Monitoring and management plan for Amphibian populations in the Kotyhi-Strofylia wetlands

S.C. Hoogendoorn June 1 2017

Thesis VHL University of Applied Sciences




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ΥΓΡΟΤΟΠΟΙ
ΚΟΤΥΧΙΟΥ - ΣΤΡΟΦΥΛΙΑΣ

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NATURA CERCA

EPMAC-EUROPE
Educative and Participative Monitoring for Amphibian Conservation

Colophon

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Date:	June 1 2017
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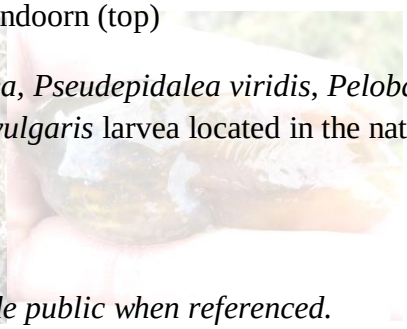
Cover Photo's: Prokopos Lagoon by C. Hoogendoorn (top)

From left to right: *Hyla Arborea, Pseudepidalea viridis, Pelobates Syriacus* larvea and *Lissotron vulgaris* larvea located in the national park by C. Hoogendoorn (bottom)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Thesis commissioned by VHL university of applied sciences, EPMAC Europe and the managing body of the Kotyhi – Strofylia wetlands

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Keywords: Kotyhi – Strofylia, Greece, wetland, herpetology, amphibians, monitoring, conservation, management

Acknowledgement

In front of you is an investigation report written as the final thesis of the bachelor study Forestry and Nature Conservation on Van Hall Larenstein University of Applied Sciences. The aim of the research is to lay the groundwork for a monitoring program for amphibians in the national park Kotyhi – Strofylia for better understanding, awareness and protection.

My time in Greece has been very valuable to me in several ways. The beautiful landscapes, the nice weather, magnificent wildlife but especially the amazingly nice people who helped me and treated me as one of their own made this research period a golden time. The research started out with a bit of a setback when my teammate was forced to quit the research due to serious personal problems and I was forced to go alone. But then the management team of Strofylia as well as local people welcomed me and supported me with so much warmth and hospitality that the whole experience turned out beautiful. My heart goes out to all the people in Greece and I can't thank you enough for the generosity even though the financial situation is so bad now, efcharisto…

Furthermore I would like to thank my teammate and friend Stuart van Baren for laying the groundwork for this research together with me before he was forced to quit. Next I am grateful for my supervisors: Wouter de Vries of Natura Cerca for his inspirational and enthusiastic as well as professional guidance during the fieldwork and Marius Christiaans for his supervision of the whole process and his critical look on the report. Also I highly appreciate the way I was welcomed and supported by Vasiliki Orfanou and the rest of the management body of the Kotyhi-Strofylia wetlands. Also many thanks to the local farmer family of Alexandra, Neoklis, Aspasia and Andreas Tsafos for their hospitality in letting me into their home and the local herpetologists Elias Tsoras and Phillipos Katsiyannis for showing me some good places in the area.

June 1 2017

Christiaan Hoogendoorn

Figure 1: Impressions of the National park (photos: Christiaan Hoogendoorn)

Abstract

This report is written in the context of a bachelor thesis for the VHL University of Applied Sciences. This study contains an extensive survey to amphibian species and their habitats in the national park Kotyhi-Strofylia wetlands and the goal of the report is to provide local management and monitoring suggestions for conservation of amphibians. The study is part of EPMAC-Europe which is a European monitoring system for amphibians. The national park Kotyhi – Strofylia wetlands is a Laguna, dune, swamp and forest area located in the north-western part of the Peloponnesus. The national park Kotyhi-Strofylia wetlands is well recognized as a valuable national park with high biodiversity and landscape value. Yet there is relatively little known about several species groups including amphibians (*Orfanou, 2016*). International law provides clear requirements for the protection of amphibians.

The goal of this study is to provide the foundations for a monitoring and management plan. This includes a complete management cycle. This management cycle includes all the steps that need to be taken now and in the future to ensure the conservation of amphibians in the area. The goal of this research is not to complete this whole management cycle but to describe the current situation. In other words: this research is a 'baseline' monitoring.

This research works with 50 sample locations that have been selected after a large field survey in the whole area. Every location is visited three times, two times at day and once at night and monitored according to the standard EPMAC method. Then this data is interpreted to find out whether the populations are sustainable. However it has to be stated that making any assessments on sustainability of populations is very hard, almost impossible, especially after only one year of monitoring. Lastly there is a need to look at the qualities and weaknesses of the area for each of the different amphibians.

There are 7 species of amphibians observed during this research in the Kotyhi-Strofylia wetlands and indication is given on the sustainability of their populations: *Lissotron vulgaris*: not sustainable. *Pseudepidalea viridis*: sustainable. *Hyla arborea:* sustainable. *Pelophylax epeiroticus and Pelophylax kurtmuelleri:* sustainable. *Rana dalmatina:* not sustainable. *Pelobates syriacus:* not sustainable.

The first thing that strikes is the amount of fish in the area. Almost all ponds in the area have fish present and that is usually not a good sign for amphibian population. The next factor, isolated ponds is also important for quality. All the ponds that are isolated are of much higher quality than the big connected water for all the sensitive species. Roads that are located next to the waters are clearly a problem.

There are some management actions that can be suggested after this research. The first suggestion is to dig small tunnels under the asphalt roads that cross the area. Secondly, its recommended to dig extra ponds in the area that are further away from the lagoons so that they won't be filled up with sea water during the floods but stay closed off all year so that fish won't be able to enter. This will cause drastic improvements in amphibian populations

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1. Introduction

Amphibians are a very sensitive group of animals who are overall declining everywhere in Europe(*Bishop, 2012*). To stop this decline laws and regulation have been put in place to ensure their protection. To do this a long term monitoring of the species and a management plan is needed. The aim of this study is to provide clear insight in the management cycle needed to ensure the protection of amphibians as well as the baseline for the long term monitoring needed.

1.1 Context of the study

This report is written in the context of a bachelor thesis for the VHL University of Applied Sciences. This study contains an extensive survey to amphibian species and their habitats in the national park Kotyhi-Strofylia wetlands and the goal of the report is to provide local management and monitoring suggestions for conservation of amphibians. The study is part of EPMAC-Europe which is a European monitoring system for amphibians.

EPMAC-Europe is a reference tool for the evaluation of regional research and conservation of amphibians. EPMAC stands for Educative and Participative Monitoring for Amphibian Conservation and seeks to combine education and participation with conservation and monitoring. This results in support and awareness as well as the actual scientific knowledge about amphibians and their habitats do to analyses with and base conservation advice on. The system works in close collaboration with volunteers who do most of the fieldwork under guidance of semi-professionals. The main objectives of EPMAC are monitoring of all amphibian species and habitats, creating data on natural dynamic on a landscape level, define status and priority for conservation actions, increase species recognition and awareness on conservation requirements and increase participation and education.

The national park Kotyhi – Strofylia wetlands is a Laguna, dune, swamp and forest area located in the north-western part of the Peloponnesus. The Protected Area extends over an area of 14300ha, with a shore line of approximately 22 km, spanning across both Achaia and Ileia prefectures. The area presents a mosaic of different habitats which include wetlands and seasonally flooded expanses, the Umbrella pine forest, sand dunes and calcareous hills with remnant shrub vegetation. Due to its high biodiversity and rare aesthetic value, a number of protection designations have been assigned to the area. Part of it has been recognized as a Wetland of International Importance in 1975, when it was included in the 10 Wetlands of Greece protected under the Ramsar Convention. Later, parts of the area were recognized as Special Protection Areas (SPAs) for Birds, in accordance with the Directive 2009/147/EE, as well as Sites of Community Importance (SCIs) in accordance with the Directive 92/43/EEC, which led to the establishment of the European NATURA 2000 Network of protected areas.
The Management Body of Kotychi and Strofylia Wetlands was founded in 2002, and its task is the conservation, management and sustainable development within the area. (Orfanou, Strofylia national park, sd). Management at the moment is limited to preventing illegal activities like poaching, logging and illegal recreational activities, monitoring programs (primarily for birds) and raising awareness with tourists and locals.

The national park Kotyhi-Strofylia wetlands is well recognized as a valuable national park with high biodiversity and landscape value. Yet there is relatively little known about several species groups including amphibians (*Orfanou, 2016*). The monitoring in the area focusses primarily on birds and plants(*Georgiadis, 1989*) There has been one global monitoring on species groups like reptiles, amphibians and mammals conducted by the university of Patras*(Γκιώκας, 2015).* This research did a global singular sample in the area focussed mostly on audio recordings and found a total of eight species of amphibians in the area: *Lissotron vulgaris, Bufo bufo, Pseudepidalea viridis, Hyla arborea, Pelophylax epeiroticus, Pelophylax kurtmuelleri, Rana dalmatina, Pelobates syriacus* (see table 1 and appendix 5 for more information on the species). This research, however, was small scale and one time without considerations for repeating it in the future. There is still a need for a more detailed and long term monitoring program for the amphibians in the area.

a/a	Species name	National legislation	Bern convention	European Directive 92/43/ EC	Breeding season
1	*Lissotriton vulgaris*	**Presidential decree - 1981**	Appendix 3		half February
2	*Bufo bufo*	**Presidential decree - 1981**	Appendix 3		March – June
3	***Pseudepidalea viridis***	**Presidential decree - 1981**	**Appendix 2**	**IV**	February - July
4	***Hyla arborea***	**Presidential decree - 1981**	**Appendix 2**	**IV**	March – May
5	*Pelophylax epeiroticus*		Appendix 3		March – April
6	*Pelophylax kurtmuelleri*		Appendix 3		Early spring
7	***Rana dalmatina***	**Presidential decree - 1981**	**Appendix 2**	**IV**	Early spring
8	***Pelobates syriacus***	**Presidential decree - 1981**	**Appendix 2**	**IV**	February – May

Table 1: Present amphibian species and their conservation status and breeding season, the more rare species are displayed in bold (see appendix 5 for more detailed information on the species.)

1.2 Problem statement

The amphibians in the area are under constant duress (*Orfanou. 2016*). The area is quite densely populated and the natural resources are under stress by poachers, loggers, fishers, tourists or other polluters. A small look on the roads in the area shows many amphibians trampled by cars. Also the lagoons in the area and consequently the marshes and almost all the other water bodies are managed by fishers (*Γκιώκας, 2015*) and maintain contact with the sea. So there are many natural competitors and treats to the amphibians like shrimps and predatory fish in the area. There are only few waters that remain detached from the big water bodies and thus are without fish (see chapter 2 and the habitat analysis in chapter 4 for more detailed information about the area). Also there is agriculture that borders with the natural area brings several problems like toxic pesticides and nutrients into the soil and the water. The management body of the Kotyhi-Strofylia wetlands has the wish to conserve all amphibians in the area (*Orfanou, 2016*).

International law provides clear requirements for the protection of amphibians. The statement 'we need to conserve sustainable population of amphibians' needs to be backed up with something. Unfortunately we can't simply make this statement based on our own idealism however much we may want to. We need to back it up with some authority, which we as nature conservationists don't really have. Simply not everyone agrees that amphibians or animals in general need to be protected. Luckily the people who care about the protection of these animals have lobbied for the creation of laws and regulations to force conservation, both on a national and an international level. International laws must be implemented by national and local management. In the case of amphibians in Greece there is the national legislation (ΠΔ 67\1981 (ΦΕΚ 23\Α), 1981) which mentions six of the eight species in the presidential degree of 1981(see table 1 on the previous page). Additionally there is convention Bern which is a binding international legal instrument in the field of Nature Conservation, it covers the natural heritage in Europe, as well as in some African countries. The Convention was open for signature on 19 September 1979 and came into force on 1 June 1982. It is particularly concerned about protecting natural habitats and endangered species, including migratory species (*Bern, 1979*). Bern lists all the amphibian species present in the area in either appendix III or II meaning they are all under strict protection. Finally four of the eight species of amphibians found in the area are listed in annex IV of the European directive (*Natura 2000*) which means that they are species of community interest that demand strict protection. See table 1 for an overview of the laws per species.
These provide the motivation to this whole research. In the context of the law we don't just monitor and conserve the species out of hobby or idealism but because we actually have to by law. Also we can force third parties who could possible form a danger to the amphibians like tourist, collectors, polluters and farmers to work with us. However, there is little known about the conservation status of amphibian species in Strofylia. Not all species are monitored, and there is not yet at a detailed multiple year monitoring of the populations and their habitats.
It requires insight into the population structure of different species of amphibians in Strofylia and the environment to take targeted control measures. The amphibian populations in and around Strofylia must be inventoried and there must be a management plan focused on amphibians.

1.3 Research questions

Are the populations of amphibian species in the national park Kotyhi-Strofylia wetlands sustainable at this moment and if not what can the management do to improve on them?

Sub-research questions:

1. What amphibian species live in the national park Kotyhi-Strofylia and where and in what amounts?
2. Are the populations of amphibians in the national park Kotyhi-Strofylia sustainable at this moment?
3. What can the management of the national park Kotyhi-Strofylia do to protect, conserve and\or improve the populations of amphibians?

1.4 Research goal

The goal of this study is to provide the foundations for a monitoring and management plan. This includes a complete management cycle as visualized in figure 2 below. This management cycle includes all the steps that need to be taken now and in the future to ensure the conservation of amphibians in the area.

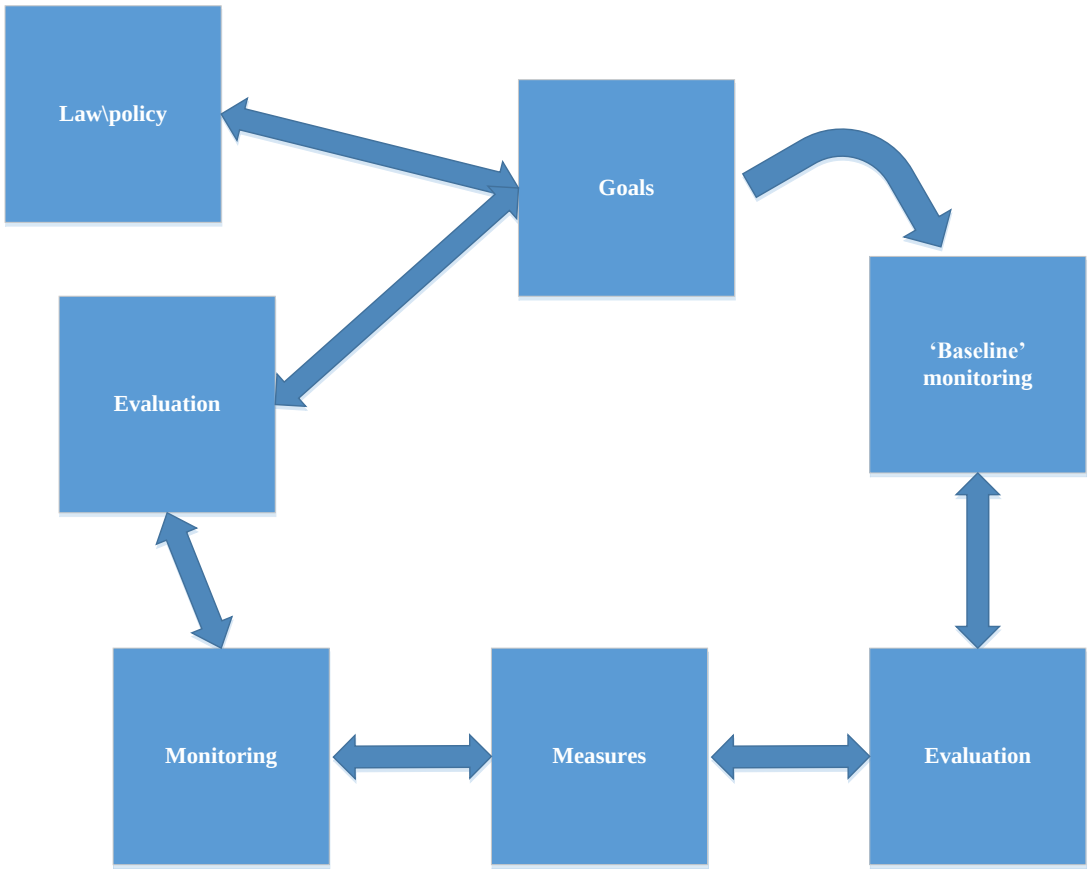

Figure 2: Management cycle

The cycle starts with determining the reasoning behind starting the management cycle at all. Those are the laws and regulations that apply to the amphibians in the area that force the management and the locals of the area to take their conservation into account. From there management goals are established. In a broad sense the goal in this management plan is simply 'create or conserve a sustainable population of all the eight amphibian species in the Kotyhi-Strofylia wetlands'. This broad goal has to be divided in more specific measurable goals. Sustainability of amphibian populations are determined by availability and quality of reproductive waters and land habitat. Those measurable goals then have to be evaluated after the monitoring.

Then monitoring is necessary to determine the qualities and weaknesses with regard to amphibians of the area. Then management actions to preserve the qualities and repair the weaknesses are outlined. Then we need to continue monitoring over the course of several years to observe the decline or improvement of the populations so we can evaluate the management and formulate new goals, thus starting the cycle all over again.

The goal of this research is not to complete this whole management cycle but to describe the current situation. In other words: this research is a 'baseline' monitoring that can be the basis for the long term monitoring. It is meant as a reference tool for future researchers as well as the management team.

1.5 Thesis outline

This report contains a total of six chapters. In the first chapter: introduction, the context and background of the study are explained and the problem as well as the research questions are introduced. The area, the qualities and weaknesses of the area and the amphibian species in the area and the EPMAC monitoring system are introduced. Also the goal of the research is outlined and placed in the context of a monitoring cycle. The laws and regulations that apply to the amphibians in the area are described, thus founding the need for this research.
The second chapter deals with the study area and shows some maps and descriptions of where and what the national park Kotyhi-Strofylia wetlands are. As well as a brief overview of the area's sub habitats and specifically the qualities and weaknesses of these habitats for amphibians are described.
The next chapter is called methods and here all the aspects of the field work (day and night inventarisations, materials) and the data analysis.
In the following chapter which is called 'Results' the result of this specific research is given which is the current situation and the baseline monitoring. The results of the field work are shown in tables and maps and in the next chapter they are also interpreted in graphs showing whether or not we are dealing with sustainable populations or not. Then some suggestions for management actions are provided.
In the conclusion and recommendations the answer to the research questions are provided a recommendations about continuing the research in the coming years are outlined. Finally in the chapter 'discussion' the methods and some results are questioned and discussed.
The report is concluded with an appendix that contains a plethora of useful background information like the used field form, a map of the 50 sample locations, picture file of the 50 sample locations, description and coordinates of the 50 sample locations and description of the 8 amphibian species in the area.

2. Study area

This chapter deals with the study area. The location of the Kotyhi-Strofylia wetlands is shown on maps and the research area within the national park is outlined. Also the different habitats are introduced and described with specific attention to the requirements for amphibians.

2.1 Location

The study area is the National Park Kotyhi-Strofylia at Kalogria beach (see figure 4) in the Northwestern edge of the Peloponessos in the area of Patras (see figure 3).

Figure 3: Area of Patras in Greece

Figure 4: Kotyhi-Styrofylia wetlands

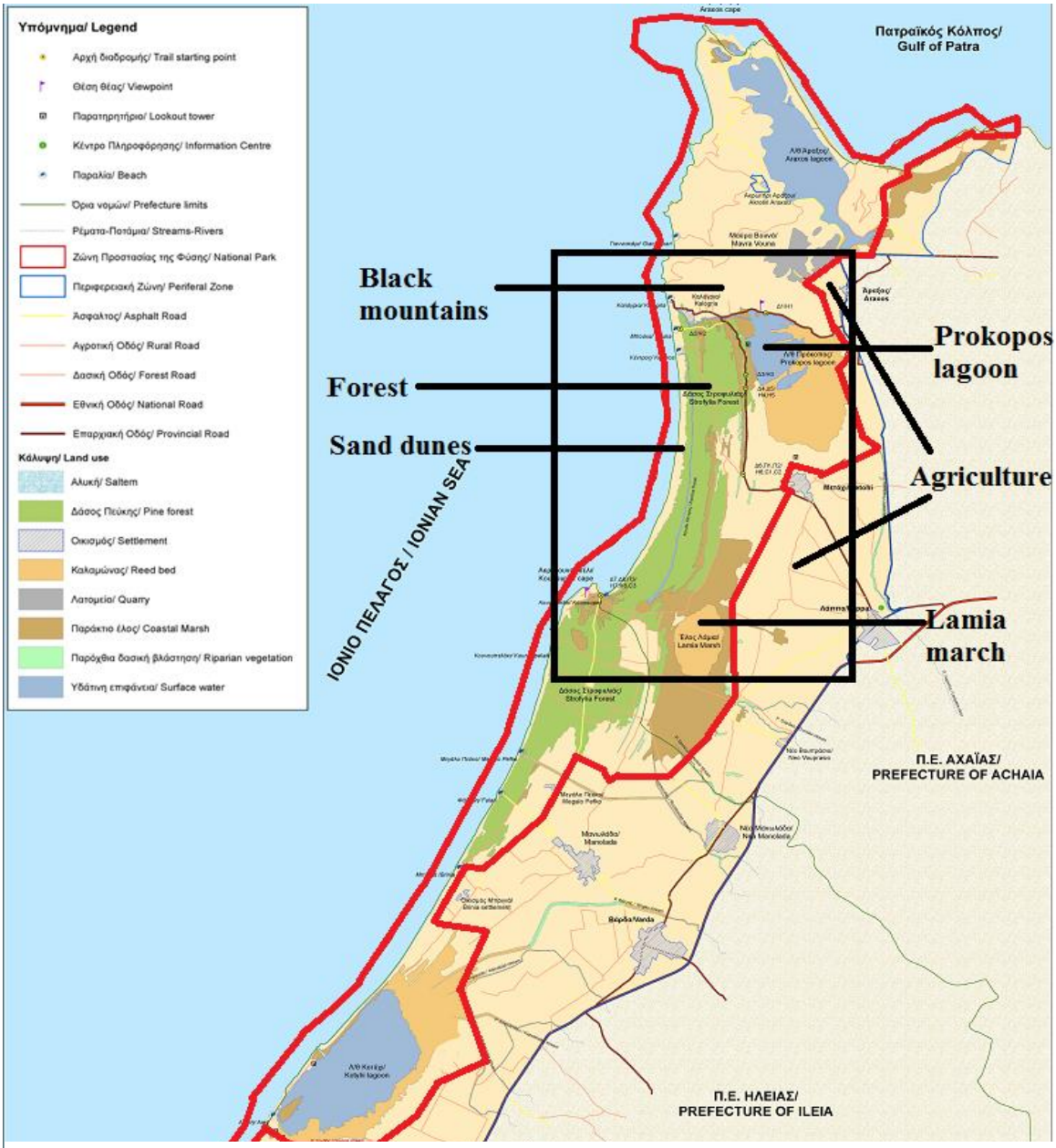

Figure 5: Map of the study area

Within the borders of the national park there are several different habitats that all have different properties to attract different species of amphibian. These habitats are: sand dunes, mountains, forest (*Pinus pinea, Pinus halepensis and Quercus macrolepis*), Lagoons, marshes as well as agriculture. The natural area is protected and is outlined with red lines on figure 5 as zone A. The surrounding agriculture is called zone B. With regards to this specific research an area that has all of this habitats included is selected to research (*see figure 5 for a map of this subarea*). The area is about 1/4 of the whole national park and thus it's about 35 km2 big. With regards to time constraints and realism of this research it is chosen to not investigate the whole national park but rather a smaller, well reachable part that is representative. This area is selected because it contains good quality examples of all of the different sub habitats and is realistic for one researcher to fully investigate with the time and resources constraints of this research (see chapter 3-Methods for further information on the selection).

2.1 Habitat description

Here a description of the six different habitats in the study area is included. These habitats include agriculture, forest, marsh, lagoon, sand dunes and mountains. They all have different qualities for attracting different types of amphibian. All of these habitats are included in the 50 sample locations that are used in this research (*see chapter 3-Methods*).

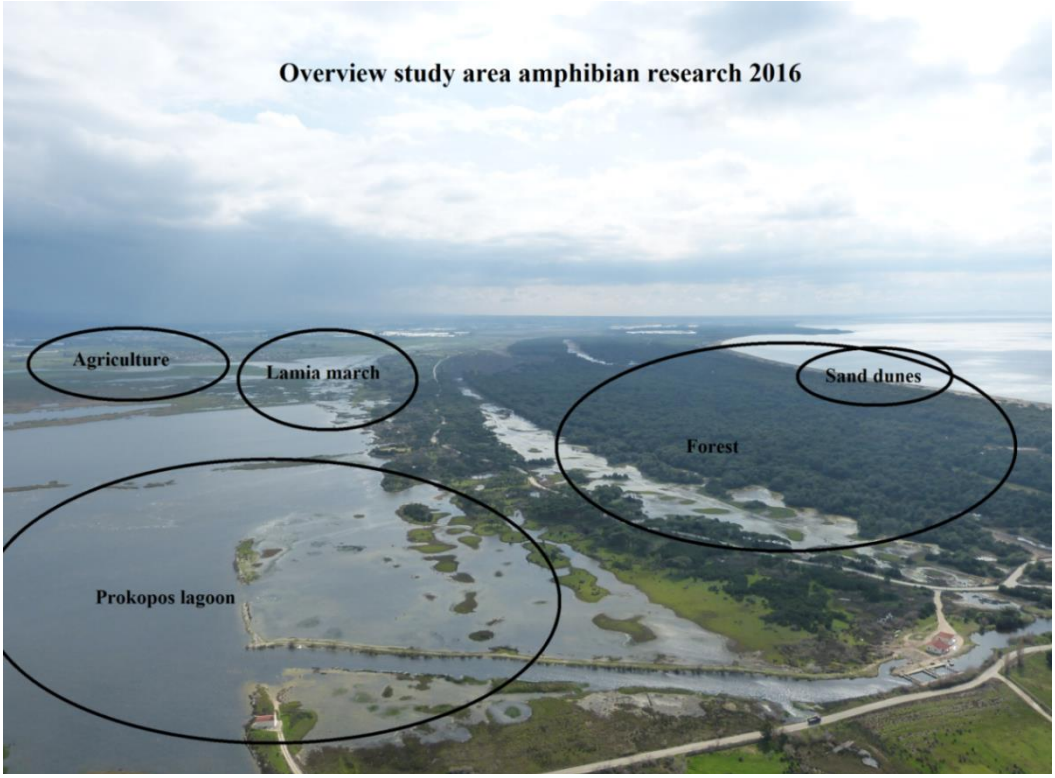

Figure 6: Overview of the research area. Photo: Christiaan Hoogendoorn

In this chapter all the habitat characteristics that are relevant for amphibians are shortly described for all of the six sub habitats present in the Kotyhi-Strofylia wetlands. These requirements indicate the level of research that will be conducted in each of the sub habitats. Habitats that don't fit any of the requirements don't need to be researched a great deal. The aim of this research is to investigate the best quality of the habitats. First and most important is the presence of water. This research focusses on reproductive waters so no water means no need for research beyond the first survey. The period of drought is also notable. When does the water dry up? Do the amphibians have time to reproduce before the drought? Further: waters with high salinity content are not the most suitable for amphibians and that also directly corresponds with the connection it has to the sea. Presence of fish is a big one, fish are big predators on the fragile amphibian larvae so waters without them will be a lot more suitable. Also the size of the water is important. Big, vast water bodies like lakes and lagoons are not going to be as suitable as small closed off ponds because the latter contain less risk and less turmoil. Flowing water is also less suitable than stagnant. And lastly the presence of roads is important since amphibians will need to cross them and that is a risk. In the most ideal circumstances amphibian breeding water bodies are small closed off ponds that contain water throughout all the year, with low salinity content, no fish, no connection to the sea, low depth and stagnant (*deVries, 2016*). See table 2 for an overview of these requirements per habitat.

Habitats	Presence and kind of water bodies during research	Period of drought	Salinity content	Presence of fish	Connection to sea	Size and depth of water (average)	Water stagnant or flowing	Roads around the area (risk)
Black mountains	None	-	-	-	-	-	-	High risk(many dead animals have been found)
Sand dunes	None	Spring and summer	-	High	Yes	-	-	Low risk
Strofylia forest	Closed off ponds and fens	Fens dry up during late spring and summer. Ponds remain.	Low	Fens: low Ponds: none	No, but connection to Prokopos lagoon in flood season	Ponds: 30m2 and 1m depth Fens: 50m2 and 20cm depth	Stagnant	Low risk
Prokopos lagoon	Big lake and small ponds in the edges	Small ponds in edges dry up in summer but new ones form as the lagoon retreats	High	In general high but the small ponds that form in the edges are low.	Yes: through a canal	Large lake of about 1ha and 1.5 m depth. Edge ponds: 30m2, 50cm depth	Flowing	High risk(many dead animals have been found)
Lamia marsh	Large semi-connected water body	Edges dry up during spring and winter and more closed up ponds form.	Low	In general high but the small ponds that form in the edges are low.	No, but connection to Prokopos lagoon in flood season	Marsh: -> 1 ha and 1m depth Ponds in edges: 10m2 and 10cm to 1m depth	Stagnant	Low risk
Agriculture	Manmade ponds for farm hydration	Never	Medium	Low	No	30m2 and 1-5 m depth	Flowing due to pumps	High risk

Table 2: Habitat requirements relevant for amphibians per sub habitat present in the national park Kotyhi-Strofylia wetlands. The habitats are further described below.

Black mountains

The black mountains are a small rocky mountain range in the north part of the study area. They are about 250m above sea-level in elevation and have really steep slopes with a lot of rocks. The vegetation mainly consists of Prygana and bushes as you would expect on dry rocky calcareous substrates with limestone as main substrate (*Georgidanis, 1989*). Characteristic species are *Phlomis fruticosa, Salvia fruticosa, Juniperus phoenicea* as well as Greek endemics like *Centaurea niediri*. There are no water bodies on the black mountains but they border to the Prokopos lagoon and the rocky slopes are a good land habitat for species like *Lissotron vulgaris, Bufo bufo, Pseudepidalea viridis* and *Pelopates syriacus*. The area is very easy to reach as there are good roads around the area and trails in the area. But these same roads are also a high risk to the amphibians for there have been very many young animals found on the road in between the black mountains and Prokopos lagoon.

Figure 7: Black mountains: (photo: Christiaan Hoogendoorn)

Sand dunes

The sand dunes are a small strip of land along the coast with s mean width of about 100m in the western borders of the study area. The area is sandy and flat but the winds contribute to the forming of several sand hills. The vegetation consists of pioneer species like *ammophila arenaria, Pseudorlaya pumila, Oninis variegate* and *Euphorbia paralias*, all species in the *Ammophiletum arenarae* association (*Georgidanis 1989*).

There are no water bodies in the sand dunes except for small fens that are dry throughout most of the year. During the field survey a lot of dried out fens with reed grouwing around them have been found, indicating that the fens had just recently dried up.The mull sandy environment is especially perfect for *Pelobates syriacus* since this species likes to dig itself in the soil. Also *Lissotron vulgaris, Bufo bufo* and *Pseudepidalea viridis* in the land phase are to be expected here. However in the time of this research there was no reason to investigate this area further due to lack of water bodies. The area is well reachable as there are many roads leading to the coast.

Strofylia forest

The forest is the centre of the study area. It contains three main species: *Pinus pinea, Pinus halepensis and Quercus macrolepis.* So there are three habitats within this one habitat as each of

Figure 8: Pond in the forest (photo: Christiaan Hoogendoorn)

these species have their own unique characteristics and species. The *Pinus pinea* forest shrub and herb layer is dominated by *Stripa bromoides, Briza maima, Myrthus communis* and *Pistacia lentiscus*. In the north part the grazing and the farming have destroyed the shrub layer and the herb layer there is dominated by *Asphodelus aestivus*. In the shrub and herb layer of the *Pinus halepensis* the species *Stipa bromoides, Brachypodium sylvaticum, Pistacia lentiscus* and *Myrthus communis*. The forest of *Quercus macropolis* is a remainder of the old forest before human activity (*Orfanou 2016*). The herb layer is dominated by *Asparagus acutifolius, Anthoxanthum odoratum* and *Briza maxima* (*Georgidanis 1989*).
There are several different types of water bodies within the forest. Small closed off ponds (*see figure 8*), swampy fens that dry up during the summer (*see figure 9*) and canals (*see figure 10*). The fens are formed during the winter when the lagoon is flooding and they slowly dry up during the spring and summer (*Orfanou, 2016*). So they contain lagoon water that is also full of high salinity content and fish. However when they start to dry up and become more isolated they mix with the rain water and the amount of fish becomes less. Then they become very suitable for amphibians and a lot of larvae have been found there. However in the start of summer many of those ponds where completely dried up so there is only a small window of opportunity for reproduction.
The isolated ponds deeper in the forest don't dry up and are never connected to the lagoon. Resulting in low salinity content and no fish. They are, however surrounded by trees and thus covered in shade, which makes the water cold and not very suitable for amphibians.
The canal is a means of connecting the sea to the lagoon and it has a very high salinity content and a lot of fish, as well as a high flowing pace. So not very suitable.
All 8 amphibian species are to be expected in the Strofylia forest. Especially *Hyla arborea* and *Rana dalmatina* since those are forest dwelling frogs.

Figure 9: Fen in the forest (photo: Christiaan Hoogendoorn)

Figure 10: Canal in the forest (photo: Christiaan Hoogendoorn)

Prokopos lagoon

The prokopos lagoon is a large lagoon with high salinity content right below the black mountains. Its edges are quite swampy all around and there are large reed beds around. The lagoon is characterized by two mayor aquatic associations, of *Phragmites australis* and *Scirpus maritimus* (*Georgidanis 1989)*.
The whole area is basically a water body. It is a big lake of around 1 hectare large (*see figure 11*) that stays in direct contact with the sea through a canal, thus it'll never dry up. There are a lot of

fish in this area as well as migratory birds that rest and forage here. The large water body is not very suitable for most amphibians but there are a large number of *Pelophylax kurtmuelleri* and *Pelophylax epeiroticus* there. The chorus of their singing is overwhelming when you cycle next to the lagoon.
Especially the small ponds that form around the edges of the lagoon (*see figure 12*) as the water is retreating during spring are very suitable for this research. Expected amphibians are, *Hyla arborea* in the edges, *Bufo Bufo, Pseudepidalea viridis* and *Lisotron vulgaris.* These ponds form in the lagoon edges as the lagoon water retreats. Similarly to the fens in the forest they slowly dry out but become very suitable for amphibians in between because the amount of fish deteriorates and the salinity content drops and it becomes more stagnant and less deep.
The road that borders the lagoon is a problem though since many dead subadult amphibians have been found here.

Figure 11: Prokopos lagoon (photo: Christiaan Hoogendoorn)

Figure 12: Pond forming in the edges of the lagoon (photo: Christiaan Hoogendoorn)

Lamia marsh

The lamia marsh is a big swamp in the south of the study area. It is bordered by the forest, the Prokopos lagoon and agriculture. The associations of *Scirpetum maritimi, scirpetum litoralis, Alismetum and pure populations of Scirpus Maritimus, Eleocharis palustris, Scirpus litoralis* and *Beckmannia eruciformis* are developed (*Georgidanis 1989*). The swampy base of the marsh (*see figure 13*) is always wet but the edges are drying up in summer, leaving only some small ponds in the wet meadows (*see figure 14*). The water flows similarly as in the prokopos lagoon. There is a large water body of about 1 hectare large with small temporary ponds in the edges. The salinity content of the water and the amount of fish, however, are slightly lower than in the Lagoon since there is less connection to the sea. This also results in more stagnant water and more vegetations which in turn results in lower depth. Also there are not a lot of busy roads around the area. Overall the Lamia marsh is quite suitable for amphibians, especially the ponds in the edges.
All 8 species of amphibian are to be expected here.

Figure 13: Lamia marsh (photo: Christiaan Hoogendoorn)

Figure 14: Pond on the edges of the marsh (photo: Christiaan Hoogendoorn)

Agriculture

Then lastly there are the agricultural lands around the protected area (zone B, see figure 4). Here there is agriculture going on in various stages of intensity. From small olive orchards to greenhouses. There are several water bodies in the area varying from irrigation ditches to big man-made ponds also for irrigation (*see figure 15*). The ponds are artificially controlled by pump systems making sure that they never dry out. This also means that the water is not stagnant however. The salinity is low because they are not connected to sea water. Most of them do have some fish but not in great amounts. The water is very deep however so the temperature is quite cold. Lastly, there are a lot of busy roads in this area. There are also a few ponds that are no longer in use and they were of excellent quality for amphibians, a good example of this is pond 45 (*see overview in appendix 4*). This is because those ponds have stagnant water and are drying up so that the fish die out.

Expected species are *Bufo bufo*, *Pelophylax kurtmuelleri*, *Pelophylax epeiroticus* and *Hyla arborea*.

Figure 15: Man-made pond in the agricultural land (photo: Christiaan Hoogendoorn)

3. Methods

In this chapter the methodology for collecting data and processing data are described so that further investigation can replicate the research. This chapter is build up in three chapters, each of them explaining the methodology used to answer one of the research questions. The first research question deals with where and which species are living in the area. This research works with 50 sample locations that have been selected after a large field survey in the whole area. Then the field work is outlined. Every location is visited three times, two times at day and once at night and monitored according to the standard EPMAC method. The materials needed for the field work are also laid out. Then, for the second research question the methodology for the data analysis is presented. How the habitat is analysed and how can be determined whether the populations of amphibians in the area are sustainable at this moment. Lastly the methods used for determining what the management can do to improve are explained.

3.1 Research question 1: What species live where and in what amounts?

3.1.1 Sample locations

The first step is to determine which locations to sample. To do that there has to be a good understanding of the whole study area. Therefore upon arrival in the area the first two weeks were spend investigating the area. Each of the six habitats present in the area as described in chapter 2 was intensively visited. Both on foot, by bike as well as with jeep. The management team of the Kotyhi-Strofylia wetlands was very helpful in driving me around and taking me on their excursions. The aim of this first field survey was to get insight in all of the different habitats in terms of structure, flora, fauna, management, threats and quality. From this survey an area that contained good quality examples of all the habitats was selected to further investigate. This research area is shown on figure 5. The most important reason for scaling down the research area is the fact that there was only one researcher with limited means of transportation and with only two months' time conducting this research so it would have been

Figure 16: selected water bodies

unrealistic to survey the whole national park. This smaller research area is however an excellent sample and the findings of this research say something about the whole area.
Special focus during the field survey, obviously, was on the relevant habitat information regarding amphibians. So water bodies and land habitats were looked for. All the water bodies in the area where visited and inventoried and some transects on land were walked in order to try to find adult amphibians in land phase. From this inventory a selection of 50 sample locations were selected. This selection aims to represent the most suitable locations for amphibians in the area.
The selection is based on the amphibian activity observed and aims to include all the different habitats in the study area as described in chapter 2. In general the types of water bodies in the area are: marsh, pond, fen and lagoon. So ten of all these were included in the selection, leaving room for 10 more locations that seem to be of especially high quality for amphibians. These last 10 were selected if a striking amount of amphibian activity was observed or if the pond looked to be of perfect quality (isolated, shallow, low salinity, no fish). Also all the habitats were evenly represented in the selection. In this way the selection is a representation of all the best quality and diversity of the habitat in the area. Many of the selected waters happen to be close to the roads but that is because large areas (north and south of Metochi on the map) are big lakes and swamps and therefore not suitable for amphibians. Way more interesting are the edges of these big lakes and especially the isolated ponds that form in the edges and those happen to be close to the roads.
See figure 16 GIS map with the chosen 50 locations for monitoring and appendix 2 for a more detailed and bigger map and for a description as well as pictures of the sample locations see appendices 3 and 4.

3.1.2 Field work

Field work for this research happened during March, April and May of 2016. This time of year was chosen to include all the species reproductive periods as described in table 1. The fieldwork after selecting the 50 sample locations consisted of sampling those selected locations two times during daytime and one time during night-time. The method used here is the standard EPMAC method. This method is the method used by all the other EPMAC projects and I did not see any pressing reason to change that for this research. This method places primary importance on the locating of larvae. Because this gives information on breeding success of amphibians and thereby also of the quality of aquatic habitat (*Briggs, 2006*). Sightings of larvae says much more about the quality and sustainability of amphibian populations and their habitats than sightings of adults since those adults could just be moving without any intention of staying. Also it's much harder to get a full count of all the adults living in the area while catching larvae is relatively easy (*deVries, 2016*). The EPMAC method is a proven method that has been used in countless monitoring in several countries across Europe.

First day sample

The first visit is used to describe and photograph the site as well as note all the species that are visible on sight. The location is photographed and the coordinates are determined. Then the basic vegetation structure is noted with the most dominant species and the percentage of cover, both in the aquatic, shrub, herb and tree layer. Special attention to the presence of shade from surrounding trees. Furthermore the pond type is noted and the surroundings and size as well as depth of the pond. This data can be compared with future data to monitor changes in the area. Also visible conservation threats are noted such as pollution, intensification of agriculture, roads, fish or shrimps in the water or signs drying up of the water. This data will be used for the

analysis. Additionally, changes in vegetation and\or water level in the future can be compared with the data of this year. This will be helpful in future years. All this data is filled in on the field form that is included in appendix 1. Then a short investigation to signs of amphibian life is done, this means looking for adults with the naked eye or listening to sounds as well as looking for eggs. Eggs are fragile so they are searched and determined on sight before entering the water. Contact with the eggs is avoided as much as possible after they are located. This way the disturbance of eggs is kept to a minimum. Also sightings of reptiles are noted as 'other species'.

Second day sample

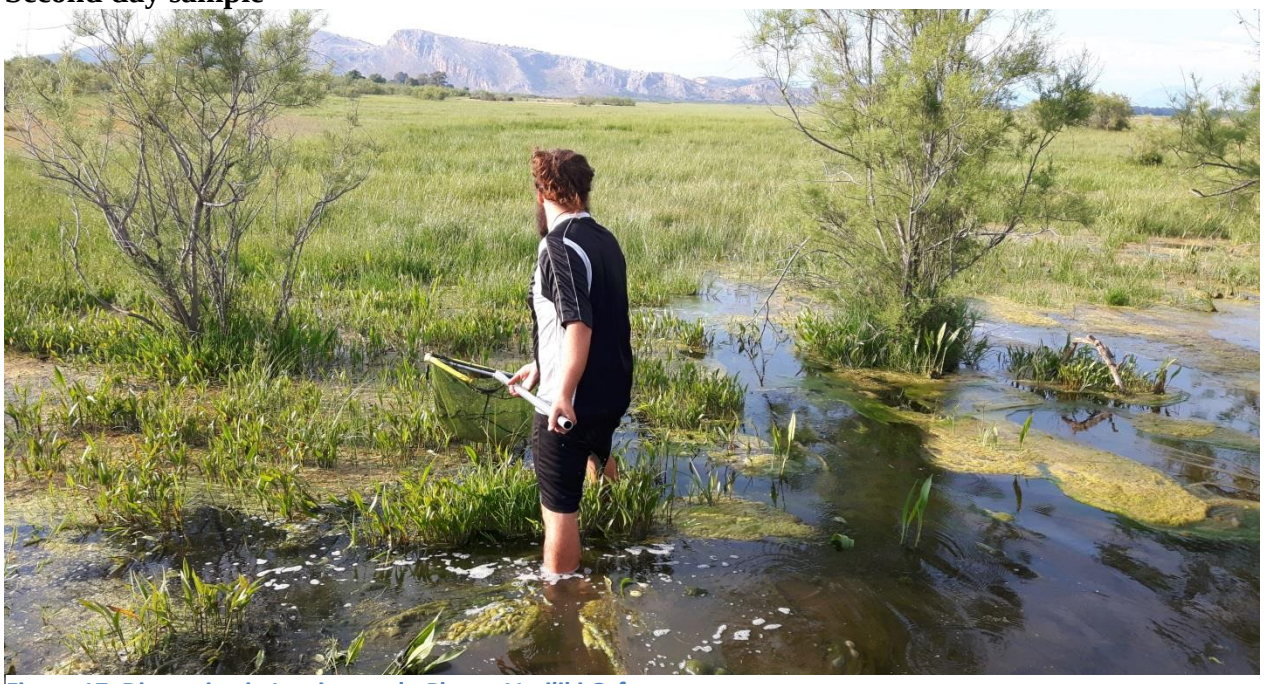

Figure 17: Dipnetting in Lamia marsh. Photo: Vasiliki Orfanou

During the second day visit the water body is inventoried with dipnetting according to the standardized EPMAC method. In general 10 sweeps are made at every sampling site. 5 dips in the shore area of the water, followed by 5 dips in the deeper area. Very small waters (less than 3 m2) will have less sweeps adapted to the size of the water surface. One half of these waters will be sampled so that not every part of the pool will be disturbed. This will give enough data to estimate the size of the population. No animals will be collected and every content of the net will be released in the same water. The dips are 1m long and go into the moving water if the water is not stagnant. There is a 5m interval in between every dip. Each caught individual in every different life stage is counted and noted on the field form and each species photographed.
The big connected water bodies like lagoons and marshes are monitored by walking transects of 50m along the shore and straight into the water and doing about one sweeb every 5 meters.
There are also three sample locations that don't have water. These are rocky slopes on the black mountains because they represent a excellent land habitat. These will be investigated by walking transects of 100m and 10m broad upwards the slope of the mountains. All large rocks along the transect lines will be picked up to look for amphibians in land phase.

Night sampling

During the night round adult amphibians are searched with flashlights and looked for on sound. This is necessary because some amphibian species are active around and after sunset. The calling of adult amphibians can give a good impression of population sizes and migrating amphibians can also give an insight in the migration routes. Species and numbers will be estimated on sight and sound. Transects in the waters are walked (a line of 100 meters along the shore or straight into the swamp or lake).

Every location, every species in every life stadium is photographed on location.

Materials:

- Bicycle for transportation
- Permits for entering the Natural Park of Kotychi – Strofylia Wetlands
- Permits for catching amphibians
- List with important telephone numbers
- Field forms (and pen)
- Notebook
- Waders
- Dipnet (RAVON type net, 50 cm wide)
- Garmin GPS
- Flashlights
- Camera
- Cuvet

Figure 18: All the research materials (photo: Christiaan Hoogendoorn)

3.2 Research question 2: Are the populations sustainable?

To answer the second research question a data analysis has to be conducted. The data analysis consists of coherently organising the field data in tables, graphs and maps. Programs used for this purpose are excel and GIS. Then, after the field data has been organized it has to be interpreted in order to be able to answer the question whether the current situation of amphibian populations is sustainable. However it has to be stated that making any assessments on sustainability of populations is very hard, almost impossible, especially after only one year of monitoring. That being said, there are two methods used in this research that can give some indications on the topic, but the research has to be repeated in order to make any definite statement. Those two methods are described below. The results are found in chapter 4.2.

FRP – Counting adults

The most well-known method for determining population quality is FRP (Favorable Reference Population). FRP is defined as: population in a given biogeographical region considered the minimum necessary to ensure long term viability of the species (Ottenburg, 2014). The FRP has to be large enough to ensure long term viability of the species and also to guarantee geographical dispersion of the species. Taken into account is both the scale of the subpopulation (population of a species in one serried area) as well as metapopulations (several spatially separated populations that interact at some level). The FRP is determined by extensive research in genetic processes and the so called population viability analysis witch take into account factors like environmental disasters and human influence. From these methods the general rule of thumb that a subpopulation of vertebrates has to contain at least a 1000 adult individuals to be viable and that metapopulations need at least six of these subpopulations of at least a 1000 adults in an area the size of the Netherlands (*Ottenburg, 2014*). But within the context of this research only the subpopulation of the Kotyhi-Strofylia wetlands is looked at. So for this method all the adults have to be counted and if there are a 1000 or more this is a clear indication that the species is doing well.

It is, however, quite clear after only a brief glance on the results that there are no 1000 adult individuals of any species caught in this research. The EPMAC method focusses more on determining quality of habitat through larvae detection and did not aim to provide a total count of all individuals in the area. Therefore the FRP method is not sufficient for this research, see the chapter discussion for more on the topic.

EPMAC - Rating the reproductive waters

A different approach of determining the sustainability of the populations is looking at the availability, distribution and apparent quality of reproductive waters. Observations of adults are obviously very important as they are necessary for genetic variation and have a higher rate of survival than larvae. However there are multiple reasons why focusing of larvae is a better method for determining population quality. First of all adult amphibians are harder to find because they live sheltered life in their land phase and only live visible during the reproductive period while larvae are easy to find with dip netting on the right places at the right times. An observation of a larvae tells the story of reproduction and therefore suitable habitat while an observation of an adult does not necessarily indicate a suitable habitat. In the end the sustainability of amphibian populations is determined by their ability to procreate (deVries, 2016).

To find this out all the sample locations are rated on availability of larvae and the results put in graphs for each species. Basically the amount of larvae present in the sample location correlates directly with that waters quality and also with the amount of adults that must be present in the area. For this research a rating system from 0 to 3 was conceived, 0 indicating bad quality and 3 indicating high quality. This system is explained in table 3. There was the need for a rating like this to make comprehensive graphs. If the total amount of larvae per sample location would have been put to graph then some location would have to display hundreds of larvae while others had only a few. Those small ones wouldn't even be visible on the graph then, hence the choice for a rating like this. For the graphs per species see chapter 4.2.

Rating	Description	Explanation
0	No activity	If a species is not found at all in a sample location that locations is rated with value 0 for that particular species, which means that there is no amphibian activity and also definitely no reproductive activity in this sample location.
1	Low quality	If only adults or just a small amount of larvae (1-10) are found than it's rated with value 1 meaning 'low quality'. If adults are there than that indicates that they are at least investigating the location and that it might be a successful location in the coming years. If there are a few larvae present than that shows that reproduction has happened in small scale but it is too early to say if it was successful.
2	Average quality	If in between 10 and a 100 larvae are found the location is rated with a 2 meaning average quality. The presence of this amount of larvae indicates that the location is used with some success for reproduction but it's not stellar, hence the average rating.
3	High quality	If more than a 100 larvae are found the location is rated with a 3 meaning high quality. When these number show we can safely say that the location is used with great success to reproduce and thus also is of high quality.

Table 3: Rating system for the quality of the sample locations for amphibians.

Then all these ratings are put together and we can see how many suitable locations there are per species. If there are less than ten locations with a rating and none with high ratings then we can indicate that the populations are not sustainable with the data of this research. This is because a sustainable population needs a spread of metapopulations (*Ottenburg, 2004*). If there are only one or a few locations with high quality than they have no recourse and one disaster on that one suitable place can wipe out the whole population. We need at least 10 strong metapopulations to constitute a sustainable population.

So there are 2 components to the EPMAC method:

1. When there is a lot of activity observed in a sample location then that indicates a better quality then if there is no or a little activity.
2. When there are multiple locations with amphibian activity than that indicates a better quality of the population than if there are only a few. At least 10 sample locations with a rating of at least 1 for each species within the 50 sample locations will give an indication that the species in sustainable.

This afore mentioned method was conceived for this specific research and is a modification of the EPMAC method. In EPMAC statements about sustainability are usually only made after several years of monitoring (*de Vries, 2016*) but for this research there was the need to give some indications already after one baseline monitoring.

3.3 Research question 3: What can management do?

For the third and final research question there is a need to look at the qualities and weaknesses of the area for each of the different amphibians. In the first and second research question we already looked at which species live where and if there is an indication if their populations are going well. Is this third part of the research we try to find out what the management can do to conserve the ones that are doing well and to improve upon the ones that aren't doing so well.

There are two parts to this. The first step is to find out what the management is already doing. The methodology to find that out is to interview several members of the management team on the subject and to join them on their field work. How does the management uphold the laws that apply for the amphibians? What policy did they develop? Which management cycle do they abide by? Part of this also is a literature study that aims to provide background to the research like information about the target species, monitoring methods and management plans from other areas. The management body of the Kotyhi-Strofylia wetlands has been very helpful in explaining the management as well as providing reports, monitoring data and other useful information about the area.

The second step is investigate the area to get a clear view on the qualities and weaknesses in the area are. In other words: what should be preserved and what can be improved? To find this out a habitat analysis has to be conducted that focusses on the specific habitat requirements and threats visible on each on the 50 sample locations. This habitat analysis is the first day sample as described in chapter 2.1.2 Field work. Things that are specifically looked at are: presence of fish, whether ponds are closed off from larger water bodies and thus are more stagnant, roads nearby, salinity content of the water and is the ponds seem temporary. See appendix 1 for the field form used and table 2 in chapter 2.2 for a global description of these factors of the area.
Then this information per sample location is organized in graphs and compared to the results of the monitoring and the sustainability assessment to get an overview of which location with which properties constitutes a quality or a weakness. For example if all the locations where presence of fish is rampant happen to be low quality for amphibians then we can formulate presence of fish as a weakness. Then some management suggestions can be laid out in the recommendations of this report to improve upon these weaknesses.

4. Results

In this chapter the results of this research are given. The three subchapters correspond with the three research questions from chapter 1.3.

4.1 Baseline monitoring

The first monitoring lays the foundation for the monitoring and management plan and answers the question: 'what do we have right now?' or 'what is the present situation?' This is the first step of the three step program that is the basis of nature management (and all of life): 'What do I have?', 'What do I want?' and 'How do I get what I want?' Only when this step is taken we can start evaluating our goals and thinking about measures to take (see figure 2). The results are summarized down below in tables and visualized in distribution maps. For each species the following information is provided: the water bodies in which the species is found and information about this water body, the amount of individuals per water body and the total amount. These numbers include both adults, sub adults and larvae and is the result of the two day surveys and the night survey. Only caught individuals have been counted so the many sound observations have just been written down as 'calling' without a number. The larvae of the *Pelophylax* species are not distinguishable, so they have been written down together as *Pelophylax* larvae spec in the table for *Pelophylax* epeiroticus. Also for each species a map showing the presence in the area is included. For pictures of the sample locations, a more detailed map, a description and coordinates see appendices 2, 3 and 4.

Table 4: Lissotron vulgaris

Sample location	Type	Life stage	Amount
1	Rain pond	Adult	1
17	Rain pond	Larvae	5
40	Marsh	Larvae	2
45	Agriculture pond	Larvae	+- 1000
46	Marsh	Larvae	8
49	Marsh	Larvae	1
Total: 6			1017 Adult: 1 Larvae: 1016

Table 5: Bufo bufo

No data			

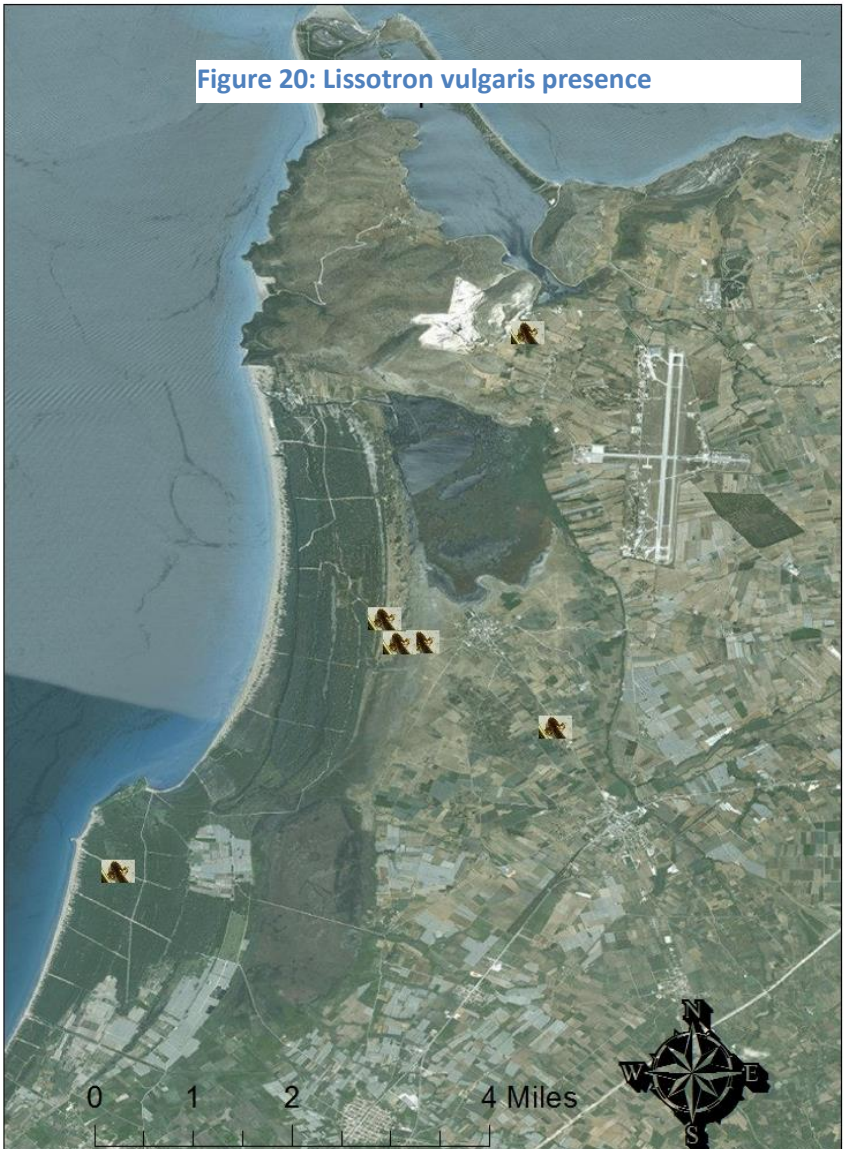

Figure 20: Lissotron vulgaris presence

Table 6: Pseudepidalea viridis

Sample location	Type	Life stage	Amount
12	Marsh	Larvae	38
13	Marsh	Larvae	15
19	Lagoon edge	Larvae	58
21	Fen	Adult	5
22	Rain pond	Adult	1
23	Lagoon	Adult	1
		Juvenile	1
27	Fen	Adult	10
31	Lagoon edge	Juvenile	1000
33	Transect	Adult	5
34	Transect	Adult	3
35	Transect	Adult	1
41	Agriculture pond	Adult	1
43	Agriculture pond	Larvae	1
Total: 13			1140 Adult:27 Juv:1001 Larvea:112

Table 7: Hyla arborea

Sample location	Type	Life stage	Amount
2	Cattle pond	Adult	5
9	Marsh	Adult	3
		Larvae	12
16	Fen	Adult	1
17	Rain pond	Larvae	10
18	Cattle pond	Adult	8
19	Lagoon edge	Juvenile	8
27	Fen	Adult	1
28	Rain pond	Larvae	1000
40	Marsh	Larvae	28
46	Marsh	Larvae	3
47	Marsh	Juvenile	1
48	Marsh	Juvenile	1
49	Marsh	Larvae	3
50	Marsh	Larvae	2
		Juvenile	1
Total: 14			1087 Adult:18 Juv:11 Larvea: 1058

Figure 21: Pseudepidalea viridis presence

Figure 22: Hyla arborea presence

Table 8: Pelophylax epeiroticus

Sample location	Type	Life stage	Amount
1	Rain pond	Adult	5
2	Cattle pond	Adult	21
3	Salt marsh	Adult	Calling
4	Marsh	Adult	12
		Pelophylax larvae spec	28
5	Marsh	Adult	10
		Pelophylax larvae spec	8
6	Marsh	Adult	18
		Pelophylax larvae spec	25
7	Marsh	Adult	20
		Pelophylax larvae spec	174
8	Marsh	Adult	28
		Pelophylax larvae spec	118
9	Marsh	Adult	18
		Pelophylax larvae spec	43.
10	Rain pond	Adult	13
		Pelophylax larvae spec	4
11	Marsh	Adult	46
12	Marsh	Adult	8
13	Marsh	Adult	28
14	Marsh	Adult	38
		Pelophylax larvae spec	8
15	Marsh	Adult	20
		Pelophylax larvae spec	23
16	Fen	Adult	8
17	Rain pond	Adult	10
18	Cattle pond	Adult	18
19	Lagoon edge	Adult	8
		Pelophylax larvae spec	1
20	Fen	Adult	33
21	Fen	Adult	15
22	Rain pond	Adult	Calling
23	Lagoon	Adult	18
		Pelophylax larvae spec	113
24	Lagoon edge	Adult	5
25	River	Adult	95
26	Fen	Adult	6
		Pelophylax larvae spec	88
27	Fen	Adult	28
28	Rain pond	Adult	10
29	Lagoon edge	Adult	10
		Pelophylax larvae spec	105
30	Lagoon edge	Adult	5
31	Lagoon edge	Adult	4
32	Lagoon	Adult	15

Table 9: Pelophylax kurtmuelleri

Sample location	Type	Life stage	Amount
1	Rain pond	Adult	Calling
2	Cattle pond	Adult	15
3	Salt marsh	Adult	Calling
4	Marsh	Adult	Calling
5	Marsh	Adult	Calling
6	Marsh	Adult	Calling
7	Marsh	Adult	Calling
8	Marsh	Adult	Calling
9	Marsh	Adult	Calling
10	Rain pond	Adult	5
11	Marsh	Adult	11
12	Marsh	Adult	12
13	Marsh	Adult	Calling
14	Marsh	Adult	Calling
15	Marsh	Adult	16
16	Fen	Adult	Calling
17	Rain pond	Adult	Calling
18	Cattle pond	Adult	Calling
19	Lagoon edge	Adult	10
20	Fen	Adult	25
21	Fen	Adult	Calling
22	Rain pond	Adult	Calling
23	Lagoon	Adult	11
24	Lagoon edge	Adult	Calling
25	River	Adult	75
26	Fen	Adult	Calling
27	Fen	Adult	Calling
28	Rain pond	Adult	Calling
29	Lagoon edge	Adult	Calling
30	Lagoon edge	Adult	8
37	Lagoon	Adult	99
38	Lagoon edge	Adult	Calling
39	Agriculture pond	Adult	Calling
40	Marsh	Adult	Calling
41	Agriculture pond	Adult	Calling
42	Agriculture pond	Adult	11
43	Agriculture pond	Adult	Calling
44	Agriculture pond	Adult	Calling
45	Agriculture pond	Adult	Calling
46	Marsh	Adult	Calling
47	Marsh	Adult	Calling
48	Marsh	Adult	Calling

36	Lagoon edge	Adult	20		49	Marsh	Adult	Calling
		Pelophylax larvae spec	95		50	Marsh	Adult	Calling
37	Lagoon	Adult	119		Total: 47			Adult: 285
		Pelophylax larvae spec	98					
38	Lagoon edge	Adult	30					
39	Agriculture pond	Adult	41					
		Pelophylax larvae spec	20					
40	Marsh	Adult	10					
41	Agriculture pond	Adult	25					
42	Agriculture pond	Adult	20					
43	Agriculture pond	Adult	35					
		Pelophylax larvae spec	1					
44	Agriculture pond	Adult	5					
45	Agriculture pond	Adult	15					
		Pelophylax larvae spec	1000					
46	Marsh	Adult	15					
		Pelophylax larvae spec	25					
47	Marsh	Adult	13					
		Pelophylax larvae spec	4					
48	Marsh	Adult	21					
		Pelophylax larvae spec	8					
49	Marsh	Adult	15					
		Pelophylax larvae spec	12					
50	Marsh	Adult	2					
		Pelophylax larvae spec	15					
Total: 47		Larvea: Adult:	3081 959					

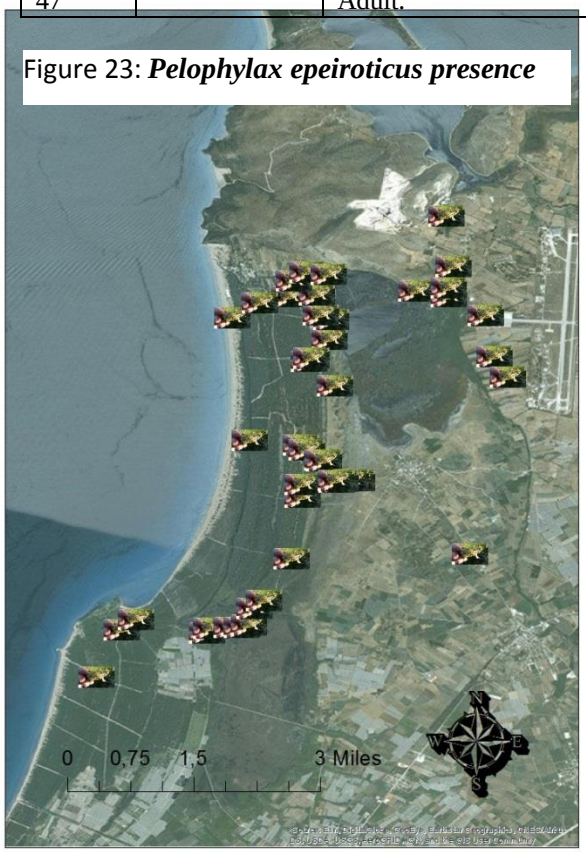

Figure 23: ***Pelophylax epeiroticus presence***

Figure 24: ***Pelophylax kurtmuelleri presence***

Table 10: Rana dalmatina

Sample locations	Type	Life stage	Amount
1	Rain pond	Adult	1
10	Rain pond	Larvae	2
15	Marsh	Larvae	15
Total: 3			18 Adult: 1 Larvea: 17

Table 11: Pelobates syriacus

Number	Type	Life stage	Amount
46	Marsh edge	Larvae	1
49	Marsh edge	Larvae	1
Total: 2			Larvea: 2

Figure 25: Rana dalmatina presence

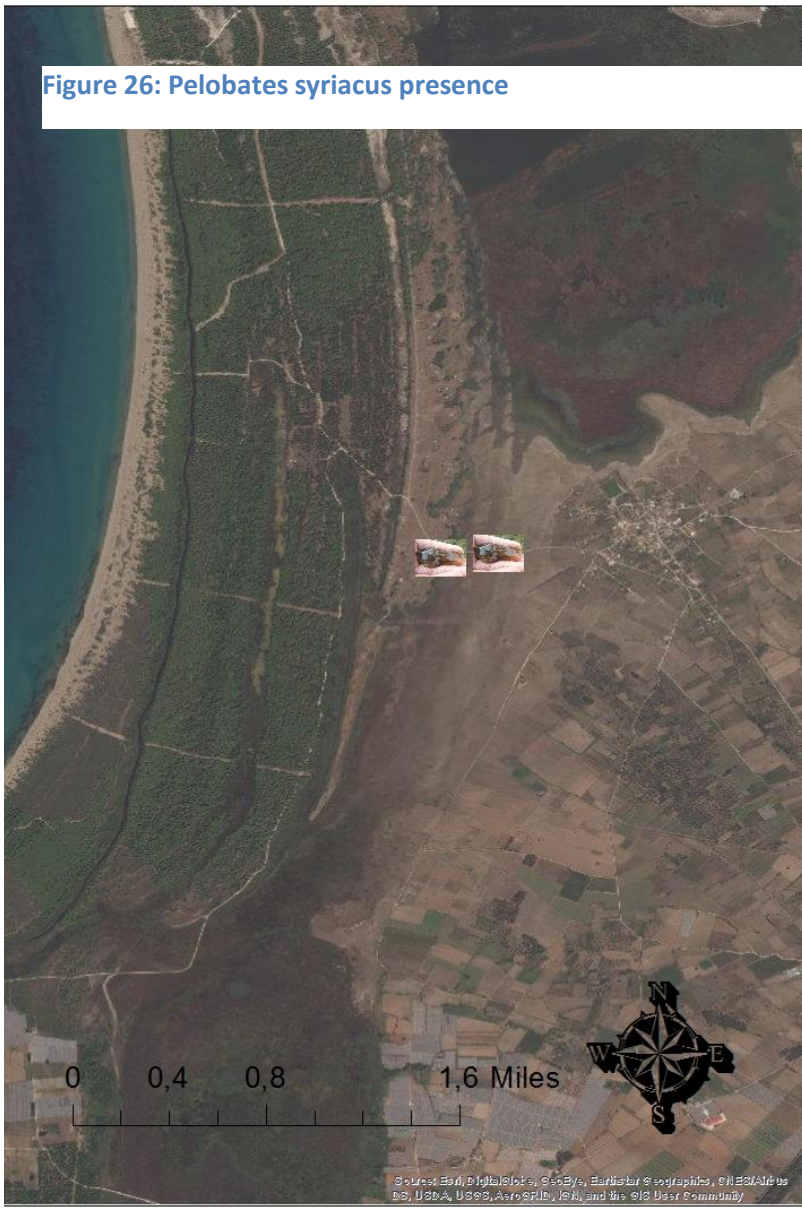

Figure 26: Pelobates syriacus presence

Description of the distribution maps
In this section the distribution maps are shortly described for each species,

Lissotron vulgaris: this species has been found on a total of 6 locations. One of them: number 45 shows a striking amount of larvae found while the other 5 show only low numbers. Table 4 and figure 20.

Bufo bufo was not found in the area.

Pseudepidalea viridis was found in 13 locations with one strikingly high amount of juveniles. For the rest it was generally found in low numbers. It primarily resides in forest areas and for land habitat in the mountains region. Table 6 and figure 21.

Hyla arborea: found in a total of 14 locations in generally low numbers but with a few large numbers. Quite a lot of adults being observed. Only found in forested areas. Table 7 and figure 22.

Pelophylax epeiroticus and Pelophylax kurtmuelleri were both found all across the area in large numbers. The larvae of this species are indistinguishable from each other so all the larvae of the two species together are put in table 8 while table 9 only includes the adults from P.kurtmuelleri.

Rana dalmatina was observed on three locations but in low amounts, all in forested areas. Table 10 and figure 25.

Pelophylax syriacus was found only in two locations and in very low amounts. Both times in marsh edges. Table 10 and figure 26.

4.2 Sustainability assessment

In this section the results of the baseline monitoring are organized in such a way that they show some indications on sustainability of the individual species according to the 2 methods as described in chapter 3.2. However it has to be said again that it's hard to make any statements about sustainability of amphibian populations with just one year of monitoring. More research is needed. It is possible, however, to give some indications whether the populations seem sustainable or not in the year this research was conducted.

FRP
In this method we look at the number of adult individual's caught in the area.

Species	No of adults
Lissotron vulgaris	1
Pseudepidalea viridis	27
Hyla arborea	18
Pelophylax epeiroticus	959
Pelophylax kurtmuelleri	285
Rana dalmatina	1
Pelophylax syriacus	0

Table 12: Adults caught in the research area

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With this method we rate the sample locations on quality for reproduction based on how well they are used by amphibians. See chapter 3.2 for the methodology. A value of 0 indicates no quality, a value of 1 indicates low value, a value of 2 indicates sufficient quality and a value of 3 indicates high quality. And if a species has 10 or more reproductive waters it is deemed to indicate a sustainable population. How these values are determined is explained in the section 3.2 in chapter methods. The pond numbers used in the graphs correspond with the 50 sample locations so more information about them can be found in appendices 2, 3 and 4 and in 4.4.1. The graphs are discussed in chapter 5 discussion.

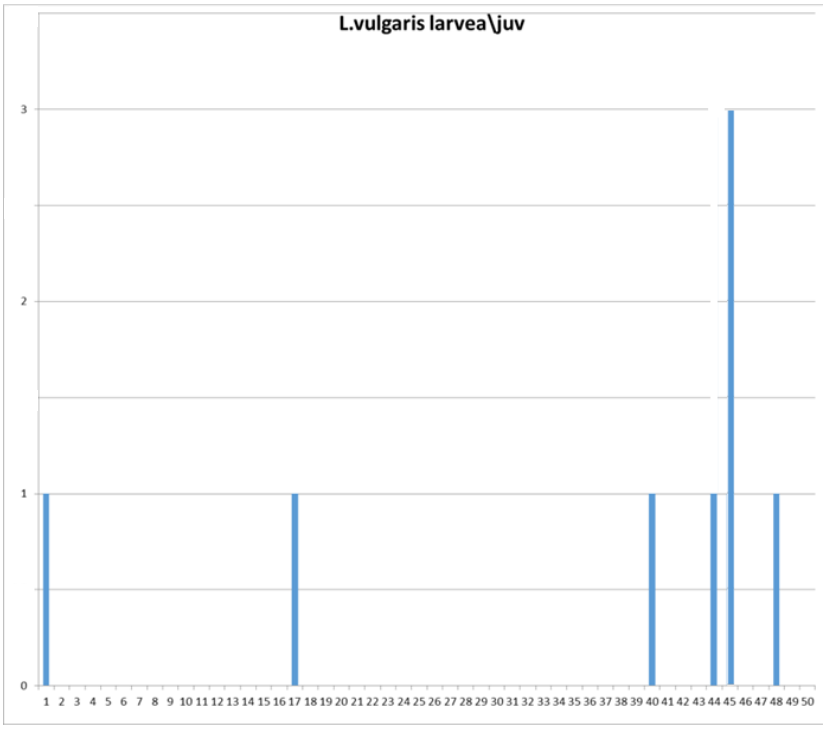


Figure 27: *Lissotron vulgaris* reproductive waters quality

The *lissotron vulgaris* is observed in six locations. Only one of which is rated with high quality.

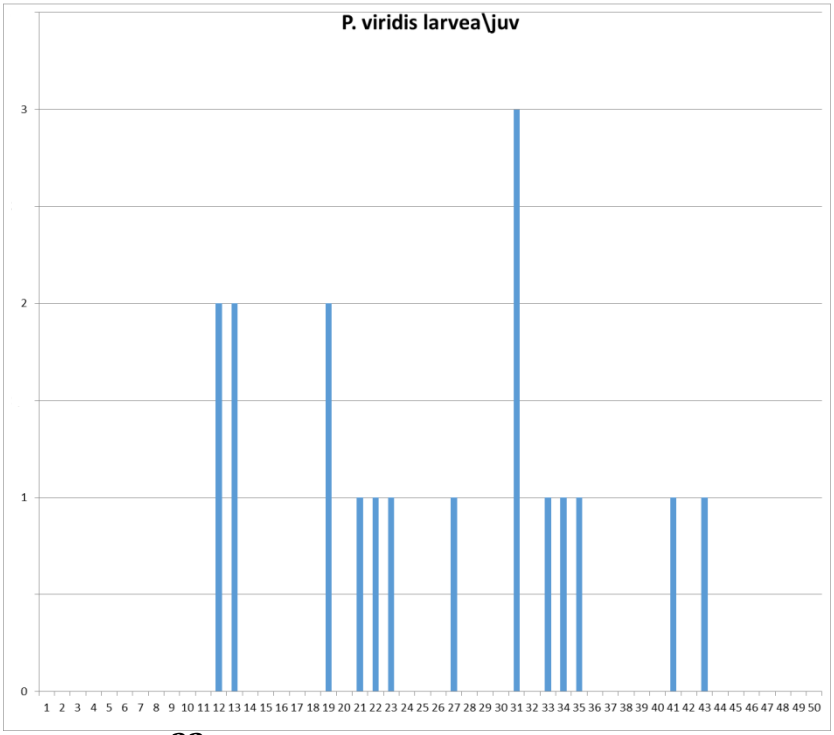
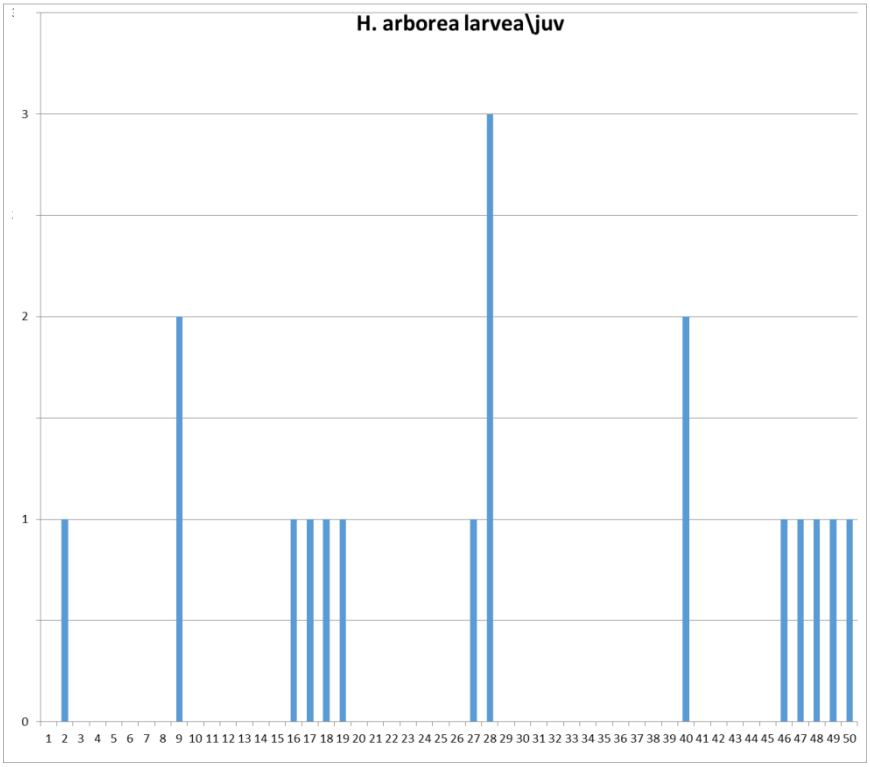


Figure 28: Pseudepidealis viridis reproductive water quality

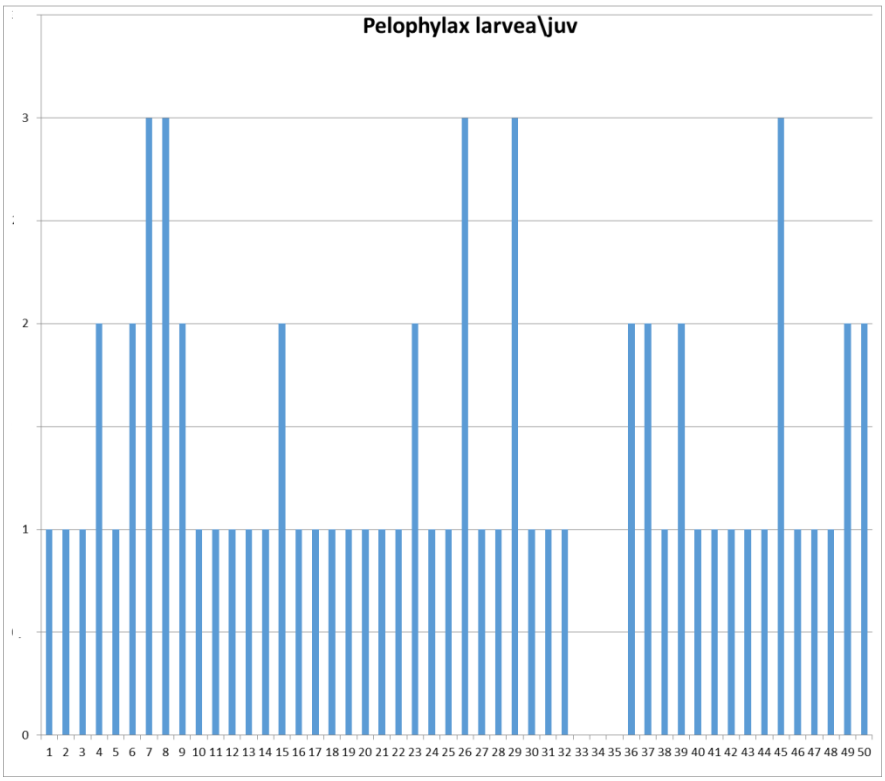
Of the 13 locations that *Pseudepidalea viridis* has been observed, only one was rated with high quality. Three were rated with medium quality and the rest low.

Figure 29: Hyla arborea reproductive waters quality



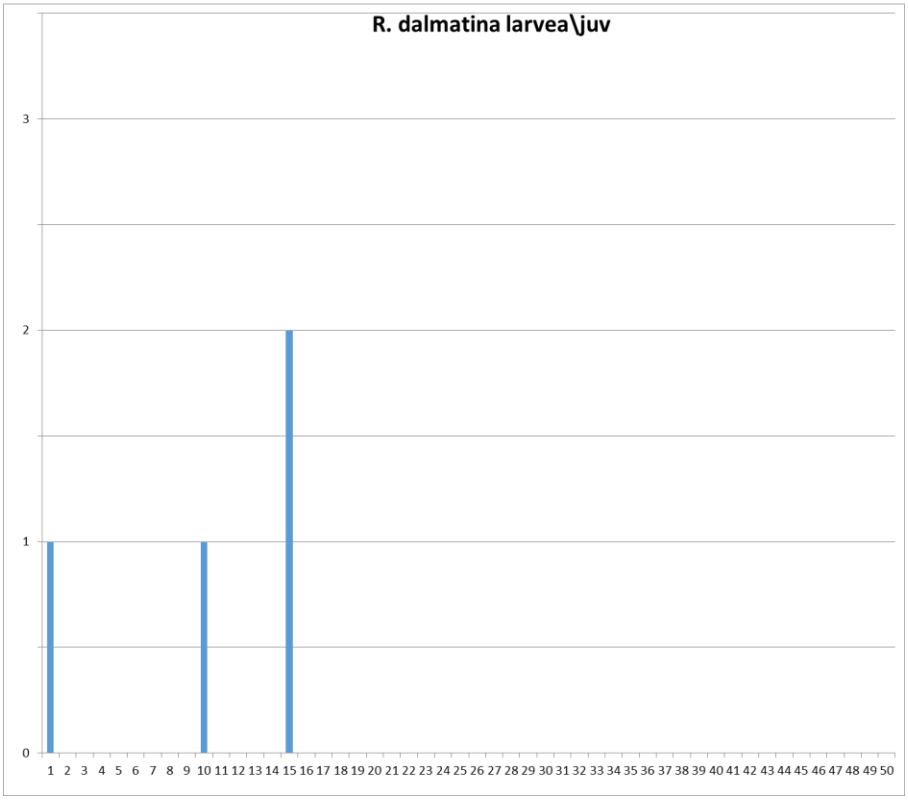
Hyla arborea has been observed on 14 locations, one of which was rated with high quality, two medium and the rest low. The distribution is spread fairly evenly across the area.

Figure 30: Pleophylax spec reproductive waters quality



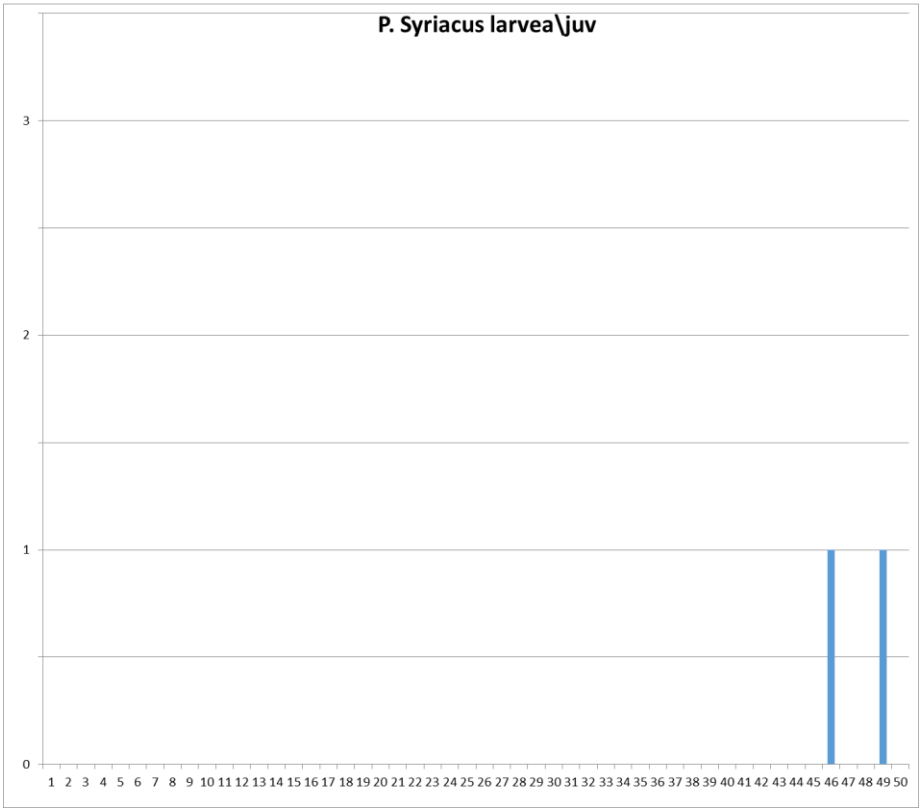
The *Pelophylax* species were observed in 47 of the sample location (all the water bodies). So this species is all over the place. 5 locations were rated with high quality, 10 medium and the rest low.

Figure 31: Rana dalmatinas reproductive waters quality



Rana Dalmatina was observed in three sample locations, one of which was rated with 2 and the others with a 1.

Figure 32: Pelobates syriacus reproductive waters quality



Pelophylax syriacus was observed in only two location. Both in the edges of lamia marsh. Both instances are rated with low quality.

4.3 Qualities and weaknesses

In order to find out the answers to the question: What can management do to protect, conserve and\or improve the populations of amphibians? We need to have a clear overview on the qualities and weaknesses of the area. We need to look at the 50 sample locations and assess them on their quality with regards to amphibian relevant habitat information. We can then compare that information to the results in 4.2 to get an overview of the properties of locations that had favourable quality and those of low quality and then formulate some management suggestions, see chapter 7 recommendations. See chapter 2.2, table 2 for a global overview of amphibian relevant habitat factors. See appendix 3 and 4 for relevant data per each individual sample location and chapter 3.3 for more information on the methodology. Down below are included graphs that put the 50 sample locations against relevant habitat information.

Figure 33: Presence of fish

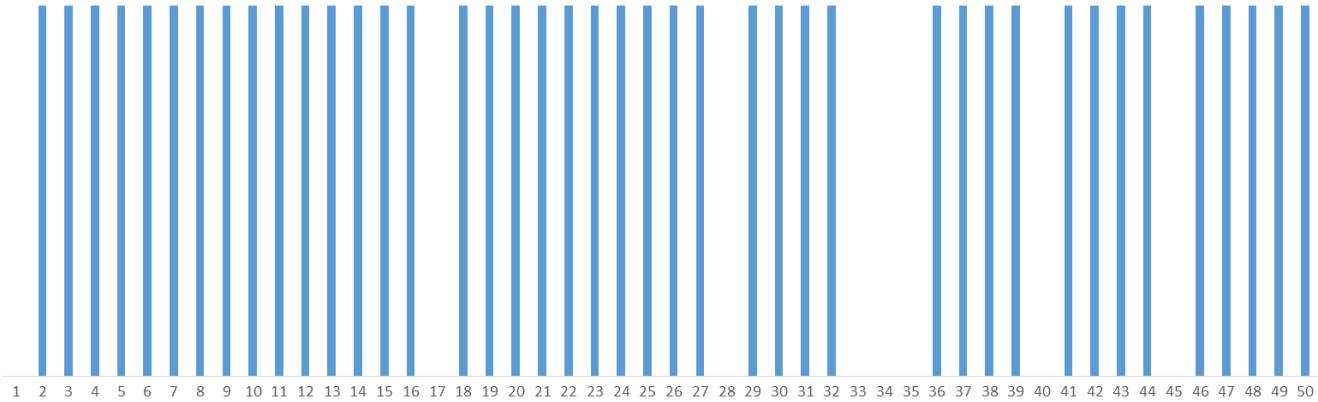


Figure 33 shows which sample locations contain fish. The only locations that don't contain fish are the location numbers 17, 28, 33, 34, 35, 40 and 45. In the case of 33, 34 and 35 this is because those are land habitats and no water was present there.

Figure 34: Ponds that are closed off from big water bodies at time of research

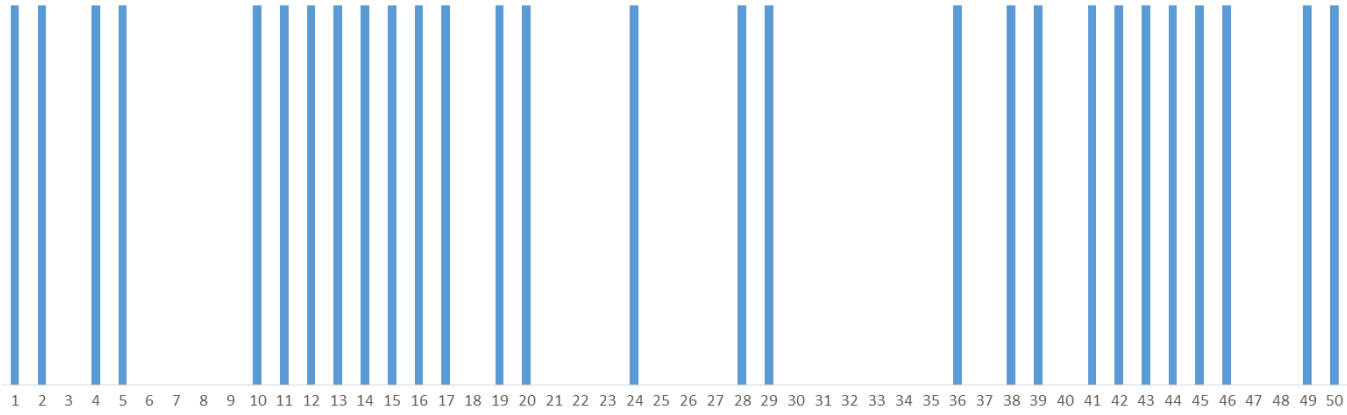


Figure 34 shows which sample locations are closed off from the big connected water bodies like the prokopos lagoon and the lamia marsh during the time of this research and thus are less stagnant. Most of these are connected to the big water bodies at least throughout some of the year as the presence of fish from figure 33 also shows.

Figure 35: Sample location with roads nearby and a lot of dead animals found

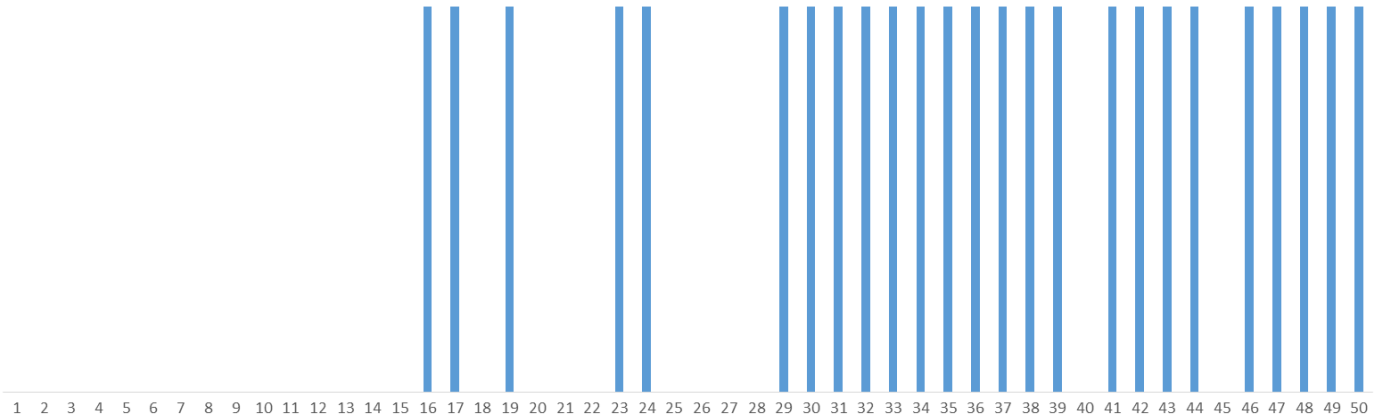


Figure 35 shows the sample locations have road located very nearby. Roads form an extra risk factor both for adults moving towards the reproductive water as well as subadults moving out of the water and onto the land. Along all of these road there have been a noticeable amount of dead amphibians observed.

Figure 36: Sample locations with high salinity content

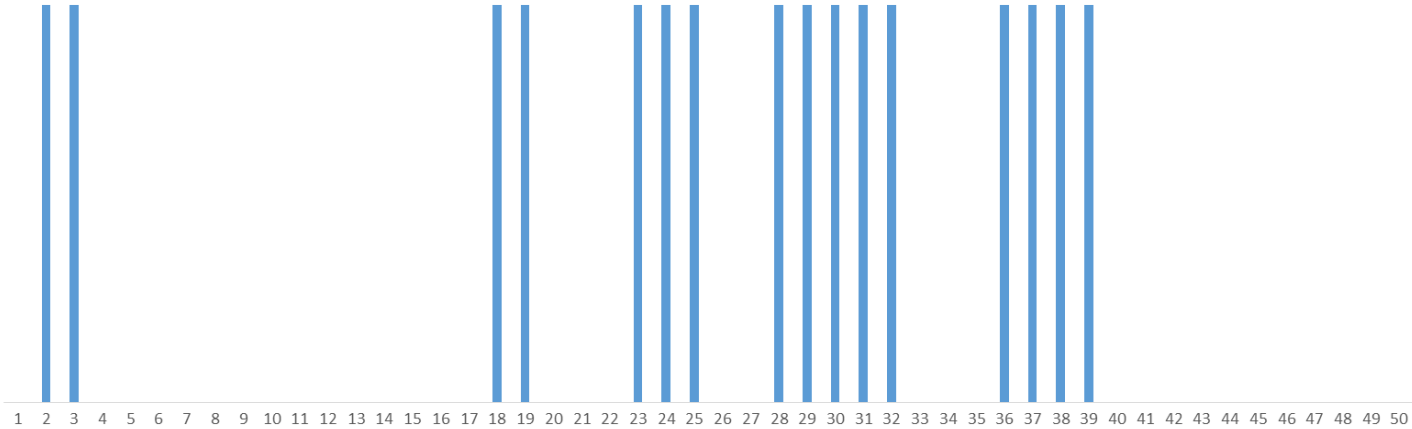


Figure 36 shows which sample locations have high salinity content. These are the locations that are either part of prokopos lagoon or are closed of ponds in the edges of prokopos lagoon or canals of fens close to the sea.

Figure 37: Water bodies that seem to be temporary

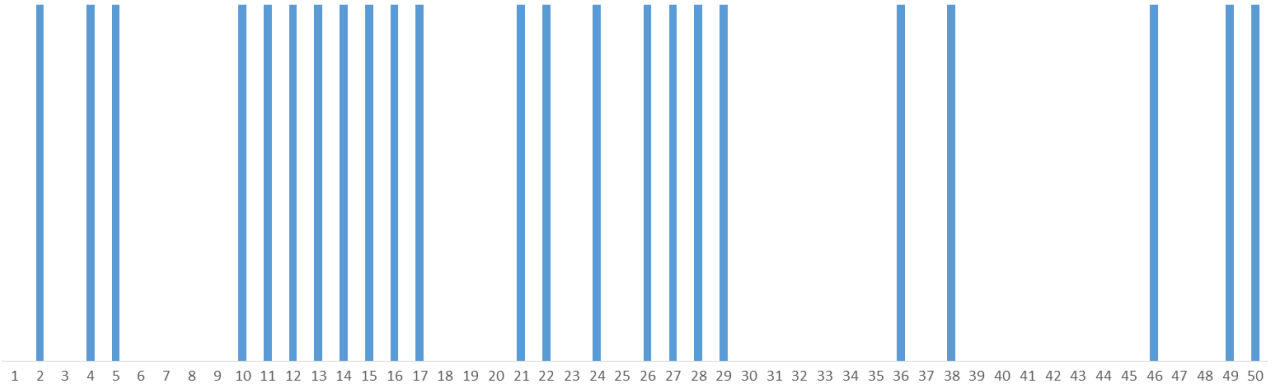


Figure 37 shows the water bodies that seem to be temporary. These are the closed off ponds in the edges of the lagoon and the marsh that form as it is drying up as well as fens in the forest. The big connected water bodies are not going to be drying up any time soon.

5. Discussion

This chapter consists of two parts. First the discussion of the results in which all the results from chapter 4 are discussed and interpreted and secondly the discussion of the methods in which the methodology is questioned and aspects that could have been done better are outlined.

5.1 Discussion of the results

FRP

The first thing that needs to be discussed are the results of the FRP method which deals with counting adult individuals. In this research the goal of a 1000 adults has not been met by any of the species as can be seen in table 12 in chapter 4.2. Only Pelophylac epeiroticus came close with 959 adults but other than that no species even came close. So according to this method none of the species in the area have sustainable populations. This is, however, due to methodology issues so we can't really honestly evaluate this goal. The method used in this research was clearly focused on catching larvae and using that information to rate the reproductive waters. It is a possibility to adapt the research to better meet those requirements of searching for all the adults in the area in the future (look for all of them in 1 km2 and extrapolate over the whole area) (*Ottenburg, 2006).*

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We can more clearly evaluate the analysis of the reproductive waters. The goal of at least 10 suitable reproductive waters for each species has not been met by *Lissotron vulgaris, Bufo bufo, Rana dalmatina* and *Pelobates syriacus* so these species are species of interest and need to be the focus from protective management and close monitoring. Below are discussions for each of the species reproductive water analysis from 4.2.

The *Lissotron vulgaris* graph shows only one high quality reproductive water which is backed up only by 5 other waters with low quality. These results suggest that this species is not doing so well and needs to be a management target.

The *Pseudepideala viridis* seems to be doing well in the areas in the center of the area close to the lagoon and the mountains. With 13 waters in which it was located and 1 high quality and 3 medium quality reproductive waters the species does not seem to be in dire straits.

The *Hyla arborea* does especially well in areas in the forest. The results show a sufficient spread of 14 suitable location with 1 rating high quality. It does not seem to be in dire straits but the few waters that are going really well need to be conserved.

This research clearly indicates that *Pelophylax kurtmuelleri* and *epeiroticus* are doing exceptionally well in the area. They have somewhat suitable reproductive possibilities everywhere in the area. They have been grouped together in this graph because the larvae are not distinguishable.

The *Rana dalmatina* was only observed in forested areas. So this habitat is to be the target of conservation. The species seems to be doing very badly in the area with only three suitable reproductive waters and is a species of concern.

The *Pelobates syriacus* was only found in small closed off ponds in the Lamia marsh edges, notably not without fish. The species is clearly a species of concern with only two reproductive waters which are of low quality.

Habitat analysis

The next step is to look at the results from 4.3 and compare these to 4.2. In 4.3 the relevant habitat information for amphibians is shown for each of the 50 sample locations. The first thing that strikes is the amount of fish in the area. Almost all ponds in the area have fish present and that is usually not a good sign for amphibian populations (*Nectar, 1997*). The only waters without fish (numbers 17, 28, 40, 45) all happen to be off good quality for several species and some even have rating three. This suggest that waters without fish should be a management goal. The next factor, isolated ponds is also important for quality. All the ponds that are isolated are of much higher quality than the big connected water for all the sensitive species. The *Pelophylax* also does fine in the big connected waters and one notable exception is pond 31 that is not isolated but is rated high quality for the Pseudepidea viridis. Roads that are located next to the waters are clearly a problem. Especially for pond 31 that is of value 3 for the P.viridis and right next to the road. Salinity content doesn't seem to be a great factor. Amphibians show high resilience against salinity (*Katz, 1973*). But when its really high only Pelophylax seems to handle it well.

5.2 Discussion of the methods

- The selection of the 50 sample locations was done by myself after a lot of field research and excursions with the management team of Kotyhi-Strofylia and consultation with Wouter de Vries from EPMAC Europe and local herpetologists. However it would have been better to have made the selection after more extensive field research with more researchers. Then I could better guarantee that the selection are the best possible locations to monitor.

- No eggs have been found within this research. This is probably due to the same reasons as the point above that there was too little time and people for an extensive first survey. Additionally it seems that the reproductive period was a little stirred this year, possibly due to climate change. The reproductive period is the key time of year to conduct this monitoring.

- The Pelophylax epeiroticus and Pelophylax kurtmuelleri are interbreeding (Tsoras, 2016) in the area. So this makes determination of the species very hard especially in the case of the larvae. For this research I have not made a distinction in determination of the larvae of these two species, only with the adults I have made the distinction because they can be determined on sound. But the case could be made to just merge them together and include them in the research as Eperoticus spec.

- No Bufo bufo has been found within this research even though they have been observed in the past(Γκιώκας, 2015). A possible explanation for this is that they live very sheltered lives in their landphase and only have a short water(reproductive) phase which is early in the year(Valakos, 2008). Also their reproductive calls are very soft and subtle and are easily overshadowed by the loud Eperoticus species. However another explanation could be that the species is just doing really badly in the area because of pollution that is one of its greatest threats (Valakos, 2008) and that its protection is of vital concern. More research is needed.

-In the chapter 'Baseline monitoring' the numbers of all the observations have been counted. However observations of just sound have not been included since it's hard to determine the amount of individuals on sound. These observations have been noted but without an amount. So the amount of individuals observed was far greater than just the once written down.

6. Conclusion

In this chapter the answers to the research question and sub research questions are presented. The main research question is: Are the populations of amphibian species in the national park Kotyhi-Strofylia wetlands sustainable at this moment and if not what can the management do to improve on them? This main question is dissected in three sub questions that are answer below.

1. **What amphibian species live in the national park Kotyhi-Strofylia and where and in what amounts?**

There are 7 species of amphibians observed during this research in the Kotyhi-Strofylia wetlands:
- *Lissotron vulgaris:* this species has been found on a total of 6 locations and total amount: 1017. See table 4 and figure 20 in chapter 4.1.
- *Pseudepidalea viridis:* this species was found in 13 locations with a total amount of 1140. See table 6 and figure 21 in chapter 4.1.
- *Hyla arborea:* this species was found in a total of 14 locations with a total amount of 1087. See table 7 and figure 22 in chapter 4.1.
- P*elophylax epeiroticus* and *Pelophylax kurtmuelleri:* these two species larvae are indistinguishable from each other and they are also interbreeding a lot so they are grouped together. They were both found all across the area, in 47 locations in large numbers: together: *3366.* See table 7 and 8 and figure 23 and 24 in chapter 4.1.
- *Rana dalmatina*: this species was observed on three locations but in low amounts of total 18. See table 10 and figure 25 in chapter 4.1.
- *Pelobates syriacus:* this species was only observed in two locations with a total amount of 2. See table 10 and figure 26 in chapter 4.1.

2. **Are the populations of amphibians in the national park Kotyhi-Strofylia sustainable at this moment?**

Making any statements on sustainability of amphibians is near impossible with the data of only one year of monitoring. However we can give some indications:
- *Lissotron vulgaris*: not sustainable. Only observed in six locations with only one instance of high quality. See figure 27 in chapter 4.2.
- *Pseudepidalea viridis*: sustainable. Observed in 13 locations with 4 instances of high and medium quality. See figure 28 in chapter 4.2.
- *Hyla arborea:* sustainable. Observed in 14 locations with three instances of high/medium quality. See figure 29 in chapter 4.2.
- *Pelophylax epeiroticus and Pelophylax kurtmuelleri:* sustainable. Observed in 47 locations with 15 instances of high/medium quality. See figure 30 in chapter 4.2.
- *Rana dalmatina:* not sustainable, species of concern. Only observed in three locations with one instance of medium quality. See figure 31 in chapter 4.2.
- *Pelobates syriacus:* not sustainable, species of great concern. Only observed in two locations, both of which low quality. See figure 32 in chapter 4.2.

3. **What can the management of the national park Kotyhi-Strofylia do to protect, conserve and\or improve the populations of amphibians?**

There are again only limited suggestions to be made because this is only the first monitoring season. So the monitoring had to be continued in coming years and the management cycle from figure 2 in chapter 1.4 has to be completed as this research is only the first step, see chapter 7 recommendations for some suggestions how to do this. It is however a remarkable feat from the habitat analysis from chapter 4.3 that the sample locations that have no presence of fish, are isolated from big water bodies like lagoons and marches and have low salinity content are so much more valuable for amphibians as shown in chapter 4.3 and the chapter 5.1 discussion of the results. It is suggested to take management precautions to conserve ponds that have these properties as well as create new ones like that. See chapter 7 recommendation for suggestions on how to do this. Lastly the amount of roads around valuable amphibian habitat is striking, see figure 35 in chapter 4.3, something has to be done about that as well: see chapter 7 recommendations.

7. Recommendations

-The most important recommendation that flows from this research is to repeat this research in the coming years. This research only provides the first step in the management cycle and the monitoring has to be continued to create some real datasets that can be used for evaluation and management. To continue the monitoring its recommended to use the EPMAC program. EPMAC stands for Educative and Participative Monitoring for Amphibian Conservation. Thus the interactive nature and use of volunteers makes this system suitable for the Kotyhi-Strofylia wetlands that is also trying to conduct participatory management. EPMAC usually works with very large area's of around 80km2 with just about one pond selected every 5km2 or so. The area in this research is obviously much smaller than that but the area can be a part and a focus of a larger scale EPMAC project. In that case a group of volunteers will be coming to the area every year under the guidance of the EPMAC crew and coordinated by me and\or my possible student successor. They will visit the same 50 locations as surveyed in this research and then move on to the next area. The data accumulated will be added to this research, thus completing the management cycle. This will obviously be done in close collaboration with the management body of the Kotyhi-Strofylia wetlands. This will but the area on the map for international ecologists, provide data for the management plan for amphibians, create more participation and education possibilities in the area and also earn some money for the national park.

-While amphibians are numerously represented in the area, the closely related species group of reptiles are the real gold mine of the area. The reptile biodiversity is tremendous and very interesting. Some species that have been found during this research in the area without even actively looking for them are: Pseudopus apodus, Platyceps najadum, Anguis graeca, Eurotestudo boettgeri, Emys orbicularis, Caretta Caretta, Algyroides moreoticus, Testudo marginata, Xerotyphlops vermicularis, Elaphe quatuorlineata, Natrix tessellate, Natrix natrix, Chelonia mydas, Ablepharus kitaibelii, Podarcis tauricus and Mauremys rivulata. Also there are several other very interesting species to be found there. Its strongly recommended to conduct a research like this for reptiles as well or possible add this species group in the continuation of this research.

-The most valuable and rare species in the area is the Pelobates syriacus. And it has only been observed twice in this research. Its recommended to closely monitor the area where this species was observed(close to the wooden cabin on the border of lamia marsh and Prokopos lagoon, see chapter baseline monitoring in the results for the specific location). This species and the area where it was observed should ideally be monitored year round and more intensively.

-Its recommended to conduct this research a little earlier in the year next times around. Some species start their reproductive season in February so its recommended to start around that time just to have more certainty that the most individuals will be observed. The period used in this research(march and april) is good as well but just to be sure its recommended to start a little earlier because it will cover the early reproducers, spring migration and the egg deposition phase better.

-There are some management actions that can be suggested after this research. The first suggestion is to dig small tunnels under the asphalt roads that cross the area. Many dead individuals where found on these roads that were trampled by cars. These tunnels will provide safe passage under the road for the amphibians. Recommended locations for these tunnels are known breeding spots like pond number 31 at 38.15984, 21.38174(see figure 10 and 17 and table 4). Here 1000s of juvenile P.Viridis where found and also trampled on the roads. Basically for all the sample locations that were rated with 3(high quality) for the species that seem to be a bit vulnerable(*Lissotron vulgaris, Pseudepidelea viridis, Hyla arborea*) en all the sample locations that had any rating at all from the species that seem to be really vulnerable(*Rana dalmatina, Pelobates syriacus*) in the chapter 'interpretations of the results' that are close to asphalt roads need to be considered for the corridor tunnels.
Secondly, the biggest threat to the amphibians in the area seems to be the predatory fish that are in almost every water. The majority of the waters are connected to sea for part of the year so the salt water fish are also dwelling. These fish are huge predators of amphibians (Wells, 2007). The few ponds that where surveyed for this research that did not contain any fish because they were closed off all the year from the rest of the connected waters had by far the best results. All these ponds were rated with 3 in the chapter 'interpretation of the results' see figure 16, 17 and 18 and appendix 2, 3 and 4. Examples are sample location 17(38.1274, 2138456), 40(38.16943, 21.4055) and 45(38.11145, 21.40962).
So its recommended to dig extra ponds in the area that are further away from the lagoons so that they won't be filled up with sea water during the floods but stay closed off all year so that fish won't be able to enter. This will cause drastic improvements in amphibian populations. Doing this specifically in the leaf forests should improve the *Rana dalmatina* populations which are not going so well in the area see figure 14 and 20 and table 8. The other species of interest which needs to be improved is the *Pelobates syriacus*. So the area were they have been observed needs to be the main target for creating new closed off ponds. See figure 15, 21 and table 9. This is the area around sample location 49 at 38.12376, 21.38675.

Literature

Bibliography

Bern, 1. (1979). *Convention on the Conservation of European Wildlife and Natural Habitats *.* Zurich, Switserland: Council of Europe.

Bishop, P. J. (2012). *The Amphibian Extinction Crisis - what will it take to put the action into the Amphibian Conservation Action Plan?* S.A.P.I.EN.S [Online].

Blamey, M. (2004). *Wild Flowers of the Mediteranian.* London: A&C Blsck publishers.

Bodie, R. D. (2003). *Biological for buffer zones around wetlands and riparian wetlands for amphibians and reptiles.* Columbia, USA: University of Missoury.

Briggs, L. (2006). *Monitoring methods for the great crested newt.* Tallinn-Odense: Life04.

C, O. F. (JulY 2014). *Gunstige referentiewaarden voor populatieomvang en verspreidingsgebied van soorten van bijlage II IV V van de habitatrichtlijn. WOT Natuur en milieu, .* wageningen: Wageningen UR.

Degregorio, B. A. (2014). *Commercial value of amphibians produced in an isolated wetland.* USA: University of Notre dame.

Efstratios D. Valakos, P. P. (2008). *The Amphibians and Reptiles of Greece.* Frankfurt am Main: Edition Chimaira.

Horner, A. L. (2001). *Wetlands and urbanisation, implications for the future.* London: Lewis publishers.

Joachim Mergeay, M. V. (2013). *Analyse van duurzaamheid van Europees beschermde Amfiebieen en Reptielen.* Brussel: Agentschap voor bos en milieu.

Katz, U. (1972). Studies on the adaptation of the toad Bufo viridis to high salinities: oxygen consumption, plasma concentration and water contend of the tissues. *Journal of experemental biology*, 785-796.

Knecht, B. d. (2005). *Monitoringsgegeven voor het natuurbeheer anno 2005.* Wageningen: Wageningen University.

Leduc, J. C. (2012). *Ecology of herpetofaunal populations in smelting tailings wetlands.* Ontario, Canada: Department of Biology, Laurentian university.

Meijden, R. v. (2005). *Heukels Flora van Nederland.* Groningen/Houten: Noordhof Uitgevers.

More, O. J. (2005). *ANWB Bomengids van Europa.* Den Haag: ANWB B.V.

Nectar, S. J. (1997). The effects of predatory fish on amphibian species richness and distribution. *Biological Conservation*, 117-314.

Orfanou, V. (2016, March). Management and ecology in the Strofylia national park. (C. Hoogendoorn, Interviewer)

Orfanou, V. (n.d.). *Strofylia national park*. Retrieved March 2016, from http://www.strofylianationalpark.gr/

PARC. (2015). *Protecting wetlands for amphibian conservation .* USA: EPA.

Rannapa, R. (2011). *Habitat requirements of Pelobates fuscus and Leucorrhinia pectoralis.* Tallinn: Life08.

RAVON. (2016). *Reptile, amphibian and fish conservation Netherlands.* Nijmegen: RAVON.

Riinu Rannap, V. R. (2008). *Protection of the Yellow-spotted whiteface and the common spadefoot toad.* Estonia: Environmental board of the repiublic of Estonia.

Riinu Rannap, W. d. (2012). *Criteria for assessing tha favorable conservation status of Pelobates fuscus.* Tallin: Life08.

Sparling, D. W. (2002). *Using Amphibians in bioassesment of wetlands.* Washington: Office of water.

Th. Georgiadis, E. E. (1989). *Flora and vegetation on the strofilia coastal area.* Patras: University of Patras.

Ton Stumpel, H. S. (2006). *Veldgids: Amfibieën en Reptielen.* Zeist: KNNV Uitgeverij.

Tsoras, E. (2016, April). Amphibian hotspots in Strofylia. (C. Hoogendoorn, Interviewer)

Vries, W. d. (n.d.). Retrieved Maart 2016, from EPMAC Europe: http://www.epmac-europe.com/wordpress/

Vries, W. d. (2016, December). Determining sustainability of populations. (C. Hoogendoorn, Interviewer)

Wells, K. D. (2007). *The ecology and behaviour of amphibians.* Chigago: University of Chigago.

Γκιώκας, Σ. (2015). *ΕΠΟΠΤΕΙΑ ΚΑΙ ΑΞΙΟΛΟΓΗΣΗ ΤΗΣ ΚΑΤΑΣΤΑΣΗΣ ΔΙΑΤΗΡΗΣΗΣ ΤΩΝ ΤΥΠΩΝ ΟΙΚΟΤΟΠΩΝ ΚΑΙ ΤΩΝ ΕΙΔΩΝ ΧΛΩΡΙΔΑΣ ΚΑΙ ΠΑΝΙΔΑΣ ΤΩΝ ΟΔΗΓΙΩΝ 92/43/ΕΟΚ ΚΑΙ 2009/147/ΕΚ.* Patra: University of Patra.

ΠΔ 67\1981 (ΦΕΚ 23\Α). (1981, 01 30).

ΣΗ, Τ. Ε. (2002 - 2006). *Σχέδιο Διαχείρισης Ερπετοπανίδας Προστατευόμενης Περιοχής Υγροτόπων Κοτυχίου - Στροφυλιάς.* Kotyhi-Strofylia: Life02.

ΥΑ 33318/3028 (ΦΕΚ Β 1289). (1998, 12 28).

Appendixes

Figure 38: sundown in Strofylia. Picture by Christiaan Hoogendoorn

Appendix 1: Field form

YEAR		**AREA**			**GPS-NUMBER**		
DATE		**POND NUMBER**		**MAP:**	**UTM-WGS 84 /34N**	**X:**	**Y:**
TIME (d/n)	s.	e.	**Registrator (s)**			**Photographer**	
METHODS	Picture numbers: ___						
	WS = water survey				WD = 5 x dipnetting edge PLUS 5 x deeper		
	+ = other	.....additional dipnets			Other metods:		

Pond type	☐	cattle p.	☐	fish pond	☐	March	☐	Salt march	☐	river	☐	lake
	☐	Lagoon	☐	Rain pond	☐	Lagoon edge	☐	Fen	☐	stream	☐	ditch
	Other:											
Hydroperiod	☐	Temporary	☐	Permanent	☐	dry every few years	☐	seems temporary	☐	seems permanent	☐	
Surrounding (100 m)	☐	meadows	☐	fields	☐	forest	☐	urban	☐	river/streams	☐	Others

Size (water surface during sampling)		m²		length m		width	m
Depth	☐	<0,5 m	☐	0,5 - 1 m	☐	> 1 m	
Edges	☐	0-11	☐	11-22,5	☐	22,5-45	> 45
Shadow from bushes and trees on water		%					

Weather: T .....ºC
Wind:
Rain:
Sun:

	EGGS			LARVAE			JUVENILES			SUBADULTS			ADULTS			CALLING		
AMPHIBIANS	WD	WS	+	WD	WS	+	WD	WS	+	WD	WS	+	WD	WS	+	WD	WS	+
Lissotriton vulgaris																		
Bufo bufo																		
Pseudepidalea viridis																		
Hyla arborea																		
Pelophylax epeiroticus																		
Pelophylax kurtmuelleri																		
Rana dalmatina																		
Pelobates syriacus																		

%	**Vegetation in and on edge of aquatic site**		
☐	*Aquatic vegetation cover*	☐	*Shrub layer cover:*
☐	*Dominant species:*	☐	*Dominat species*
☐		☐	
☐		☐	
☐		☐	
☐		☐	
☐	*Herb layer cover*	☐	
☐	*Dominant species*	☐	*Tree layer cover*
☐		☐	*Dominant species:*
☐		☐	
☐		☐	
☐		☐	
☐		☐	
☐		☐	

Visible conservation threats	
Fish	
Intensification of agriculture	
Pesticides	
Drained	
Filled in	
Silting up	
Becomming land	
Overgrowing (bushes)	
Pollution	
LANDOWNER DETAILS:	

MANAGEMENT SUGGESTIONS

YEAR		**AREA**			
DATE		**POND NUMBER**		**MAP.NO:**	
TIME (d/n)		.	**Registrator (s)**		

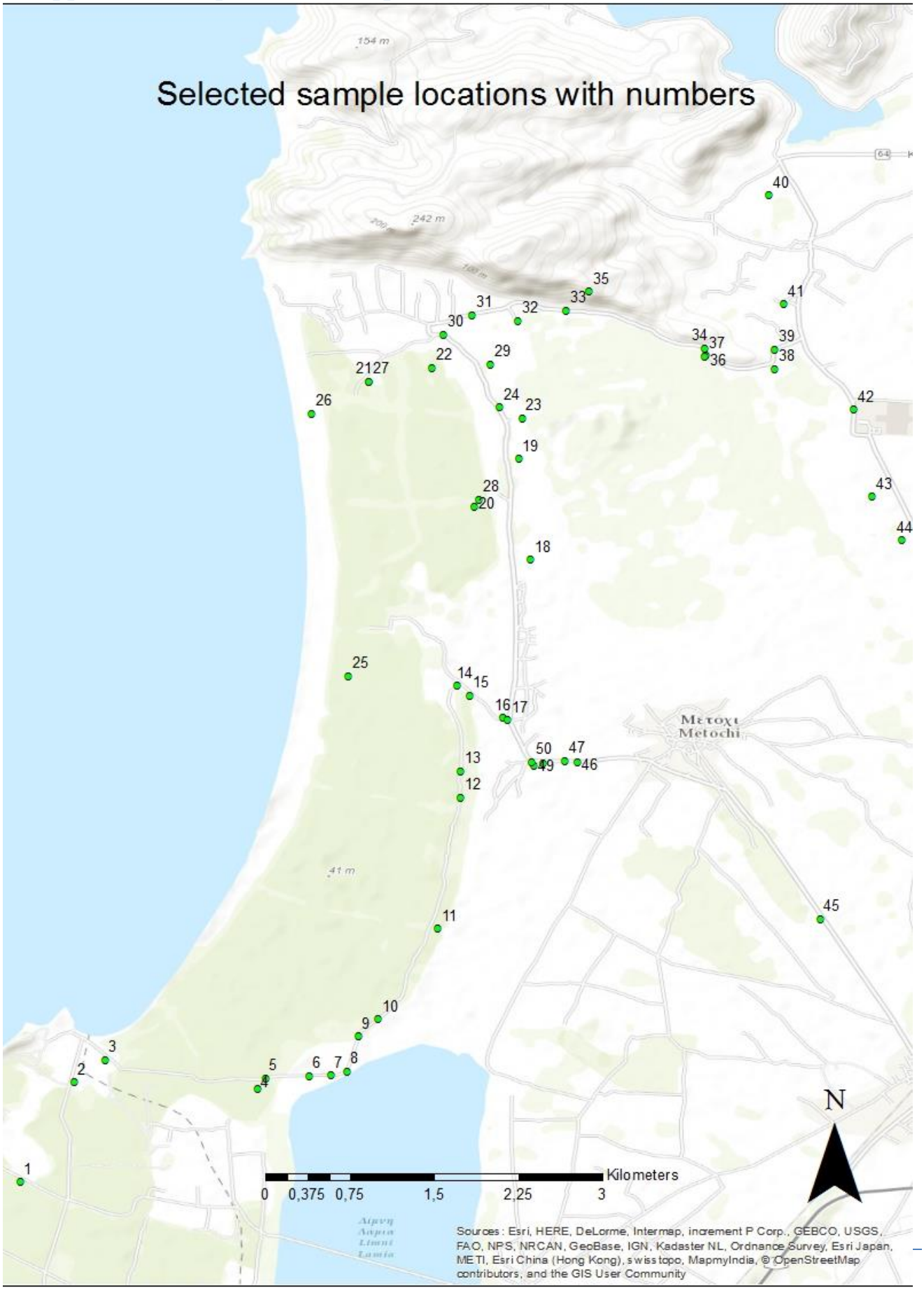
Target species:	Priority for the conservation of target species		
	High	Medium	Low
Dredge			
Enlarge			
Dig new pond nearby			
Remove fish			
Cut trees/bushes N - S - E - W from edge			
Establish buffer N - S - E - W			
Protect as diversity habitat			
Avoid overgrowing of surroundings			
Avoid intensification of surroundings			
Avoid destruction by surr. land use			

Sketch

Other species:

Notes:

Appendix 2: Map of the 50 sample locations



Appendix 3: Picture file of the 50 sample locations All pictures taken by Christiaan Hoogendoorn

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Appendix 4: Description and coordinates of the 50 sample locations

No	Coordinates	Description
1	38,09038 21,34553	Closed off pond in the Pinus forest, 100% shade cover. Size: about 30m2
2	38,09838 21,34986	Pond in a meadow with high salinity content. Size: about 30m2
3	38,10016 21,35236	Salt marsh with very high salinity content and fish. Size: about 30m2
4	38,09784 21,36454	Closed off pond in marsh edges with fish and visible pollution. Size: 40m2
5	38,09869 21,36521	Closed off pond in marsh edges with fish. Size: 40m2
6	38,09887 21,36873	Sample in large marsh with fish. Size -> 1ha
7	38,09891 21,37043	Sample in large marsh with fish. Size -> 1ha
8	38,09924 21,37173	Sample in large marsh with fish. Size -> 1ha
9	38,10205 21,37263	Sample in large marsh with fish. Size -> 1ha
10	38,10342 21,37425	Closed off pond in marsh edges with fish that seems to be drying up. Size: 5m2
11	38,11068 21,37902	Closed off pond in marsh edges with fish. Size: 10m2
12	38,12121 21,38083	Closed off pond in marsh edges with fish. Size: 10m2
13	38,12329 21,38085	Closed off pond in marsh edges with fish. Size: 10m2
14	38,13017 21,38055	Closed off pond in marsh edges with fish. Size: 30m2
15	38,12935 21,38152	Closed off pond in marsh edges with fish. Size: 30m2
16	38,12757 21,38425	Closed off pond in marsh edges with fish. Size: 30m2
17	38,12740 21,38456	Closed off pond in marsh edges without fish. Size: 5m2
18	38,14026 21,38641	Big deep pond in lagoon edge with lots of fish and shrimp. Size +- 100m2
19	38,14831 21,38547	Closed off pond in lagoon edge with lots of fish and shrimp. Size: 40m2
20	38,14447 21,38194	Closed off pond in the Umbrella pine forest, 75% shade cover. Size: about 30m2
21	38,15453 21,37345	Large fen in forest edge, seems temporary. Size about 100m2
22	38,15563 21,37855	Fen in forest edge, seems temporary. With a lot of larvae from dragonfly. Size about 50m2
23	38,15161 21,38575	Sample in large lagoon with lots of fish and shrimp. Size-> 1 ha
24	38,15245 21,38396	Closed off pond in lagoon edge with lots of fish and shrimp. Size: 40m2
25	38,13091 21,37183	Manmade canal in forest with lots of fish and high salinity content. Size-> 1 ha
26	38,15197 21,36887	Fen in forest edge, seems temporary. With a lot of larvae from dragonfly. Size about 50m2
27	38,15451 21,3735	Fen in forest edge, seems temporary. With a lot of larvae from dragonfly. Size about 50m2
28	38,14508 21,38233	Closed off pond in lagoon edge without fish. Size: 40m2
29	38,15590 21,38326	Closed off pond in lagoon edge with lots of fish and shrimp. Size: 40m2
30	38,15830 21,37945	Sample in large lagoon with lots of fish and shrimp. Size-> 1 ha
31	38,15984 21,38174	Sample in large lagoon with lots of fish and shrimp. Size-> 1 ha
32	38,15940 21,3854	Sample in large lagoon with lots of fish and shrimp. Size-> 1 ha
33	38,16021 21,38932	Transect in mountains. Size-> 1 ha
34	38,15718 21,40036	Transect in mountains. Size-> 1 ha
35	38,16174 21,39116	Transect in mountains. Size-> 1 ha
36	38,15659 21,40051	Closed off pond in lagoon edge with lots of fish and shrimp. Size: 40m2
37	38,15653 21,40038	Sample in large lagoon with lots of fish and shrimp. Size-> 1 ha
38	38,15554 21,40599	Closed off pond in lagoon edge with lots of fish and shrimp and lots of pollution. Size: 40m2
39	38,15709 21,40596	Manmade pond for agriculture with fish. Size: 30m2
40	38,16943 21,4055	Sample in small marsh without fish that seems to be overgrowing with bushes. Size +-100ha

41	38,16072 21,40674	Manmade pond for agriculture with fish. Size: 30m2
42	38,15229 21,41235	Manmade pond for agriculture with fish. Size: 30m2
43	38,14530 21,41379	Manmade pond for agriculture with fish. Size: 30m2
44	38,14181 21,41614	Manmade pond for agriculture with fish. Size: 30m2
45	38,11145 21,40962	Manmade abandoned pond for agriculture without fish. Size: 20m2
46	38,12401 21,3902	Closed off pond in marsh edges with fish. Size: 30m2
47	38,12415 21,38919	Sample in large marsh with fish. Size -> 1ha
48	38,12391 21,38744	Sample in large marsh with fish. Size -> 1ha
49	38,12376 21,38675	Closed off pond in marsh edges with fish. Size: 30m2
50	38,12402 21,38651	Closed off pond in marsh edges with fish. Size: 20m2

Appendix 5: Description of the 8 amphibian species in the area

1. Lissotron vulgaris – Smooth newt – Kleine watersalamander - Κοινός Τρίτωνας

Lissotron vulgaris larvae in Lamia marsh. Photo: Christiaan Hoogendoorn

Characteristics

Small salamander of 11cm length maximum, smooth skin and dark longitudal stripes on the head. The base back color of the back is brownish to olive-grey and the belly is yellow, orange or red. The back and belly are separated by a white line. Males in the reproductive time have a crest on back and tail and wear numerous round black spots on their whole body. In the land phase the animals become light to dark brown. This is the only salamander observed in the area. The eggs can be found wrapped around the leaves of aquatic plants in groups of at least 60.

Habitat
Very flexible species that breeds and develops larvae in a large variety of both deep and shallow, permanent or temporary water bodies like marshes, slow flowing rivers, brooks, channels, reservoirs and lake shores. But its favorite habitat are small ponds with a lot of vegetation. Land habitat includes deciduous and mixed forests, grassland, meadows and cultivated areas. As long as there are logs or rocks to hide under.

Life cycle
It lives on land throughout most of the year where it is active at night or after rain. In winter it hibernates in groups in rotten trees or burrows. In early spring, right after hibernation, it starts the reproductive period and the aquatic phase. The larvae usually take a few months to transform but sometimes they over-winter as larvae.

Conservation status
Listed in appendix 3 of the Bern convention. Protected by national law as well. Natura 2000? Biggest treats are the changing of water quality and the loss of water bodies due to agriculture.

2. Bufo Bufo – Common toad – Gewone pad - Μπράσκα, Βούζα
* Not observed in the area by me

Characteristics
Large to middle large toad of maximum 15cm long, with a horizontal pupil, a back covered with a lot of tubercles with black tips and a round nose. Back colour varies from grey to brown to olive brown to red. Belly light yellowish grey with dark spots. Below the toes it has 2 small bulbs at the bones. Males have nuptial pads on forelimb fingers and are smaller. Eggs are recognisable as they are long gelatinous strings and the larvae are recognisable by the ´school´ behaviour that they exhibit, meaning that they flock together in groups.

Habitat
Mainly found in forested areas of all kinds. But also in scrublands, forest meadows, cultivated land and gardens and even urban environments. It likes dense vegetation with water bodies close. During reproduction it prefers large and deep open waters like edges of lakes, large ponds, ditches and streams.

Life cycle
Hibernation occurs on land, where it digs itself in the soil. After the hibernation period there is a large migration towards the breeding habitat. Breeding occurs from March to June. The larvae are developed to adult in 1.5 to 2.5 months. Feeding is done exclusively on land and it can frequently be found foraging for ants.

Conservation status
Listed in appendix 3 of the Bern convention. Protected by national law as well. Natura 2000? Destruction of forests and wetlands as well as environmental pollution due to fertilizers, waste, recreation and urbanization are the biggest treats for this species.

3. Pseudepidalea viridis – Green toad – Groene pad - Πρασινόφρυνος

Pseudepidalea viridis in the black mountains. Photo: Christiaan Hoogendoorn

Characteristics

Middle-large toad of maximum 10cm length, an unmistakable green spots all over the body(like military camouflage clothing) on a beige or white base color, horizontal pupils, warts all over the back that are often orange or red and a white of grey belly without any dots. The males differ in heaving nuptial pads on their forelimb fingers and a purple throat. The sound is very melodic and soft. The eggs are organized in long gelatinous strings. The larvae are recognizable by usually being found in very superficial waters and living in their own small holes in the ground.

Habitat

Lives in a wide variety of habitats. Very tolerant to dry circumstances and can be found in forests and mountains often far away from water. Breeding waters can be both fresh and brackish and are preferably not deeper than 50cm and therefore usually temporary waters.

Life cycle

Active at night and hiding under rocks or logs during the day. Often travels to up to 2.5km from land habitat to breeding waters. Breeding takes place in between February to July. This is partly because they often breed in temporary waters and those dry up sometimes before the larvae are developed. Metamorphosis takes place from spring through the summer.

Conservation status

Listed in appendix 2 of the Bern convention and Annex IV of the EU natural habitats directive and also protected by national law. Destruction of meadows and cultivation of wetlands and damage done by recreation are the main treats for this species. But destruction of forests seems to favor the Green toad, since it is adapted to open areas.

4. Hyla arborea – Common tree frog – Boomkikker - Δενδροβάτραχος

Hyla arborea in Strofylia forest. Photo: Christiaan Hoogendoorn

Characteristics

Small frogs of maximum 5cm length, distinctly light green colored, with adhesive pads on the finger and toe tips, horizontal pupils and a band that separates the colored dorsal surface from the white ventral surface. Males differ in heaving a large vocal sac that is distinguished by darker skin folds and wrinkles on the throat. Very distinct, loud and fast past sound that can be heard from afar. The eggs are dropped in small batches of 200 to 2000 eggs.

Habitat

Forest dwelling frog. Likes areas with thick woody vegetation. Usually broad leaved of mixed forests or shrub lands or sometimes reed beds. Small closed off meadow ponds close to shrubs are preferred for reproduction. But swamps, ditches and puddles will also do. As long as there is stagnant, closed off water close to dense vegetation.

Life cycle

During the day, the species is warming up in trees or shrubs. In the evenings and night it comes down to forage and hydrate. Hibernation takes place on land, in soil tree holes or burrows, from November until February. Reproduction takes place between March and May and the metamorphosis of the larvae occurs from May to august.

Conservation status

Listed in appendix 2 of the Bern convention and Annex IV of the EU natural habitats directive and also protected by national law. Fragmentation of habitat, pollution and collecting are treats.

5. Pelophylax epeiroticus – Epirus water frog – Griekse poelkikker - Βάτραχος της Ηπείρου

Pelophylax epeiroticus in Lamia marsh. Photo: Christiaan Hoogendoorn

Characteristics

Medium sized water frog with a maximum length of 10cm. dorsal surface if greenish brown with black spots. The flanks are yellowish. Most easily recognizable due to the loud choruses of sound fast past sound it forms in the reproductive period.

Habitat

The species prefers still, warm, open waters with a lot of vegetation. High water salinity is tolerated. The breeding and larval development take place in still waters, slow-moving rivers, irrigation ditches and marshes.

Life cycle

The species hibernates in unfrozen water bodies from December to the beginning of February. Breeding occurs from March to April, during which time the loud choruses can be heard. The eggs are laid in large clumps among aquatic plants.

Conservation status

Listed in appendix 3 of the Bern convention. Loss of wetlands, water pollution and collection for commercial and culinary purposes are the biggest treats to its survival.

6. Pelophylax kurtmuelleri – Balkan frog – Balkan meerkikker - Βαλκανοβάτραχος

Pelophylax kurtmuelleri in Lamia marsh. Photo: Christiaan Hoogendoorn

Characteristics

Middle-sized frog of maximum 8cm. The eyes are set closely, hind legs are long, paired vocal sacs on males. Dorsal color is green to brown-green. Well-developed dorsolateral skin folds. Can be most easily distinguished by the vocals which are lower and slower than P.epeiroticus.

Habitat

A strongly aquatic species which can inhabit a large variety of water bodies. Preferably open, warm water with abundant vegetation. But it also dwells in shallow puddles and ponds, large lakes and rivers and mountain streams. It tolerates high water salinity levels.

Life cycle

Hibernation occurs from November until the beginning of February. Breeding takes place twice a year during early spring and autumn. Eggs are laid in large clumps among aquatic plants or in open water.

Conservation status

Listed in appendix 3 of the Bern convention and in annex V of the EU natural habitat directive. The biggest threat to the species is large scale collection for commercial and culinary purposes.

7. Rana dalmatina – Agile frog – Springkikker - Πηδοβάτραχος, Σβελτοβάτραχος

* Not photographed in the area by me

Characteristics

Medium sized frog with a maximum length of 9cm, but usually shorter. It has exceptionally long legs and the tibio-tarsal articulation will always exceed the tip of the nose when the hind leg is stretched alongside the body. It has a V shaped dot between the shoulders and dark brown bands on the legs. Base color is yellowish-brown with only sporadically some dots. Can be recognized by the remarkable length which it can jump (up to 2m). Nuptial pads are developed on the first finger of males.

Habitat

Typical forest dwelling frog, preferably deciduous or damp meadows with high vegetation. Hides under thick layers of leaf litter. Breeding waters are stagnant, not too large, warm and illuminated waters close to forests.

Life cycle

During the land phase it's mainly active at night. But in the breeding period also during the day. The breeding occurs early in spring, sometimes in February. Eggs are deposited in clutches in the aquatic plants and in the most open parts of the pond.

Conservation status

Listed in appendix 2 of the Bern convention and annex IV of the EU natural habitat directive. Its main treats are deforestation or replacement of deciduous forest to coniferous forest.

8. Pelobates syriacus – Eastern spadefoot - Syrische knoflookpad - Πηλοβάτης

Pelobates syriacus larvae in Lamia marsh. Photo: Christiaan Hoogendoorn

Characteristics

Small toad with a maximum length of 8cm. It has a robust body, short hind legs, large head, smooth skin, vertical pupils and a large yellowish spade-like tubercle on the hind legs. Dorsal color is yellowish to white-grey with dark-green dark edged spots. Eggs are laid in gelatinous strings in small ponds larvae are recognizable by being up to 160mm large with a marked golden belly and a pointy tail. .

Habitat

The species lives in forested, bushy areas nears pools, ponds, lakes, marches and swamps. It avoids the deep forests and prefers open landscapes. It prefers sand or clay soil so it can dig itself in during the day or when in danger. The reproductive waters are small stagnant water bodies.

Life cycle

Spends the day hiding in burrows that it digs itself or sometimes in burrows of rodents or under rocks. The breeding season occurs from February until May and the species is active during the day in this period as well, but only on the bottom or the banks of small stagnant ponds.

Conservation status

Listed in appendix 2 of the Bern convention and in annex IV of the EU natural habitat directive, as well as under national law. Habitat loss due to agriculture is its biggest treat.