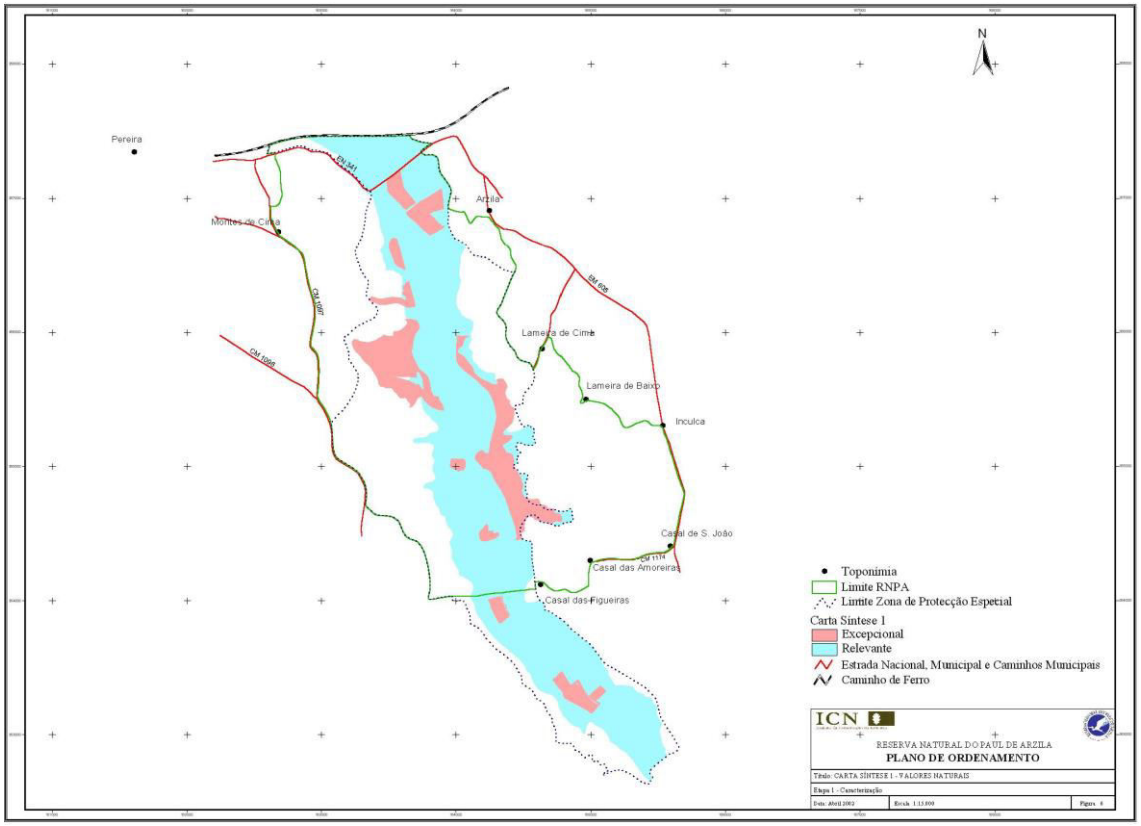


Figure A48. Importance of vegetation landscapes (exceptional, relevant)

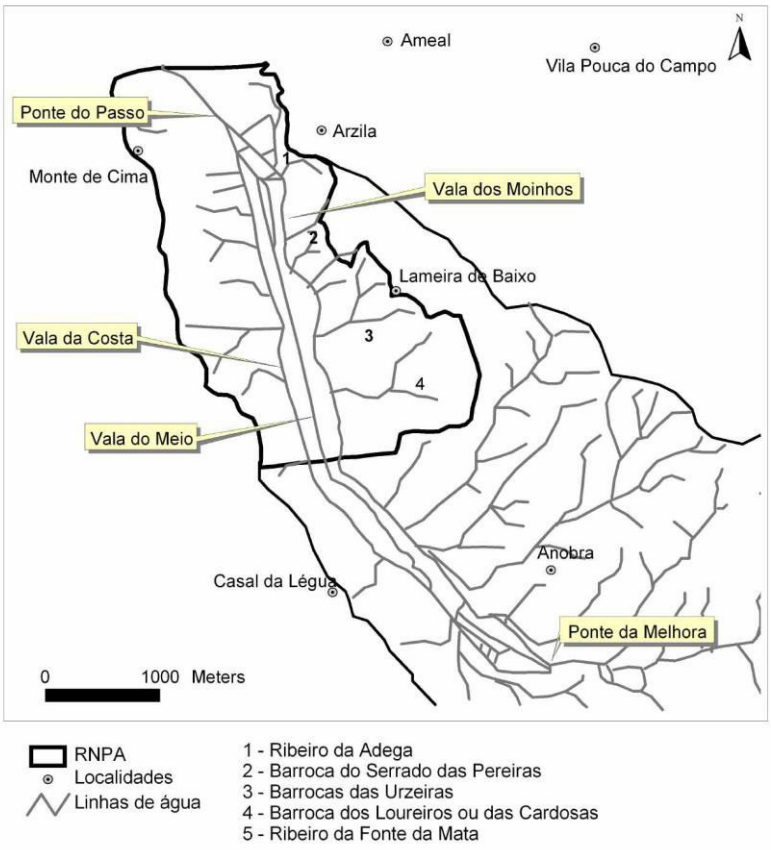


Figure A49. Location of the ditches in the reserve (ICN,2004)

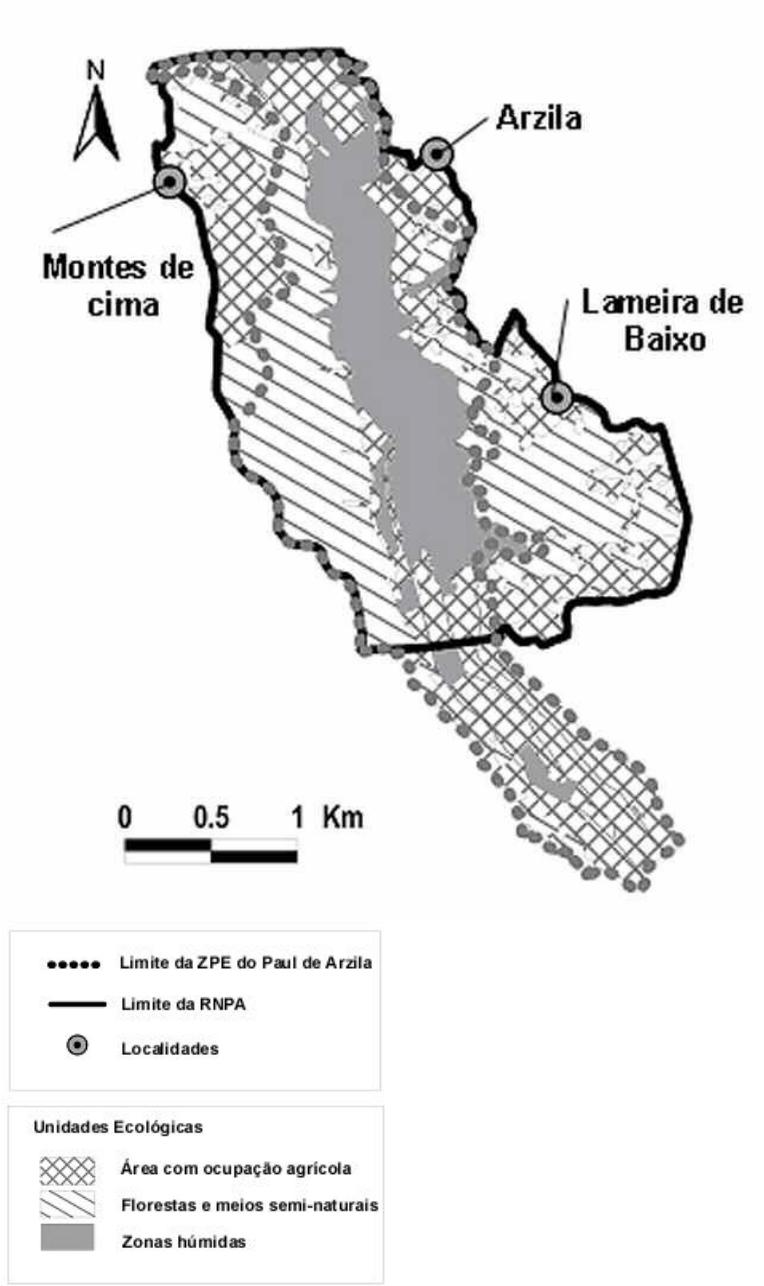


Figure A50. Area of the reserve by the landscape type and activities carried out (ICN, 2004)

Table A7. Distribution of 3 areas within the reserve (ICN, 2004)

Unidades	Área (ha)	Percentagem (%)
Área com ocupação agrícola	264,2	38,3
Florestas e meios semi-naturais	257,8	37,3
Zonas húmidas	144,7	21,0

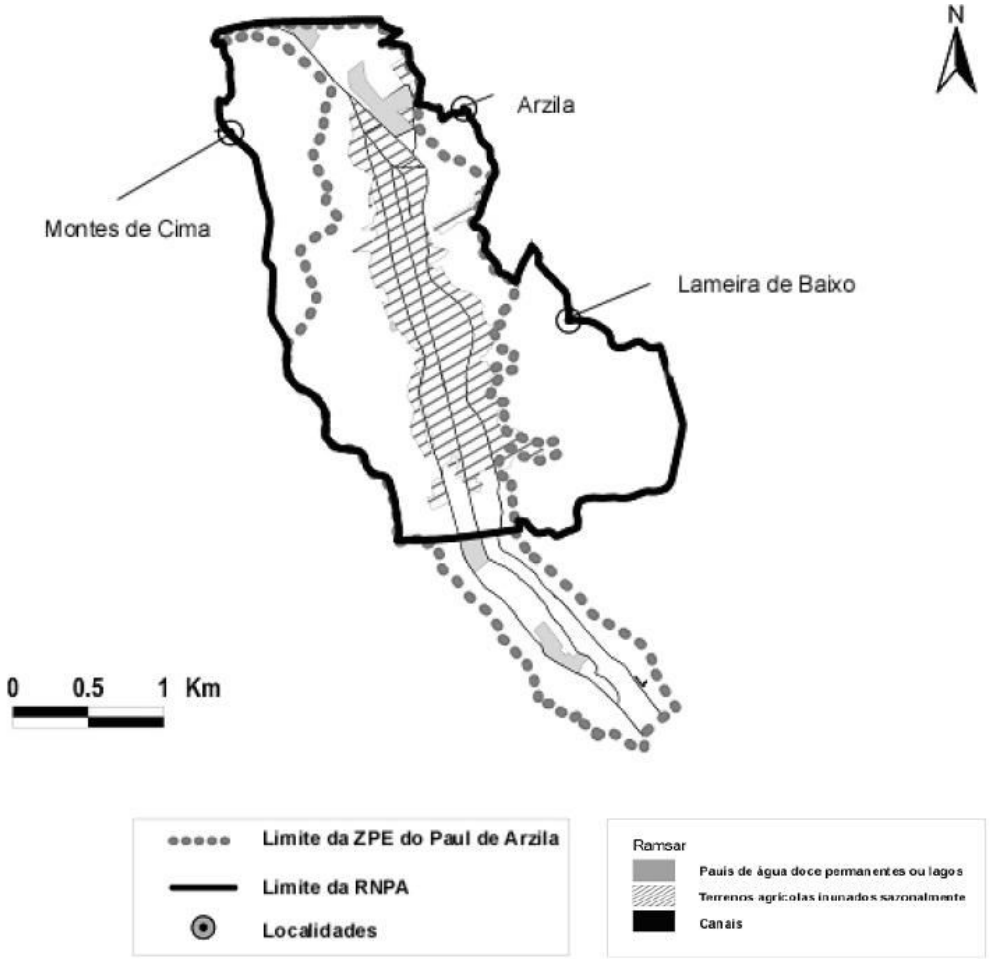


Figure A51. Wetland types in the reserve (ICN, 2004)

Table A8. Distribution of 3 area types within the wetland area (ICN, 2004)

Código Ramsar	Descrição	Área (ha)	Área (% zona húmida)	Área (% total)
Tp	Pauis de água doce permanentes ou lagos	116,4	80,3	11,6
4	Terrenos agrícolas inundados sazonalmente	17,9	12,4	1,8
9	Canais	10,6	7,3	1,1

Table A9. Wetland types according to vegetation

Tipologia Ramsar	Descrição	Código MedWet	Área (ha)	Área (%)
Tp	- Paul, com superfície aquática livre.	PBOKPF- -	1,2	0,9
	- Paul (caniçal/ bunhal), com *Scirpus* sp. como espécie dominante.	PBEPLF-B	7,1	4,9
	- Paul (caniçal/ bunhal), com *Phragmites australis* como espécie dominante.	PBEPLF-P	61,1	42,2
	- Paul (caniçal/ bunhal), com *Phragmites australis* como espécie dominante, artificialmente controlado por um dique.	PBEPPFDP	3,0	2,0
	- Paul (caniçal/ bunhal), com *Populus alba* como espécie dominante.	PBFDUF-L	0,7	0,5
	- Paul (formações aluvionares e ripícolas), com dominância de *Salix* sp. e inundação . semi-premanente	PBUELF-S	0,3	0,2
	- Paul, (formações aluvionares e ripícolas), com dominância de *Salix* sp. e solo saturado.	PBUEUF-S	34,6	23,9
	- Paul (formações aluvionares e ripícolas),, com mistura de espécies vegetais arbustivas.	PBUEUF-	0,1	0,1
	- Paul (formações aluvionares e ripícolas),, com dominância de *Salix atrocinerea*.	PBUEUF-A	10,2	7,0
	- Paul (formações aluvionares e ripícolas),, com dominância de *Salix alba*.	PBUEUF-C	1,1	0,8
4	- Arrozal, inundado sazonalmente e artificialmente.	PBENSFFR	17,9	12,4
9	- Canal de água corrente dominado por vegetação emergente persistente.	PBEPPF- -	1,7	1,1
	- Canal de água corrente sem dominância de vegetação.	RWOSPF-	5,9	4,1

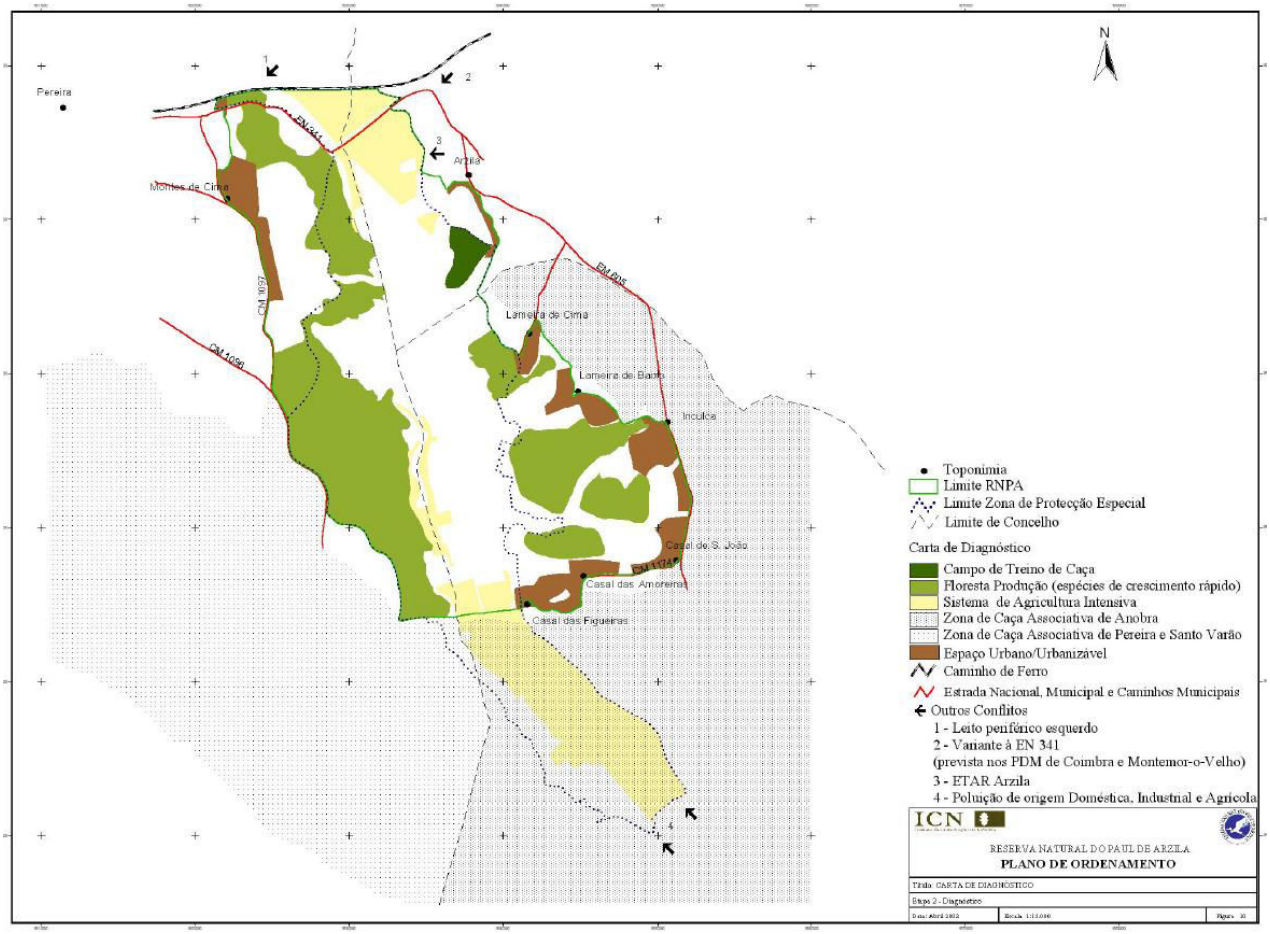
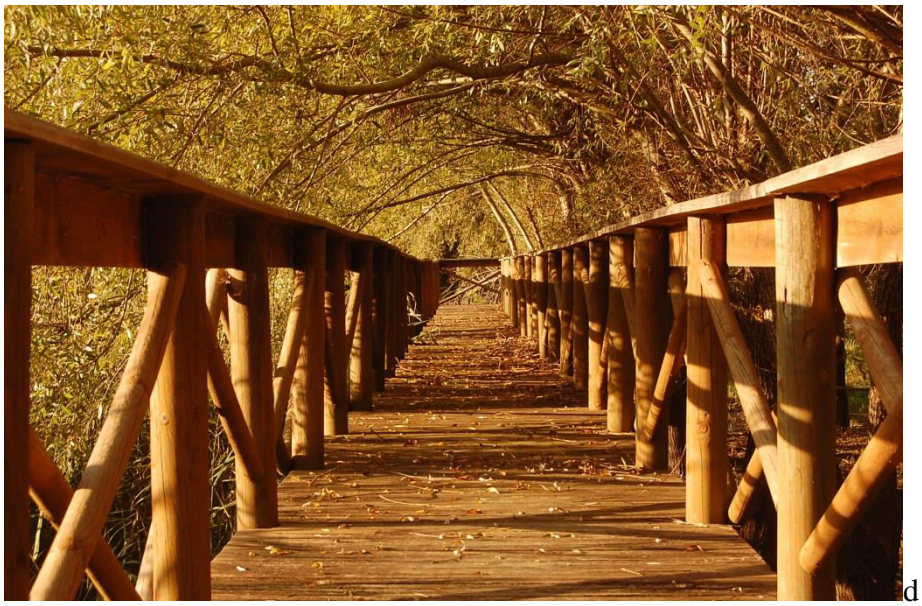


Figure A52. Map of diagnosed threats for the reserve under the Report-Diagnostics (ICN, 2004)

a

b

c



d

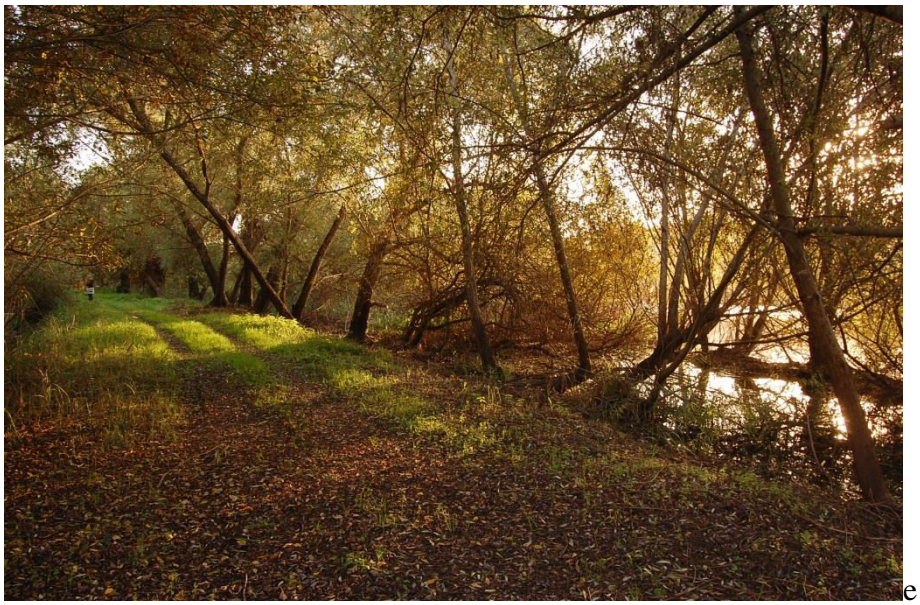

e

Figure A53. a. Lousiana Crayfish; b. Interpretation centre; c. Views of the marsh; d. Observation tower; e. Pedestrian trail

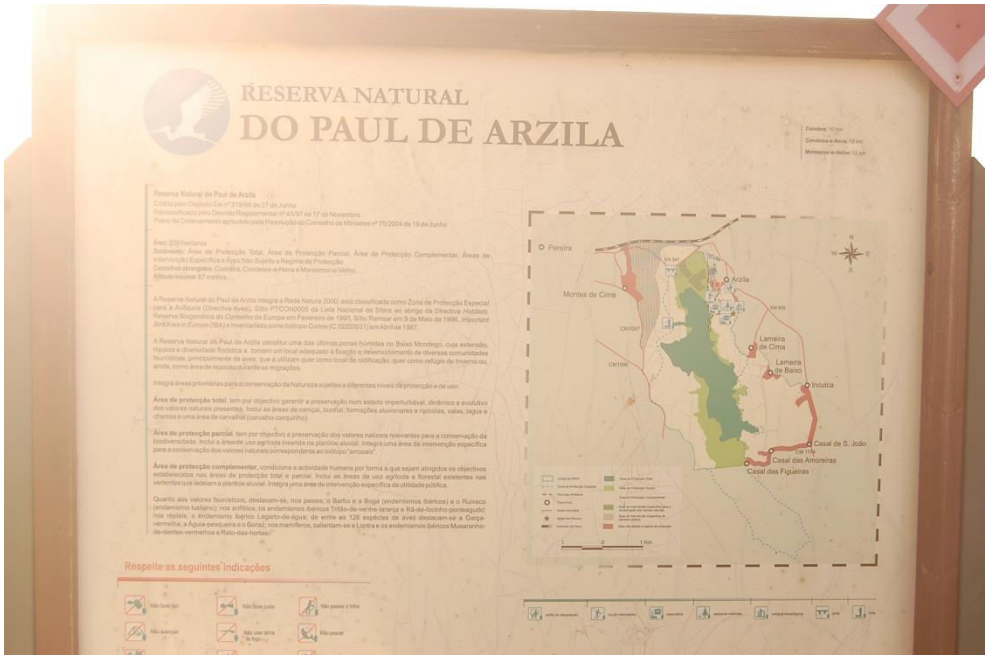


Figure A54. Information board

Water quality analysis

Water quality analysis has been carried out with the help of two information sources: the research of 1999 and the 2011 the data of the National System of Information on Hydrological Resources. Therefore, it consists of two parts: the one with the 1999 results and the other with the 2011 data.

Part 1

The 1999 research was on control of vegetation expansion in the marshes of the Lower Mondego, and in particular, on improvement of habitat management for aquatic birds in Paul de Arzila.

There were chosen 8 sampling points in the area of the paul. They are shown on the map below (Figure A55).

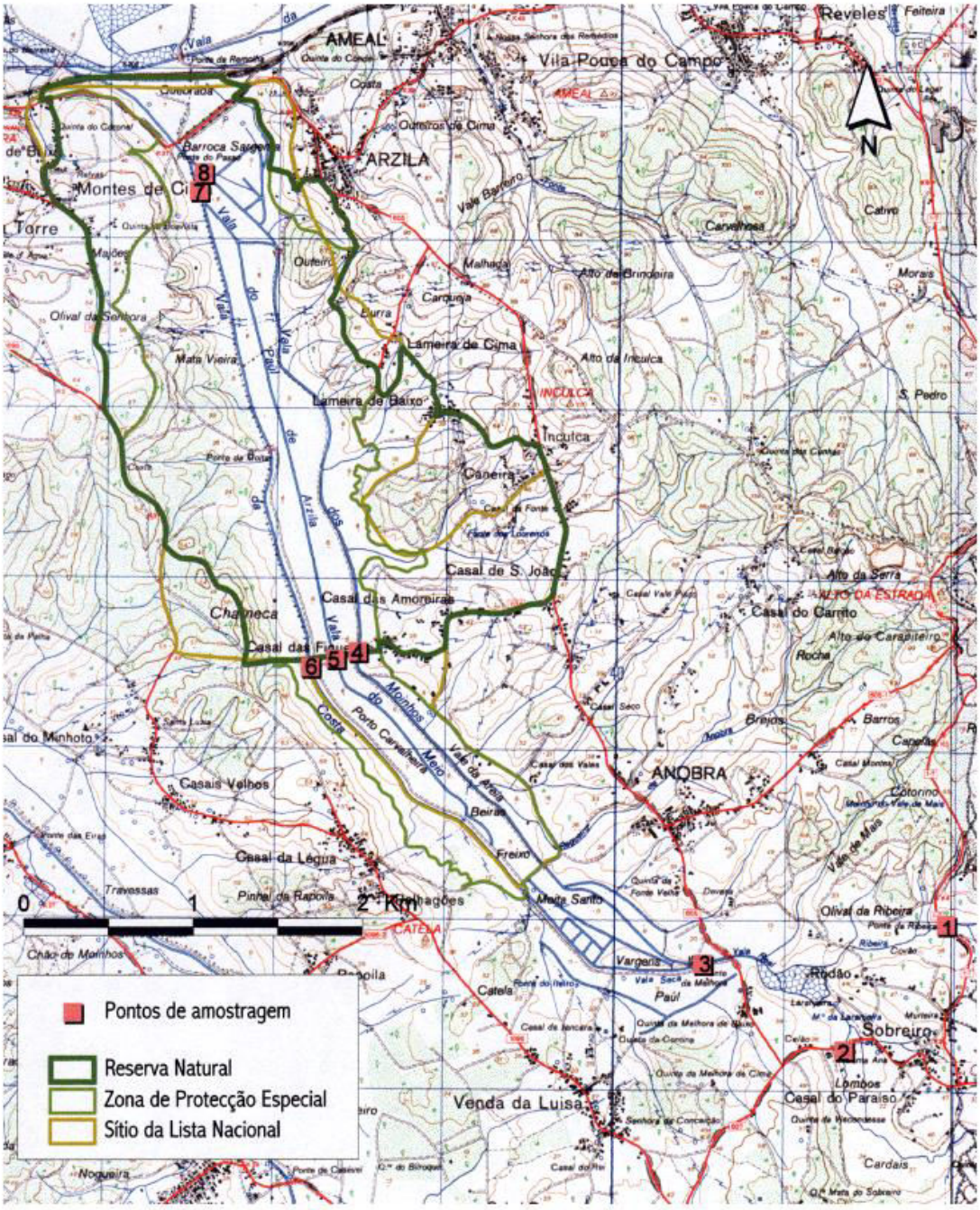


Figure A55. Sampling points in the Paul de Arzila

1 – Ribeira da Malga – the point of release of two effluents from the industries of the region – one on meat production and the other on ceramics production (which is now terminated). Thus, potentially the most polluted point;
2 – Ribeira de Cernache – located next to the village of Sobreiro which is subjected to agricultural and domestic pollution;
3 – Ponte de Melhora – the point where two principal water lines of the River Cernache meet, subjected to agricultural, industrial and domestic pollution;
4 – Vala dos Moinhos (Casal das Figueiras) – entrance to the reserve, just on the border of the paul, agricultual and domestic pollution;
5 – Vala do Meio – Casal das Figueiras – next to Vala dos Moinhos, one of the three ditches in the paul, agriculture is the main pollutant;

6 – Vala da Costa (Casal das Figueiras) – subjected to agricultural pollution, its waters directly enter the paul;
7 – Dique (dam) – located at the exit from the paul being an important point to compare the water quality entering and leaving the area;
8 – Vala dos Moinhos – exit, is not located within the reserve.

Thus, points 1, 2, 3 are located in the long distance from the paul, 4, 5, 6 are at the entrance to the paul, and 7,8 are at the exit.

The samples were taken monthly during the year of 1999. The following parameters were assessed at each point: ph, temperature, dissolved oxygen, conductivity, nitrates, phosphates, ammonia.

Results

Ph – ph values vary during the year identically for all the points except for point 1 (Ribeira da Malga) and point 7 (Dique) which have the lowest values due the certain level of industrial pollution (point 1) and circulation difficulties (point 7) due to opening/closing of the gates. However, the values are not critically bad, they are in normal range of 7-8 (Figure A56).

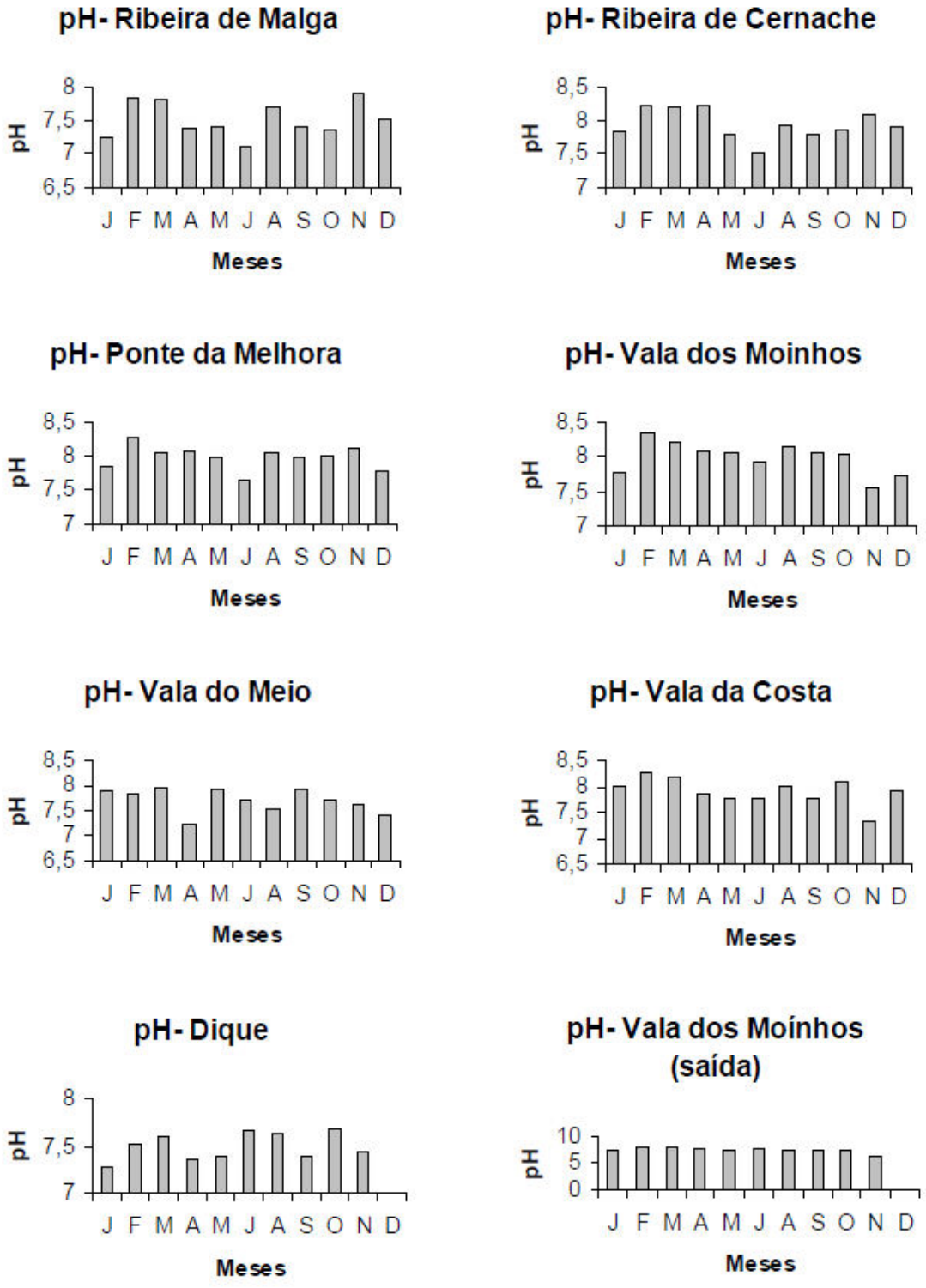


Figure A56. Ph values at the sampling points in the area of Paul de Arzila

Dissolved O2 – seasonal variations at all the points (the higher the temperature the less oxygen it contains and vice versa), the highest values registered in the raining season when the water flow is at its maximum. 5 mg/l is considered to be a minimum normal level. Points 1, 7, and 8 have the lowest values which can mean there are pollutants accumulated in the water and causing poor O2 saturation (Figure A57).

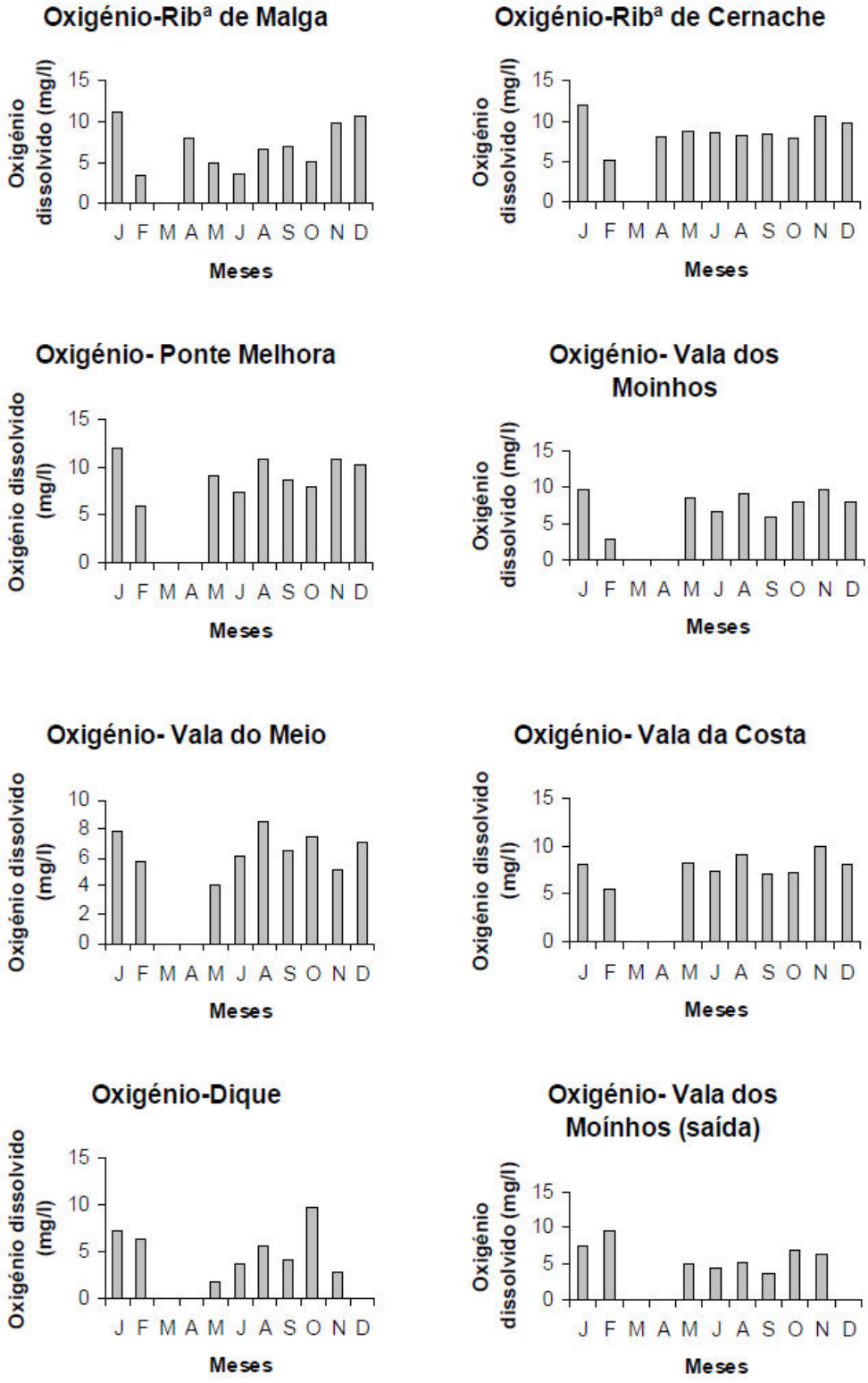


Figure A57. Dissolved oxygen values at the sampling points in the area of Paul de Arzila

Conductivity – highest in the summer when the temperatures are high and the water flow is low. Normal level range is 200-1000 us/cm. Point 1 again has the highest values due to the certain pollution level (Figure A58).

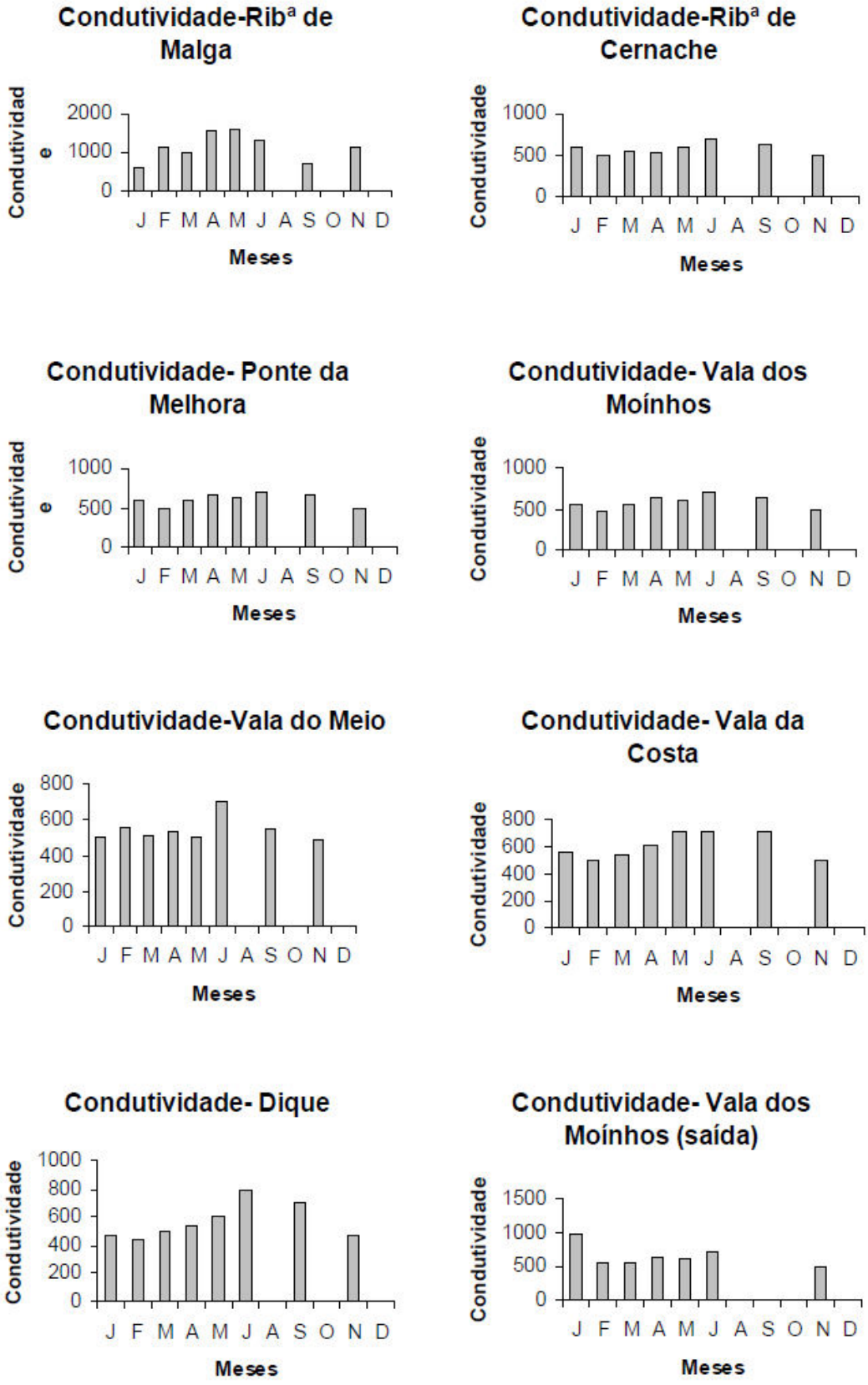


Figure A58. Conductivity values at the sampling points in the area of Paul de Arzila

Quantity of nutrients (ammonia, nitrates, nitrites, phosphates) – Figures A59-A62.
Nitrates normal range is less than 5 mg/l – all the points show positive values, except for single higher than 5 mg/l values at points 2 and 3 in June;
Phosphates normal range is less than 0.54 mg/l – very high values (with maximum value of 3 mg/l) during all the year at point 1;
Ammonia normal range is less than 0.10 mg/l – higher than normal at points 1, 3, 5, 7, point 1 having maximum value of 2 mg/l.
Point 1 values reflect high level of accumulated pollutants whereas at other points the values are mostly in a normal range, with seasonal variations.

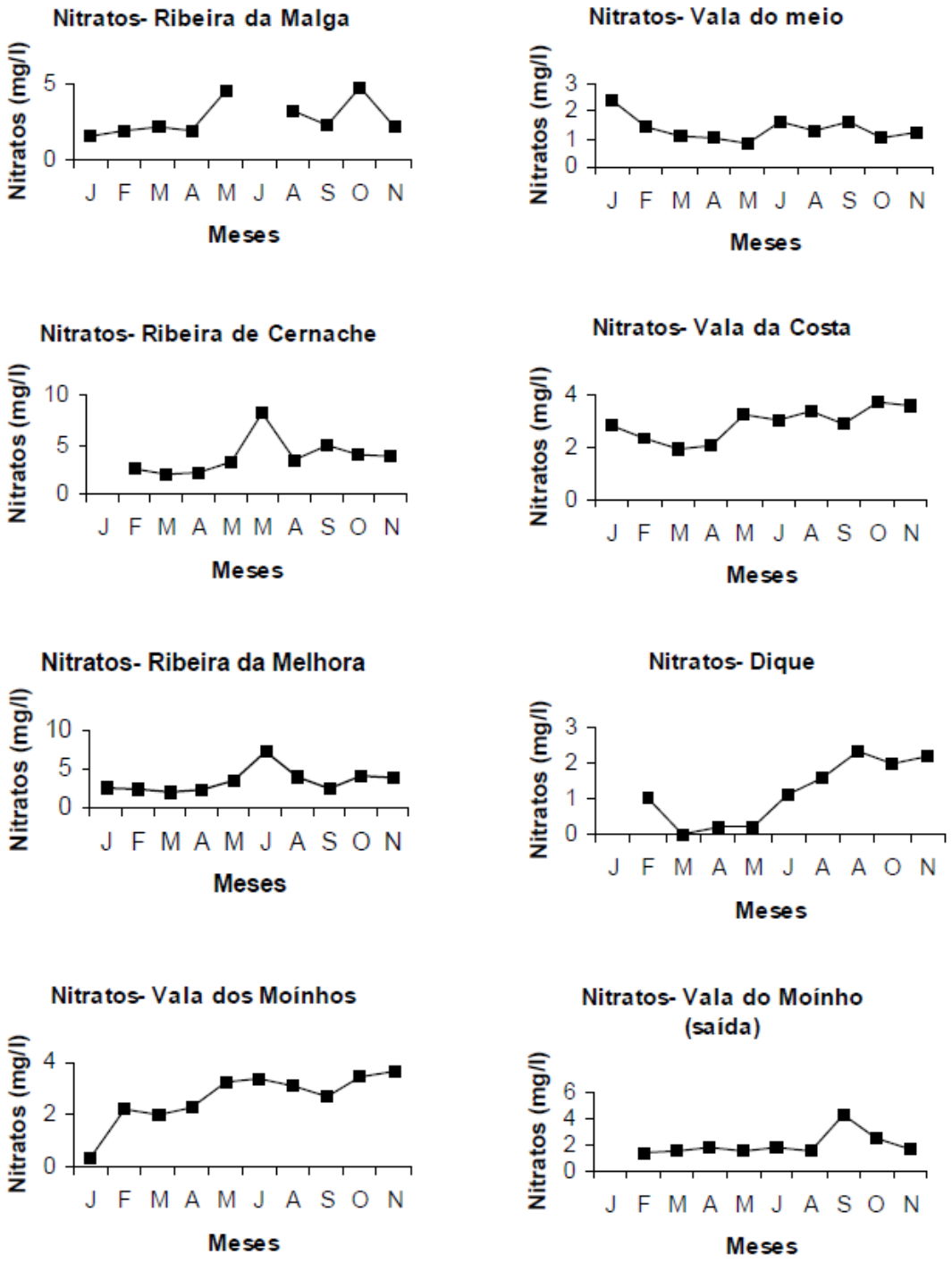


Figure A59. Nitrates values at the sampling points in the area of Paul de Arzila

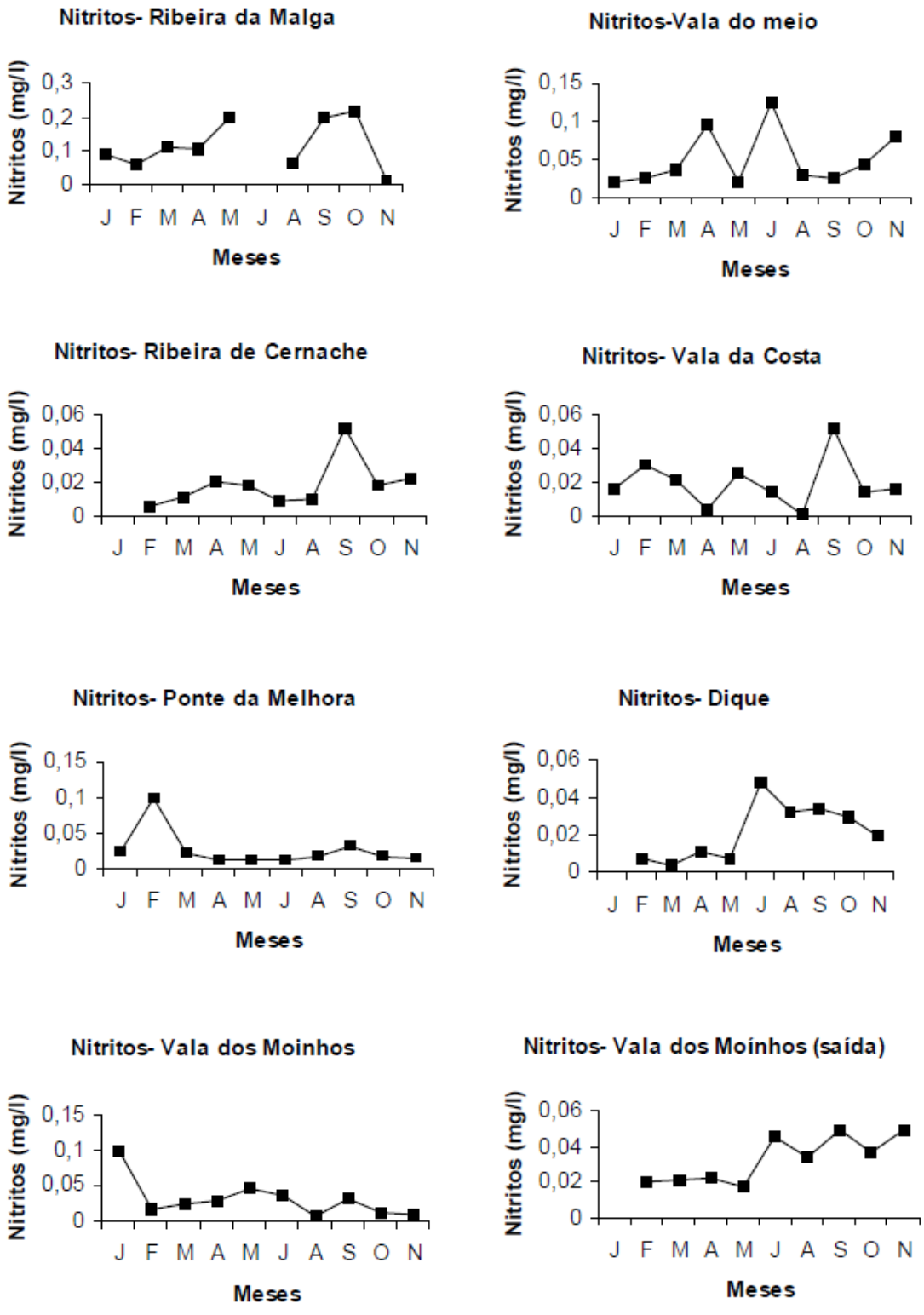


Figure A60. Nitrites values at the sampling points in the area of Paul de Arzila

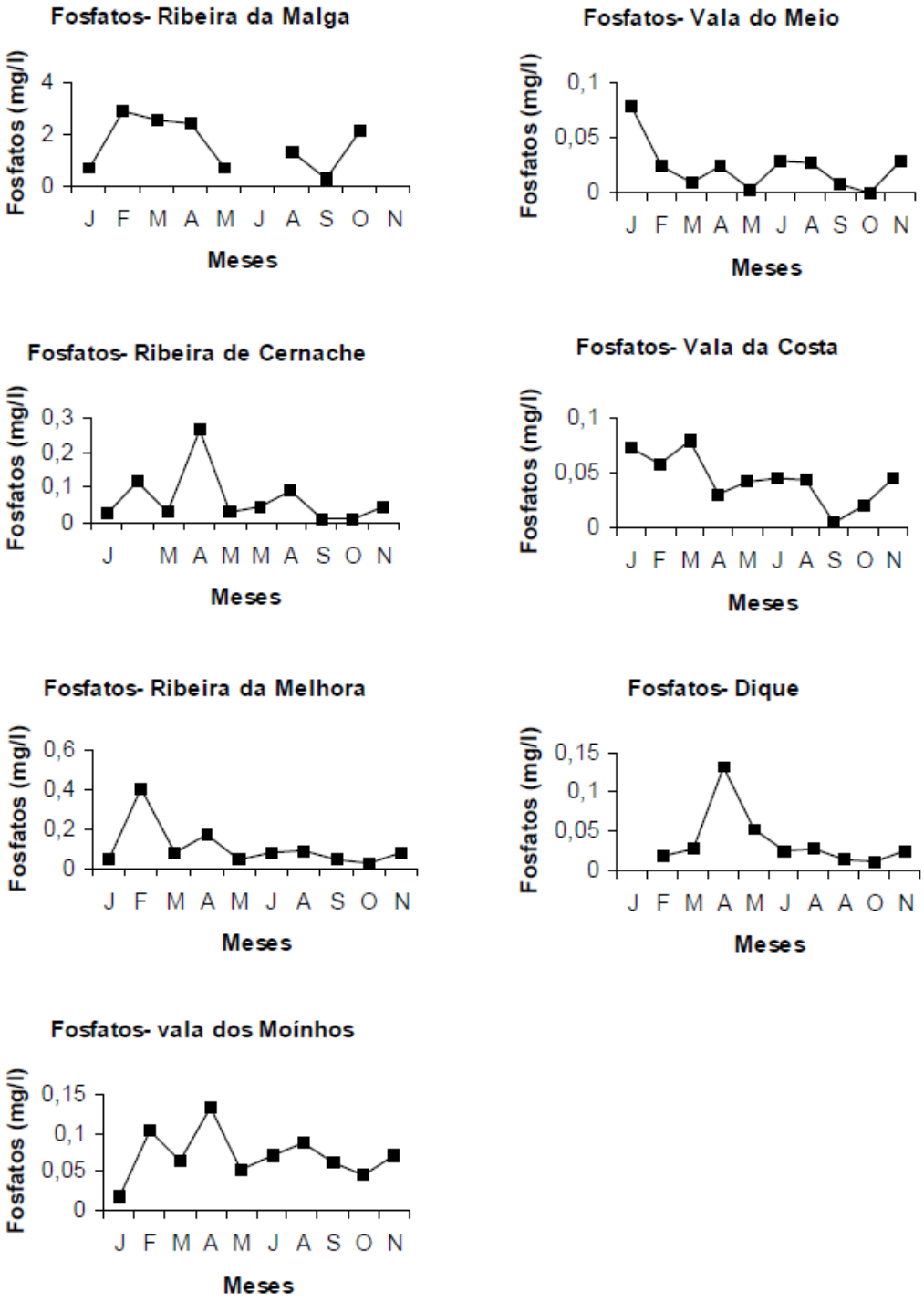


Figure A61. Phosphates values at the sampling points in the area of Paul de Arzila

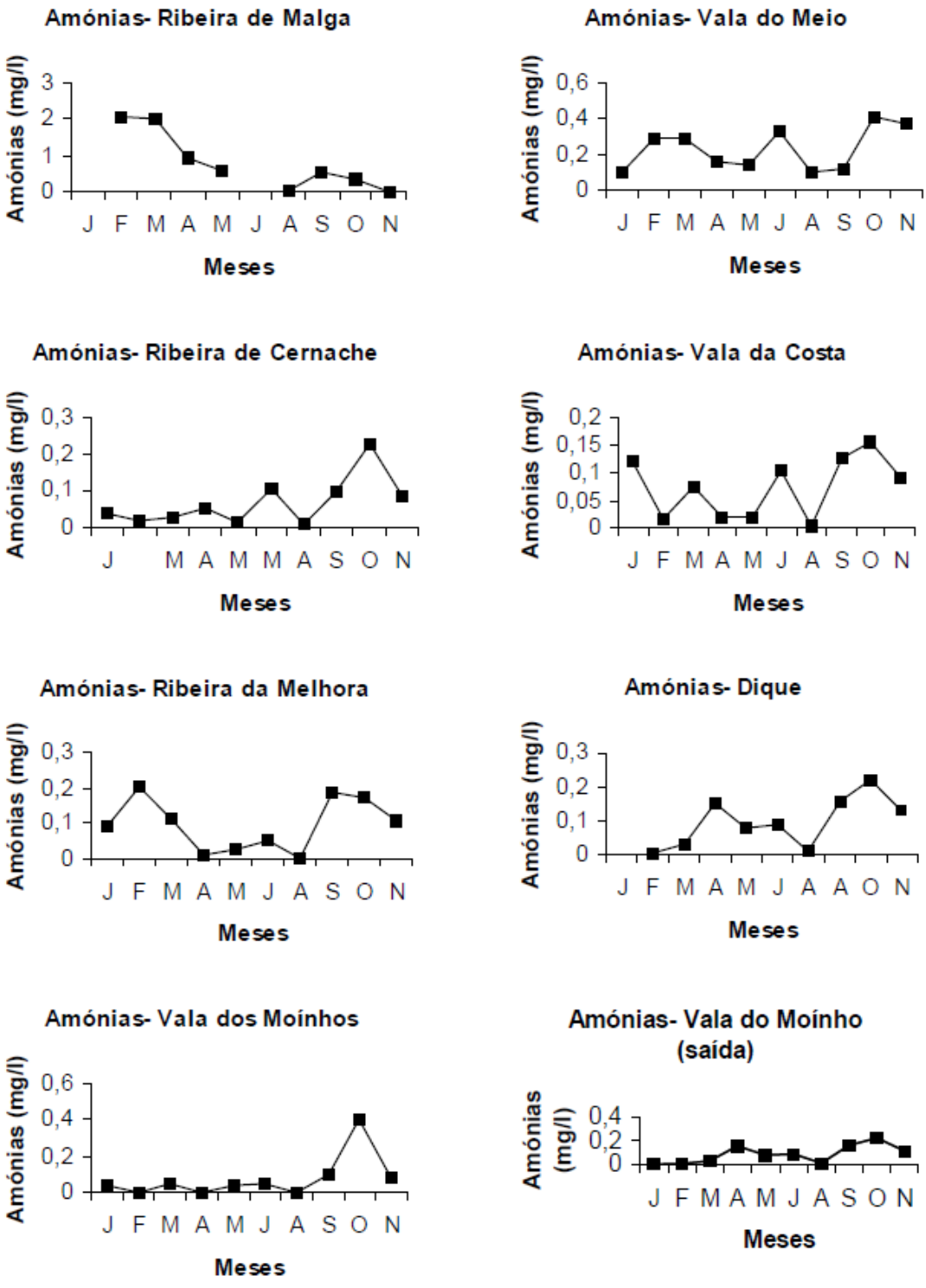


Figure A62. Ammonia values at the sampling points in the area of Paul de Arzila

It is therefore obvious that except for point 1, water indicators for the other points in the paul particularly do not have the evidence of serious deterioration because of the nearby pollutants. Moreover, as for 1999, the values at distance points and at the entrance to the paul are far worse than at the exit from the paul (Figures A63-A64).

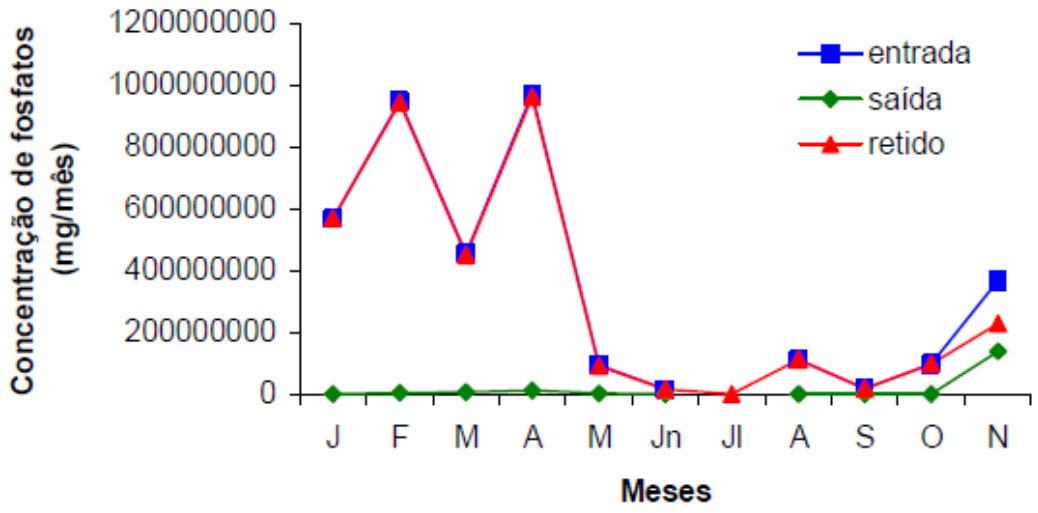


Figure A63. Phosphates levels at the entrance and exit from the Paul de Arzila

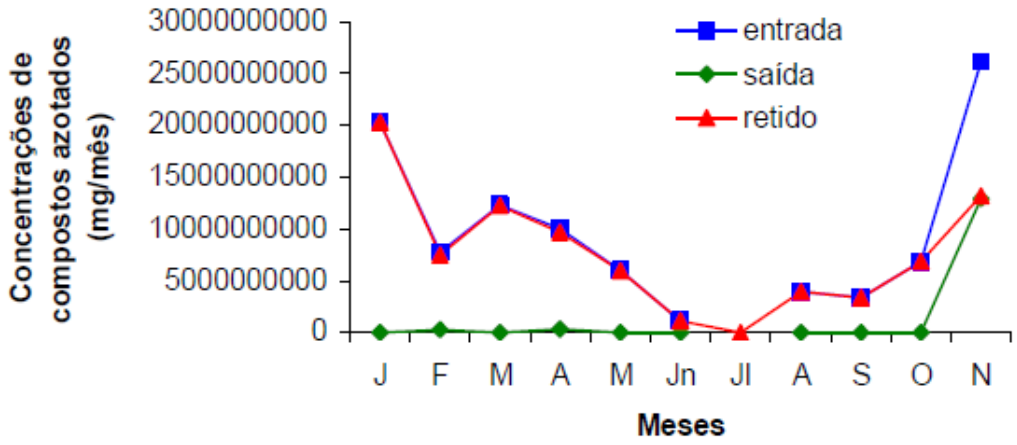


Figure A64. Nitrogen compounds levels at the entrance and exit from the Paul de Arzila

Anyway, probably evidence of accumulation is only a question of time since there is another non-quantative evidence of pollution such as emergent vegetation of reedbed, willow which means pollutants have been accumulating and causing extremely active vegetation growth and accumulation of organic material and its decomposition, which further means water eutrophication and wetland habitat transformation into a forest land. What is more, the above described values are the results of the 1999 research, further analysis of the 2011 data will be very helful since it will provide an opportunity of comparison and making a more sensible conclusion on the aspect of water quality degradation in Paul de Arzila.

Part 2

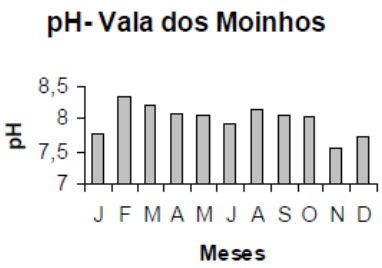
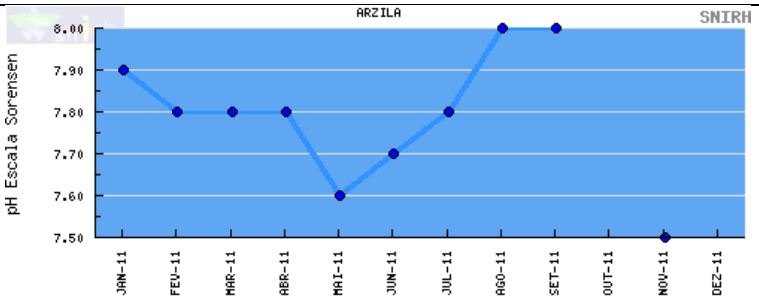
The National Information System on Hydrological Resources provides information on two sampling points – point 3 (Ponte de Melhora) from the previous research and one point next to the village of Lameira de Baixo and Vala dos Moinhos, called Arzila, in the middle part of the paul. Thus, we have one point next to the pollution sources and

the other directly in the paul. We will compare all the parameters of these 2 points with one another and with the values of the same points in 1999*.

*Ponte Melhora is the same point in 1999 and 2011 data. Arzila point of 2011 is to the north of Vala dos Moinhos of 1999 but they are both inside the paul, not in a long distance and disturbed by the same factors, thus they can be taken for comparison.

Results

Table A10. Water quality indicators

<table>
<tr><td>1999</td><td>2011</td></tr>
<tr><td> 
</td><td> 
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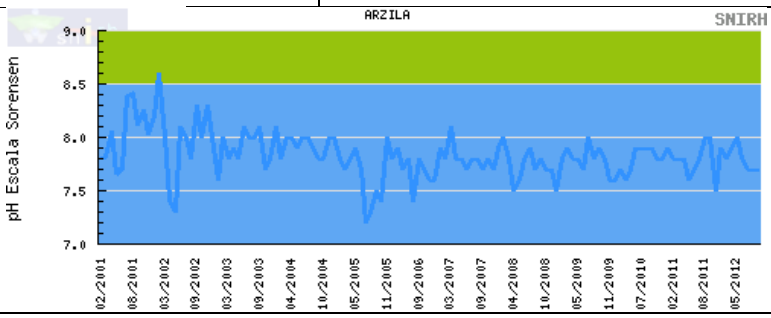
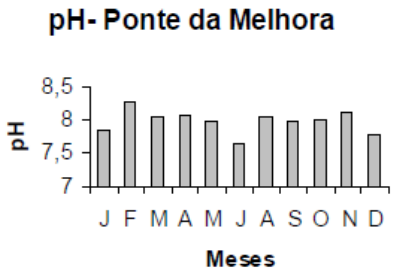
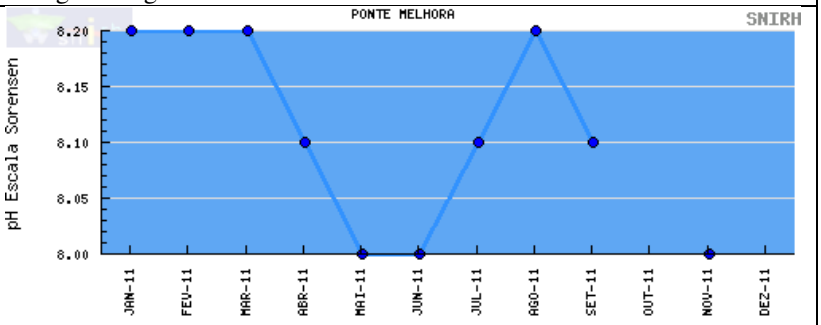
<tr><td colspan="2"> 
</td></tr>
<tr><td colspan="2">The ph values have remained in the same normal value range during 1999-2011.</td></tr>
<tr><td> 
</td><td> 
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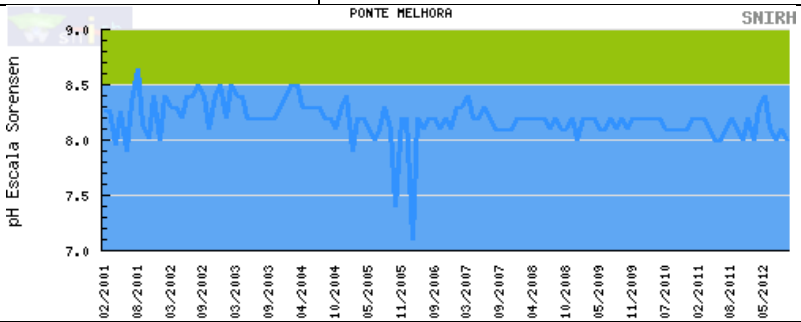
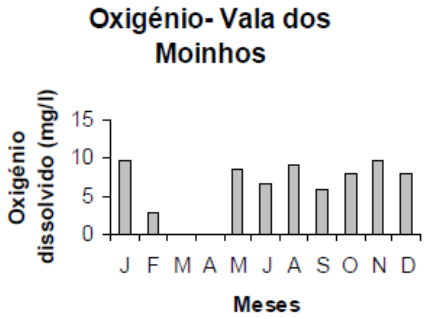
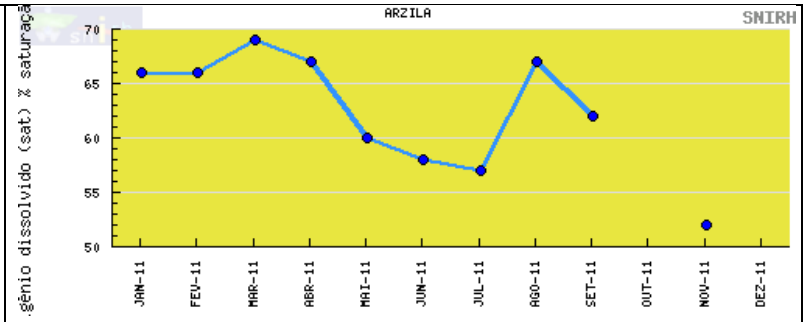
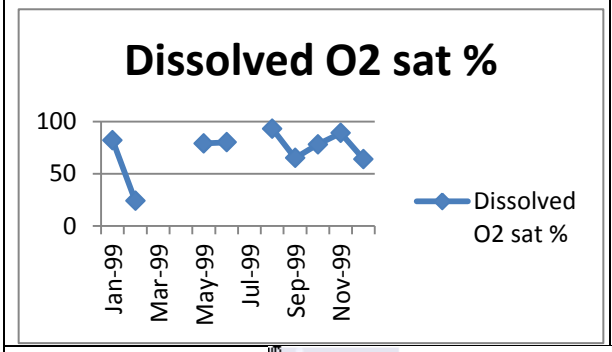
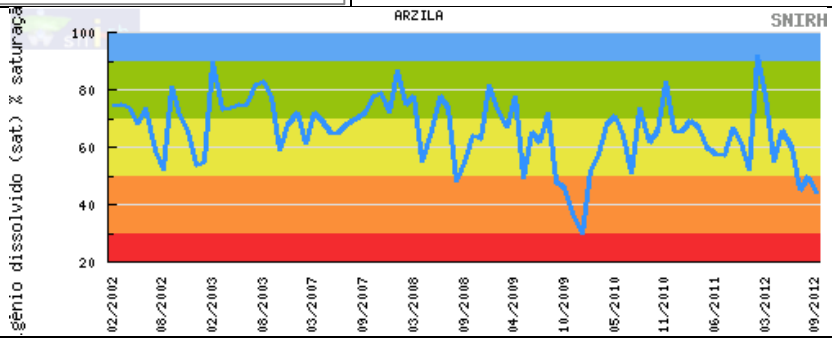
<tr><td colspan="2"> 
</td></tr>
<tr><td colspan="2">The ph range has remained in the similar range.

The ph values have stayed almost the same at both points. This does not give enough information for assessment of pollution levels.</td></tr>
</table>

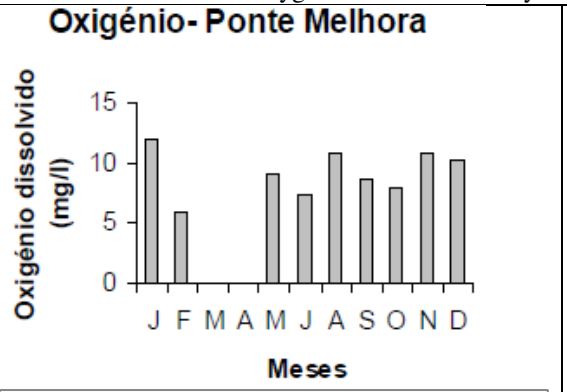


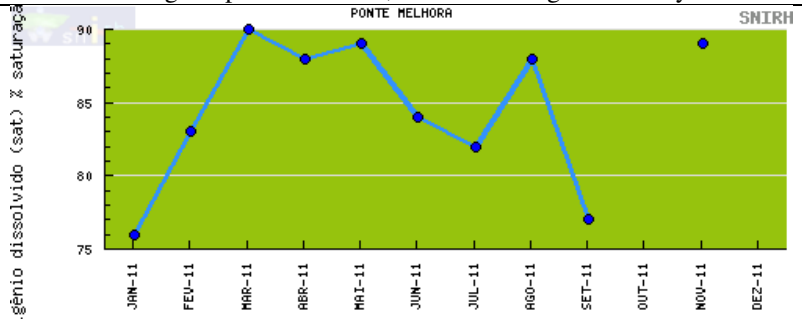


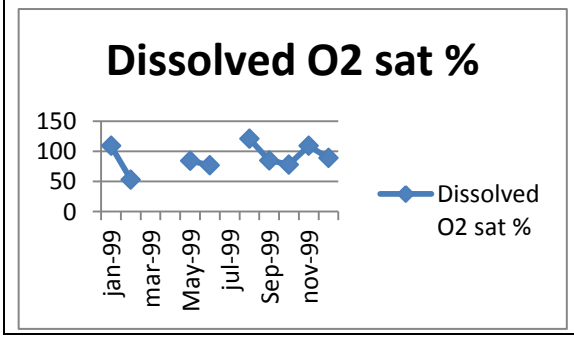


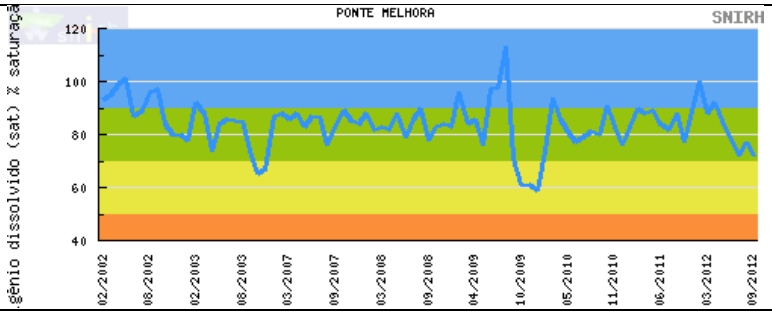


The levels of dissolved oxygen at Arzila have stayed in the same range of poor saturation, have not changed seriously.



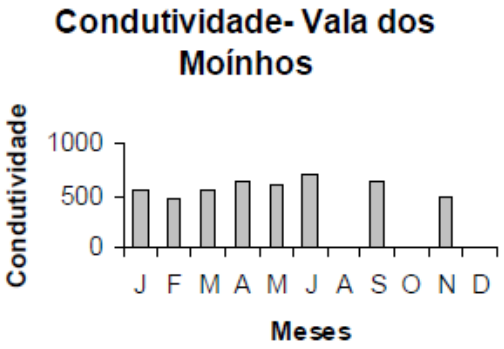


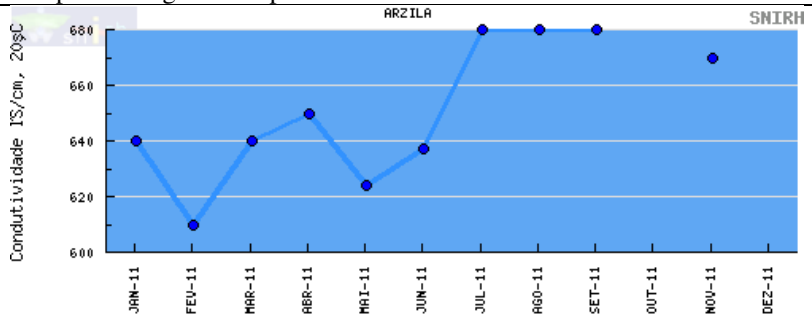


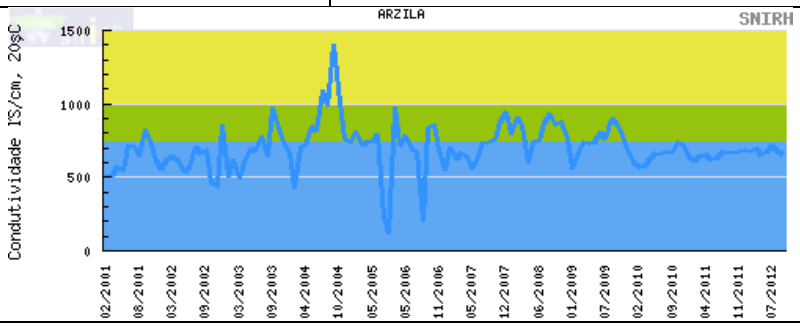


Dissolved oxygen levels at Ponte Melhora have stayed in the same range of moderate saturation, although in 1999 there were more higher than 100 values.

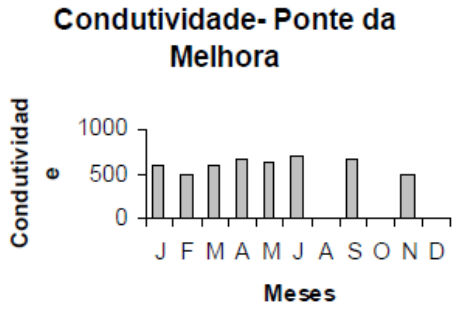
The oxygen levels have not changed much at both points, only Arzila point is far less saturated than Ponte de Melhora which can be the evidence of ongoing pollution which has been penetrating into the paul itself.

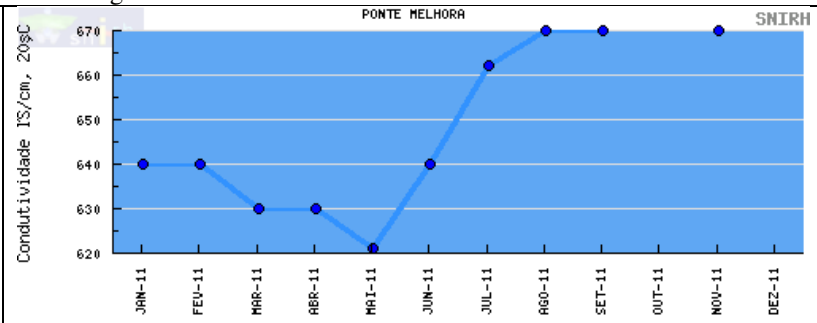


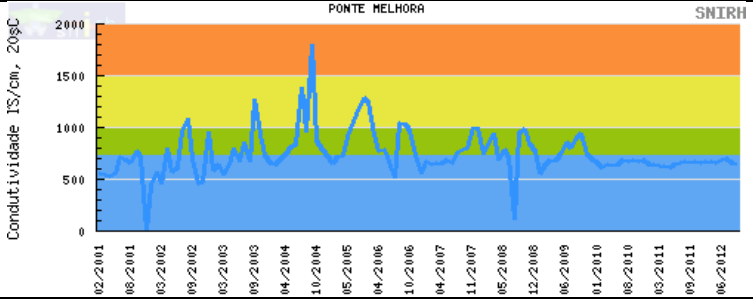




Conductivity levels at Arzila have not changed much during 1999-2011. There were elevations in 2003-2004, 2006, 2008-2010 but this paramter does not seem to reflect any siginificant change.

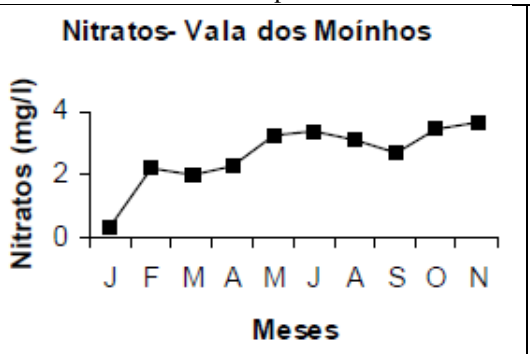


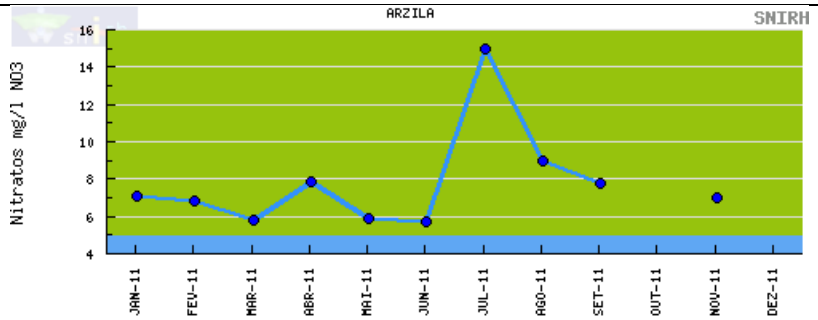


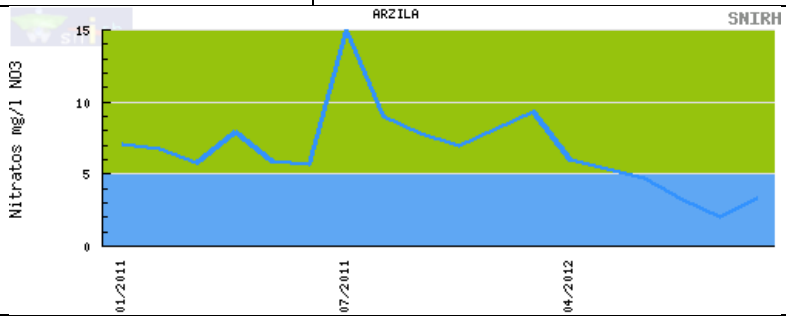


Conductivity values at Ponte Melhora have not changed much if compare 1999 and 2011 values there was observed a significant increase in 2002-2004 and 2006-2009 which reflects an elevation in pollution levels.

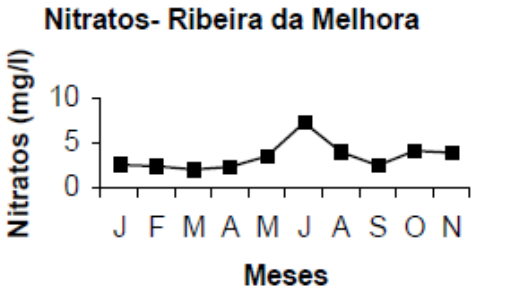
There are no big changes between conductivity levels in 1999 and 2011 but there were periods of serious elevations of its values which can mean increase in pollution levels.

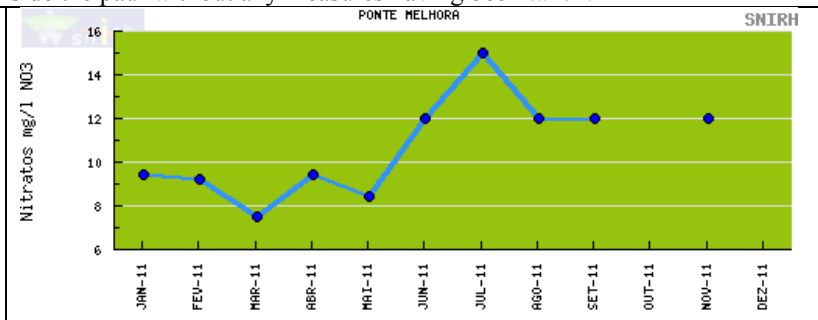


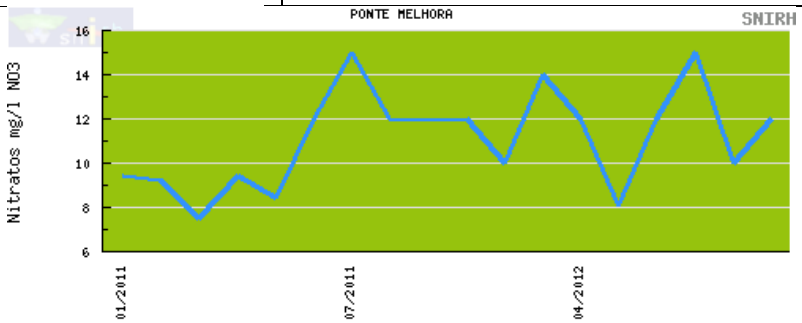




There has been an increase in nitrates levels at Arzila from a range of 0.3-3.9 to the one 6-15 which is a drastic change and evidence of serious pollution of the area. Unfortunately, there are no results on the levels development in the years of 2000-2010 but today's results show habitat deterioration inside the paul without any measures having been taken.

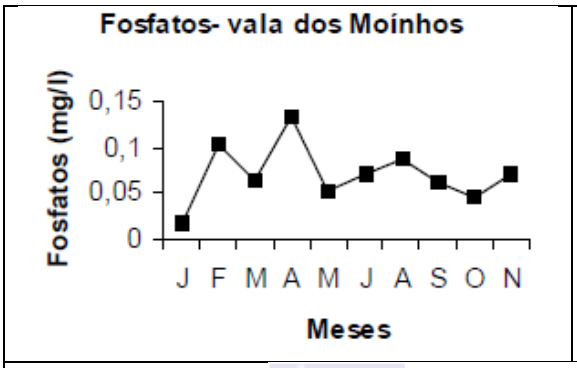


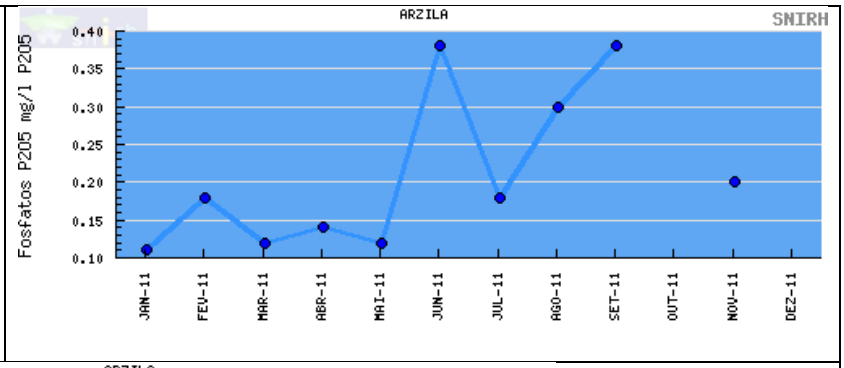




The level of nitrates at Ponte Melhora has increased from the range of 2.5-7 to 5-15 which is a drastic change and possible consequence of uncontrolled pollution.

The nitrates levels at the 2 points were in different ranges in 1999 but evened dramatically by 2012. This can be the evidence of ongoing pollution which has now reached the paul itself and still no measures have been taken to put it under control.





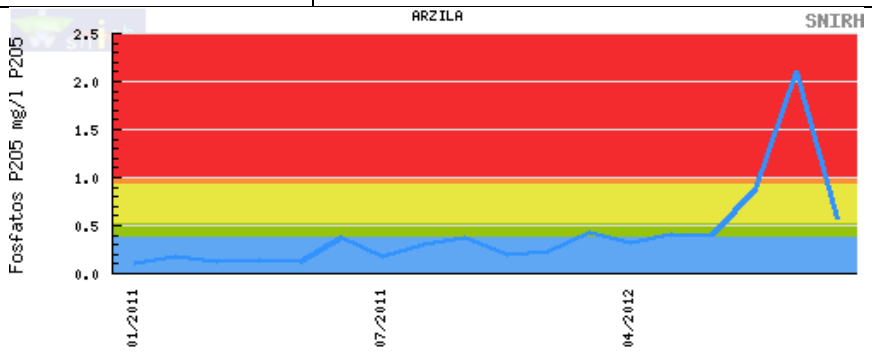
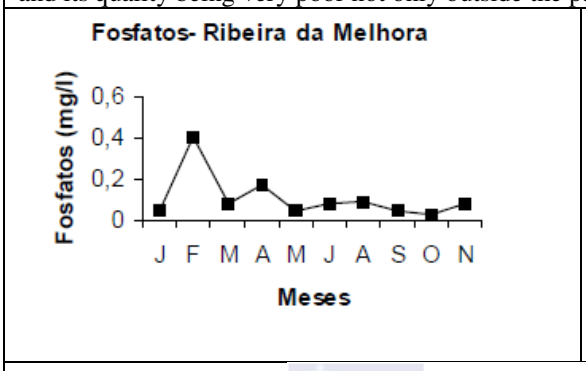
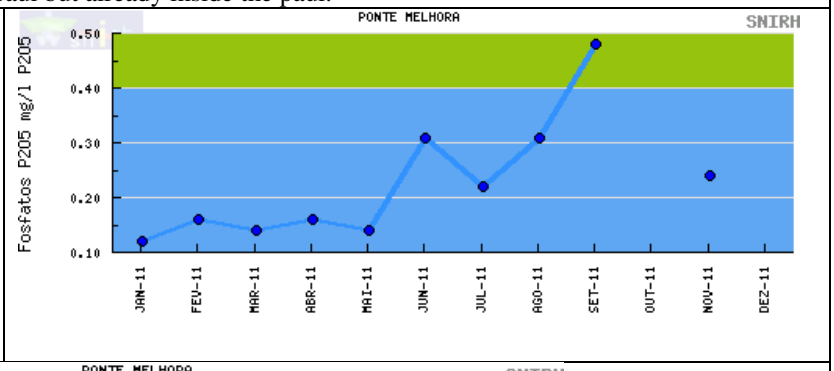
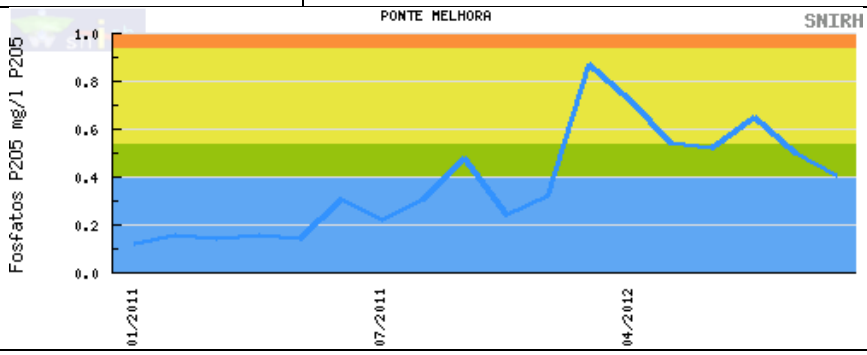


Figure 111.

Phosphate levels at Arzila have experienced an increase in their values in 1999-2011 from a range of 0.01-0.14 to 0.10-0.40. Unfortunately, there are no results for the years of 2000-2010 but it is important to note that there has been a drastic increase in phosphates in 2012, values reaching its possible maximum which can be an evidence of high amount of nutrients in the water and its quality being very poor not only outside the paul but already inside the paul.

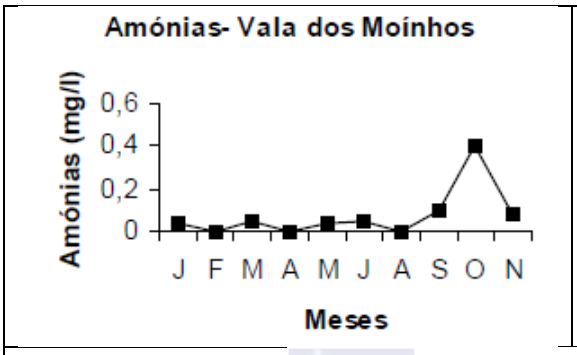


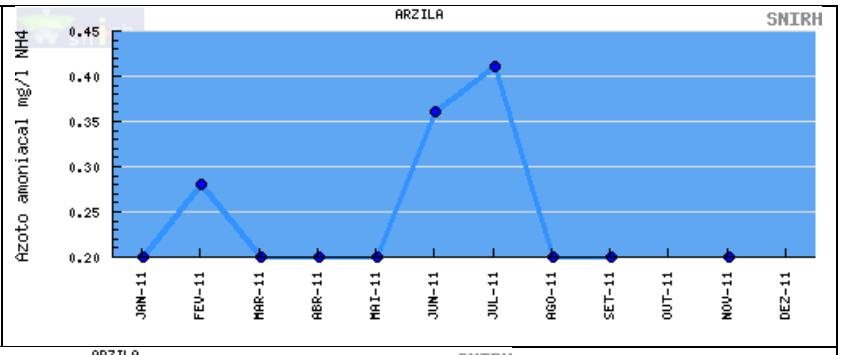


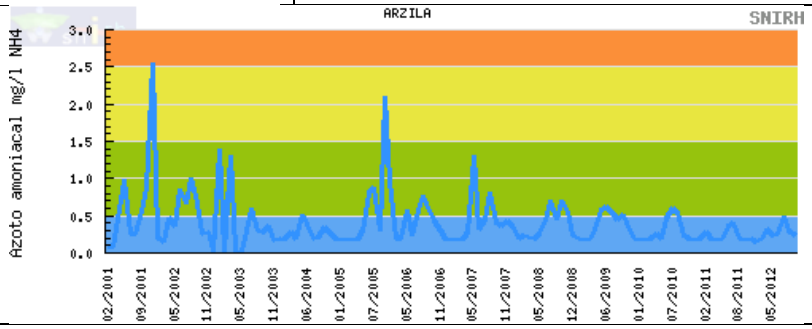


There has been an increase in phosphates levels at Ponte Melhora, from the range of 0.05-0.4 to the one of 0.10-0.50. Moreover, there have been elevations till critical levels of 0.9 in 2012. All this proves high speed of pollution penetration inside the paul.

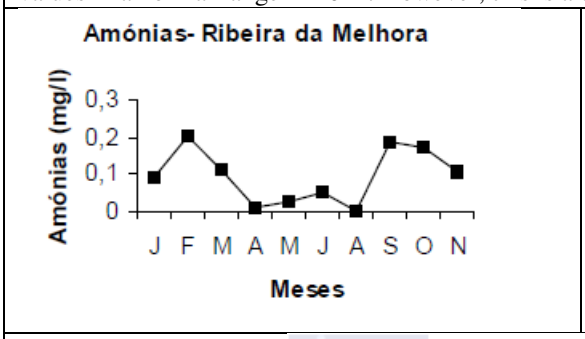
In 1999 the phosphates levels at the 2 points were in different ranges, Ponte Melhora having much higher values which was normal sicne it is closer to pollution sources. In 2011 these ranges became the same with an increase for Arzila point. Moreover, a drastic elevation in 2012 was observed at both points, with a time difference of 6-7 months, Ponte Melhora being obviously the first to have it. All this can be the consequence of an ongoing pollution which has not been put under control.

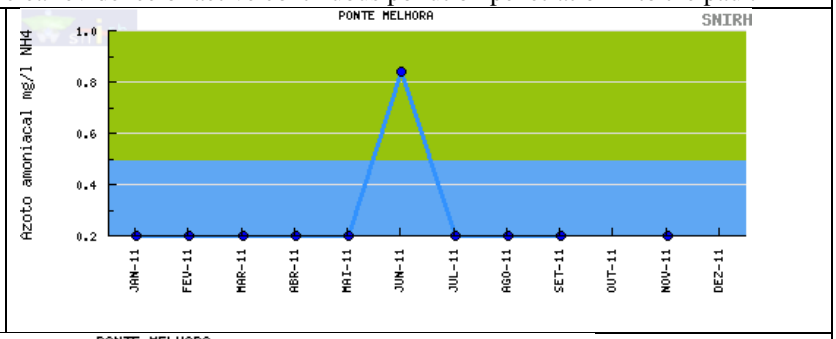


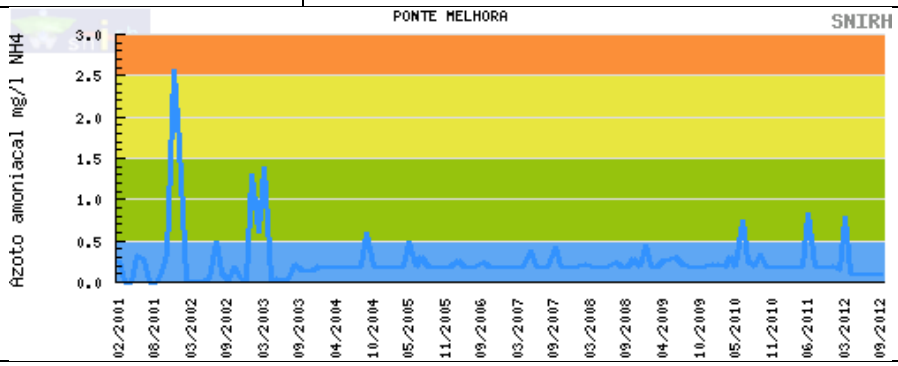




Increase in ammonia level at Arzila has been observed in 1999-2011, with drastic elevations in 2001-2003, 2005-2008 and values in a normal range in 2011. However, this is a clear evidence of active continuous pollution penetration into the paul.







Increase in ammonia levels at Ponte Melhora has been observed, with drastic elevations in 2001-2003 ans 2010-2012 which is a proof of high pollution levels.

There can be easily observed almost identical increases in ammonia levels during 1999-2011 at the 2 points, with a time difference of 1-2 months between them, Ponte Melhora being the first to experience elevations and Arzila being the second. Thus, the pollution processes are obvious and deepening, penetrating into the paul. Now not only expansive vegetation growth is an indicator of pollution but the parameters themselves.There is also a clear evidence of absence of any activities on conservation of the paul and efforts to decrease the pollution levels.

Overall water quality – there is a EU classification of water quality into 5 types: high, good, moderate, poor, and bad (accordingly blue, green, yellow, orange and red colours). The final judgment on the water quality type is made on the basis of assessment of several physiochemical parameters.

Arzila

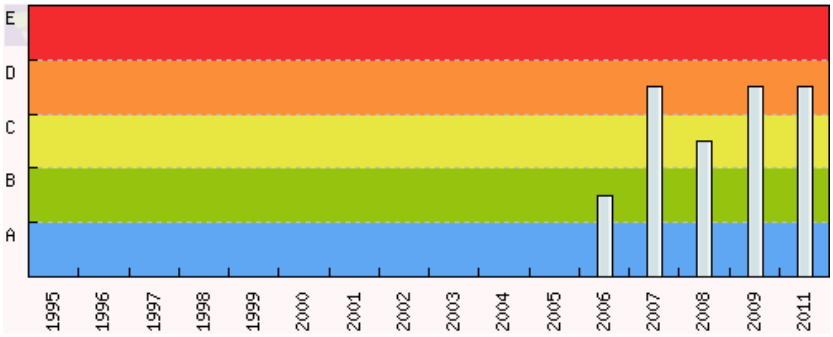


Figure A65. Overall water quality at Arzila

Ponte de Melhora

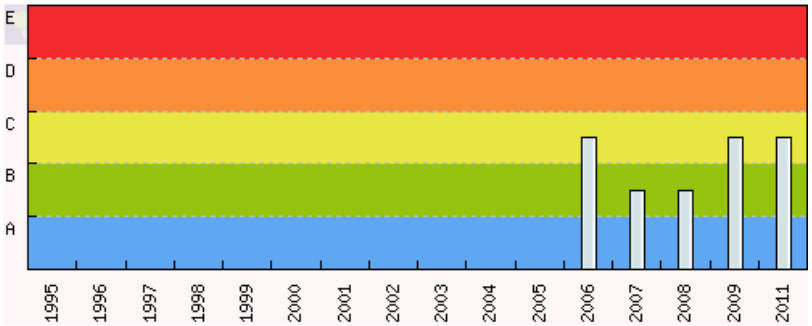


Figure A66. Overall water quality at Ponte Melhora

Judging by these tables, water quality at Arzila inside the paul has been worse than that at Ponte Melhora where water is supposed to be more polluted due to the nearby industries. This could mean that comparing with 1999 research pollutants have penetrated further down the river flow, right into the paul, and now are visible in parameters' values.

Wetland condition analysis

Wetland name: Paul de Arzila
Region: Portugal/Centro/Baixo Mondego
Date: 29-30.10.13

Classification: I System	**IA Subsystem**	**II Wetland Class**	**II Wetland Form**
Palustrine	Permanent	Marsh*	Floodplain, pool, channel

***Permanent freshwater marshes/pools; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season (Tp), Ramsar classification

Indicator	**Indicator Components**	**Specify and Comment**	**Score 0-5**	**Mean Score**
Change in hydrological integrity	Impact of manmade structures	Totally affected by manmade structures 3 drainage ditches, one of them visible to visitor; complete change of hydrological regime, vegetation and fauna communities Sewage pollution by nearby industries, use of fertilizers by agriculturers	0	1.67
	Water table depth	With abandonment of the area the water table has increased in some parts of the wetland. However, significant changes have caused soil erosion and diminution of fish flow, seasonal fluctuations with dry summer period.	2	
	Dryland plant invasion	Visually obvious, *Salix* and *Phragmites australis* occupy a large part of the area (almost 50% of the paul itself)	3	
Change in physicochemical parameters	Fire damage	No evidence of fire damage	5	3.67
	Degree of sedimentation/erosion	None detected	5	
	Nutrient levels	Very high according to water quality analysis, industrial, domestic pollution, malfunction of wastewater treatment plants. Penetration of pollutants into the paul itself. High euthrophication.	1	
	von Post index	No peat	-	
Change in ecosystem intactness	Loss in area of original wetland	Over 40 % of the wetland area lost since its abandonment and due to drainage consequences (*Salix* and *Phragmites* invasion)	3	3
	Connectivity barriers	App 40% of downstream connection lost Disturbance fish flow, open pools creation and interconnection of all the pools – flow of non-native species of fish and crayfish	3	
Change in browsing, predation and harvesting regimes	Damage by domestic or feral animals	No big influence	5	3.67
	Introduced predator impacts on wildlife	Non-native species of crayfish brought mostly to extinction two native frog species	2	
	Harvesting levels	Abandonment. No harvesting Past use for rice fields cause disturbance of the hydrological regime	4	
Change in dominance of native plants	Introduced plant canopy cover	Over 60% of wetland is overgrown with reeds and willows	2	3.5
	Introduced plant understorey cover	none	5	
Total wetland condition index 15.51 / 25				

Degree of modification assigned as follows: 5=very low/none, 4=low, 3=medium,
2=high, 1=very high, 0=extreme

Chapter 3.2.2

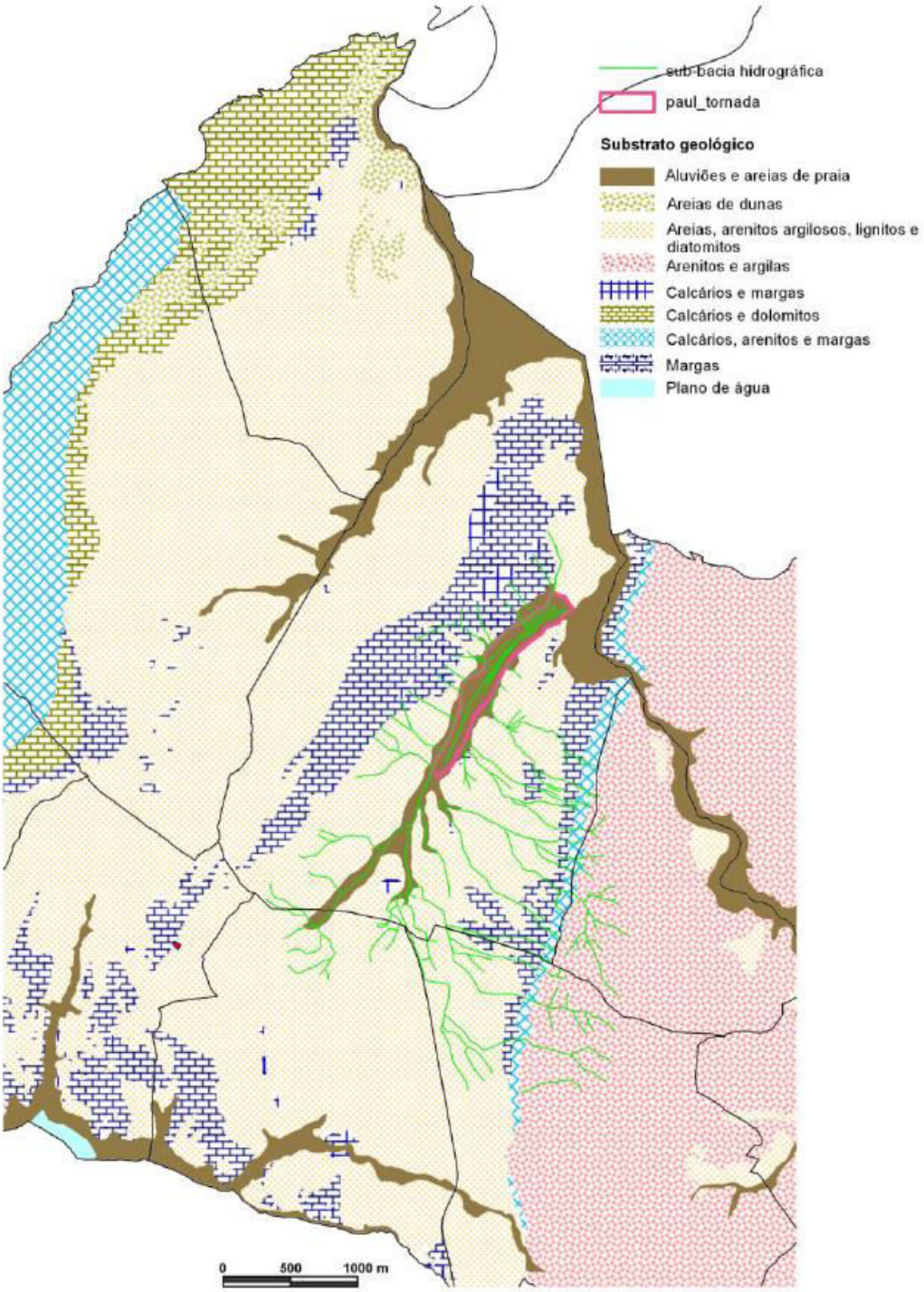


Figure A67. Geological features of the paul

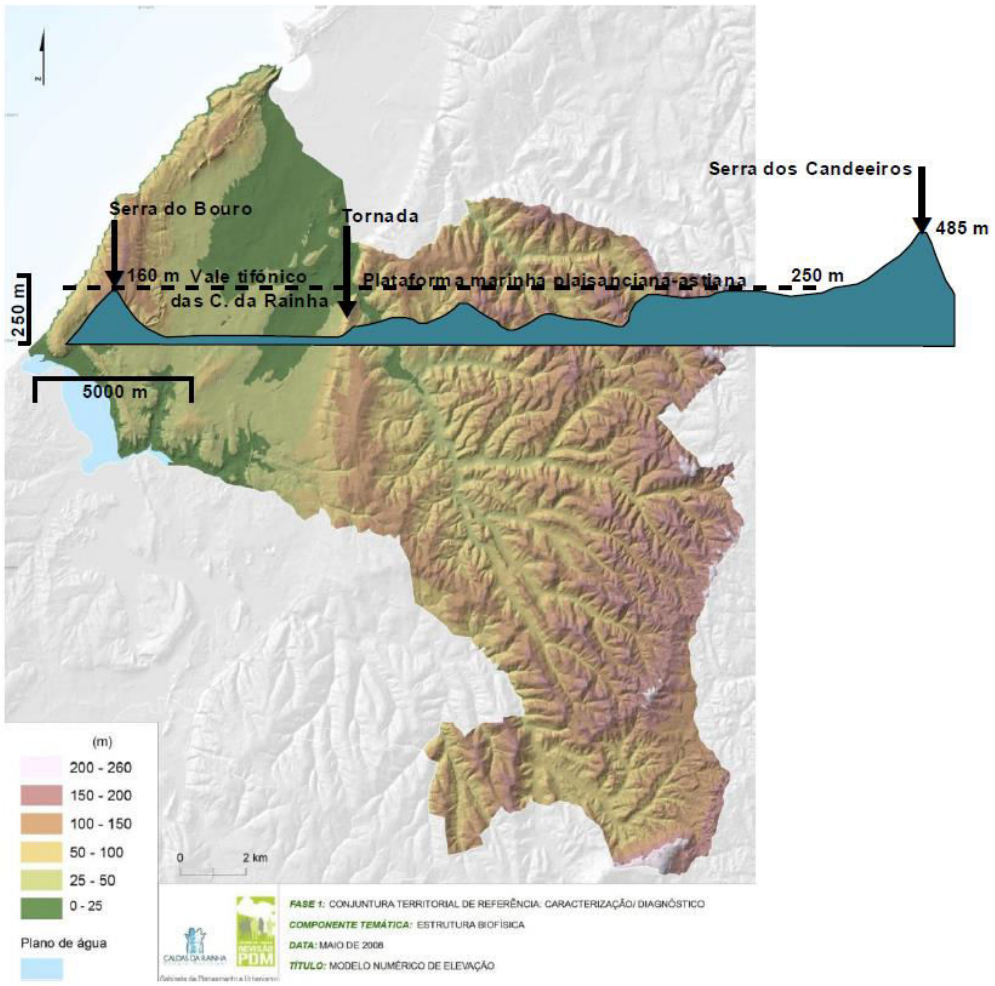


Figure A68. Representation of paul formation history

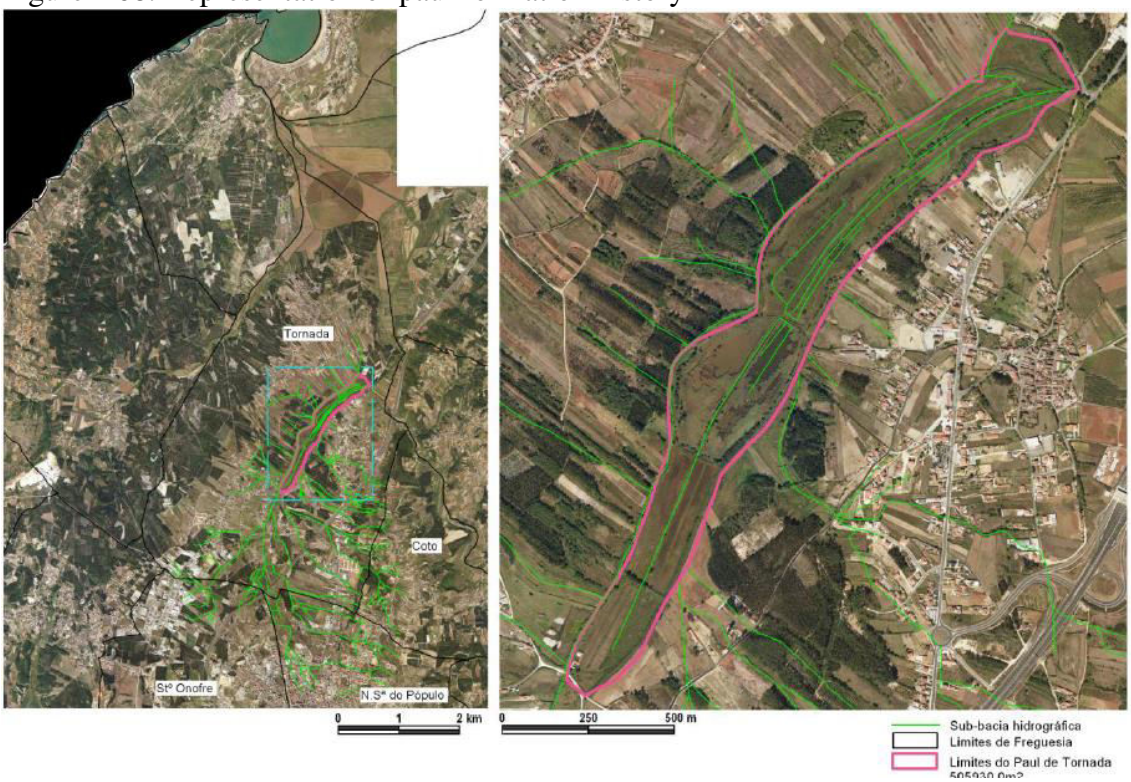


Figure A69. Sub-basin of Paul da Tornada

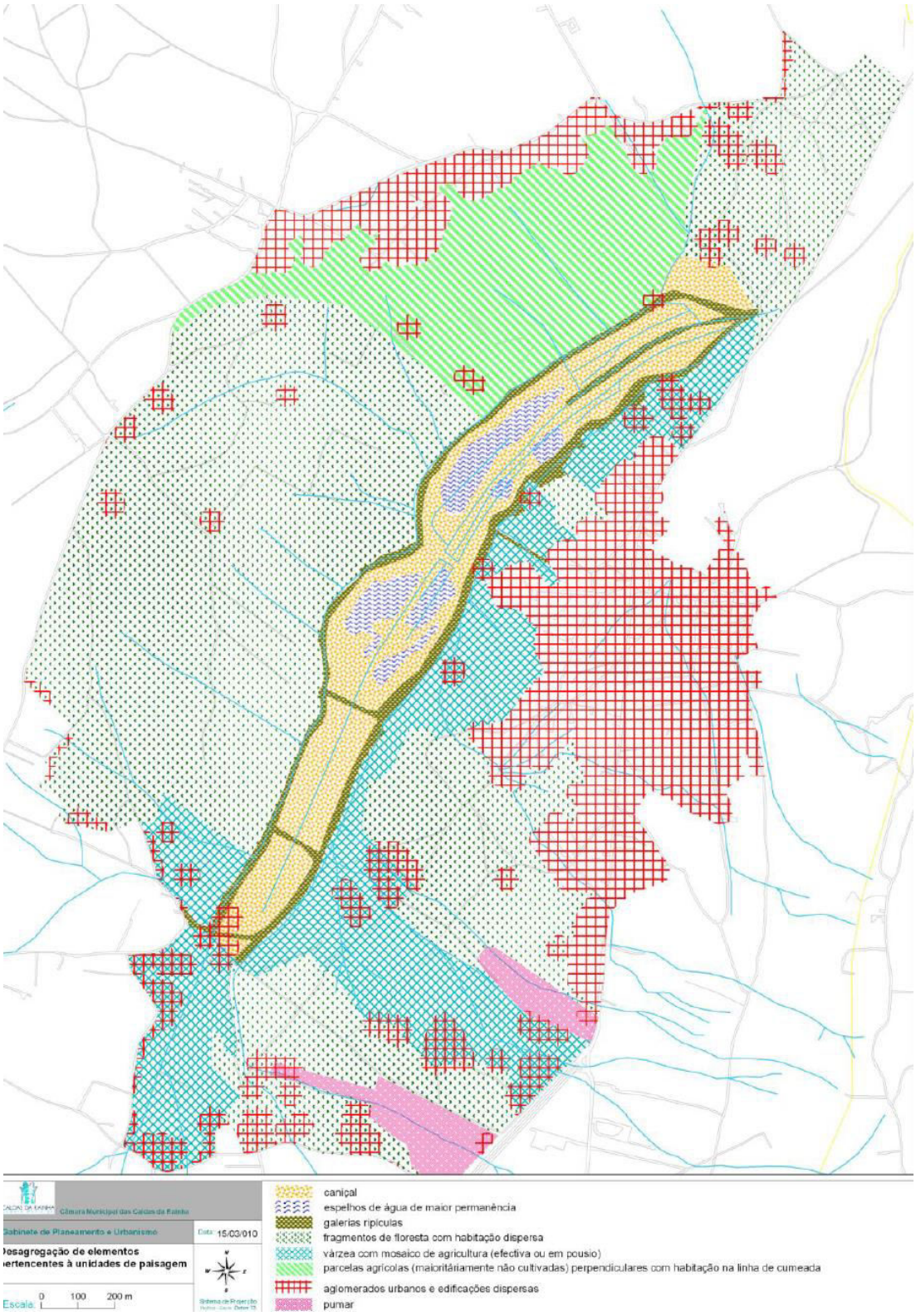


Figure A70. Zoning of the Paul by its dominant vegetation and activities conducted

Figure A71. Interpretation centre of the Tornada marsh

Figure A72. Visits to the paul and pedestrian trail

Water quality analysis

To conduct water quality analysis for Paul da Tornada data from SNIRH were taken. There were no more information accessible or given to me at the reserve.

Ph

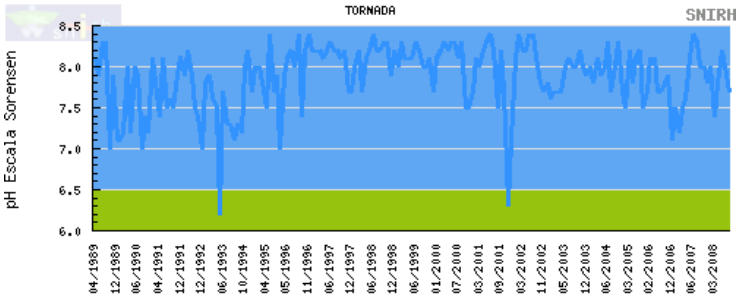


Figure A73. Ph values at Paul da Tornada

Ph values have been in a normal range in 1989-2008.

Dissolved oxygen

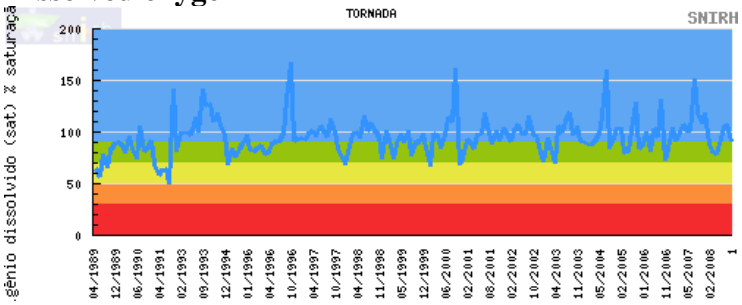


Figure A74. O2 saturation

Oxygen saturation has been at a normal level, with a tendency of its value increase from 1989 till 2008.

Conductivity

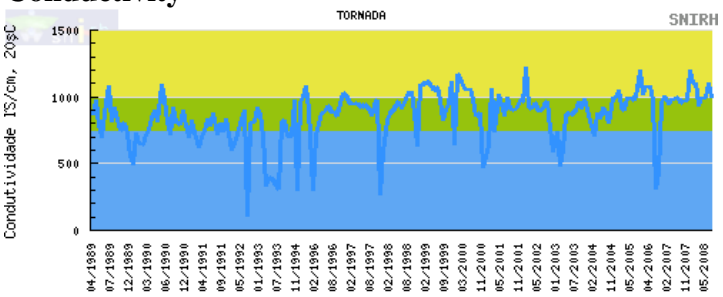


Figure A75. Conductivity values

The conductivity values had been in normal range until 1999 when they started to get higher than maximum acceptable 1000. This could mean the rise in pollutants level in the marsh.

Phosphates

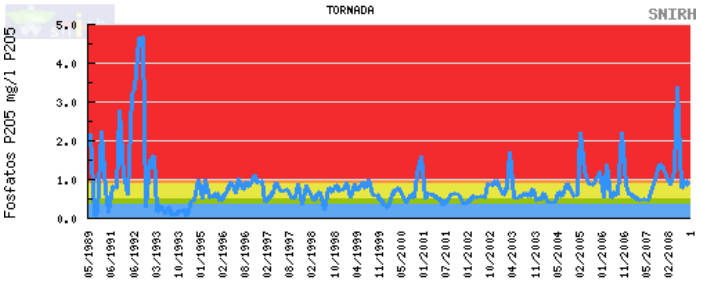


Figure A76. Phosphates levels at Paul da Tornada

P2O5 level has always been in green-to-red range of values, having reached its maximums in 1989-1993, 2005-2008. This can be the evidence of pollutants accumulated in the paul.

Ammonia

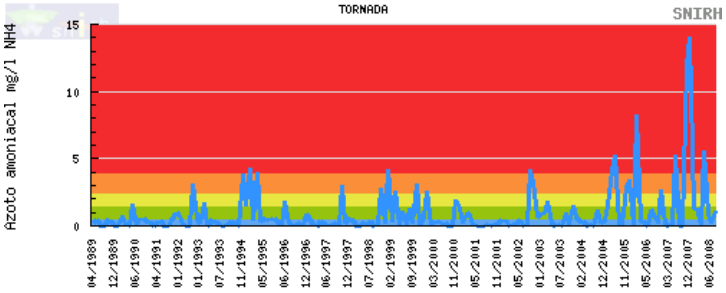


Figure A77. Ammonia levels

Ammonia levels have been increasing with time, its values being in the green-to-red range since 1990 and reaching its maximum in 2007. This, similar to P2O5, can indicate accumulation of pollutants in the water.

Nitrates

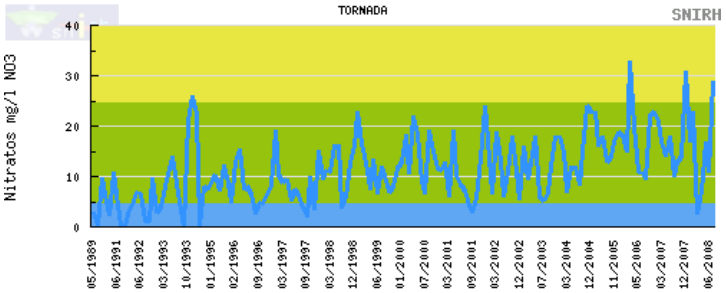


Figure A78. Nitrates values

Nitrates values have always been in the green range, showing not maximum high but moderately high levels. This, similar to phosphates and ammonia, seems to prove the facvt of the ongoing pollution of the paul.

Overall water quality

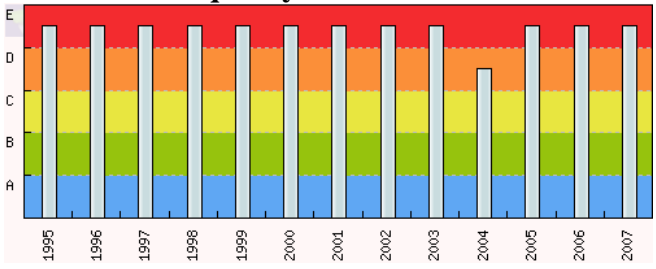


Figure A79. Overall water quality at Paul da Tornada

The overall quality of water was permanently very low in 1995-2007.

Wetland condition analysis

Wetland name: Paul da Tornada
Region: Portugal/Centro/Oeste/ Leiria district
Date: 28.10.13

Classification: I System	**IA Subsystem**	**II Wetland Class**	**II Wetland Form**
Palustrine	Permanent	Marsh*	Marsh, pool, pond

*Freshwater, tree-dominated wetlands; includes freshwater swamp forest, seasonally flooded forest, wooded swamps; on inorganic soils (Xf)
Seasonal/intermittent freshwater marshes/pools on inorganic soil; includes sloughs, potholes, seasonally flooded meadows, sedge marshes (Ts)
Permanent freshwater marshes/pools; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season (Tp)

Indicator	**Indicator Components**	**Specify and Comment**	**Score 0-5**	**Mean Score**
Change in hydrological integrity	Impact of manmade structures	Totally affected by manmade structures 3 drainage ditches, traces of them visible to visitors from the centre; complete change of hydrological regime, vegetation and fauna communities Sewage pollution by nearby industries	0	2
	Water table depth	Water table has not decreased significantly since the system of ditches works properly. However, fluctuations with dry summer period are registered, overgrowth with bushes.	4	
	Dryland plant invasion	Visually obvious, overgrowth with reeds, invasive exotic plant species	2	
Change in physicochemical parameters	Fire damage	Fires on the margins of the ditches, prevention measures taken but still not efficient	4	3.33
	Degree of sedimentation/erosion	None	5	
	Nutirent levels	Very high according to water quality analysis, industrial, domestic pollution, past consequences. High euthrophication.	1	
	von Post index	No peat	-	
Change in ecosystem intactness	Loss in area of original wetland	Hard to access, less than 25% lost	4	3.5
	Connectivity barriers	Ditches functioning and causing disturbance of the hydrological regime of the whole area though connections with the basin are not lost	3	
Change in browsing, predation and harvesting regimes	Damage by domestic or feral animals	None	5	4.67
	Introduced predator impacts on wildlife	None	5	
	Harvesting levels	Hardly intensive agriculture in the seasonally inundated areas, little influence. Consequences of past use for rice cultivation and preceding drainage	4	
Change in dominance of native plants	Introduced plant canopy cover	Over 60% of wetland is overgrown with reeds	2	3.5
	Introduced plant understorey cover	None	5	
Total wetland condition index 17 / 25				

Degree of modification assigned as follows: 5=very low/none, 4=low, 3=medium,
2=high, 1=very high, 0=extreme

Chapter 3.2.3

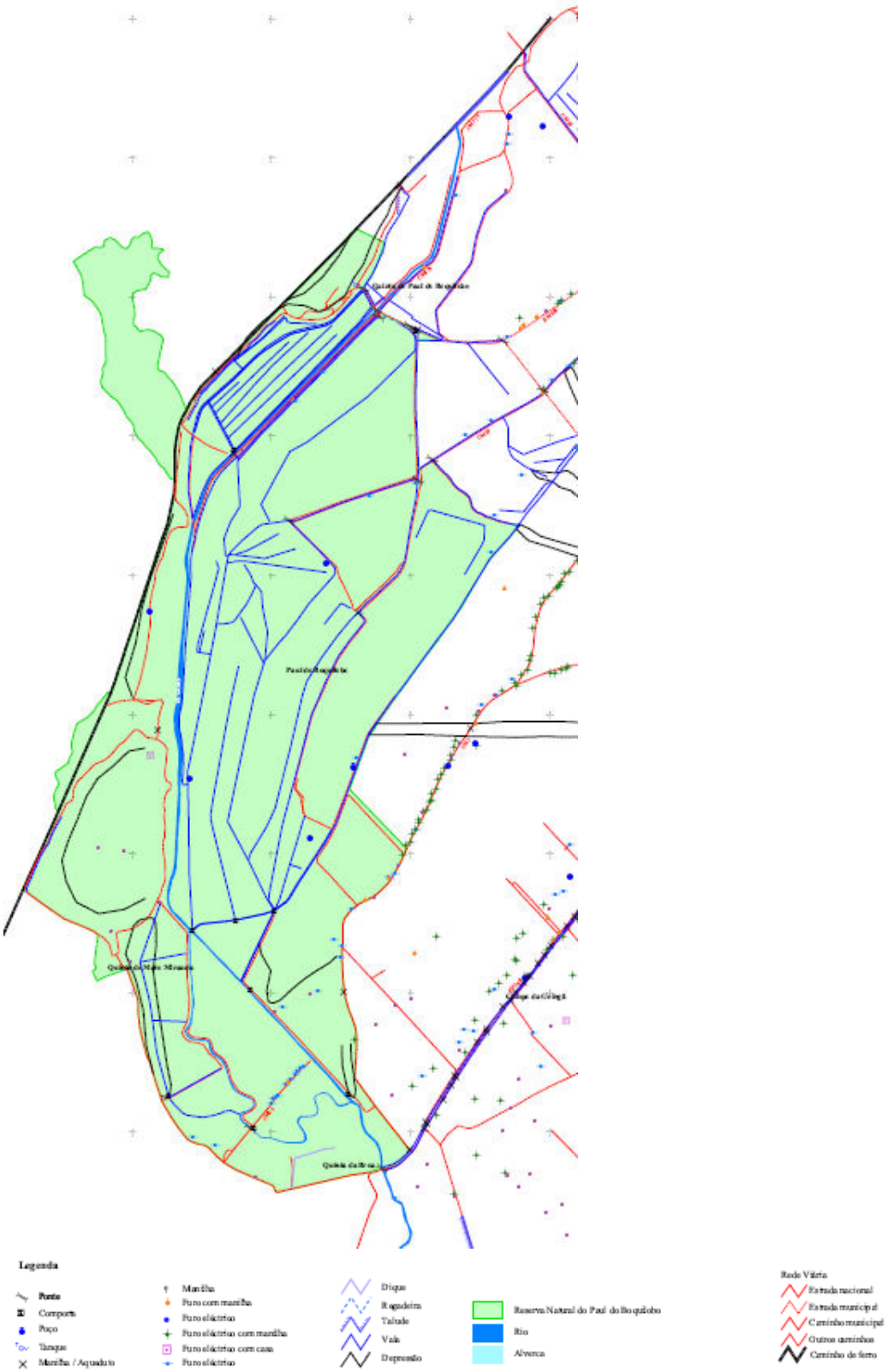


Figure A80. Hydrographic system of the Almonda River

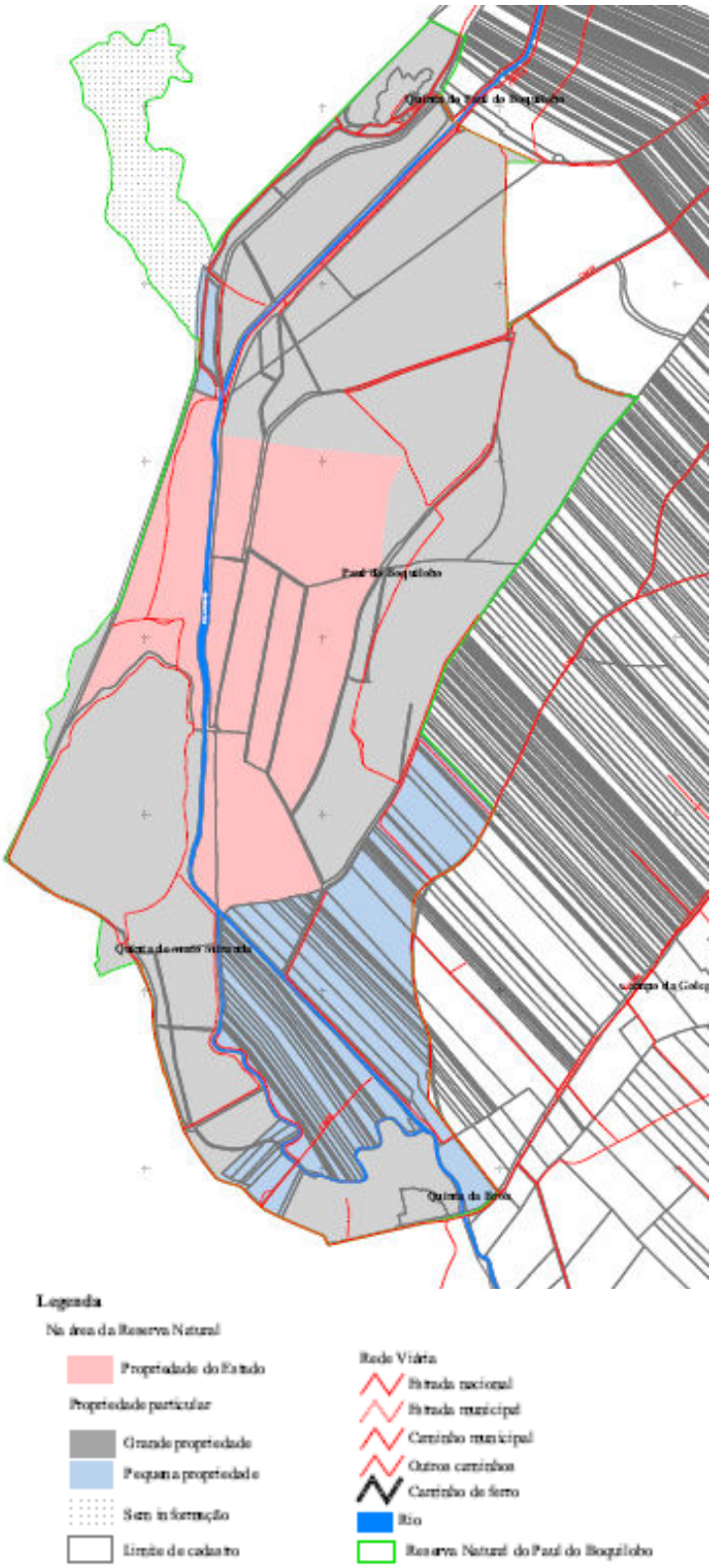
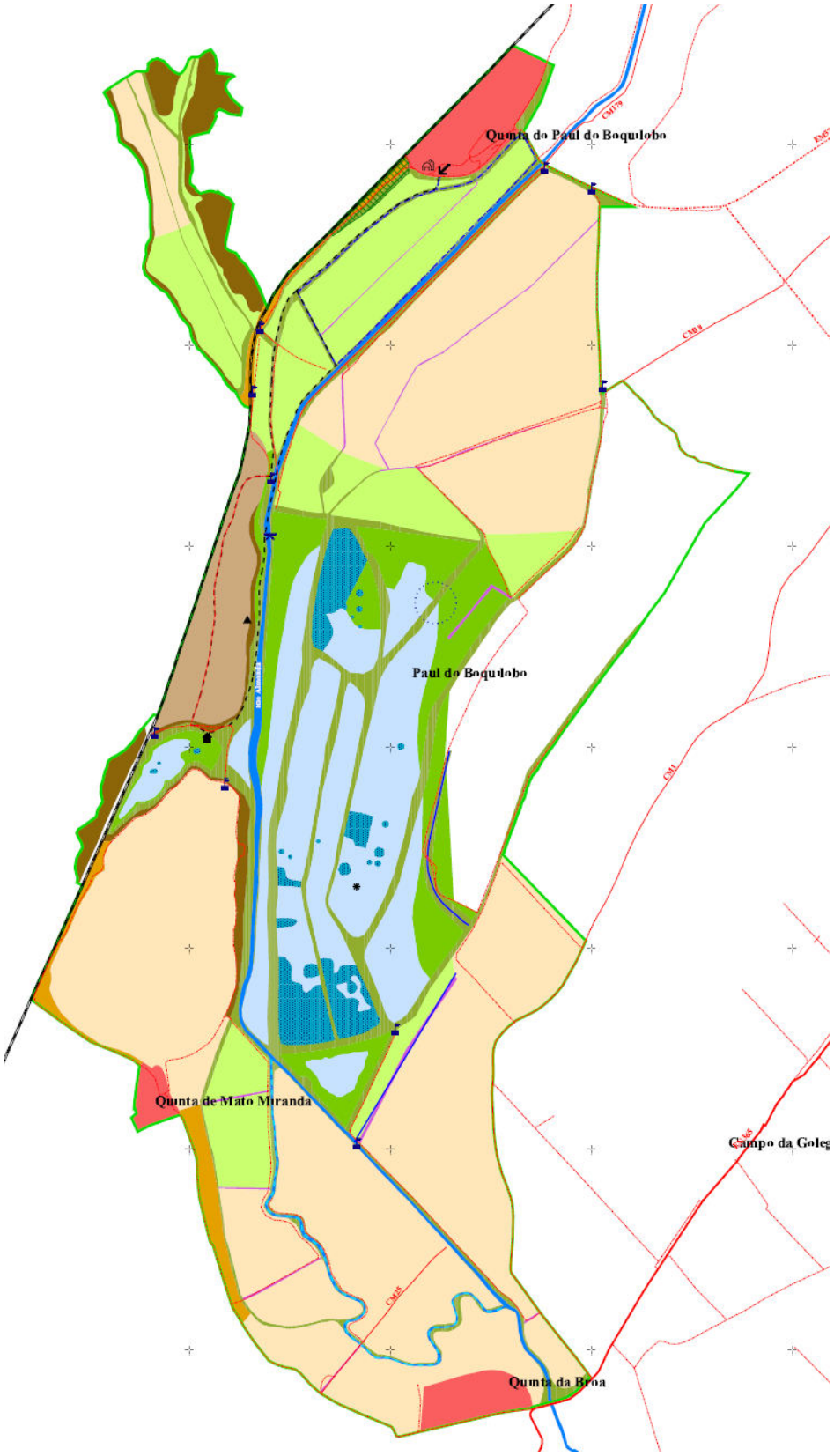


Figure A81. Distribution of landowners in the reserve


Quinta do Paul do Boquilobo
Paul do Boquilobo
Quinta de Mato Miranda
Quinta da Broa

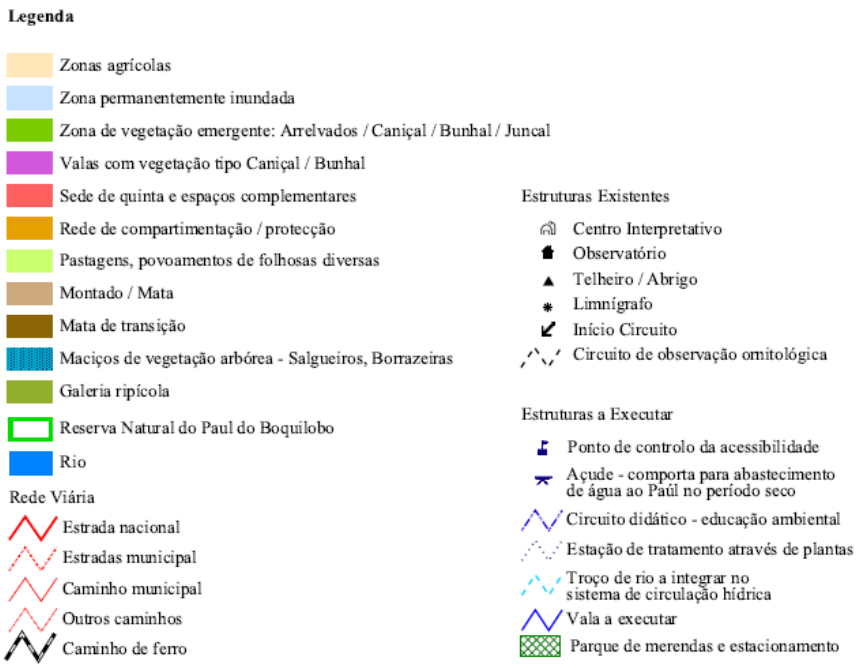


Figure A82. Landscape types in the reserve

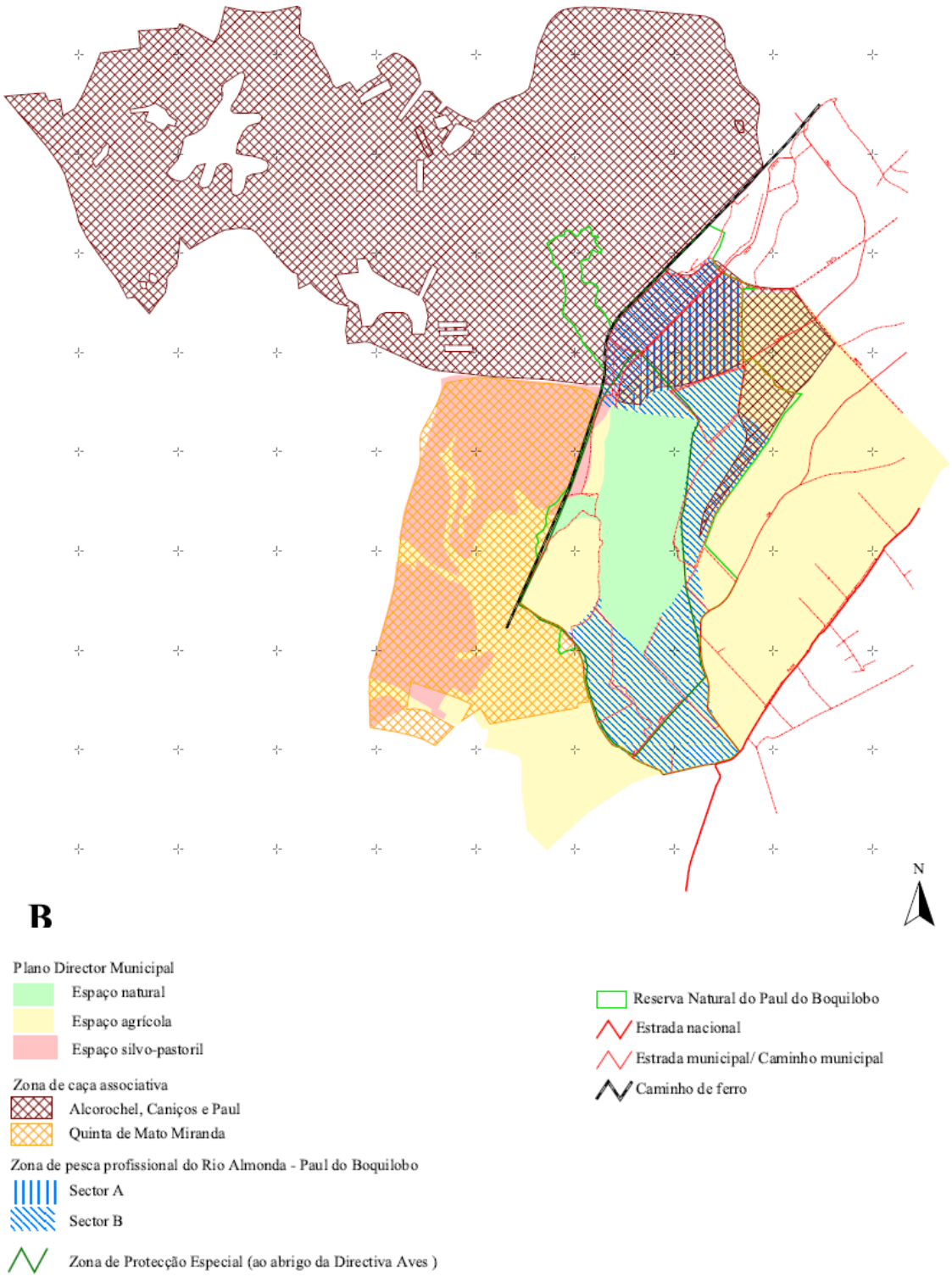


Figure A83. Distribution of landscapes and activities inside and outside of the reserve

Figure A84. Pedestrian trail and views

Figure A85. Infoboards and observation tower

Water quality analysis

Analysis I

During the preparation process of the 2008 Management Plan there was conducted water quality analysis at 5 points of the reserve which showed that at the 2 points of the Total Protection Zone (Braço Cortiço and Claros) water quality is the best, next by the quality level go the River Almonda to the north and south of the paul, and Vala da Perreira.
The River Almonda sampling point revealed elevated levels of nitrites and nitrates with low levels of oxidizability.
Vala de Perreira has serious pollution levels. It connects the paul with the upstream villages and has high levels of ammonia, phosphates, low levels of dissolved oxygen and evidence of fecal contamination.

However, it was stated that none of the sites, including the first 2 ones, satisfied the requirements of water quality for life support of animal species. High levels of nutrients are evidence of eutrophication processes ongoing in the paul.

Analysis II

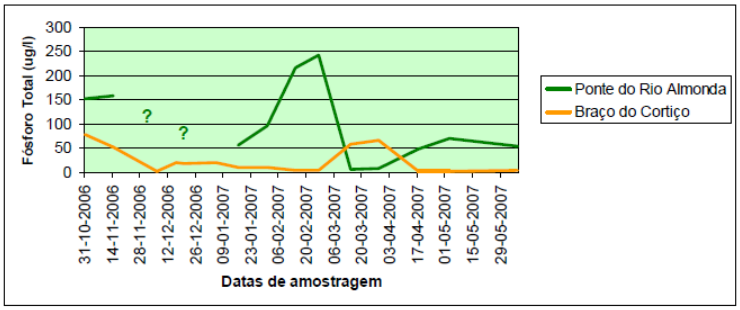
In 2006-2007 there was a research study on sampling microinverterbrates and assessing water quality in the paul.
Microinvertebrates are an indicator group for evaluation of water quality: they were sampled and Biological Monitoring Working Party (BMWP) indicator was determined. It turned out to be 58 in the range of 36-60 which corresponds with Contaminated Waters in the evaluation table.

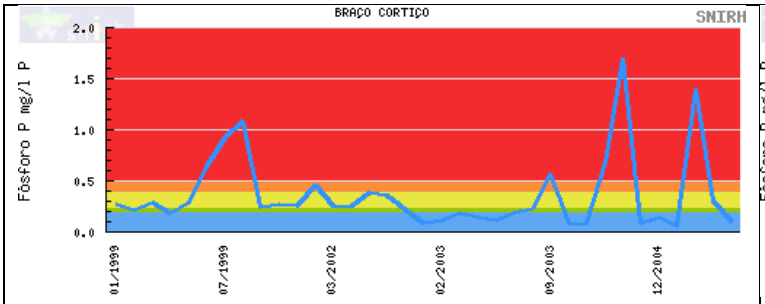
Water samples were taken every 15 days from November 2006 till June 2007 at two points – Braço do Cortiço and Ponte do Rio Almonda (Ponta Nova), the first of them is right in the centre of Total Protection Area, next to the observatory, the second one is next to the Interpretation Centre in the northern part of the reserve, at the entrance to Quinta do Paul. The difference between them is in location and waterflow speed, at Braço do Cortiço the current is weak, the river widens there, whereas at Ponte the water current is fast. The sampling sites are shown on the map below (Figure).

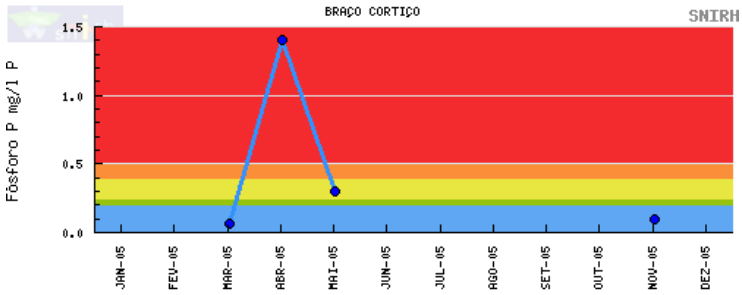
Figure A86. Sampling points at Paul do Boquilobo: BC - Braço do Cortiço, PN – Ponta Nova

The samples were used to determine phosphate, nitrate and chlorophyll levels.
The 2006-2007 results will be compared with the information obtained from SNIRH. For Braço Cortiço information only on 1999-2005 is available, whereas for Ponta Nova there are 1988-2012 results.

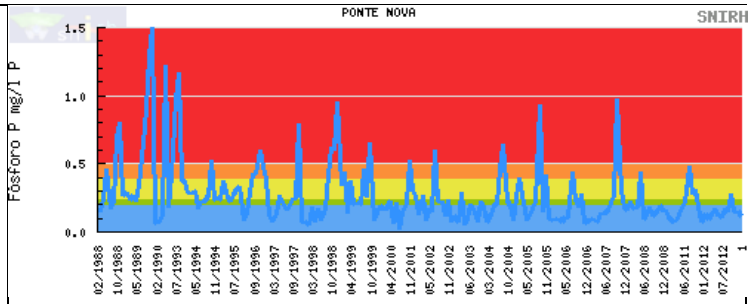
Table A11. Water quality indicators

Braço Cortiço	Ponta Nova
Phosphorous	
	
Average P is 0.23 mg/l which is a maximum value of the P normal range	Average P is 1.03 mg/l which is 5 times higher than the normal range maximum limit of 0.2 mg/l





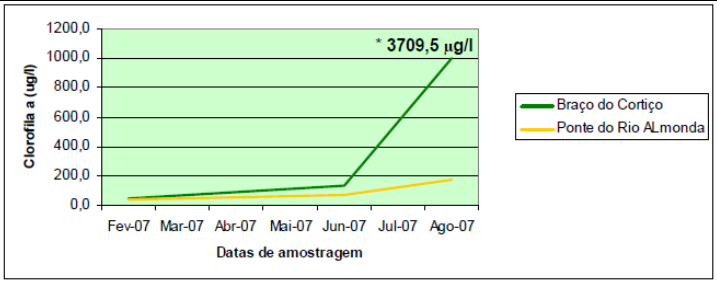
The P level is higher than the normal range of <0.2 mg/l, with abrupt increases to >1 mg/l in 1999, 2004, 2006-2007. Average P in 1999-2004 is 0.55 mg/l. This shows that the P level decreased from 1999-2004 to 2006-2007 to the normal level range.



The P level is higher than the normal range, with average being 0.42 mg/l. This means that 2006-2007 were one the peaks of P values but still its levels are high.

P levels at Braço de Cortiço have turned out to decrease with time to the normal range values (from 0.55 mg/l in 1999-2004 to 0.23 mg/l in 2006-2007) whereas the Ponta Nova values have been permanently out of the normal range, 2 times higher (0.42 mg/l with peaks of 1.03 mg/l in 2006-2007). This can result from the fact that that Ponta Nova is outside the paul and pollution from the nearby industries and agricultural practices is more visible here, whereas inside the paul, at Braço de Cortiço, waterflow is weak and nutrients are accumulating over time and either will be more visible in the future years or they are consumed by phitoplancton which is there in great amounts.

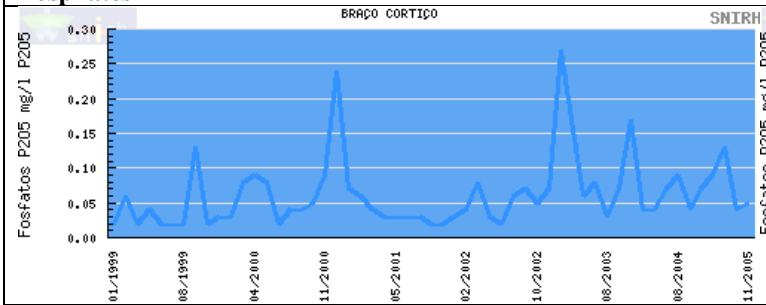
Chlorophyll

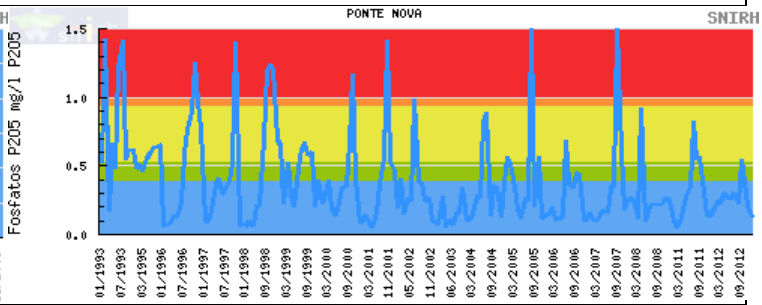


47.4, 132.4. 3709.5 ug/l	35.9, 70.4, 178.6 ug/l

Chlorophyll values at Braço Cortiço are each higher than the ones at Ponta Nova which can be explained by the fact that the first point is part of a more closed system with weak waterflow and bigger amount of phytoplancton. Green colour of water at both points is an evidence of eutrophication due to pollution and invasion of water hyacinth.

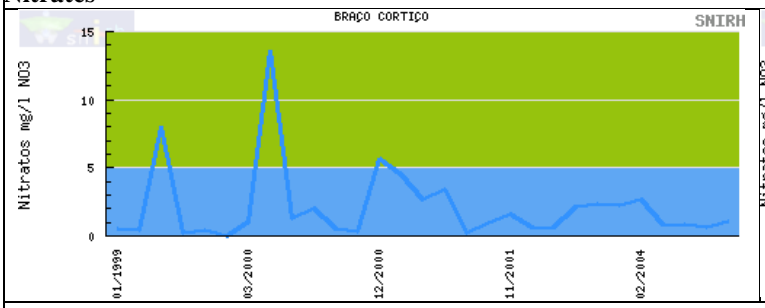
Phosphates

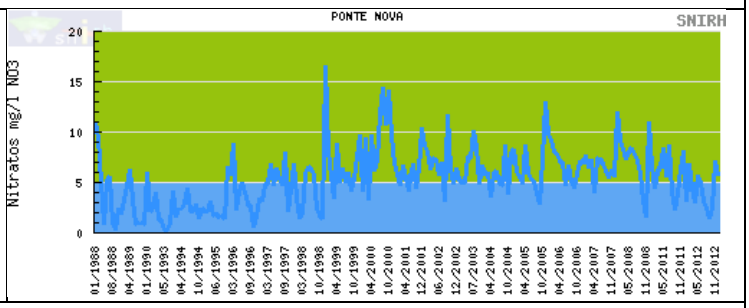




Phosphates levels are much higher at Ponta Nova (at Braço Cortiço they are in the normal range, at Ponta Nova reaching critical values) which confirms the hypothesis about the ongoing pollution and its accumulation in the paul still not visible in PO5 values inside it but already seen at the site outside the paul. It is important to note that the values at the 1st point are from 1999-2005 whereas Ponta Nova has the latest values, so, there is a possibility of PO5 levels at Braço Cortiço already being much higher.

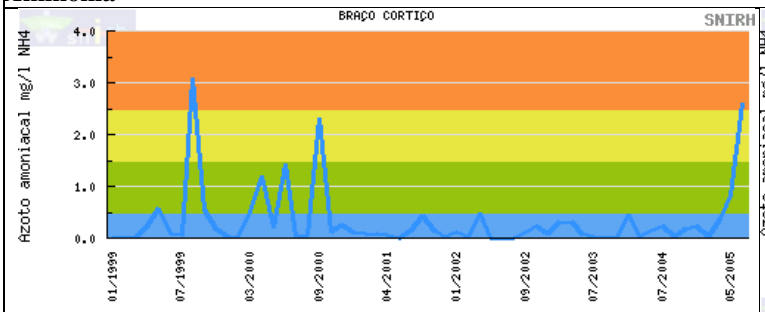
Nitrates

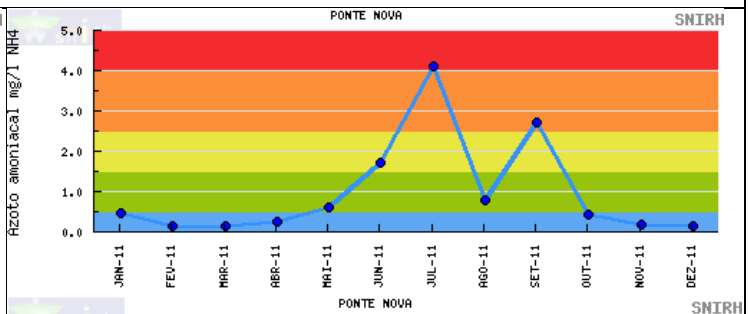


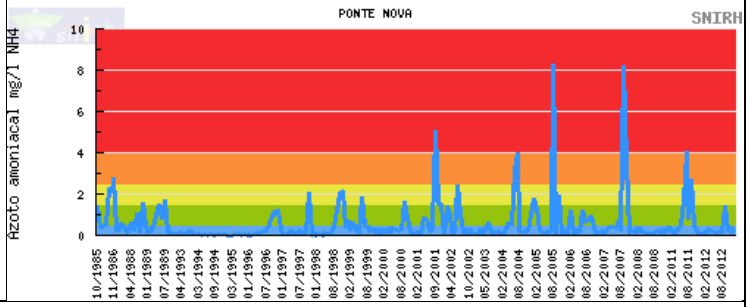


Nitrates levels have the same trend as phosphates, except for the values not being in the critical range, confirming the sensibility of the above mentioned idea.

Ammonia

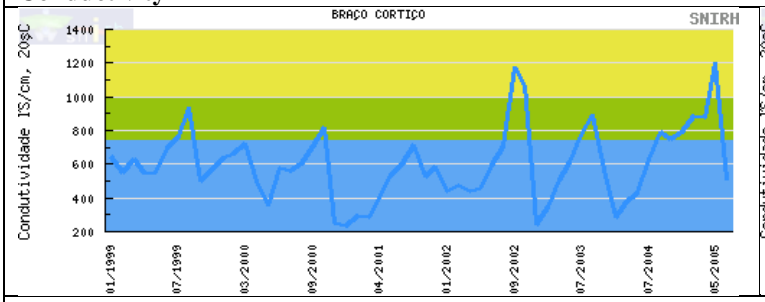


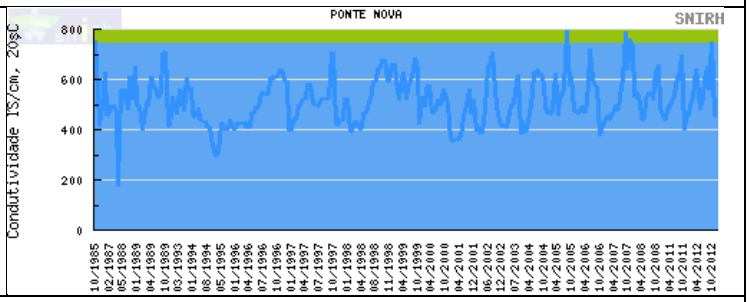




Ammonia levels at Ponta Nova are much higher than those at Braço Cortiço, although both points show values out of the normal range, which, if to take into account the accumulative feature of wetlands, can mean that current values inside the paul (Braço Cortiço) can be much higher.

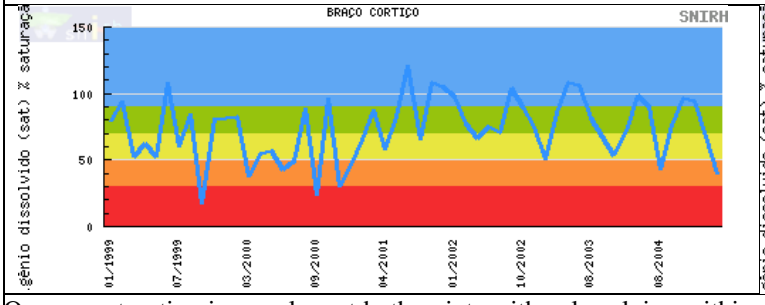
Conductivity

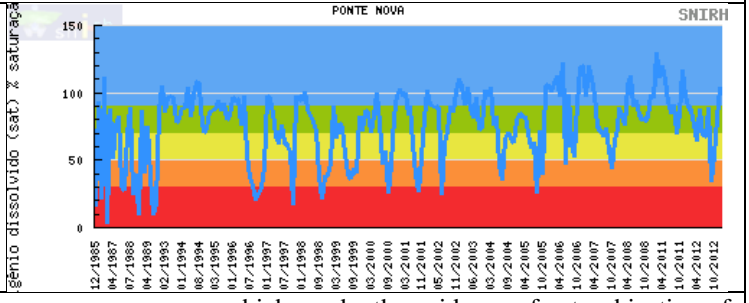




Average conductivity levels at 2 points are in the normal range, only in some periods at Braço Cortiço being higher than normal but that can not be exact proof of pollution.

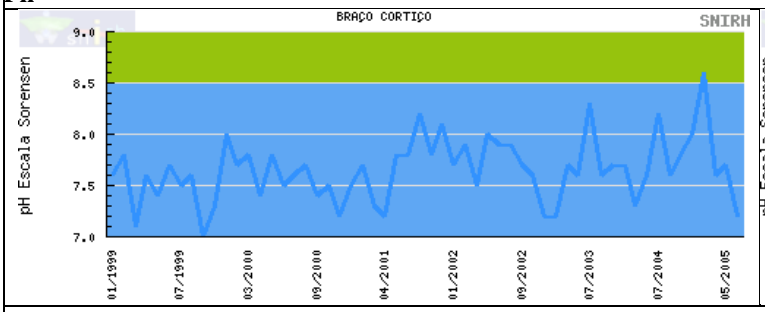
Dissolved O2

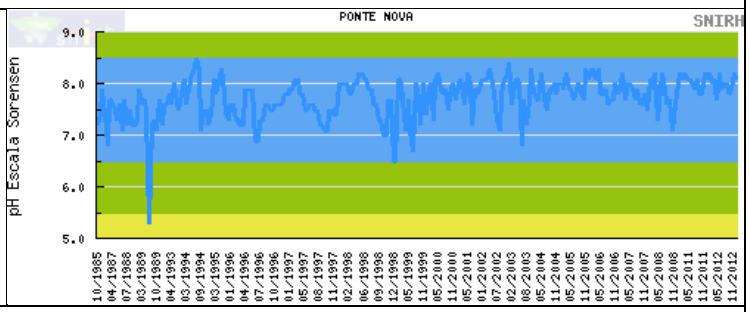




Oxygen saturation is very low at both points with values lying within green-orange range which can be the evidence of eutrophication of the area which in its turn proves that the paul suffers from ongoing pollution, drainage consequences and bad water renovation system.

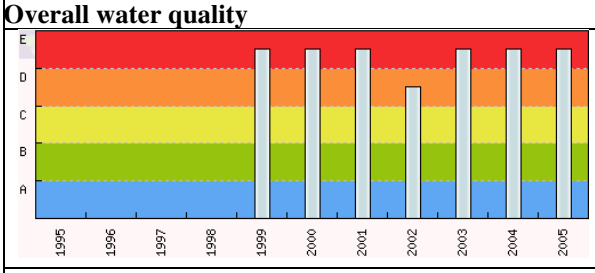
Ph

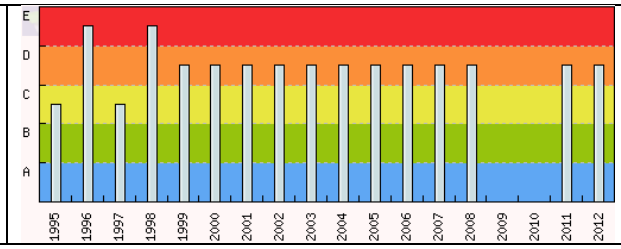




Ph levels are in the normal range.

Overall water quality





General tables are good to verify the above mentioned conclusions. Both points show poor water quality absolutely confirming the information about ongoing natural (consequences of artificial) processes in the paul. The water quality at Braço Cortiço by this table results is even worse than the one at Ponta Nova.

Wetland condition analysis

Wetland name: Paul do Boquilobo
Region: Portugal/Centro/Lisboa e Vale do Tejo
Date: 28.10.13

Classification: I System	IA Subsystem	II Wetland Class	II Wetland Form
Palustrine	Seasonal	Marsh*	Basin, channel

* Seasonal/intermittent freshwater marshes/pools on inorganic soil; includes sloughs, potholes, seasonally flooded meadows, sedge marshes (Ts); Permanent freshwater marshes/pools; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season (Tp)

Indicator	Indicator Components	Specify and Comment	Score 0-5	Mean Score
Change in hydrological integrity	Impact of manmade structures	Totally affected by manmade structures New landscape of drainage ditches and lowlands between them Weak water renovation with the Tagus and Almonda rivers. Industrial pollution by nearby farms	0	2.33
	Water table depth	Difficult to access because of artificial regulation of water level Certain decrease in the water level of 25% of the paul	4	
	Dryland plant invasion	Almost 50 % of area has dryland plant species present Salix sp, Phragmites australis, Scirpus lacustris	3	
Change in physicochemical parameters	Fire damage	No evidence of fire damage	5	3.5
	Degree of sedimentation/erosion	-	-	
	Nutrient levels	Ongoing accumulation of pollutants High eutrophication due to Water Hyacinth, invasive plant species, spread, and sewage and agricultural pollution	2	
	von Post index	-	-	
Change in ecosystem intactness	Loss in area of original wetland	App 40 % of area lost	3	3
	Connectivity barriers	Around 50% of downstream connection lost	3	
Change in browsing, predation and harvesting regimes	Damage by domestic or feral animals	No damage detected	5	3.33
	Introduced predator impacts on wildlife	Louisiana Crayfish High impact	2	
	Harvesting levels	25-49 % of area affected by active harvesting	3	
Change in dominance of native plants	Introduced plant canopy cover	Water hyacinth invasion forming patches on the water Around 25% of the area	4	4.5
	Introduced plant understorey cover	None	5	
Total wetland condition index 16.66 /25				

Degree of modification assigned as follows: 5=very low/none, 4=low, 3=medium, 2=high, 1=very high, 0=extreme

Chapter 3.2.4

The peat bogs in Portuguese mountains (Serra de Estrela, Peneda-Geres) are often degraded due to active unsustainable use for pastures, excessive spread of nutrients that is why they are subjected to conservation measures such as construction of barriers for cattle, restoration of natural hydrology through construction of dams. These conservation measures have been implemented by Quercus NGO through creation of a biological micro-reserve (one of the 3 at the moment) in the mountaneous peat area of Serra da Freita by prohibition of all non-scientific activities, control of fertilizers use, vehicles, pastures.

Figure A87. Ph meter Combo

Figure A88. Analysis process and equipment

The amount of decomposition is gauged in the field by assessing the distinctness of the structure of plant remains and colour, determined by squeezing wet peat in the hand. The following standards are based on those of von Post (Clymo 1983).

1. Undecomposed: Plant structure unaltered. Yields only clear colourless water.
2. Almost undecomposed: Plant structure distinct. Yields only clear water coloured light yellow-brown.
3. Very weakly decomposed: Plant structure distinct. Yields distinctly turbid brown water; no peat substance passes between fingers, residue not mushy.
4. Weakly decomposed: plant structure distinct. Yields strongly turbid water; no peat substance passes between fingers, residue rather mushy.
5. Moderately decomposed: Plant structure still clear but becoming indistinct. Yields much turbid brown water; some peat escapes between the fingers; residue very mushy.
6. Strongly decomposed: Plant structure somewhat indistinct but clearer in the squeezed residue than in the undisturbed peat. About half the peat escapes between the fingers; residue strongly mushy.
7. Strongly decomposed: Plant structure indistinct but still recognisable. About half the peat escapes between the fingers.
8. Very strongly decomposed: Plant structures very indistinct. About two-thirds of the peat escapes between the fingers; residue consists almost entirely of resistant remnants such as root fibres and wood.
9. Almost completely decomposed: Plant structure almost unrecognisable. Almost all the peat escapes between the fingers.
10. Completely decomposed: Plant structure unrecognisable. All the peat escapes between the fingers.

Figure A89. Von Post criteria for peat analysis

Wetland condition analysis

Wetland name: Lagoa do Dom João
Region: Serra de Montemouro
Date: 30.10.13

Classification: I System	IA Subsystem	II Wetland Class	II Wetland Form
Mountain	Mountaineous marsh	Bog	Lake, bog

Indicator	Indicator Components	Specify and Comment	Score 0-5	Mean Score
Change in hydrological integrity	Impact of manmade structures	None.Only stone-fences are next to the sitebut without any impact	5	5
	Water table depth	Normal for the peat bog, depending on precipitation	5	
	Dryland plant invasion	none	5	
Change in physicochemical parameters	Fire damage	there have been fires in the recent years but there are no negative consequences noticed	4	4.50
	Degree of sedimentation/erosion	none	5	
	Nutrient levels	none	5	
	von Post index	3	4	
Change in ecosystem intactness	Loss in area of original wetland	none	5	5
	Connectivity barriers	none	5	
Change in browsing, predation and harvesting regimes	Damage by domestic or feral animals	The site is used for pastures but within the stone-fence boundaries. There is no serious damage to the site.	4	4.67
	Introduced predator impacts on wildlife	none	5	
	Harvesting levels	none	5	
Change in dominance of native plants	Introduced plant canopy cover	none	5	5
	Introduced plant understorey cover	none	5	
Total wetland condition index 24.17 / 25				

Degree of modification assigned as follows: 5=very low/none, 4=low, 3=medium,
2=high, 1=very high, 0=extreme

Chapter 3.2.5

Figure A90. Information board set next to the project sites

Key features of the native and exotic turtle species

1. **Exotic species**

Pond Slider *Trachemys scripta* – the most popular pet turtle in the world. It is native in the east of the United States and adjacent areas in the northeast of Mexico. This species has been released into the wild everywhere in the world. It is well-known in Europe due to its invasion into freshwater ecosystems, although in other regions of the world its distribution is not known.
It has 3 subspecies: the most common is Red-eared slider *Trachemys scripta elegans*, then goes Yellow-eared slider *Trachemys scripta scripta* and Cumberland slider *Trachemys scripta troosti*.

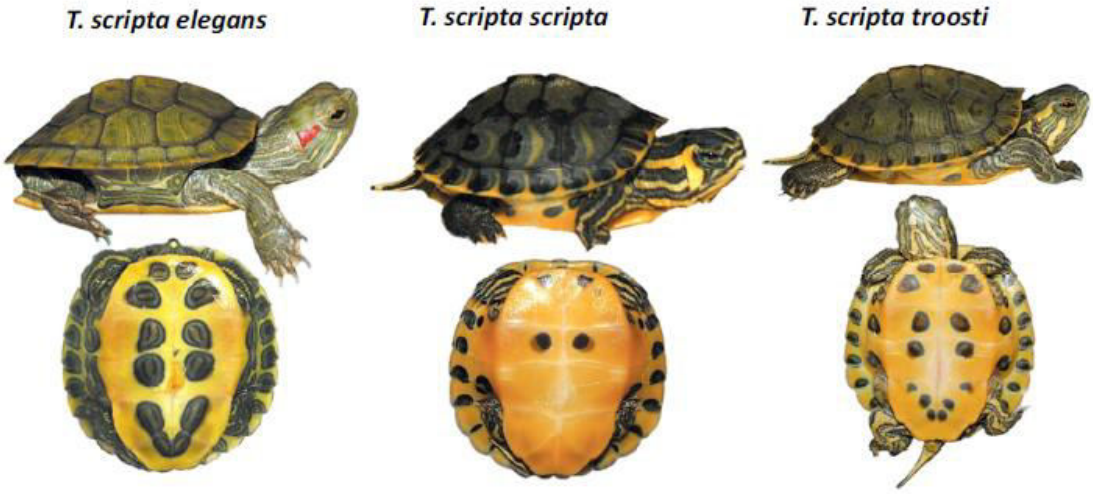


Figure A91. Subspecies of *Trachemys scripta*

The species is omnivorous with a rich diet (from insects and other invertebrates to amphibians, reptiles, small mammals and birds) and represents a great capacity of dispersion through the freshwater channels, travelling long distances on land and getting over various barriers. Thus, it is a good survivor. Moreover, it is characterized by high competitiveness for alimentation, thermoregulation places and nesting sites. This feature arises from the early sexual maturity age, high fertility, bigger size and aggressiveness if compared to the native species. What is more, *Trachemys scripta* is capable of spreading diseases and parasites which can affect the native turtles, aquatic animals and even humans.

Other exotic species
Unfortunately, trade of other exotic turtle species is permitted in Portugal. These ones can be encountered in pet shops:

Figure A92. From left to right: River cooter *Pseudemys concinna,* Florida Redbelly Turtle *Pseudemys nelsonii,* False map turtle *Graptemys pseudogeographica*

Besides the fact that the species are legally sold to public, they possess the same competitive-aggressive characteristics as *Trachemys scripta.* Thus, if released into the wild, they are able to cause the same negative impacts on the environment.

2. Native species

European Pond Turtle *Emys orbicularis* – the smallest freshwater turtle in Europe. Endangered species in Portugal, rarely encountered on the Iberian Peninsula, its populations are small and isolated. More easily found in the basins and lakes of the southern Portugal.
Its number has significantly decreased in the last 100 years due to habitat alteration and destruction (paludal landscapes), intentional catches and introduction of exotic species. Moreover, the species is rather fragile, sexual maturity of females is late which causes low fertility rates together with high infant mortality rates, and further brings low population growth and reduced recuperation ability of the species especially in case of negative impacts such as exotic species introduction.
Mediterranean Turtle *Mauremys leprosa* – the biggest freshwater turtle in Europe. Quite common in Portugal (Least concern status of protection), its biggest populations are found on the Iberian Peninsula. Well spread to the south of the River Tagus in Portugal. Encountered populations are usually of a high density although there has been noticed reduction of the distribution area due to extinction of the certain populations.
Factors of disturbance are the same as for *Emys orbicularis.* Illegal captures for trade or using for alimentation have become the most serious threat to this species. Exotic species are also a threat although *Mauremys leprosa* is much stronger and more flexible in terms of survival than *Emys orbicularis.*

Figure A93. Nasas (left) and fluctuating traps (centre and right)

Figure A94. Hand capture (left) and collection with a shrimp catcher (right)

Figure A95. Renovated fluctuating traps in 2012

Figure A96. Localization of traps

Localidade	Capturas 2011	Capturas 2012	Capturas 2013	Neonatos 2011	Neonatos 2012	Neonatos 2013	Total capturas	Percentagem	Ninhos
Garrão	0	0	0	0	0	0	0	0 %	0
Dunas Douradas	3	1	1	0	0	0	5	1,7 %	0
São Lourenço	65	61	45	8	10	2	191	63,9 %	10
Quinta do Lago Sul	12	5	14	1	0	0	32	10,7 %	0
Quinta do Lago Norte	10	1	12	0	0	0	23	7,7	0
Quinta do Lago Oeste	0	3	0	0	0	0	3	1	0
Pinheiros Altos	0	0	5	0	0	0	5	1,7	0
Jardins públicos	16	18	6	0	0	0	40	13,3 %	0
TOTAL	**106**	**89**	**83**	**9**	**10**	**2**	**299**	**100 %**	**10**

Figure A97. Number of captures of exotic species on the project sites

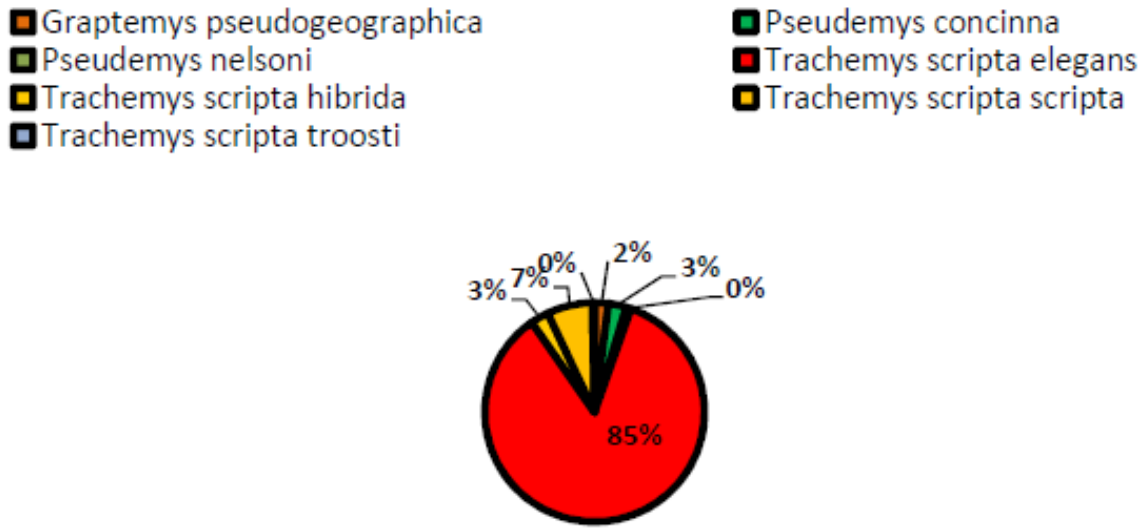


Figure A98. The number and percentage of captures of exotic species

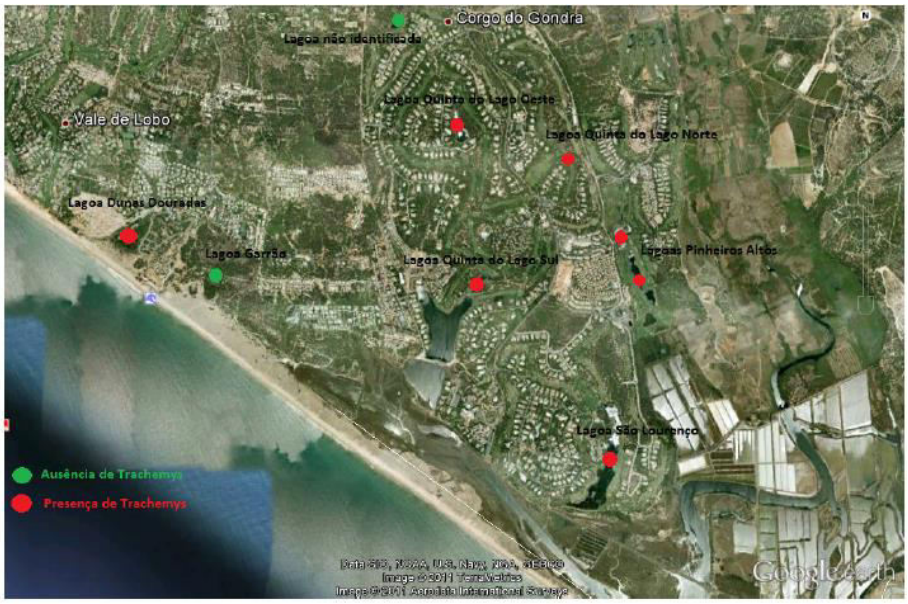


Figure A99. Map of initial distribution of presence and absence of *Trachemys* in the complex of lakes defined as project sites

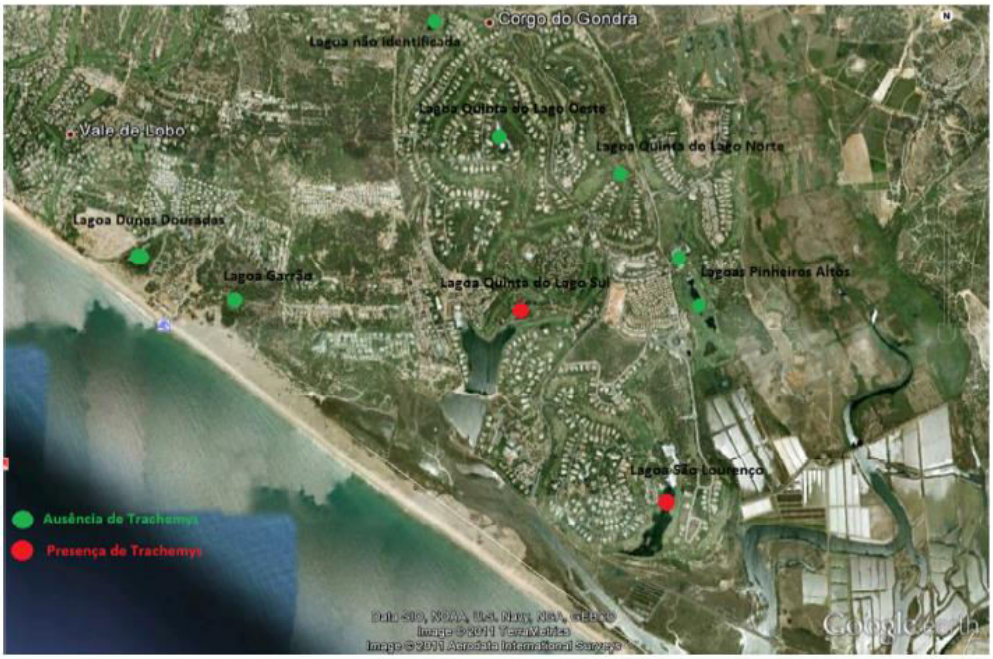


Figure A100. Map of final distribution of presence and absence of *Trachemys* in the complex of lakes defined as the project sites

Table A12. Results per action area: number of captures, proportion of sexes, pregnant females, age groups of *Emys orbicularis* captures during the project

Localidade	Capt	Rec	% Rec	M	F	Ind	M:F	F grá	Ad	Juv	Nn	% Ad	% Juv	%Nn
Lagoa do Garrão	22	46	209	17	5	0	1 : 0,29	2	21	1	0	95,5	4,5	0
Lagoa das Dunas Douradas	39	104	266	34	5	0	1: 0,15	3	37	2	0	94,8	5,2	0
Lagoa de São Lourenço	180	477	265	75	66	39	1 : 0,88	22	121	21	38	67,2	11,6	21,2
Lagoa da Quinta do Lago Sul	101	507	502	38	56	7	1 : 1,47	15	50	46	5	49,5	45,5	5
TOTAL	**342**	**1134**	**331**	**164**	**132**	**46**	**1 : 0,80**	**42**	**229**	**70**	**43**	**76,8**	**16,7**	**6,5**

Capt – total number of captured individuals; **Rec** – total number of recaptured individuals; **% Rec** – Rate of recaptures; **M** – total number of captured males; **F** – total number of captured females; **Ind** – total number of individuals of undetermined sex; **M:F** – proportion of sexes: males vs females; **F grá** – total number of captured pregnant females; **Ad** – total number of adult individuals (>100 mm); **Juv** – total number of juvenile individuals (>40 mm<100 mm); **Nn –** total number of neonates (<40 mm); **% Ad** – percentage of adults; **% Juv** – percentage of juveniles; **% Nn –** percentage of neonates.

Analysis of the results per each lake

Lagoa do Garrão

6 traps (´nasas´ in Portuguese) were placed in 2011, evenly distributed in the lake to get the real density of the species;

In 2012 traps were removed due to complete drought of the lake during the whole period of captures;

In 2013 the water level stabilized and 3 new traps were placed in the lake. The distribution of traps is shown in the figure below.

Figure A101. A – localization of traps in Lagoa do Garrão during 2011; B – localization of traps in Lagoa do Garrão during 2013

The number of recaptures (46) compared to the number of captures (22 individuals) is a high indicator which shows that there is a high probability the number of captured *Emys orbicularis* is close to their real quantity.
Capture of only one juvenile is a worrying result since deficit of juveniles can have serious consequences for renewal of the population. However, capture of 2 pregnant females is a positive fact which can mean that the low number of captured juveniles can result from abundant vegetation in the lake being a good refuge for the species and from the type of traps used.

Lagoa das Dunas Douradas
6 nasas and 6 fluctuating traps were placed in the lake in 2011;
In 2012 due to a drastic fall of the water level 3 nasas and all the fluctuating traps were removed, with only 3 nasas left;
In 2013 due to the still low water level 3 nasas remained in the lake, no more traps were place there. The distribution of the traps is shown in the figure below.

Figure A102. A – localization of traps in Lagoa das Dunas Douradas during 2011; B – localization of traps in Lagoa das Dunas Douradas during 2012 and 2013

The number of recaptures (104) again has a very high value in comparison to the number of captures (39 individuals) which means this number of the individuals of *Emys orbicularis* is rather close to reality.
Similar to Lagoa do Garrão, there is a low number of juveniles captured but 2 pregnant females which, taking into account closeness of Lagoa do Garrão, can indicate that the colonization of new individuals will not occur in this area in the future.

Lagoa de São Lourenço
Every year (2011, 2012, 2013) 5 nasas and 9 fluctuating traps were placed in the lake. Due to the big size of the lake, it was divided into 3 zones – north, south and centre. The traps were distributed evenly in each zone to ensure the equilibrium of trapping.

Figure A103. Localization of traps in Lagoa de São Lourenço during 2011, 2012, 2013

The number of recaptures (477) is again much higher than the number of captures (180 individuals) which indicates this number can be close to reality. 21 juveniles and 38 neonates, although being a low number, is a positive result which shows nesting of *Emys orbicularis* occurs safely in the lake.

Lagoa Quinta do Lago Sul
In 2011 5 nasas were placed in the lake, evenly distributed around its perimeter;
Due to maintenance works in the northern part of lake in 2012, only 3 nasas were placed in the south of the lake;
In 2013 4 nasas were placed in the south of the lake like it was in 2011, while it was not possible to locate 1 nasa in the north.

Figure A104. A – localization of traps in Lagoa Quinta do Lago Sul during 2011; B – localization of traps in Lagoa Quinta do Lago Sul during 2012; C – localization of traps in Lagoa Quinta do Lago Sul in 2013

The number of recaptures in this case (507) was extremely high in comparison to the number of captures (101) which guarantees a little margin of error for the real number of individuals in the lake.
The number of captured juveniles (46) is the highest among the 4 project sites although it is all the same low in comparison to the number of adults. The results show that the population of *Emys orbicularis* in the lake is theoretically healthy, with mature adult individuals capable of reproduction and renewal of population.

Table A13. Results per action area: number of captures, proportion of sexes, pregnant females, age groups of *Mauremys leprosa* captures during the project

Localidade	Capt	Rec	% Rec	M	F	Ind	M:F	F grá	Ad	Juv	Nn	% Ad	% Juv	%Nn
Lagoa do Garrão	266	358	135	161	101	4	1 : 0,63	17	183	79	4	68,8	29,7	1,5
Lagoa das Dunas Douradas	873	767	88	464	380	29	1 : 0,82	13	595	250	28	68,2	28,6	3,2
Lagoa de São Lourenço	643	819	127	311	288	44	1 : 0,93	9	350	249	44	54,5	38,7	6,8
Lagoa da Quinta do Lago Sul	507	877	173	252	232	22	1 : 0,92	13	278	208	21	54,8	41	4,2
TOTAL	**2289**	**2821**	**123**	**1188**	**1001**	**99**	**1 : 0,84**	**52**	**1406**	**786**	**97**	**61,4**	**34,4**	**4,2**

Capt – total number of captured individuals; **Rec** – total number of recaptured individuals; **% Rec** – Rate of recaptures; **M** – total number of captured males; **F** – total number of captured females; **Ind** – total number of individuals of undetermined sex; **M:F** – proportion of sexes: males vs females; **F grá** – total number of captured pregnant females; **Ad** – total number of adult individuals (>100 mm); **Juv** – total number of juvenile individuals (>40 mm<100 mm); **Nn –** total number of neonates (<40 mm); **% Ad** – percentage of adults; **% Juv** – percentage of juveniles; **% Nn –** percentage of neonates.

Chapter 4.1

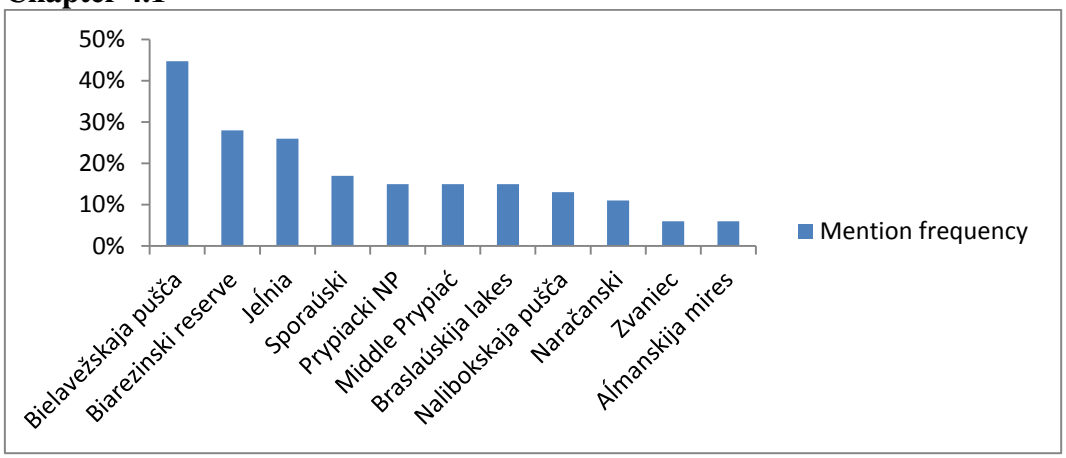


Figure A105. Mention frequency of Belarusian protected areas

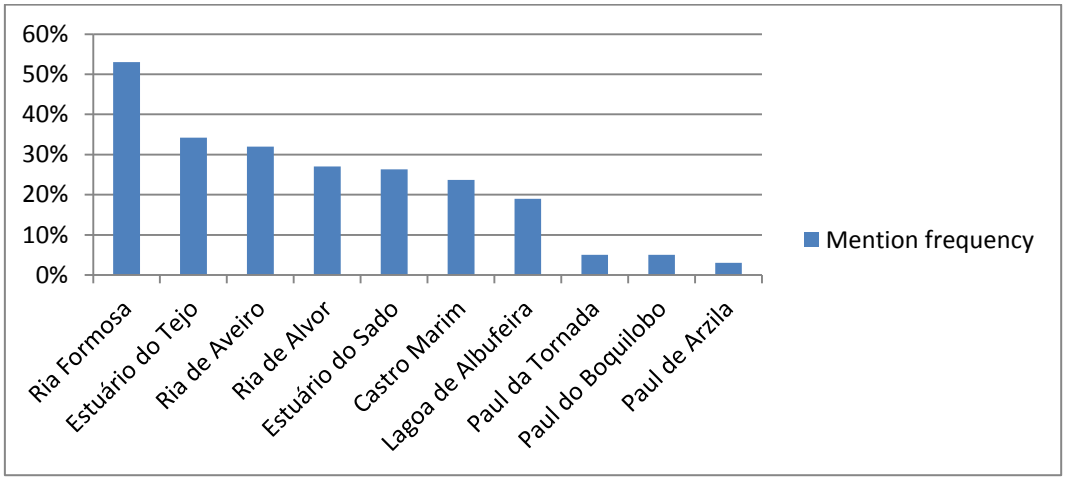


Figure A106. Mention frequency of Portuguese wetlands