# MONITORING OF THE NORTHERN CRESTED NEWT *(TRITURUS CRISTATUS)* IN GRENSPARK DE ZOOM-KALMTHOUTSE HEIDE

SURVEY ON DISTRIBUTION AND POPULATION GROWTH


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| Academic Year: | 2013 – 2014 |

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# 1. INTRODUCTION

## 1.1 ORIGIN OF GRENSPARK DE ZOOM – KALMTHOUTSE HEIDE

Grenspark de Zoom – Kalmthoutse Heide is a cross boundary park situated between Hoogerheide and Huijbergen (Netherlands) and Kalmthout and Heide (Belgium) (figure 1).

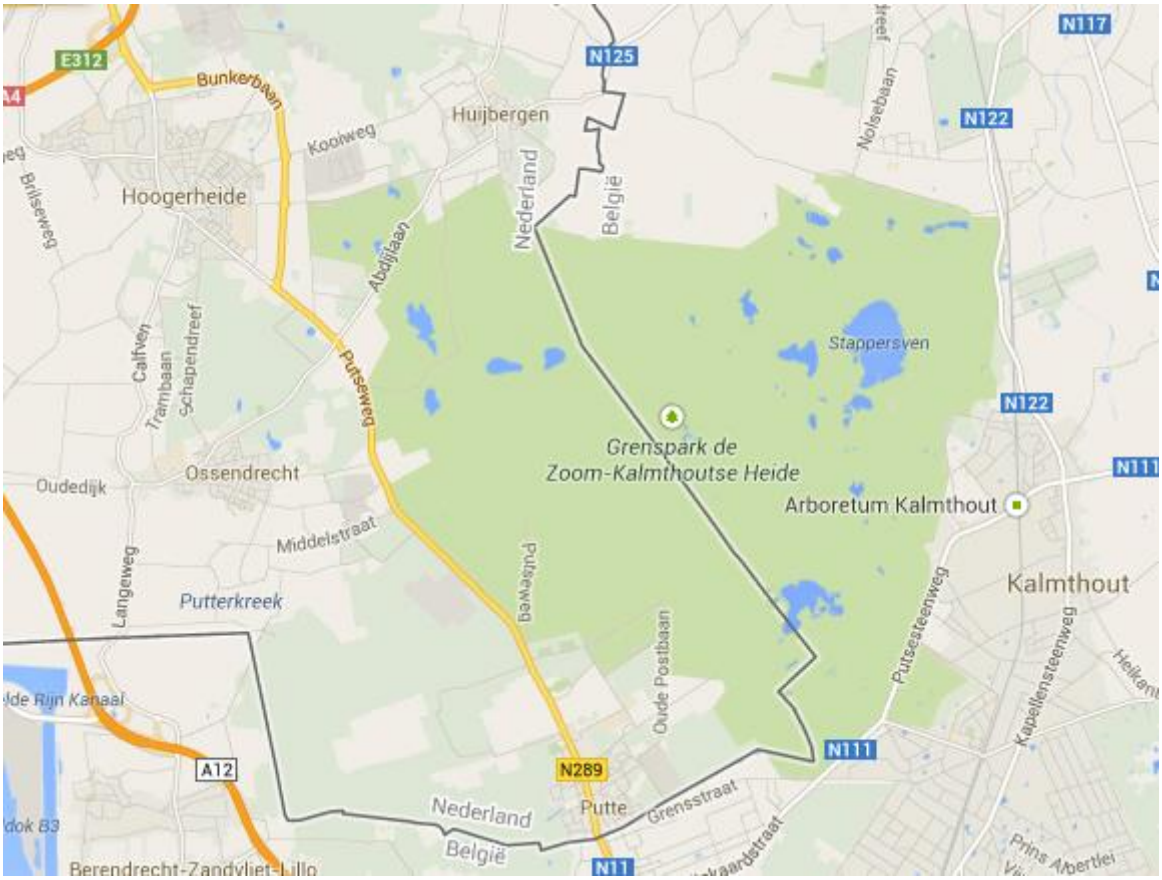


**Figure 1. Situation of Grenspark de Zoom – Kalmthoutse Heide (Google Maps, 2014).**

Although the national border originates from 1843, there were still boundaries earlier. Local landlords claimed different areas, including the areas of other landlords (Grenspark de Zoom – Kalmthoutse Heide, 2014).

The area has been used as heathland for centuries. Due to grubbing the heath replaced the forests. This heathland was used for grazing by sheep, sod-cutting, fire wood, etc. The sods were used for the sheep to deposit their manure. This manure served as fertilizer for the land. This agricultural method ensured maintenance of the heathland (Grenspark de Zoom – Kalmthoutse Heide, 2014).

In the 19th century the government bought the heathlands and sold them to private land owners who afforested these areas. This resulted in a decrease in the heathland area. The remaining heath resulted in a large area of valuable nature in 2000 at both sides of the national border. This consisted of nature reserves, agricultural areas, governmental forests, private areas, and fragmented forest areas. These areas were all properties of different land owners and had different functions and purposes (Grenspark de Zoom – Kalmthoutse Heide, 2014).

Grenspark de Zoom – Kalmthoutse Heide is established in 2001 as a crossboundary park. At that time the park covered an area of 4000 ha. In 2011 the area is expanded to 6000 ha (Grenspark de Zoom – Kalmthoutse Heide, 2014).

Nowadays there are still some private land owners left in the park (figure 2).

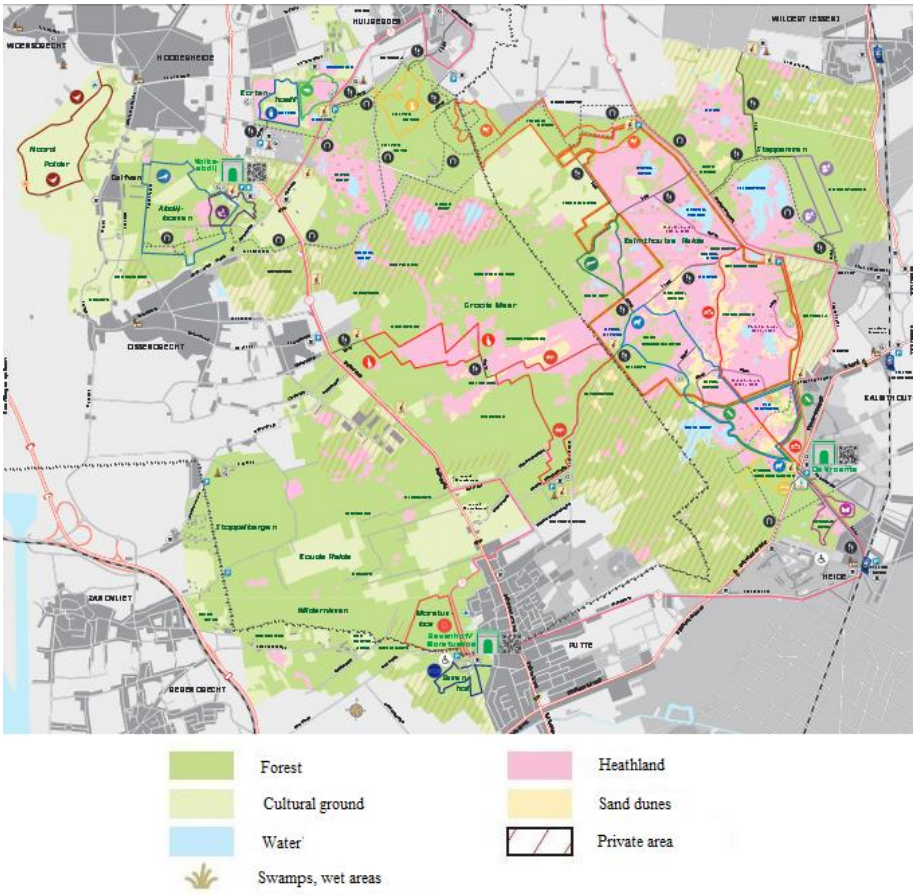


**Figure 2. Overview of habitat types in grenspark de zoom – kalmthoutse heide.**

## 1.2 ORGANISATION

The Grenspark is a voluntary cooperation between landowners and managers working on a common nature- and water management. This includes recreation, education and information. The vision is aimed on securing, enhancing and developing of potential present nature- and landscape values, and creating information, education, recreation, wood production and management of fauna. Development of specific ecotopes (e.g. heathlands, fens, dunes, etc.) is very important (Grenspark de Zoom – Kalmthoutse Heide, 2014).

The Grenspark is controlled by the 'Bijzondere Commissie' (special commission), which consists of representatives of all partitioning organizations and governments. This includes for example the Benelux, Staatsbosbeheer, Natuurpunt, Ministry of Defenses and the Ministry of Economics, but also private land owners, local municipalities and provinces. This commission determines the policy of the Grenspark (Grenspark de Zoom – Kalmthoutse Heide, 2014).

## 1.3 NORTHERN CRESTED NEWTS

### 1.3.1 IDENTIFICATION OF INDIVIDUALS

Northern crested newts can reach a maximum overall length of about 17cm, although there may be a difference in size between populations. Females typically reach 11 – 13 cm, while males may grow to an adult of about 15 cm (Langton et al., 2001).

The skin of adult northern crested newts has a black or dark brown background color with darker spots, which in the males extend onto the crest. On the flanks there are very fine white spots (Langton et al., 2001).

The males can be distinguished from the females by looking at the crest. Males have a jagged crest along the back and a smoother edged crest above and below the tail. From the tail tip along the central section of the tail there is a white, silver or grey stripe (figure 3a). Females, however, lack a crest and white tail stripe, but have instead a yellow-orange stripe along the bottom edge of the tail (figure 3b).

Figure 3. (A) A northern crested newt male with the white/silver stripe in the tail. (B) Females lack the stripe and the crest.

The bellies of both sexes are orange or yellow with an irregular pattern of black spots or blotches, which makes it possible to recognize individuals. Males have a more swollen and black cloaca (figure 4a), while the cloaca of the females are more orange (figure 4b) (Langton et al., 2001).

Figure 4. (A) The black cloaca of a male northern crested newt. (B) Female northern crested newts have an orange cloaca

When leaving the water, the adult males will be almost entirely black and the crest shrinks back against the body. Juveniles leaving the water lack the black spots/patterns that develop on the bellies as they grow. The white tail stripe and crest are developed in the second or third season, and normally occurs when the newts reach 9 – 12 cm in size. Juveniles cannot be sexed externally, because they lack the crest and tail stripe (Langton et al., 2001). Figure 5 shows the growth and development of the northern crested newts based on their approximately life size. This figure also shows the different shapes of the newts at each stage in their life.

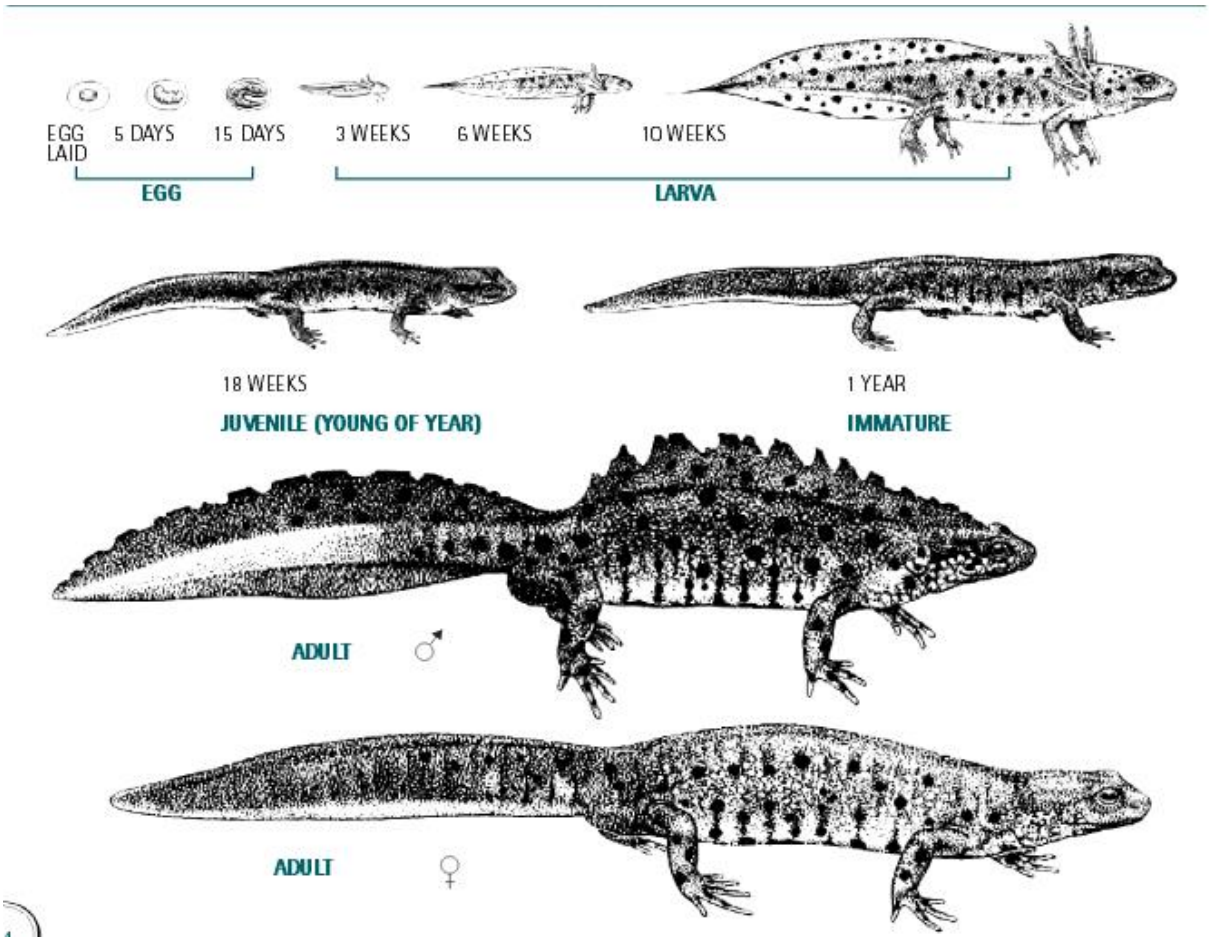


**Figure 5. Growth and development of northern crested newts at approximately life size (Langton et al., 2001)**

Northern crested newts usually lay their eggs on the leaves of aquatic plants, which serve as a refuge for the larvae. This means that the species depends on aquatic plants in their life in order to have a higher chance of survival. However it is also important to have a good structural variation in or near the ponds, because it offers diurnal refuges to adults during the terrestrial period.

### 1.3.2 LIFE CYCLE

During the aquatic period northern crested newts feed on aquatic invertebrates, tadpoles, and occasionally small fish. In this period breeding occurs. During the terrestrial periods its diet consists of invertebrates. It forages during night and rest during day under stones, logs and other refuges (European Commission, 2007).

The life cycle depends on primarily water temperature and availability. Newts show a considerable variation according to climatic conditions, because of the alternation between aquatic and terrestrial activity and dormancy. The species occurring in northern areas often hibernate during winter and have a period of dormancy during the summer (European Commission, 2007).

As mentioned earlier eggs are laid on emergent plants. They mature over a period of 12 – 18 days and the young larvae emerge and swim freely (European Commission, 2007). In figure 5 the development of the larvae is illustrated.

During their life *T. cristatus* do not migrate but disperse to adjacent pools. Individuals use a series of pools and move between them. Most of these pools serve as resting places. Northern crested newts inhabit these ponds and the adjacent terrestrial habitat. Only a small proportion of the ponds used by an individual will be used as a breeding site (European Commission, 2007). Figure 6 shows the annual activity pattern of the different life stages of the northern crested newt.

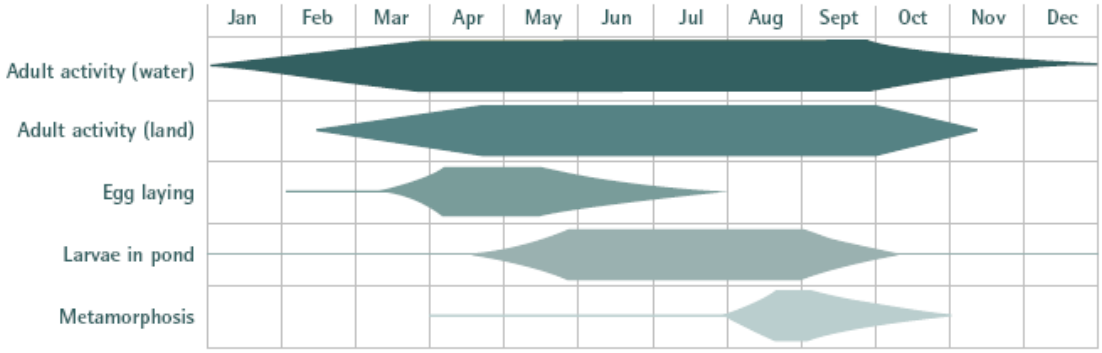


**Figure 6. Annual activity patterns of northern crested newts. (Langton et al., 2001)**

### 1.3.3 DISTRIBUTION, CONSERVATION STATUS AND THREATS

Northern crested newts (*Triturus cristatus*) belong to the family of the Salamandridae. They are also called great crested newts. Their habitat preferences range from coniferous, mixed and deciduous forests, their glades and edges to forest steppe, bush lands, pastures, meadows, parks and gardens. Northern crested newts have an altitudinal range from sea level to 1,750m above sea level (IUCN, 2013). Reproduction occurs in permanent stagnant and semi-flowing waters. Figure 7 shows the distribution of northern crested newts. It is obvious that northern crested newts are still quite common in Europe.

According to the IUCN Red List they belong to the red list category of least concern, because of its wide distribution, tolerance of a degree of habitat modification, presumed large population, and because it is unlikely to be declining fast enough to qualify for listing in a more threatened category (IUCN, 2013).

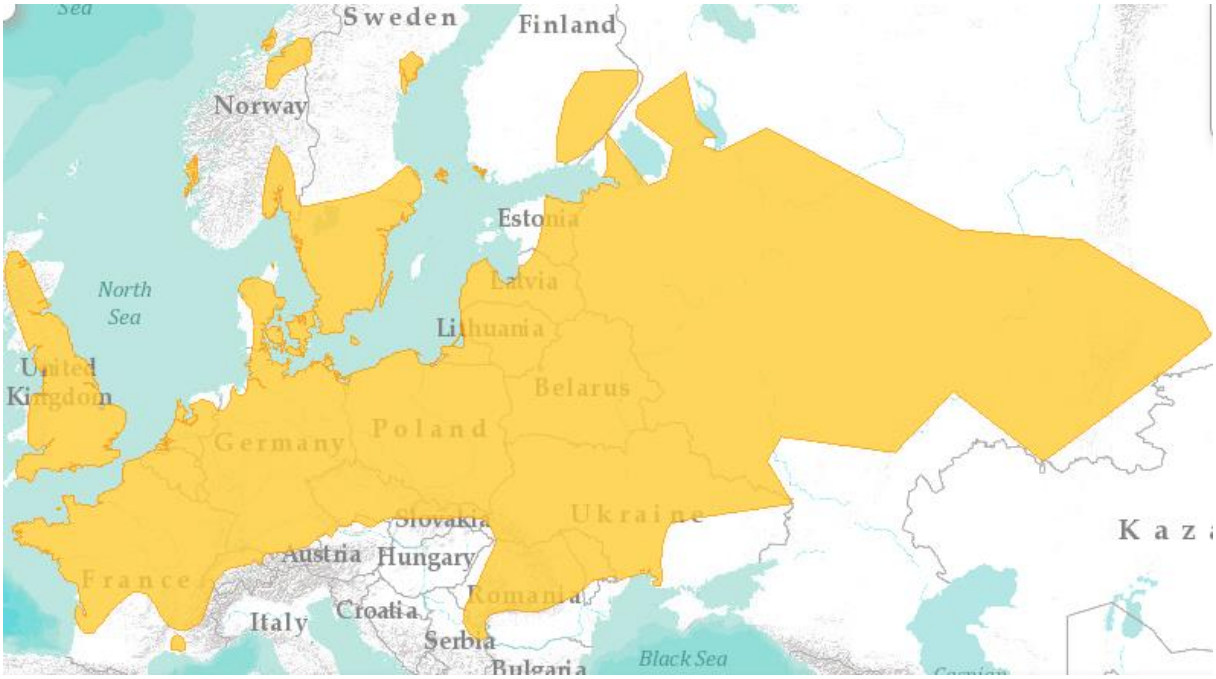


**Figure 7. Distribution of *T. cristatus*** (IUCN, 2013)

Although classified as least concern, the species is known to be declining in parts of its distribution. The general population trend is decreasing. The major threats are changes in water quality, but also industrial pollution, destruction and drainage of ponds.

Natural factors such as overgrowing, shallowing and eutrophication is harmful to populations in urban areas and populations near range margins. Also habitat fragmentation and introduction of predatory fishes can be seen as threats to the northern crested newts (European Commission, 2007; IUCN, 2013).

### 1.3.4 CONSERVATION OF NORTHERN CRESTED NEWTS IN EUROPE

Northern crested newts are listed on several international treaties and conventions. In 1985 the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) was entered into force. All EU member states are bound by the Convention's provisions. Appendix II of this Bern Convention lists the species which may neither be disturbed nor captured, killed or traded. This means that these species are strictly conserved. Included on this appendix is *T. cristatus* (Federal Agency for Nature Conservation, 2014).

Besides the Bern Convention the northern crested newt is also listed on annexes II and IV of the EU Natural Habitats Directive (BUWA, 2007; IUCN, 2013). Annex II mentions species of community interest whose conservation requires the designation of special areas of conservation. Species of community interest in need of strict protection are listed in annex IV (European Commission, 2007).

### 1.3.5 PREVIOUS OCCURENCES IN THE GRENSPARK

Northern crested newts have been observed earlier in the kwekerijven (1 female in 2005), kleine meer (2 males and 1 female in 2004, and 5 males and 1 female in 2005), the leemputten (2 males and 1 female in 2004, 7 males and 13 females in 2005, and 7 males and 2 females (of which 1 was dead) in 2006), and the ranonkelven (1 male and 1 female in 2005) (Teunen, J., 2006). According to the excel database of the Grenspark more than one individual has been found in the eastern part of the Groote Meer, and more than 6 in the western part of the Groote Meer (both in 2006).

More recent data shows that in the leemputten 2 females were found in 2010, 3 males and 3 females in 2011, and 2 males in 2013. In the western part of the Groote Meer 1 male and 2 females northern crested newts were observed or caught in 2011.

## 1.4 AIM OF THE RESEARCH

The aim of this survey is to get more information on the distribution and population growth (positive or negative) of the northern crested newt in Grenspark de Zoom – Kalmthoutse Heide. Based on the distinctive patterns on the bellies, individual *T. cristatus* can be recognized. This will be used to create a database of all northern crested newts caught during this research. The database can be used in the following years to observe whether the population is growing, which ponds are used by which individual, whether individuals survived during the interval between monitoring periods, etc.

Also two different monitoring methods will be used (more in detail in chapter 2). There is not much known about the method with the flashlight, and therefore a comparison of the different results will give possible information about which method is the most effective or efficient.

Based on the monitoring data a comparison with past years can be made to observe whether the population is increasing or decreasing.

# 2. METHOD

## 2.1 SAMPLING LOCATIONS

This survey takes place in the Dutch part of Grenspark de Zoom – Kalmthoutse Heide (figure 8). The areas included in the monitoring are Groote Meer (both the east and west side of the lake), Zwaluwmoer and the small fens North of it (kwekerijven and talingven), Kleine meer and the small fens North-West of Kleine Meer (Leemputten) and the Ranonkelven. All lakes together are referred to as domain Groote Meer

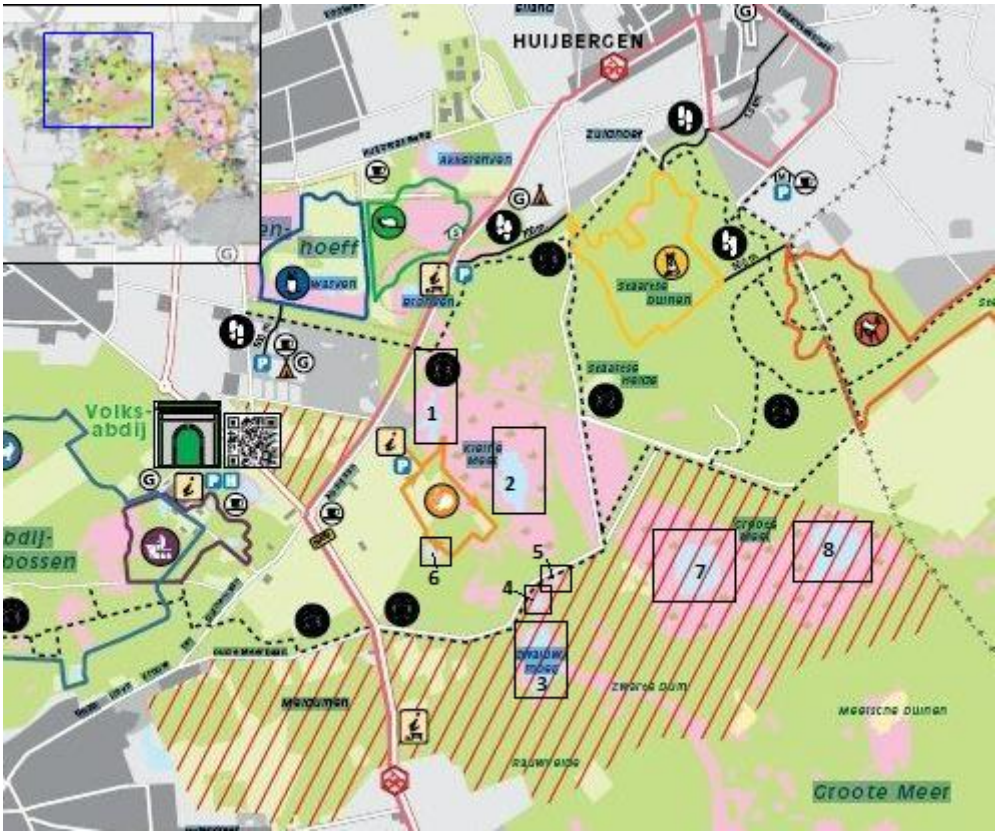


**Figure 8. Overview of a section of the Dutch part of the Grenspark. The lakes and fens surrounded by a black square are the ones that are monitored in this survey. 1 = leemputten, 2 = kleine meer, 3 = zwaluwmoer, 4 = talingven, 5 = kwekerijven, 6 = ranonkelven, 7 = groote meer west, 8 = groote meer east.**

In the following parts about the lakes and fens the surface area of the fens and lakes is estimated using google maps, because no accurate data was available on the size of the lakes. The Kleine and Groote Meer (both parts) lakes show very fluctuating surface areas as a result of the temperature and precipitation. Unfortunately no information on the history of the zwaluwmoer, kwekerijven, talingven and ranonkelven has been found.

### 2.1.1 LEEMPUTTEN

The Leemputten consist of two fens, which are separated by a small piece of land; a large fen (figure 9) and a smaller fen (figure 10). The Leemputten are a remnant of the exploitation of clayey loam used in the production process of for example tiles. After this exploitation period the area developed to a nutrient poor fen.

**Figure 9. Panoramic photograph of the southern part (and the biggest fen) of the Leemputten.**

**Figure 10. A section of the smaller fen of the Leemputten (the northern part).**

The size of the Leemputten together is approximately 2400m$^2$.

### 2.1.2 KLEINE MEER

The Kleine Meer is situated south-east of the Leemputten. It is almost fully overgrown with *Typha sp.* and purple moor grass (figure 11). As a result of the impermeable clay layers and loam in the soil water cannot penetrate the soil, remains at the surface and creates a lake or wet area. During dry summers the Kleine Meer is completely dry. Wet winter periods ensure the presence of water.

**Figure 11. Overview of the Kleine Meer area.**

The size is estimated on 2400m$^2$ during the April monitoring period.

### 2.1.3 ZWALUWMOER

**Figure 12. Panoramic view of the Zwaluwmoer.**

The size of the Zwaluwmoer is estimated at 38700m$^2$.

### 2.1.4 TALINGVEN

**Figure 13. Overview of the Talingven.**

Talingven has a surface area of approximately 13500m$^2$.

### 2.1.5 KWEKERIJVEN

**Figure 14. Kwekerijven in Grenspark de Zoom-Kalmthoutse Heide**

The surface area of the Kwekerijven is 21600m$^2$.

### 2.1.6 RANONKELVEN

**Figure 15. Ranonkelven**

An estimation of the surface area of the Ranonkelven resulted in a surface of 13300m$^2$.

### 2.1.7 GROOTE MEER

**Figure 16. Overview of the Groote Meer area. The lake in front is the western part. The eastern lake lies in the back of the picture.**

As mentioned earlier, the surface area of the Groote Meer lakes are fluctuating as a result of fluctuating temperature and precipitation. During the April monitoring the size of the western part of the Groote Meer is estimated at 129900m$^2$, while the eastern part of the lake has a surface area of 7500m$^2$.

The Groote Meer originates mainly because of the impermeable clay and loam layers in the soil. There are also impermeable layers which contain iron-oxide. The Groote Meer is well known for the plant community of the shore weed covenant (*Littorellion uniflorae*). The fen is relatively shallow. There is almost no peat formation and the soil consists mostly of bare sand. The northeastern part of the bank has almost no vegetation due to the dominant wind direction and waves that are created. On these places the plant of the *Littorellion uniflorae* are found. However over the last decades there is a decrease in the population of these plants, mainly due to dehydration, acidification and nutrient-rich water entering the fen. In

the eastern part plants such as reed (*Phragmites australis*), yellow iris (*Iris pseudacorus*) and longroot smartweed (*Persicaria amphibia*) occur as a result of the agriculture in the Steertse Heide. The Grote Meer is mainly rainwater and surface water fed. Only a small part receives upwelling groundwater.

During the 17th century the hydrology of the area is frequently altered. In the 17th century the area served as a fishing pond. Several canals were dug to other fens in the area. At the end of the 19th century the heathland was converted to pine forest. At the beginning of the 20th century the Steertse Heide was mined, which resulted in an important change of the hydrology. The drainage water flowed towards the Groote Meer, which resulted in very high water levels and the need to drain the excessive water from the Groote Meer into the polders. A second big change in hydrology is due to the groundwater extraction, especially in the sixties (Teunen, J., 2006).

### 2.1.8 HISTORY OF DOMAIN GROOTE MEER

For centuries the Groote Meer area knew different owners. In 1870 father and son Servais bought different grounds and created the domain. This consisted of the fens and the surrounding land. In 1890 the first building was built (the house 'Politie' were the forester lives). In 1895 the 'Meerhuis' was built. Approximately 14 people (including women and children) worked on the domain for the Servais family. After several years a 'jachthuis' (called 'Het Hof') has been built.

The drive from the Putseweg to the Meerhuis was finished around 1900. This driving lane was 1300 m long and had to be straight. As a result it was built partly through the Zwaluwmoer. On the highest hill a watchtower called Belvedère was made.

The Servais family sold the area in 1902 to the Manceau family (shipowners from Antwerp). The existing forest was deforested and the Kleine Meer would become an agricultural area. As mister Manceau was not very friendly, no one felt bad when he sold the area in 1919 to Joseph Cogels, an investor from Schoten.

The Cogels family was very friendly and because of them several hectares of forests was planted and dehydration of the Kleine Meer was stopped and reversed. Cogels was a hunter and preferred forests and fens over agriculture. The grandfather of Wilton de Dooij (forester in the area nowadays) and his three sons worked in the forests and maintained the remnant agricultural field, which had some cows, sheep, geese, and chickens.

During the Second World War a lot of wood got cut by the Germans and all buildings were destroyed. Except for the watchtower all buildings are restored. Joseph Cogels died in 1954 and his son expanded the area to almost 750 ha. In 1960 the family van Havre made a house near the Groote Meer Lake and lived there from the beginning of the sixties with their children. After their parents passed away they sold their part of the domain to Natuurmonumenten in 1999. Wilton de Dooij worked since 1983 for family Cogels, and was involved in the take-over of the domain. That is how he joined Natuurmonumenten (de Dooij, 2007).

## 2.2 MONITORING

As mentioned in the introduction two monitoring methods are used. A first method consists of setting traps (figure 17) at each location (depending on the size of the lake). The day after setting the traps, they are emptied and the captured newts are counted and photographs are taken of their bellies. Of each individual the sex is noted. All other newt species are also monitored. This will be done twice (once in April and once in Mai (As illustrated in figure 6 April and Mai are months in which the newts have optimal activity in the water)), and can be seen as a capture-mark-recapture method. Therefore also the population size in each fen or lake can be estimated.

**Figure 17. One of the newt traps used in the monitoring.**

The second method is based on visual monitoring. This means that the newts are not caught and thus there are no photographs taken. A flash light is used on the water surface to observe newts that have to get air. All species of newts are counted.

## 2.3 DATABASE

A database has been made in Microsoft Access 2010. This database consists of five different tables (one per newt species, and one with the individual northern crested newts). Although each table contains information on the monitoring date, location and number, the table for the northern crested newts is more specific as number of individuals is divided into males and females. There is also a column with attachments, which contains the photographs of the belly patterns of each individual caught. All previous occurrences of the northern crested newts have been added to this database. The database also provides information on the monitoring method used, as a distinction is made between visual observations and caught newts.

## 2.4 STATISTICAL ANALYSIS

Statistical analysis will be done in R 2.15.2 ( R Core Team, 2012).

At first the different monitoring methods will be compared. Based on one measurement with a flashlight and one measurement with traps in each lake, a Wilcoxon rank sum test is used, to compare the outcomes for each location and for the total number of newts monitored with both methods in all lakes.

Second the monitoring data with traps in April can be compared (with a two-sample T-test) with those in Mai to observe differences in monitoring period. This can be important, because the weather conditions in April do not have to be optimal for the newts and therefore fewer newts are monitored, or the winter period could have been warmer and therefore the newts are earlier active, reproduce earlier, and move earlier to deeper waters.

The surface area of the lake can also influence the occurrence of the newts. Therefore simple linear regression will be performed to observe whether the number of newts depend on the area of the lakes and fens.

Finally the monitoring data of this survey will be compared with those of last years, to observe whether or not the total population is increasing. This will be done with a simple linear regression.

# 3. RESULTS

## 3.1FLASHLIGHT

Monitoring with a flashlight took place in April only. Table 1 shows the number of individuals per species observed with a flashlight during the evening monitoring. These results will be discussed later in chapter 4.

**Table 1. Results of monitoring with flashlight in April**

| Location | Northern Crested Newt (*Triturus cristatus*) | Smooth newt (*Lissotriton vulgaris*) | Alpine newt (*Ichthyosaura alpestris*) | Palmate newt (*Lissotriton helveticus*) | Green frog (*Pelophylax sp.*) | Common Toad (*Bufo Bufo*) |
|---|---|---|---|---|---|---|
| **Groote Meer West** | 0 | 0 | 0 | 0 | 5 | 0 |
| **Groote Meer Oost** | 0 | 0 | 0 | 0 | 2 | 0 |
| **Zwaluwmoer** | 0 | 0 | 0 | 0 | 3 | 0 |
| **Kwekerijven** | 0 | 2 | 0 | 0 | 3 | 0 |
| **Talingven** | 0 | 1 | 0 | 0 | 0 | 0 |
| **Kleine meer** | 0 | 0 | 0 | 0 | 0 | 0 |
| **Leemputten** | 0 | 1 | 0 | 0 | 3 | 1 |
| **Ranonkelven** | 0 | 3 | 0 | 0 | 2 | 0 |

## 3.2 TRAPS

In this section the results of the monitoring in April and Mai with traps are presented. In the cases that northern crested newts were observed, the photographs of their bellies are also attached. In almost all cases the traps were set for approximately 24 hours. If this is not the case it is explicitly mentioned. During the monitoring in Mai the traps were set at more or less the same places as in April. This makes a comparison between the monitoring periods more accurate.

### 3.2.1 LEEMPUTTEN

Six traps were set in the Leemputten to monitor the newts in April. Four of these traps were set in the biggest fen and 2 in the smallest fen. The traps were placed in a way that they covered a large part of the fens. The traps were emptied on 09/04/2014. 14 alpine newts (*Ichthyosaura alpestris*), 4 smooth newts (*Lissotriton vulgaris*), 3 northern crested newts (*Triturus cristatus*) and 2 green frogs (*Pelophylax sp.*) were caught in these six traps.

The northern crested newts were only found in two traps. The first one was situated in the biggest fen, very close to the smaller fen. The other one was placed in the smaller fen, close to the bigger fen.

Two males and one female of *T. cristatus* were caught. Figure 18 shows the spotted bellies of respectively the two males (18a and 18b) and the female (18c).

**Figure 18. (A & B) Spotted patterns of the bellies of two different male northern crested newts caught in the Leemputten. (C) Female northern crested newt caught in the Leemputten.**

During the monitoring in Mai six traps were used. Again four of these traps were set in the biggest part of the Leemputten and two in the smaller fen. The traps were emptied on 07/05/2014 after being for 45 hours in the water. This time only two alpine newts, three green frogs and one common frog (*Rana temporaria*) were caught.

### 3.2.2 KLEINE MEER

During the April monitoring three traps were set in the Kleine Meer area. They were emptied on 10/04/2014. Unfortunately two of these traps were empty. The third one contained 7 smooth newts.

The Kleine Meer has been monitored in Mai with three traps, which were emptied on 08/05/2014. Unfortunately no amphibians were caught in the traps.

### 3.2.3 RANONKELVEN

Monitoring with 3 traps (emptied on 10/04/2014) in the Ranonkelven resulted in 1 northern crested newt, 3 smooth newts, 2 palmate newts and 1 green frog (probably a Pool Frog (*Pelophylax lessonae*). The northern crested newt was a male and its belly pattern is shown in figure 19.

**Figure 19. The belly pattern of the northern crested newt male caught in the Ranonkelven**

The monitoring in Mai resulted in three smooth newts and 1 green frog. The traps were emptied on 08/05/2014.

### 3.2.4 KWEKERIJVEN

Three traps were used to monitor the Kwekerijven. In this fen 6 northern crested newts, 4 smooth newts, 7 alpine newts, 1 palmate newt and 1 green frog were caught. The traps were set on 10/04/2014 and emptied on the 11$^{th}$ of April. Again the green frog is probably a pool frog.

One male northern crested newts and 5 females were caught. Figure 20 illustrates the different belly patterns of these newts.

**Figure 20. Belly patterns of the northern crested newts caught in the Kwekerijven. The newt in the photograph at right bottom is the only male caught in April.**

The kwekerijven was monitored again in Mai. Three traps were set and emptied the day after it (09/05/2014). This resulted in one green frog.

### 3.2.5 TALINGVEN

In the Talingven only 13 smooth newts and 3 palmate newts were caught. Again three traps, which were emptied on 11/04/2014, were used to monitor the newts in this fen. During the monitoring in Mai the traps were emptied on 09/05/2014 and resulted in 5 smooth newts and one alpine newt.

### 3.2.6 ZWALUWMOER

During the April monitoring period four traps were set on 14/04/2014 and emptied on 15/04/2014. Only one smooth newt was caught in these traps. In Mai the traps were emptied on 02/05/2014. No amphibians were caught in the traps during the Mai monitoring.

### 3.2.7 GROOTE MEER

Three traps were set in both the western and the eastern part of the Groote Meer to monitor the newts in April. Both traps were set on 15/04/2014 and emptied on the 16$^{th}$ of April.

In the Western part of the Groote Meer 2 northern crested newts (one male and one female, figure 21), 4 smooth newts and 16 alpine newts were caught. In the Eastern part of the lake only 2 smooth newts and 6 alpine newts were caught in the traps.

**Figure 21. Belly pattern of a male (A) and female (B) northern crested newt caught in the Western part of the Groote Meer.**

In Mai the traps in the eastern and western part of the Groote Meer were emptied on 15/05/2014. In the western part one northern crested newt male (figure 22) and five alpine newts were caught, while in the eastern part one alpine newt and two smooth newts have been caught.

**Figure 22. Male northern crested newt caught in Mai in the western part of the Groote Meer.**

## 3.3 SPECIES – AREA RELATIONSHIP

In general, the number of species increases with the surface of the area (Triantis et al., 2012), because there is simply more room. This could be important from a conservation point of view, as more species could be protected by protecting a single large area. Therefore simple linear regression is used to observe whether more species of newts were caught in the bigger lakes and fens than in the smaller ones. Figure 23 shows the Species-area relationship for the results of the April monitoring.

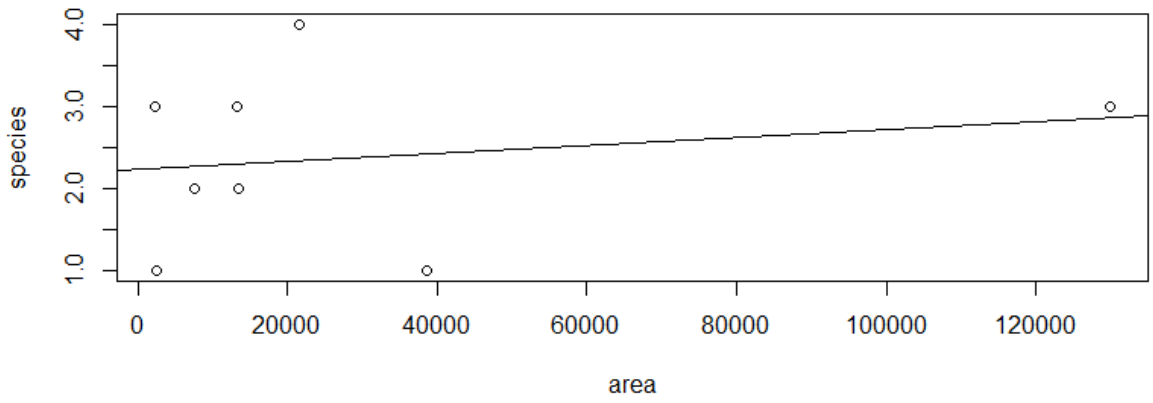


**Figure 23. Species area relationship for newts in the dutch part of Grenspark de Zoom-Kalmthoutse Heide based on monitoring data from April.**

Although the number of newt species caught in the traps seems to increase, there is no significant (p = 0.64) relationship between the number of newt species and the area of the lakes. Because there was no significant relationship between the number of species and the area, the number of individuals caught can be plotted against the area of the lakes. The same positive correlation is expected as with the species-area curve, as bigger lakes have more possible places for newts to occur and there is more room for newts to occur. Figure 24 shows the individual-area relationship.

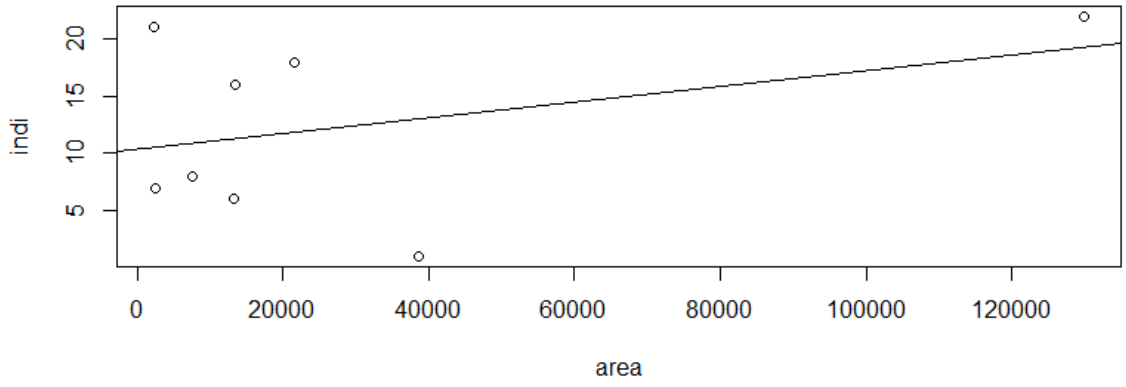


**Figure 24.Individuals-area relationship for the newts caught during the April monitoring.**

Figure 24 shows a positive correlation between the number of individuals and the size of the fens. However this is again no significant (p = 0.36) relationship.

## 3.4 POPULATION DYNAMICS

It is of major importance for the protection and conservation of the northern crested newts to observe whether the population is decreasing or increasing in size. Based on the monitoring data from the past years (starting from 2004) a simple linear regression has been made to observe the dynamics of population size over the years. Figure 25 illustrates this relationship.

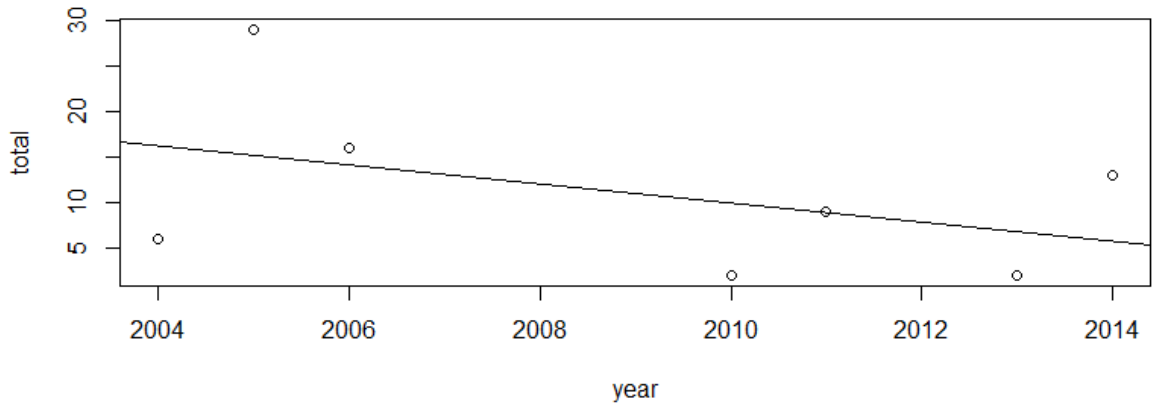


**Figure 25. Total number of northern crested newts caught since 2004.**

As can be observed from figure 25 the number of newts caught each year is decreasing over time. However this is no significant (p = 0.32) decline in population size. The figure also shows that there are major fluctuations in the number of northern crested newts over the years. A possible explanation is that Joachim Teunen from the Erasmus Hogeschool Brussel was doing a thesis in 2005 and 2006 on the northern crested newts. This could mean that the traps were set more frequently in the lakes to monitor the newts than in years like 2010. This could also be the reason for the increase in 2014, as this research is conducted in 2014.

## 3.5 STATISTICAL ANALYSIS

As mentioned earlier the results of the monitoring with the flashlight and the traps are compared between lakes and in general. In this case also the frogs are included as they were also monitored during this survey.

Statistical analysis with the Wilcoxon rank sum test show no significant difference between monitoring methods comparing the data from the Groote Meer West (p = 0.34), the Groote Meer East (p = 0.53), Zwaluwmoer (p = 1), Kleine Meer (p = 0.40), Kwekerijven (p = 0.12), Leemputten (p = 0.24), Ranonkelven (p = 0.55) and the Talingven (p = 0.46). The Wilcoxon rank sum test also shows no significant difference between monitoring methods when the number of individuals found with a certain method are summed over all location.

However when the frogs and toads are excluded from the total dataset, there is almost a significant difference between monitoring methods ($p = 0.09$).

When we only look at the results of the two monitoring methods for northern crested newts there is a significant difference ($p = 0.01$) between the methods. Comparing the two methods only for frogs results in a non-significant difference ($p = 0.54$) between the monitoring methods.

Finally the number of newts caught in April is compared to the number of newts caught in Mai to observe whether there is an effect of the monitoring period on the number of newts monitored. A significant ($p < 0.05$) difference has been found between the total number of newts monitored in April and in Mai. This means that there are significantly more newts caught in April (on average 12.375) than in Mai (on average 2.5).

# 4. DISCUSSION

## 4.1 COMPARISON BETWEEN MONITORING METHODS AND PERIOD

Based on the results it was expected that there is a significant difference in efficiency between the monitoring methods. 99 newts were caught with the traps, while only 7 were observed with the flashlight. However when the frogs and toads were included only 103 individuals were caught in the traps, while 26 were observed with the flashlight. This resulted in non-significant differences between the monitoring methods when the frogs were included. However when the frogs and toads were excluded from the dataset (and thus only newts were included) there is almost a significant difference between methods. When we only look at the difference in efficiency for monitoring northern crested newts there is a significant difference between methods.

Although this all seems logical, a few errors might have been made. First of all it is possible that not enough time has been spent in each lake with a flashlight to monitor these lakes perfectly. Besides that, it is also possible that the observer overlooked newts during the evening monitoring periods, because of a reduced sight in the water and surroundings. The only visible area is the area where the flashlight is focused on. This means that newts that get up for air in a dark(er) area are not observed. A third reason that could have caused this difference in efficiency is that walking in the water from area to area scared the newts. Walking in the water also caused more sediment to go into suspension, which resulted in no clear vision of the water and soil.

As mentioned earlier, a significant difference is found in the results of April and Mai, with more newts caught in April than in Mai. A possible explanation is that northern crested newts need macrophytes in their lifecycles. Because of the relatively warm winter and spring in 2014 they could have started reproducing earlier than the beginning of April (according to figure 6). This could also mean that the reproductive period ends earlier (e.g. at the end of April), after which the adult newts move to deeper waters with fewer macrophytes. As a result fewer newts are caught, as the traps were mostly placed in deeper areas near submerged plants.

## 4.2 POPULATION SIZE AND GROWTH

In section 3.4 a negative non-significant trend in population size for northern crested newts was found over the years. However when we look at the actual numbers instead of the trend, there is an increase in the number of northern crested newts compared with 2013. As mentioned earlier this could be due to the fact that in 2014 this study took place. Unfortunately only one northern crested newt was caught in Mai. This one was not caught in April, which means that the population size should be higher than the 13 caught individuals, as not all individuals will get caught in the traps and the traps do not cover the entire surface area of the lakes.

## 4.3 RELATIONSHIP WITH SIZE OF THE FENS

It can be expected that larger fens or lakes contain larger populations of newts and more individuals or more species of newts than smaller fens, as there is more space for these individuals to live, survive and reproduce.

However, the size of the fens is not the only factor affecting the presence of newts. Environmental factors such as pH, temperature and conductivity can also play a major role in the presence of newts. Also vegetation is important, as newts depend on the submerged plants for their lifecycle. The results shown in 3.3 show that although there is a positive correlation between the size of the fens and the number of species and number of individual newts, this correlation is not significant. This means that other factors, besides the size, play a role in the presence or absence of newts. For example only 1 newt was caught in the Zwaluwmoer, which is one of the biggest lakes monitored. However, the Zwaluwmoer is a relatively acid lake, which could influence the presence of newts.

# 5. RECOMMENDATION

Based on the results it can be concluded that monitoring northern crested newts with a flashlight is a less efficient method than using traps. However if you also want to monitor frogs, both methods can be used as there is no significant difference between the methods for frogs. This means that depending on the species you want to monitor, different monitoring methods can be used. However the best option for northern crested newts, according to this research, remains the monitoring with the traps.

Although only 13 northern crested newts were caught, and this number is less than in 2005 and 2006 (during the study of Joachim Teunen), there is still an increase in number observed compared to 2010, 2011 and 2013. It is also expected that there are more northern crested newts present in the fens than the 13 individuals that were caught during this study, because the capture-mark-recapture method showed that in the recaptured sample no previously marked individual was present. However, the recaptured sample consists of only 1 individual, which makes this conclusion less accurate and could have biased this result.

Joachim Teunen gave some ideas to manage the population of northern crested newts in the Grenspark. Based on this study and the number of newts caught, it is suggested that no extra protection measures should be taken, as there is an increase in population size compared to 2010, 2011 and 2013 and the population is expected to be almost the same as in 2006 (16 individuals were caught then). However, more monitoring data is required to estimate the exact population size and to observe the real population dynamics. It is therefore recommended to monitor each of the fens more frequently during the year (especially in April), make the database as complete as possible, and use these data to estimate the population size more accurate. Only when those things happened, it will be clear whether or not new protection measures must be taken.

## ACKNOWLEDGEMENTS

I would like to thank the Grenspark for the opportunity to do my internship at their organization and especially my external supervisor Ignace Ledegen for lending me the materials and for helping me with the research when I had questions or problems. I would also like to thank family de Dooij for helping me with the transportation of the traps when needed. Finally I would like to thank Prof. Dr. Erik Matthysen, my supervisor from the Universiteit Antwerpen for his time and help concerning the reports.

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