MONITORING METHODS FOR THE GREAT CRESTED NEWT *TRITURUS CRISTATUS*

PROJECT REPORT

"Protection of *Triturus cristatus* in the Eastern Baltic region"
LIFE2004NAT/EE/000070
Action A2

LARS BRIGGS
RIINU RANNAP
PIRET PAPPEL
FLORIAN BIBELRIETHER
ALEKSI PÄIVÄRINTA

VEJLE AMT

TALLINN-ODENSE 2006

INTRODUCTION

For the monitoring of the great crested newt *Triturus cristatus*, as well as amphibians in general, the experts in separate countries currently employ different monitoring methods. Therefore, the results gained are often not suitable for comparison. For example, Estonia has applied mainly two monitoring methods – egg searching and dip netting of larvae, which is an efficient way to gain an overview of the species' existence (eggs, larvae) and breeding success (larvae), while not providing information concerning the number of individuals in a particular water body. In addition to the methods mentioned, Denmark also has made use of the nocturnal counting of adult individuals in a water body. The primary monitoring method in Finland has consisted in live trapping and nocturnal counting of the individuals in a water body, which gives a chance to estimate the number of adult individuals in a water body, but does not provide any information on the species' breeding success. In Latvia and Lithuania, the method of visually establishing the presence of adult newts has mainly been employed.

In order to be able to compare the population estimates and find out the status and trends of the populations in different countries and larger regions, it became necessary to work out a common monitoring methodology for the great crested newt. Thus, in the frame of LIFE-Nature project „Protection of *Triturus cristatus* in the Eastern-Baltic region" (LIFE2004NAT/EE/000070), such a common monitoring methodology has been elaborated as a result of cooperation between experts from Denmark, Estonia, Finland, Germany and Lithuania. The elaboration of an optimal monitoring methodology was carried out by testing and analysing the various methods used in several countries.

The common monitoring methodology, worked out in the course of the above-mentioned project, provides a more exact overview of the situation of the species and the annual changes at the level of populations and meta-populations. Moreover, this methodology allows for assessing breeding success and estimating the number of adults in a water body as well as in an entire meta-population, at the same time making it possible to compare the status and trends of populations in different countries and regions. The monitoring methodology will be applied in the Eastern Baltic Region and Denmark, and it could also be followed in other European countries.

1. DESCRIPTION OF MONITORING METHODS

Several monitoring methods have been used in order to collect data on the status of amphibian populations in different countries. Each of these methods used is described below. Moreover, all these methods have also been tested and further analysed by several experts in Denmark, Estonia, Finland and Germany in the framework of the LIFE-Nature project. The comments added to each method are based on our own experiences.

1.1. Egg searching

Overview
This method is not too time-consuming and it is rather cheap. It is suitable for discovering new breeding sites of newts. It is also useful also for recording small populations situated between dominant populations, inhabiting temporary ponds or ponds with fish. This method does not give much information about population size or habitat quality; it only provides a possibility to register the presence of species (see Table 1). The method will prove very time-consuming in large and densely vegetated water bodies.

Description
Searching newt eggs means examining floating vegetation for the rolled egg cases of newts. Newts use soft-leaved plants like *Myosotis*, *Myriophyllum* and *Potamogeton* for egg-laying.

- Conduct the survey in late spring/early summer (depending on the temperature) – in the months of May and June (during cold years, July could also be possible in Estonia).
- Check for soft-leaved plants in the pond.
- Walk around the pond and register visible egg cases. Rolled egg cases look like folded leaves.
- To confirm species identification, some eggs may be unwrapped. White or light yellow jelly-covered eggs become visible when unwrapped.
- Evaluate the amount of eggs and fill the form.
- If pond schemes are drawn, mark areas with suitable vegetation and the presence/absence of eggs.

NB! Searchers should be very careful not to damage vegetation and eggs. There is no need to unwrap a huge amount of egg cases. Unwrapped eggs may be more sensitive to UV-rays and invertebrate predators.

A POSSIBLE DATA FORM

The number of eggs could be divided into 3 classes.

Locality: Date: *(Evaluate the amount of eggs and mark with a cross!)*				
Species	**Amount of eggs**			
	absent	***a few*** (1-10)	***several*** (<100)	***numerous*** (>100)
Triturus sp.				
Triturus vulgaris				
Triturus cristatus				

Data attainable
This method is very effective for detecting the presence of newts. Extra time to find eggs might be necessary in the case of very small newt populations. The method does not give any meaningful quantitative information on population parameters.

Failure spots – factors influencing survey results

- Excessively dense vegetation
- Large water body
- Deep and/or unclear water
- Inadequate timing of surveys
- Inexperienced field-workers

Conclusion
This method is rather effective for discovering the presence of newts.

1.2. Dip netting of larvae

Overview
This method is not time-consuming and it is rather cheap. It is suitable for searching new places of newt presence. The method gives information about breeding success and thereby also of the quality of aquatic habitat for successful reproduction (see Table 1).

Description
Dip netting for newt larvae means catching and counting newt larvae – the total number for 10 catches. In the case of large ponds and water bodies (more than 500 m^2), up to 50 catches should be made.

- Conduct the survey in the summer (depending on the temperature) – in June, July (during cold years, early August could also be possible in Estonia).
- Walk around the pond and make 10–50 catches. All corners of the ponds should be covered. The centre of the pond with open water and floating

vegetation should also be dip netted in order to catch large larvae that often stay in the deeper part of the pond. If the entire vegetation zone of the pond is not covered, more dip nets should be used. If no great crested newts have been caught after the 10th dip net, but water quality is good and there is suitable soft-leaved vegetation in the pond, dip netting should be continued. The total time of dip netting depends on the local conditions and the experience of the dip netter. In any case it should be recorded, which dip netting session yielded the first larvae. If fish is caught, there will probably be no great crested newt larvae or the number of larvae is very insignificant.

- To confirm the species, use the field guide. It is easy to distinguish between smooth and great crested newt larvae on the basis of the long tail tip. Distinguishing can be more difficult if larvae are very young.
- Count the number of larvae per 10 catches.
- If pond schemes are drawn, mark areas with suitable vegetation

NB! Searchers should be very careful not to damage the gills of the larvae. Netting can cause disturbance in the pond, and should therefore be employed with care to minimise this impact. Fish eggs and almost invisible plant seeds can also be transferred between different ponds via nets. Nets should be cleaned and dried if doubt of spreading fish/harmful plants occurs.

Data attainable
The results indicate mainly the breeding success of the species, but also the presence of the species. The information on breeding success helps distinguish between the "source" ponds and the "sink" ponds in the meta-population system.
Studies on population parameters should combine this method with counting of adults (in the form of torch surveys and adult trapping).

Failure spots – factors influencing survey results

- Inadequate timing of surveys
- Inexperienced field-workers
- Extreme physical conditions (rain, heat, etc.) can influence the movement of larvae

Conclusion
This method is cheap and effective for discovering the presence of newts.

1.3. Fence methods

Overview
The method is time-consuming and the investigation of one pond can have a time span taking up several months.
The method gives a very exact population estimate of both adults entering/leaving the pond and juveniles leaving the pond. The method also provides information on the migration paths of adults, especially into the pond (see Table 1).

Description
Before the time of migration from hibernation site to breeding site, a flexible amphibian fence has to be erected around the breeding pond. The fence must be

erected so that it is impossible for newts to climb over or dig under the fence. This means it is C-formed to avoid climbing over and digging under. The fence is connected to buckets (10 litres with vertical sides) or wooden boxes (40 cm x 30 cm x 30 cm), which are placed outside of the fence and buried in the soil so the top will be at the same level as the soil. Both buckets and boxes must have a minimum 5 cm inwards edge at the top, to keep climbing newts inside. The buckets or boxes must have a moist material of leaves and soil in the bottom, so that the newts can keep themselves moist and free from predator attacks for at least 4–12 hours, depending on how often the buckets/boxes are checked.

- Conduct the survey of adult population from January to March (in South-Germany and France), from February to April (in Denmark, Germany, Poland and South-Sweden), from March to May (in Latvia, Lithuania and Sweden) and from April to May (in Estonia and Finland), depending on the migration time from hibernation site to breeding site. Conduct the survey of juveniles from July to October, depending on the beginning and end of the juvenile migration.
- Write the data down on a form, so that the number of newts in each individual box can be counted each day.

NB! Searchers should be very careful not to damage the fence, and quickly repair damages in the fence created by humans or animals.

A POSSIBLE DATA FORM

The number of specimen could be divided into 3 classes.

Locality: Date and time: Weather:				
Species	**Box nr**	**Number of females**	**Number of males**	**Number of juveniles**
Triturus cristatus	1.			
Triturus cristatus	2.			
Triturus cristatus	3.			
Triturus cristatus	….			

Data attainable
The method is very effective for detecting the total number of newts.

Failure spots - factors influencing survey results

- Incorrectly erected fences.

Conclusion
This method is effective for counting the total number of adult newts breeding or the total number of juveniles leaving the pond. This method is to be used if there is only one suitable breeding pond available for the newts.

1.4. Searching of adults with torches

Overview
This method can be used for conducting a minimum estimate of the size of the population. It can be employed early in the season. This method is also less time-consuming than the fencing method. In some ponds, the searching of adults with torches is the easiest way to find adult newts. This method is often more reliable than dip netting of adults (see Table 1).

Description
Searching of adults with torches can be carried out at night, especially in the early hours of the night, during the breeding season, when the adult newts are active in the ponds. The walk around the pond with the torch has to be made when it is dark. All spotted newts should be registered during the walk.

Data attainable
The method is effective for reaching a minimum estimate of the size of the population. This method does not give much information on breeding success.

Failure spots – factors influencing survey results
- Excessively large ponds
- Insufficiently small population size
- Dark or unclear water, resulting in bad visibility

Conclusion
This method is rather effective for achieving a minimum population estimate.

1.5. Trapping method

Overview
The trapping method is used to estimate the local population size of newts, by making use of capture-recapture of individuals and photo marking (Bibelriether, 2006). This method can also be used for verifying the presence of the species. For this method, simple funnel traps (based on the model suggested by GRIFFITHS, 1985) are proposed. The trapping method is time-consuming. The traps are set in the evening and must be emptied every 4 hours (see Table 1).

Description
First, the funnel traps have to be built according to suggestions given by GRIFFITHS (Fig. 1). Building the trap requires plastic bottles (1.5–2 litres), strong tapes, water-proof markers and sticks for fixing the traps to the ground.

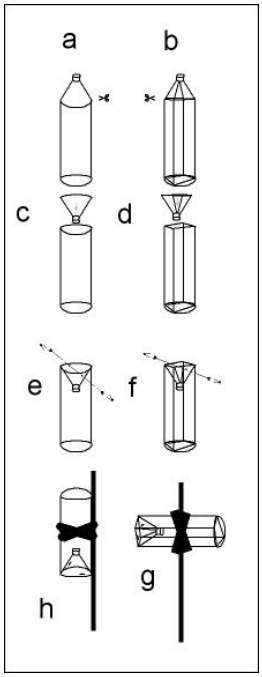

Figure 1. Construction of funnel trap

The traps (at least 10 of them) will be installed into the water body according to its size and volume. The traps have to be fixed to a metal stick, which will be pushed into the bottom of the pond (Fig. 2). The traps should be situated under water at the level of half to one meter in the bottom of the pond. The inlets of the traps have to form an angle of approx. 45° with the bottom. An air-bubble for breathing has to be left within the traps. The traps must be set in the evening and emptied in the morning, the latest.

Depending of the size of the pond, the number of traps should vary from a couple of traps to 30 traps, situated about five meters apart from each other. The trap inlet should be directed towards the pond centre. The best places for traps are often near underwater logs. The top of the trap stick must be visible enough in order to ensure that traps will not be lost in the pond.
The number of traps must be counted before trapping the site because it will endanger newt population if a trap is forgotten in the pond!

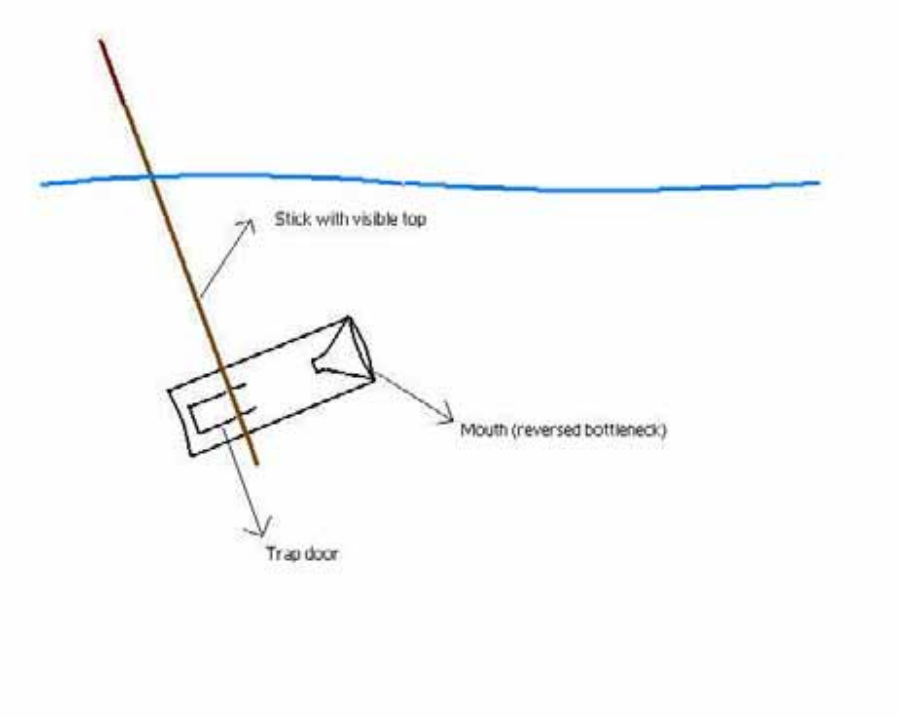

Figure 2. Instruction for placing of funnel trap

When water temperature is considerably high, this method should not be used because the newts will possibly suffer from the lack of oxygen. We have used funnel traps in a pond when water temperatures were between 5 ºC and 15 ºC. It should be kept in mind that when water temperature is well over 10 ºC, the time period before releasing newts from the traps should be only a couple of hours. With lower temperatures, the trapping time has been less than five hours.

A digital photo of the belly (ventral view) of all individuals of the great crested newt (both adults and juveniles) will be taken. The belly pattern of adult and juvenile animals is used for individual recognition.

In order to estimate the population size by the capture-recapture method, it is necessary to set the funnel traps on 3 dates with 14 days between each date.

The time of the year chosen for the investigation is of vital importance. It must be the time of breeding, when most of the adults are active inside the pond. In Southern Germany and France, the trapping should be carried out in March–May, in Denmark, Germany, Poland, Latvia, Lithuania, Sweden and Estonia, in April–June and in Finland, in May–July.

KUPFER and THIESMEIER (2000) suggest combining setting up underwater traps with offering the newts artificial daytime hiding places around the pond (e. g. boards), thus enhancing the chance of catching the animals.

To estimate the population size of the great crested newt in each pond, the following formula can be applied (SINSCH 2005):

$$N = \frac{m \cdot c}{r}$$

with: N = population size
c = individuals caught on the last day
m = total number of marked individuals
r = number of recaptures

The standard error for this method is the following:

$$SE(N) = \sqrt{\frac{(m+1)(c+1)(m-r)(c-r)}{(r+1)^2(r+2)}}$$

The standard deviation is the following:

$$s = \sqrt{\sum_{i=1}^{n} \frac{1}{n-1}(x_i - N)^2}$$ red values

N = mean value

n = total measurements

The prerequisite for this method is that in-between the emptying intervals, the population has to have enough time to completely mix itself anew. In Lützelburg, Germany, where the tested water bodies were small, this was assumed to be the case.

Data attainable

It is possible to estimate the population size at a certain site with the mark-recapture method. For this reason, individuals have to be caught and permanently marked. Installing simple funnel traps like suggested by GRIFFITHS (1985) or KÜHNEL & RIECK (1988) is, in comparison with other methods like completely fencing a pond for a long period or night counts, rather cheap and efficient. COOKE (1995) estimates that with underwater traps, 6 to 10 percent of the whole population can be caught, given a sufficiently lasting exposure of the traps at the site. However, any such data will have to be treated very carefully, as it is well known that newt populations can be subject to considerable changes over the years (e. g. ARNTZEN & TEUNIS 1993, BAKER 1999).

Failure spots – factors influencing survey results

- The success of this method will be influenced by the size of the pond, the density of the vegetation and the amount of set traps.
- One has to be critical as to the amount of newts caught. If one catches less than 10 percent of the population per catch, the population estimate has a significant uncertainty factor. Optimally, about 50% of the population should be caught per catch.
- Newts can die in the traps if there is not enough oxygen, and thus it is recommended to empty the traps every 4 hours.

Conclusion:

Installing simple funnel traps in ponds for surveying the great crested newt is a reasonable and cheap option and/or addition to other herpetological standard methods (fencing in, night counts). It is possible to use other forms of traps in addition or instead of funnel traps. The light trap (Krone 1992) has proven to work as a trap.

Trapping of adult newts may sometimes be the best way to gain an overview of the species' existence when breeding success is low and the environmental factors are not suitable for reproduction any more. Because the crested newt is a long-lived animal, it may be possible to improve its living conditions after the presence of the species has been detected in the area.

1.7. Searching of hiding juveniles

Overview

In order to get some additional information on breeding success, the searching of hiding juveniles can be used. This method is easy to use in some habitats, for example in gravel pits. The habitat should provide several hiding places for juveniles, such as stones, logs, etc. On the other hand, searching completely or partly destroys hiding places in deadwood, especially in natural habitats (see Table 1).

Description

Juvenile newts usually spend daytime in moist places: inside moss or burrows, under litter, stones or logs. In some habitats, such as gravel pits, it is easy to find the daytime hiding places of juvenile newts. First, the possible hiding places (logs, stones, pieces of wood, etc.) should be discovered, and than lifted up in order to find juvenile newts. This method can be also used for forest ponds, in case there are logs available around the pond.

Data attainable

The method provides reliable information on breeding success. It is not a very solid method for estimating negative breeding success because it can just be too difficult to find the juveniles. It can be used only in a limited number of habitats.

Failure spots – factors influencing survey results

- The method is unsuitable for use in village landscape (the juveniles could hide under the buildings) or in case there are no visible hiding places.
- In case the number of juveniles is small, it can be difficult to find them.

Conclusion

It is possible to use the method in gravel pits, if dip netting of larvae is not possible (ponds are too large, larvae are too few). This method mainly functions as an additional way to determine breeding success, besides the easier ways, such as dip netting of larvae.

Table 1. Possible monitoring methods for the great crested newt *Triturus cristatus*

Method	Advantages	Disadvantages	Type of data
1. Egg searching	Can start early in the season. Cheap. Good for searching new places. Provides results every year, also in temporary ponds.	Not much information about populations or quality of habitat. Not always possible to use in the case of large ponds/lakes with a lot of suitable vegetation.	Presence of the species – mainly qualitative information.
2. Dip netting of larvae	Quick – not time consuming. Cheap. Good for searching new places.	In temporary ponds some data can be lost – ponds will dry up too early.	Breeding success – mainly qualitative information. Data on breeding conditions and quality of aquatic habitat.
3. Adults			
3.1. Dip netting of adults	Bi-catch when dip-netting for larvae.	Difficult to use at daytime. Accidental.	Minimum population estimate.
3.2. Searching for adults with a torch	Can start early. In some ponds the easiest way to find adults. More reliable than dip netting of adults.	Difficult to use in big ponds.	Minimum population estimate.
3.3. Using traps	Can start early. Capture-recapture estimate possible by using photo marking.	Time consuming. Only in ponds with cold water; warm water can induce death in traps. Requires permission in some countries.	Minimum population estimate. Total population estimate.
3.4. Using fences	Can start early. Precise info on one certain place. Good in connection with infrastructure development (N2000A and EIA).	Time consuming. Difficult to set up around larger ponds or forest ponds.	Total population estimate. Migration direction into and out of the pond. Migration in terrestrial habitat.
4. Juveniles			
4.1. Searching for hiding juveniles	Easy to use in some habitats, for example gravel pits.	Habitat dependent – not suitable in the forest.	Successful breeding.
4.2. Using fences	Can measure breeding success not found by other methods.	Time consuming. Difficult to set up around forest ponds or larger ponds.	Migration direction out of the pond.
5. Information about the species			
5.1. Interviewing local people	For localities with no previous information about the presence of species.	Not very precise, people mix up the species.	Possible presence of the species in the area.

2. IMPLEMENTATION OF THE METHODS

While testing and analysing different methods as well as collected data, it became obvious that in order to gain a reliable and thorough picture of the state of the population, one single monitoring method is not sufficient. Thus, different monitoring methods should be combined. Searching for eggs, for example, gives information about the presence of the species. At the same time, newts sometimes lay eggs also in the ponds that dry up too early or contain fish. Thus, to be able to conclude the presence of breeding success (the viability of the population), egg searching as a single method is not sufficient. Therefore, to determine the presence of the species as well as breeding success, dip netting of larvae should be used in combination with egg searching. This combined method allows us to compare populations on a landscape level.

The selection of methods depends on different factors – the size of the site and the number of ponds in it, the resources available, the aim of the monitoring and desired preciseness of data. In the case of small populations with less than 10 breeding ponds, searching adult newts with a torch is appropriate in order to get a minimum estimate of the population size (see Table 2). This method should be combined with egg searching and dip netting of larvae. If there is only one pond with the great crested newt in a Natura 2000 site, fencing the pond or trapping adult newts might be used in order to a achieve a more precise estimate of the population size. For large areas with more than 10 breeding ponds, the combination of eggs searching and dip netting of larvae will be vital.

To be able to estimate the population size on pond level as well as to evaluate the strength of the meta-population on landscape level, we propose several parameters (see Table 2).

In order to estimate the population sizes of breeding animals in a given year, the parameters $\mathbf{N_{cr}}$, $\mathbf{N_{min}}$ and $\mathbf{N_{tot}}$ have been proposed (see Table 2). Trapping of adults, searching of adults with a torch and fencing the pond allow for gathering data about the population size. This type of data is appropriate in the case of isolated areas with less than 10 breeding ponds. If the breeding population size is 500 to 1,000 adults, the population can be considered vital, and the conservation status of the population favourable.

On landscape level with larger meta-populations (more than 10 ponds) that are more or less connected, using parameters **P**, $\mathbf{P_b}$ and $\mathbf{P_{ba}}$ has been proposed (see Table 2) in order to evaluate and compare different pond landscapes. On meta-population level, it is vital to have enough sites with positive breeding success in order for the species to be able to spread and colonise new available ponds and habitats. Therefore, the parameter of breeding success (P_b) is the most important to monitor. To achieve better understanding of the meta-populations, it is also recommended to investigate the number of sites with the presence of adult newts by searching for eggs (indicated P).
If both P and P_b are attained in a year, it is possible to calculate P_{ba}, which indicates the percentage of the ponds with adults who also indicate successful breeding. The higher the percentage of ponds with breeding success, the better the habitat (good water quality, no fish), and the more viable the population.

The parameters P, P_b and P_{ba} can be investigated and calculated every year, or every two, three or five years, depending on the monitoring program and taking into account the landscape type, number of ponds at the site or the size of the site.

Table 2. Proposed monitoring methods for different pond landscapes
(X – favourable method, (X) – method is useful in some cases)

Method	**Wider landscape (>50 ponds)**	**Site with populations in many ponds (>10 ponds)**	**Site with few *Triturus cristatus* ponds (<10 ponds)**	**A figure for comparing between countries and sites.**
1 Searching for eggs	X	X	X	Number of ponds with the species divided by the total number of ponds investigated gives P. P – can be given as a percentage.
2 Dip netting of larvae	X	X	X	P_b – percentage of ponds with breeding success out of the total number of ponds (investigated). P_{ba} – percentage of ponds with breeding success out of the total number of ponds with adults.
3. Trapping of adults	-	-	X	N_{cr} – capture-recapture estimate of the breeding population in a given year.
4. Searching adults with a torch	(X) An additional method to egg searching, also indicating a minimum population estimate.	(X) An additional method to egg searching, also indicating a minimum population estimate.	X	N_{min} – minimum estimate of the breeding population.
5. Fencing method	-	-	X	N_{tot} – a total estimate of the breeding population in a given year.

In the case of small isolated sites with only 1–2 breeding ponds, the monitoring of the population should be carried out at least every two or three years in order to register the possible negative trend in an early stage. The short monitoring interval is also important for noticing eventual negative changes in the habitat (introduction of fish in the pond).

Sites with 3–10 breeding ponds as well as large areas with more than 10 ponds should be monitored every 3–5 years. If there are 3–20 breeding ponds at the site, each pond should be checked during the monitoring period. In larger areas with more than 20 breeding ponds, a certain number of ponds (10–25% of the total) should be selected as determined ponds for each monitoring round. These certain ponds have to be monitored in every monitoring round. In addition, another 10–25% of the ponds should be randomly selected for each monitoring round at the same site in order to gain a more thorough overview of the population's situation at the site. The percentage of ponds selected for monitoring depends on the total number of ponds at the site or in the landscape (see Table 3).

Table 3. Selection of ponds for monitoring of different sites

Number of ponds with the great crested newt at the site	**Percentage of ponds with the great crested newt, selected to monitor in each round (fixed ponds)**	**Percentage of ponds with the great crested newt, selected randomly for each monitoring round**
21–40	25%	25%
41–100	20%	20%
>100	10%	10%

3. CONCLUSIONS

The monitoring methods described above were used in Finland, Estonia and Denmark when the LIFE project started. During the project, the experts from several countries have tried to apply the methods or a combination of methods in order to evaluate the population status, size and trend in different landscape situations.

When setting up a monitoring program for a population or meta-population of the great crested newt, we propose to estimate first of all the exact population size and breeding success. Our proposals are based on experiences gained with this project.

Monitoring of isolated sites with only 1 to 3 ponds with the species

The main monitoring method should be aimed at recording the continuous breeding success in all ponds. Therefore, dip netting of larvae must be employed in these areas as a main monitoring method. In some specific habitats, dip netting of larvae can be supplemented by searching for hiding juveniles. At the same time, it is also important to estimate the number of adults to be sure that the population does not drop below a critical level. It can be achieved by using either the fencing method, trapping method or counting adults with a torch. The cheapest and less time-consuming is the counting of adult newts by night with the use of a torch. This method allows estimating the

minimum population size (N_{min}). If the resources are available, fencing and trapping methods could be applied additionally in order to estimate N_{cr} and N_{tot}.
The number of adult newts in the population should be at least 100 adults in the short term and 1,000 adults in the long term.

Monitoring of small clusters with 4 to 10 great crested newt ponds

Continuous breeding success (viability of the population) is important to be monitored also in the case of small pond clusters. This should be done by dip netting of larvae.
The number of adults should also be estimated by counting the newts with the help of a torch at night (N_{min}). All ponds with the great crested newt should be monitored in a monitoring round.

Monitoring of clusters of 11 to 20 great crested newt ponds

When a great crested newt population is distributed over a wider landscape and is breeding in several ponds (more than 10), we propose to monitor the distribution of breeding newts by searching for eggs. Recording breeding success as an indicator of population viability and habitat quality is also vital and should be done by dip netting of larvae. All ponds with the great crested newt should be monitored in a monitoring round in order to estimate the status of the population.

Monitoring of large landscapes with 21 to more than 100 great crested newt ponds

When the amount of ponds in an area becomes larger, the monitoring of the individual ponds can be more extensive. Therefore, it is not appropriate to monitor all ponds with the great crested newt, but only a certain percentage of the ponds should be monitored. The percentage of monitored ponds depends on the total number of ponds in the area (see Table 3). The distribution of the species as well as the viability of the population – continuous breeding success – are the main parameters to monitor. The main monitoring methods used in a larger number of ponds are searching for eggs and dip netting of larvae. In order to evaluate the status and the trend of the population over the years, the percentage of ponds with adults (P) as well as the percentage of ponds with breeding success (P_b) should be calculated. Finally, the percentage of ponds with breeding success (P_{ba}) out of the total number of ponds with adults can be calculated. These three parameters can be a tool to compare between years or between sites.

Inventorying of new areas

In the case of new areas, where the presence of the great crested newt is not known or not proved, the first thing to start with is to make sure whether the species exists in the area or not. The best method to use in order to achieve this aim is searching for eggs of the great crested newt. This method is rather quick – a large number of water bodies can be checked during a day. When ponds are unsuitable for egg survey, they could be dip netted a little later for young larvae (this should be done early if ponds are in a bad situation, e.g. drying up).
In case of small areas with only a few suitable water bodies, trapping of adults or searching for newts with a torch can be complementarily used.
When the presence of the great crested newt is confirmed, the distribution of the species should be ascertained as the next step. This can also be done by searching for eggs, especially when there are a large number of ponds in the area.

ACKNOWLEDGEMENTS

We thank Lars Christian Adrados, Niels Damm, Sirkka Hakalisto, Marian Würtz Jensen, Ilona Lepik, Giedrijus Trakimas, Wouter de Vries and Juho-Ville Vuorio for their cooperation, comments and constructive criticism on the drafts of the report.

REFERENCES

ARNTZEN, J.W. & TEUNIS, S.F.M. (1993): A six year study on the population dynamics of the crested newt (*Triturus cristatus*) following the colonization of a newly created pond. Herpetological Journal, London 3: 99-111.

BAKER, J. (1999): Abundance and survival rates of great crested newts (*Triturus cristatus*) at a pond in central England: monitoring individuals. Herpetological Journal, London 9: 1-8.

BEEBEE, T. (1990): Crested newts rescues: How many can be caught? – British Herpetological Society Bulletin, London Nr. 32: 12-14.

BIBELRIETHER, F. (2006): Using simple funnel traps for surveying the crested newt (*Triturus cristatus*) – a cost/time analysis. Report. Inst. f. Geogr., Univ. Augsburg (manuscript) 7 p.

COOKE, A.S. (1995): A comparison of survey methods for crested newts (*Triturus cristatus*) and night counts at a secure site, 1983-1993. Herpetological Journal, London 7: 37-41.

GRIFFITHS, R.A. (1985): A simple funnel trap for studying newt populations and an evaluation in smooth and palmate newts, *Triturus vulgaris* and *Triturus helveticus* – British Journal of Herpetology, London 1: 5-10.

KRONE, A (1992): RANA 6: Erfahrungen mit dem Einsatz von Lichtfallen fuer den Nachweis von Amphibien. Pp. 158-161. Natur & Text, Potsdam.

KRONE, A (2001, Hrsg): RANA: Sonderheft 4: Der Kammmolch (*Triturus cristatus*): Verbreitung, Biologie, Ökologie und Schutz. Natur & Text, Potsdam.

KUPFER, A. & THIESMEIER, B. (2000): Der Kammmolch: Ein Wasserdrache in Gefahr. Laurenti Verlag, Bochum.

KÜHNEL, K.-D & RIECK, W. (1988): Erfahrung mit Trichterfallen bei der Amphibienerfassung. Jahrbuch für Feldherpetologie, Duisburg 2. 133-139.

SINSCH, U. (2005): Grundlagen der Ökologie: Studienbrief 1: Konzepte der Populationsökologie. Universität Koblenz-Landau, http://www.uni-koblenz.de/~eelaw/shop/abstracts/popoekologie1.pdf (24.01.2005)

Great Crested Newt Mitigation Guidelines. English Nature.2001.
http://www.english-nature.org.uk/pubs/publication/PDF/gcn0801w.pdf

HEYER et al. 1994. Measuring and monitoring biodiversity: Standard Methods for Amphibians (Biological Diversity Handbook). Washington DC, Smithsonian Institution Press. 364 p.