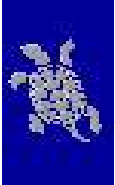




Lithuanian Fund for Nature



Project LIFE05NAT/LT/000094 “Protection of European pond turtle and threatened amphibians in the North European lowlands”

**ACTION A.6: FINDING NESTING SITES AND EVALUATION OF NESTING SITES
2005-2008**

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2 Introduction

Emys orbicularis exists at the northern boundary of distribution in the three project countries Lithuania, Poland and Germany (FRITZ 1995, 1996, FRITZ & GÜNTHER 1996). These regions are inhabited by the subspecies *Emys orbicularis orbicularis*, where turtles live under extreme climatic conditions including short summers and cold winters. This fact leads to a stressful reproduction (SCHNEEWEISS & JABLONSKY 2000). Up to the beginning of the 90's it was assumed that the extreme small and superannuated northern populations cannot reproduce any more. Though, investigations from East-Germany (ANDREAS et al. 1996, SCHNEEWEISS et al. 1998, ANDREAS 2000, SCHNEEWEISS & JABLONSKY 2000, SCHNEEWEISS 2003, 2004), Central Poland (MITRUS & ZEMANEK 1998, 2000, 2004), East-Poland (SCHNEEWEISS & JABLONSKY 2000) and Lithuania MEESKE 1997a, b, MEESKE 1998, MEESKE & RYBCZYNSKI 2002, MEESKE et al. 2002, MEESKE & MÜHLENBERG 2004) show the contrary. However, the locations and the conditions of the egg-laying places of *Emys orbicularis* in the project countries were still not known up to beginning of the protection efforts.

Hence, the aim of the present studies was to analyse the aspects of reproduction biology as well as the ecological requirements, the availability and suitability of nesting areas of *Emys orbicularis* in the North European lowlands. As a result of the varied intensity of project studies and the different situation of turtle populations including difficulties of animal observations and registrations in all project areas, the results of the partners are varying. Due to the fact that the turtles have similar climatic and ecological conditions as soon as ecological requirements in all project areas, all different types of results from the partners are presented in this report for comparison with areas where such results are still lacking.

During the project studies different data of nesting conditions were collected to evaluate the characteristics of nesting sites and the reproduction status of populations in all project countries. These results give a better understanding for the improvement of existing areas, the restoration of old sites and the creation of new potential nesting areas with regard to the habitat requirements of *Emys orbicularis* for successful reproduction.

Further, a good knowledge about the localities of old and existing nesting sites, their current status, conditions and threats is necessary for creating adequate local management and action plans for *Emys orbicularis*. With both plans a successful reproduction can be achieved as basis of a good population management and increasing population sizes which are vital for viable turtle populations.

3 Methods and Results

3.1 Lithuania

3.1.1 Methods Lithuania

The methods for identifying the nesting sites were telemetry and observations of female turtles during nesting period in Petroškai, Juodabalė and Kučiuliškė as well as additionally controls of open south exposed areas in Petroškai, Juodabalė, Kučiuliškė and Bestraigiškė. The aim of this study part was to get data about time and duration of nesting period, characteristics of used nesting sites, number and location of nests as well as number and migrations of nesting females. Regular visual controls were conducted in known and possible suitable areas/nesting sites between end of May and middle of June in the evening.

Before and during nesting period, adult females were captured by hand and with the help of traps baited with beef or pig heart (method by SERVAN 1986) (fig. 9+10). Females were located during nesting period using visual searching, capturing and radio tracking. The radiotracking equipment consisted of a receiver (Yupiteru MVT-9000MK II) combined with a hand operated unidirectional antenna and transmitters (weight: 8-10 g, durability (batteries inside): 1 year).

In 2008 and 2009 transmitters were glued on the carapace of a total of 13 females (Petroškai & Klepočiai: 7 females; Juodabalė: 2 females; Kučiuliškė: 1 female; Stračiūnai: 1 female, Bestraigiškė: 2 females) (fig. 1). During nesting period females were located 1 or 2 times during daytime in their home ponds. Additionally, migrating females were followed directly in the direction indicated by the antenna (Homing-in-on the-Animal) (WHITE & GARROTT 1990) in the afternoon and evening to find out their nesting sites in the project areas.

During summer further controls of known nesting sites were conducted to notice predated nests and indications for reproduction success. Additionally, photos and GPS-coordinates of nesting sites were taken.

Fig. 1: Old female of *Emys orbicularis* with transmitter before nesting in Juodabalė Herpetological Reserve L04

3.1.2 Results Lithuania

3.1.2.1 Time and Duration of nesting period 2008

The Lithuanian nesting period in 2008 was between the end of May and the first decade of June (30./31.05.-08./09.06.). Exact period time varied in different turtle areas e.g. the first female migrating on land was seen in Krikstonys on 30.05. by a local man. The first female in Juodabalė moved to the nesting site on 31.05.. In Kučiuliškė no female laid eggs later than 08.06., while in Petroškai the last nesting female was observed on 09.06..

3.1.2.2 Nesting sites and reproduction in Petroškai L03

Currently, 5 nesting sites are known in Petroškai. Female turtles of the same hibernation pond search for different nesting sites. Females hibernating in the main hibernation pond in the alder forest use open areas nearby the ponds 3, 4, 5, 7, 8, 9 and 10 in the north. Two of the known nesting sites are situated near pond No. 1, where females lay eggs in the edge of the road or in the slope of drained ditches. Since 2003 nesting sites have been covering by wire net as protection against nest predators. A big threat for females and hatchlings is the traffic in this place. The microclimatic conditions are suitable in this area and young turtles hatched successfully.



Fig. 2: Nesting area of *Emys orbicularis* close to the road in Petroškai L03



Fig. 3: Another nesting area of *Emys orbicularis* in Petroškai L03

Another nesting site (with 1 or 2 nests in 2008) on a slope is located near the ponds No. 2 and 3. The place is grazed and mowed regularly every year, so that the habitat conditions are stable here.

Two more nesting sites lie near the ponds No. 9 and 10. Due to the little extensive grazing there, overgrowth e.g. with hornbeams (*Carpinus betulus*) and pears (*Pyrus* spp.) destroy the open places. Habitat management is needed here to maintain the nesting sites.

5 years ago another two nesting sites were known near the ponds No. 4 and 5. Although turtles use further the ponds as summer habitats, no nests could be found there during the last 4 years because of the overgrowth with aspens (*Populus tremula*).

3.1.2.3 Nesting sites and reproduction in Meteliai Regional Park L04

Main studies in this area were conducted in the Juodabalė Herpetological Reserve with its restored and interconnected water bodies at the edge of the high moor. More than 30 individuals are estimated for this area. Concerning the first investigation results 3 nesting sites are known, but more places are assumed. Regrettably, the observation conditions are very bad having regard to the avoidance of disturbances for stressed nesting females. Dense meadows

with higher grass made visual controls of known and possible suitable nesting sites impossible from the distance, but visual controls from smaller distances interfered nesting females. For all that a small number of data could be gathered.

In Juodabalė radiotracking investigations of 2 females (3rd and 6th of June) and observations of 2 other females (31st of May and 4th of June) showed, that females inhabiting this restored pond complex prefer the south exposed nesting site close to the restored area for their nests (fig. 4). All females left their ponds in the early evening and walked directly to this nesting site. The nesting site lies in front of a small pine forest and is adjacent to a meadow. Two of the restored ponds are in a small distance to the nesting site (20-30 m) as well as the herbaceous shallow channel between both ponds. This prevents long and stressful migrations on land and finally a higher risk of predation for nesting females and hatchlings. Although the nesting site has different inclinations on sandy ground, females preferred flat and slightly inclined parts within the site, exceptionally females used strongly inclined places, too. The nesting site can be divided in 3 parts: a right and a left part with sandy dry grassland and less vegetation cover (estimated as suitable) and a middle part with much more dense and higher vegetation (complete unsuitable at present). Female observations first and predated nests later were located only in the more open places of the right and the left side of this nesting site. However, the middle part has a function as hiding site for the females.

Fig. 4: Main nesting area of *Emys orbicularis* in Juodabalė Herpetological Reserve L04

The second nesting site of the regional park is situated in the village Rockiai. Local people in the village observed several times females during nesting migrations and/or nesting. Some years ago females laid their eggs in front of the forest aisle of a pine forest, where regional park staff members found predated nests. Now, these old places are too dense with vegetation. In 2008 a female dug a nest hole next to the road in an open place with less vegetation on slightly inclined sandy ground 200 m far away from the old place. The dense vegetation could force the females to move to more open places next to the road, because other open places around are overgrown by dense meadows.

Tab. 1: Evaluation of the nesting site conditions for *Emys orbicularis* in Meteliai Regional Park L04 with the criteria (tab. 1) by SCHNITTER et al. (2006)

| Nesting site conditions | Nesting areas in Meteliai Regional Park | | |
|---------------------------|---|---------|---------|
| | Juodabalė | Rockiai | Didyjis |
| Distance to a water body | A | A | A |
| Microclimate (exposition, | A | B | A |

| | | | |
|--|---|---|---|
| southern location on a slope, windbreak) | | | |
| Number of potential nesting sites | B | C | C |
| Predation risk (e.g. wild boars) | C | C | C |
| Succession | C | C | B |

A third nesting site in the Meteliai Regional Park lies in Didyjis. Previous observations by a local man could be confirmed. The nesting site is situated in front of a small pine forest at a slope with southern/southeastern exposition. It is typical sandy dry grassland with less vegetation cover and sandy soil as well as meadows around. Two water bodies within hundred meters provide good conditions for migrating nesting females and hatchlings; 1 pond was dug during the LIFE-project. A high moor/quaking bog is also close. Unfortunately, the nesting site is close to a farm and not so far from a road. At this nesting site one female could be observed on 8th of June searching for a good place for her nest. Later a predated nest was found very close to the locality of the female. The nest was located at the steep southeastern slope, but the female dug its nest cave in the slightly inclined part of the steep slope with low vegetation density.

Most of the nests in the Regional Park were destroyed by predators in summer (3-5 nests from 2008 and also 2-3 old nests from 2007). Several nests were also demolished in 2009. Another nest in Juodabalė was dug out after summer in the end of September. Only 3 eggs (2 unfertilized and 1 developed with alive hatchling) remained in the destroyed nest hole (fig. 5). Due to the much higher risk of predation on land the hatchling was released in the shallow highly structured shore of the next pond. A high predation rate is presumed for this area. Foxes (*Vulpes vulpes*) can be noticed regularly.

Fig. 5: Alive hatchling of *Emys orbicularis* in a predated nest in September 2008 in Juodabalė Herpetological Reserve L04

Animals with different ages were determined in Juodabalė and Didyjis, consequently successful reproduction occurred every few years. The requirements at the known nesting sites allow favourable incubation, but for all that the present situation shows a big deficit of suitable nesting sites in the Meteliai Regional Park.

3.1.2.4 Nesting sites and reproduction in Kučiuliškė herpetological reserve L05

Since 1997 various investigations of reproduction biology were led in this area. About 70 turtles inhabit the reserve. Female turtles were located by observations, captures and telemetry during nesting period. Three main nesting sites with southern, southeastern or southwestern exposition are known each being separated in 2 or 3 suitable parts (fig. 6).



Fig. 6: Main nesting area of *Emys orbicularis* in Kučiuliškė Herpetological Reserve L05

All nesting sites are situated in front of pine forests on sandy dry grassland. In most of the cases smaller shallow ponds exist in distances less than 100 m to the nesting sites, which supply hiding sites for nesting females and first ponds for hatchlings. Additionally, these ponds prevent longer migrations on land and a higher predation risk outside the water. Some females of the local population lay their eggs outside from the main nesting sites in extra places (e.g. sunny meadow with less vegetation cover). Located nests can be mostly noticed in flat or slightly inclined places with less vegetation cover and on sandy, sandy-loamy or loamy soil. One part of one nesting site lies within the forest, but in an open warm place. Unfortunately, this part and another part of the same nesting site are situated very close to the meadow/forest path. In some extreme cases females dug their nests directly on the path. Such nests have a big danger to be demolished by cars. However, nest predation is the main reason for the big loss of nests in this area. In 2008 at least 10 nests were destroyed by predators [fox (*Vulpes vulpes*) and raccoon dog (*Nyctereutes procyonoides*)]. The determined high predation rate for Kučiuliškė from earlier investigations was confirmed this year.

Tab. 2: Evaluation of the nesting site conditions for *Emys orbicularis* in Kučiuliškė Herpetological Reserve L05 with the criteria (tab. X) by SCHNITTER et al. (2006)

| Nesting site conditions | Nesting areas in Kučiuliškė | | |
|--|-----------------------------|-------|--------|
| | NA I | NA II | NA III |
| Distance to a water body | A | A | A |
| Microclimate (exposition, southern location on a slope, windbreak) | B | A | A |
| Number of potential nesting sites | C | A | A |
| Predation risk (e.g. wild boars) | C | C | C |
| Succession | B | B | B |



Fig. 7: Juveniles of *Emys orbicularis* from 2 different successful hatching years in Kučiuliškė Herpetological Reserve L05

Approximately 70 % of all reproductive females reproduce per year. The Kučiuliškė-population is subdivided into two main pond complexes (A, G). Females of pond-complex A prefer other nesting sites than females of pond G. The nesting sites of A-females are more located around pond A and its summer ponds and the nesting sites of G-females lie more close to pond G and its summer ponds.

Turtles of different age classes can be found in this area, consequently successful incubation happened every few years (fig. 7). The conditions at the

used nesting sites allow favourable reproduction; nevertheless the current situation indicates a lack of suitable nesting sites in this area.

3.1.2.5 Stračiūnai Herpetological Reserve L06

The conducted investigations in 2009 did not allow nesting observations. Consequently, no data are available.

3.1.2.6 Nesting sites and reproduction in Bestraigiškė Forest District L07

Fig. 8: Predated nests of *Emys orbicularis* in Bestraigiškė Forest District L07

Between July and September regular controls were led in the mesotrophic pond (pond size: 2000 m², depth: > 1 m) inside the hilly forest of Bestraigiškė. About 20 individuals live in the forest pond all-season. No studies were carried out during nesting period in this area. However with the help of area visits nesting sites with predated nests could be determined during summer. Since shaded forest is situated around the forest pond, females have huge difficulties to find suitable places for their nests in this area. A smaller more open part on sandy ground lies 100 m far away from the forest pond. This place with southwestern exposition is slightly inclined and has less vegetation cover. 3 females dug their nests in a place of 4 m² which shows the big lack of suitable nesting sites (fig. 8). In 2009 2 females could be observed there searching for a nesting site and 2 destroyed nests were found. In 2008 a 4th nest was found 20 m away from the other 3 nests.

The small nesting site inside the forest is very threatened because of shade by overgrowth and forest around as well as by the close forest road. Especially, the 4th nest lied at the wayside of this road. Finally, cars and machines improving the forest road can destroy such nests. Regrettably, all nests could be recognized only after demolition in summer. Thus, this observation indicates a high predation rate for this area; e.g. predators like raccoon dogs (*Nyctereutes procyonoides*) live in this forest. The same situation can be assumed for the nesting areas outside but close to the forest.

The forest pond seems not to be suitable for smaller juveniles, because the youngest caught turtles have already subadult-stage (12-14 years). The distance between nesting site and forest pond is convenient, but the depth of the pond could be a problem, because hatchlings as bad swimmers and divers in the beginning have the risk to drown. The food sources in this deeper pond

could also be unsuitable for hatchlings. Smaller shallow highly structured ponds near this place would be much better. There is still the question where do hatchlings stay after leaving their nests (do other not known temporary ponds and/or flooded areas exist inside the forest?) or do they go to the forest pond with the big danger to drown or to starve? More nesting sites and observations of young turtles are known from other places in- and outside the forest due to observations by foresters, hunters and local people, but of course further investigations are needed in this place.

Tab. 3: Evaluation of the nesting site conditions for *Emys orbicularis* in Bestraigiškė Forest District L07 with the criteria (tab. X) by SCHNITTER et al. (2006)

| Nesting site conditions | Nesting areas in Bestraigiškė | |
|--|-------------------------------|--------------------|
| | inside the forest | outside the forest |
| Distance to a water body | A | A |
| Microclimate (exposition, southern location on a slope, windbreak) | B | B |
| Number of potential nesting sites | C | B |
| Predation risk (e.g. wild boars) | C | C |
| Succession | C | C |

Due to the lack of open areas close to the forest pond, other females are forced to leave the forest during nesting period and to lay their eggs in open areas in bigger distances e.g. outside of the forest. One female with transmitter could not be localized inside the forest during nesting time 2009. Presumably, she moved to another place for nesting. At least one nesting area near a farm in the north of the forest is known, where 2 dug out nests could be found in 2009.

3.1.2.7 Summary and conclusions of existing nesting sites of *Emys orbicularis* in Lithuania

- 5 nesting sites (1 xerothermic place near field path) in Petroškai L03 in the Veisiejai Regional Park,
- 3 nesting sites [1 in Juodobale Herpetological Reserve (sandy dry grassland), 1 in the village Rockiai (xerothermic place near field path and meadows) and 1 in Didyjis (xerothermic place near meadows)] in the Meteliai Regional Park L04 (more places are assumed) (fig. 2),
- 3 nesting areas separated in 7 different sites (sandy dry grasslands near meadows, 1 xerothermic place near/on a field/forest path, 1 xerothermic

place in a clearing) in the Kučiuliškė Herpetological Reserve L05 (more places are assumed) (fig. 4),

- 3 nesting sites (1 xerothermic place near forest road, 1 xerothermic place outside the forest near meadows, 1 old nesting site in the forest destroyed by overgrowth) in the Bestraigiškė Forest District L07 (more places are assumed) (fig. 5).

In all four areas (Kučiuliškė, Bestraigiškė, Meteliai, Petroškai) management activities are needed to save the small known nesting sites and to improve the general nesting site situation [to improve or enlarge existing nesting sites, to create new nesting sites, to protect known nesting sites with wild fences against the main predators e.g. foxes (*Vulpes vulpes*) and raccoon dogs (*Nyctereutes procyonoides*)]. Especially, in areas where females are forced to dig nests near or even on paths and roads, the creation of new nesting sites is essential. For females it is a risk to be killed by a car during nesting. Eggs and hatchling can also be demolished by cars. In some cases the creation of small shallow ponds for hatchlings in a small distance to the nesting sites would be helpful to prevent the higher risk of predation of hatchlings on longer ways to ponds and the bigger danger of drowning of hatchlings if only deeper ponds are situated close to the nesting sites. Additionally, further interviews of local people are necessary to get more information on old and existing nesting sites and their current status.

3.1.3 Specific study on females' behaviour and characteristics of nesting sites in Kučiuliškė Herpetological Reserve L05

3.1.3.1 Methods in Kučiuliškė Herpetological Reserve

In order to find out the number of reproductive females, the nesting migrations, the behaviour of reproductive females and the location of nests, the nesting areas were checked by visual control during nesting season. Additionally, with the help of telemetry equipment (receiver Yupiteru MVT-9000MK II, hand operated unidirectional antenna) tagged females (8-10 g transmitters were glued on the carapaces) could directly be followed ["Homing-

in-on-the-Animal“(WHITE & GARROTT 1990)] and located three or four times a day during nesting period.

The distance between old and news nests of the same female was measured. Determining the habitat requirements on nest sites different data of found nests and of 140 comparison-points were taken [substrate type (SCHLECHTER 1986), exposition with a compass, inclination with a protractor, the possible daily maximum sunshine duration (May-September) with a horizontoskop (MÜHLENBERG 1993), vegetation cover (1 m² around, 0-100 % in 10 %-steps)]. The comparison-points lied along the border of the forest edge (distance to the edge: 3.5 m; distance between the comparison-points: 5 m) at nesting area I, II and III. The distance to the forest edge was determined with the data of nest distances to the forest edge of the first two study years (1997, 1998).

The exposition values were transformed for the formation of the mean value (for values of exposition > 180° the value 360 was subtracted und the amount of the result was taken to calculate further) (MÄRTENS et al. 1997). The transformed values had the same deviation of the North-South-direction and the same number of sun hours with the same angle of insolation of the sun. Exceptionally the data of the substrate type, all other data were used for a multiple regression analyze to determine the suitability of nest sites. In the analyze nests were valued as suitable (100 %) and comparison-points as complete unsuitable (0 %).

During the study statistical analyses were calculated with multiple regression analyses with the program StepRegression 3.0 for Excel 2000 by SHEREMETEV (EXCELSTAT 2000). The models of regression were calculated with a confidence interval of 95 %.

3.1.3.2 Results in Kučiuliškė Herpetological Reserve

When finding a new nest site 38 % of the females showed a big fidelity to their previous nest sites (< 20 m) (fidelity strategy), while 24 % searched for new nest sites in distances up to 200 m and even 38 % shifted in big distances (> 500 m) (shifting strategy) (fig. 9).

The females searched for nest sites on sandy dry grassland e.g. in open areas on meadows, on paths in meadows and forests and in smaller clearings. The substrate was mainly sandy with mostly small shares of gravel or coarse grained gravel or rarely mixed with stones (n = 57). In five cases nest cavities were made on a forest/meadow path (parts of nesting area I) with a condensed loamy soil.

At the nest sites expositions of 80-280° [between east and west, after transformation (IExpos-360°): 80-180°] were determined (n = 76). A wider range of exposition data was found at the comparison-points [35-340°, after transformation (IExpos-360°): 20-180°]. Different expositions can have a similar angle of sun radiation.

The females were observed nesting on sites with different inclinations (n = 76): flat (0-5°, 35 %), slight inclined (5-10°, 31 %), strongly inclined (10-20°, 32 %) and steep ground (> 20°, 1 %). The comparison-points were located on flat (41 %), slight inclined (34 %), strongly inclined (23 %) and steep ground (2 %). This elucidates that females used strongly inclined sites more than flat sites.

The vegetation cover around the nests was distinctively smaller (average 48 %, range: 5-95 %) (n = 64) than around the comparison-points (average 71 %, range: 5-100 %). Consequently, the females preferred sites with a lower vegetation density.

The nest sites of the females could have a possible maximum daily sunshine duration with an average of 9:14 h (range: 5-13:30 h) (n = 71), whereas at comparison-points only an average of 7:54 h (range: 0-12:45 h) possible sunshine could be determined (difference: 1:20 h) (fig. 10). This shows that females searched for nest sites with more possible sunshine duration and less shade.

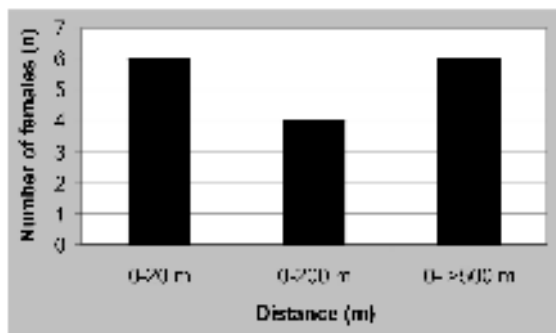


Fig. 9: Distance to the previous nest of Lithuanian *Emys orbicularis*-females

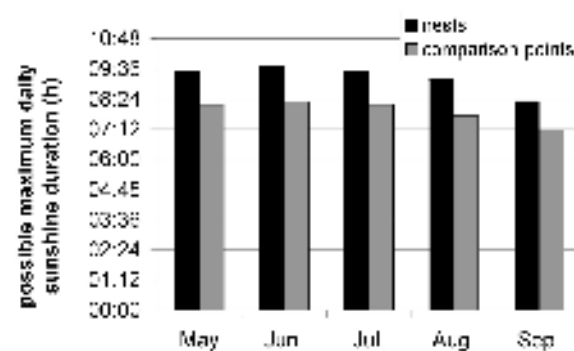


Fig. 10: Comparison of the possible maximum sunshine duration of Lithuanian *Emys orbicularis*-nests and comparison-points

A multiple regression analyze helped to determine the suitability of females' nest sites. The factor „vegetation cover“ negatively correlates and the factors „sunshine duration“ and „inclination x cos-exposition“ positively correlates with the suitability of nest sites. Inclination and exposition influence the angle of sun radiation on nests. The analyze elucidates that the factor „vegetation cover“

has the biggest influence on the suitability of nest sites and the factor „inclination x cos-exposition“ the smallest. The increasing of factor „inclination x cos-exposition“ causes the increasing of the suitability. This is similar to the possible sunshine duration. The increasing sunshine duration raises the chance of a successful incubation. On the other hand the increasing of factor “vegetation cover” reduces the suitability of a nest site, because a higher vegetation density can shade a nest. Thus, it is assumable that females choose determined sites for their nests.

3.1.3.3 Literature

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3.2 Poland

3.2.1 Methods Poland



Fig. 11-12: Methods of captures of *Emys orbicularis* in Western Poland [baited trap (fig. 11), capture by hand (fig. 12)]



Fig. 13: A female of *Emys orbicularis* with transmitter in Jeziora Pszczewskie i Dolina Obry Pk01

In East-Poland some single observations of female turtles during nesting period were led to locate nests and nesting sites. Due to the lack of turtle observations in Bialowieza - no turtle could be found between 2007 and 2009 -, no current data on reproduction and nesting could be gathered. Only, one female turtle was captured in June 2006

More intensive studies on reproduction and nesting area requirements were possible In West-Poland. Turtles were captured by hand and with the help of traps baited with beef or pig heart (method by SERVAN 1986) (fig. 11+12). The method for finding nests and identifying nesting sites was telemetry during nesting season.

In different project years single females were fitted with transmitters on carapace (fig. 13). The durability of turtle transmitters (batteries inside) was one year. Turtles were regularly located by radiotracking (equipment: receiver (Yupiteru MVT-9000MK II and hand operated unidirectional antenna) between end of May and middle of June.

Located Nests were protected against predators by using human odour (humans sweat), additionally wire gauze and plastic bottles were put on sticks (such constructions make noise in the wind) (fig. 18). Surrounding of nests was photographed and described. Close to nests two data loggers were situated (10

cm deep below ground). In 2007 in two potential nesting sites (Drawiny and Drzeczkowo) two data loggers were placed.

3.2.2 Results Białowieża

Only, one female turtle was captured in June 2006 on dry land in the village nearby fishponds and a small stream. Presumably, this female was caught during its nesting migrations. Despite of fitting this female with a transmitter and following it by telemetry, no nesting observations were possible.

3.2.2 Results Western Poland

3.2.2.1 Ujście Ilanki Pk03

In 2008 one nesting area of *Emys orbicularis* was found in Ujście Ilanki site (fig. 12-18). It was located on small forest clearing, close to a channel, which is one of the most important summer sites for turtles. With the help of radiotracking of 4 females 6 nests were localized in 2008 and 7 nests in 2009.



Fig. 14-17: Nesting site of *Emys orbicularis* in Ujście Ilanki Pk03 - general view (fig. 14) and three separate nests marked by rock or wooden sticks in 2009 (fig. 15-17)



Fig. 18: A nesting area of *Emys orbicularis* with protection against predators in Ujście Ilanki Pk03

All nests were localized on sunny slope overgrown mainly by whitish hair-grass (*Corynephorus canescens*). Among other plants in that site were such species like: stonecrop (*Sedum acre*), common bent (*Agrostis capillaries*), corn spurry (*Spergula arvensis*), common evening primrose (*Oenothera biennis*), mouse-ear hawkweed (*Hieracium pilosella*), perennial knawel (*Scleranthus perennis*), sheep's fescue (*Festuca ovina*), wild thyme (*Thymus serpyllum*) and dark mullein (*Verbascum nigrum*) (NAJBAR unpubl.).

3.2.2.2 Potential and existing nesting areas of *Emys orbicularis* in Western Poland

In different project areas few small areas were determined as potential nesting sites with the help of older female observations, but currently no nests have been found.

- Torfowisko Młodno Pk02 - 1 place (a female was observed here in 2002),
- Ujście Ilanki Pk03 - 3 places (few females were observed in 2006 and 2007),
- Uroczysko Puszczy Drawskiej Pk04 - 2 places (2 females were observed between 2002 and 2006) (fig. 19+20),

- Zachodnie Pojezierze Krzywińskie Pk05- 1 place (1 destroyed nest was recognized in the 80's and parts of a turtle carapace were found in the field in 2007), more places are possible, capture of 2 juveniles (1985 and 2009) (fig. 21+22)



Fig. 19-20: A potential turtle nesting site with female observations in Drawiny/ Uroczysko Puszczy Drawskiej Pk04



Fig. 21-22: A new juvenile turtle in Drzeczkowo 1/ Zachodnie Pojezierze Krzywińskie Pk05 (May 2009)

3.3 Germany

The investigations in the second half of the 90s pointed out that most of the historically known pond turtle populations in Brandenburg had already become extinct. The 6 remained populations were very small and overaged. No juveniles or subadults could be proved in any occurrence. Furthermore, the investigations showed that all actual German nesting sites were on agricultural or forestal used areas and therefore no reproduction of the pond turtles was possible. Presently, two *Emys orbicularis*-populations exist in the German areas

of the LIFE project (Poratz Da03 and Kölpinsee Da04). In the project area Märkische Schweiz Da02 only a very small population could be noticed in the 1990'ies. Unfortunately, since several years no individuals could be observed again and this population must be extinct. In the other project sites e.g. Da02 suitable nesting sites near the resettlement locations were created and protected for long term.

3.3.1 Methods Germany

In the frame of the monitoring nesting activities of *Emys orbicularis*-females as well as nest locations and reproduction success were determined in the project sites Poratz Da03 and Kölpinsee Da04. During the main time for nesting (between 20th of May and 15th of June) the usual nesting sites were daily controlled. Before nesting period, adult females were captured by hand and with fishery traps. Selected females were fitted with transmitters (weight: 8-10 g, durability of batteries inside: 1 year) for locating by radiotracking (fig. X). The radiotracking equipment consisted of a receiver (Wildlife Materials TRX-1000S) combined with a hand operated unidirectional antenna. During nesting period females with transmitters were located at least 1 or 2 times during daytime in their home ponds. In late afternoon and evening, they were radiotracked for following them to the nesting sites.

Nesting sites and all located nests were investigated. The recording of the ground temperatures in the traditional nesting sites was one component of the monitoring by using dataloggers put in a depth of 10 cm according the average depth of nest cavities. A parameter for the evaluation of the climatic conditions at the location and the concerning year was calculated with the help of a temperature sum formula published by SCHNEEWEISS (2003). In addition, specific climatic aspects of the respective investigation year were assessed (e.g. strong summery precipitation in 2007). With both aspects the incubation conditions for each specific location and year were evaluated. In the following spring known nests were controlled for recording the hatching success. In the case that the determined temperature sums of the evaluated climatic incubation conditions were under the critical value in summer (SCHNEEWEISS 2003), the nests were already opened in autumn (November) and the non-hatched eggs were incubated artificially. Due to the fact that the hatchlings spend the winter inside the nest cavity, the ground temperatures were also registered in winter and the climatic conditions for the survival of the hatchlings were evaluated (ground temperatures to -2°C favourable; between -3 and -6°C moderate; -6°C unfavourable).

Furthermore, a photographic documentation as well as the registration of the sites to a register on GIS base (ESRI ARC-VIEW) is part of the monitoring of the nest locations.

Several nesting sites were fenced against nest predators (fig. 29). Located nests outside the fenced nesting sites were protected by means of wire netting (fig. 25). Additionally, in winter turtle nests were covered with brushwood to prevent the freezing to death of the hatchlings in strong frosty winter seasons.

In comparable manner the conditions for a later resettlement of European pond turtles were created in three other areas. Within the scope of an accompanying monitoring a successful control of these measures was carried out.

The conditions of the nesting sites were evaluated according the criteria published by SCHNITTER et al. (2006) (tab. 4).

Tab. 4: Criteria for the evaluation of the nesting site's conditions for *Emys orbicularis* in Germany by SCHNITTER et al. (2006)

| Nesting site conditions | A very good | B good | C medium to bad |
|--|--|-------------------------------------|--|
| Distance to a waterbody | < 300 m | 300 - 1000 m | > 1000 m |
| Microclimate (exposition, southern location on a slope, windbreak) | very favourable | favourable, some aspects suboptimal | medium to bad, several aspects suboptimal |
| Number of potential nesting sites | numerous existent | sufficient existent | little existent, insufficient |
| Predation risk (e.g. wild boars) | little (e.g. protection measures) | medium | high |
| succession | no/ species-appropriate maintenance resp. management | low | In progress, scrub encroachment, tall forbs or similar |

3.3.2 Results of the *Emys orbicularis* populations in Germany

3.3.2.1 Poratz Da03

General habitat suitability and condition of the nesting sites

In the project area Poratz Da03 4 nesting sites exist (fig. 23+24). The conditions of all nesting sites were considerably improved during the project.

This was achieved by a change of utilization or specific management of the areas. Today, all habitats are evaluated with A (excellent) or B (good) concerning their conservation state (tab. 5).

Tab. 5: Evaluation of the nesting site's conditions for *Emys orbicularis* in Poratz Da03

| Nesting site | „Südhang“ (no. 1) | | „Alte Wiese“ (no. 2) | | „Kaninchenberg“ (no. 3) | | „Wildblumenwiese“ (no. 4) | |
|---|----------------------|------|-------------------------|------|----------------------------|------|---------------------------|------|
| | 2005 | 2009 | 2005 | 2009 | 2005 | 2009 | 2005 | 2009 |
| Distance to the pond | A | A | A | A | A | A | A | A |
| Microclimate (sun exposition, south exposed slope, windbreak) | A | A | A | A | B | B | B | A |
| Relative number of potential nesting sites | B | A | C | A | B | A | C (field) | A |
| Danger of predation | C | A | C | A | C | A | C | A |
| Succession | B | A | A | A | B | A | - | A |

Usage of the nesting sites by pond turtles

Female observations and telemetry during nesting period showed that the nesting sites "Südhang" and "Kaninchenberg" are the important traditional nesting sites of the population. Single nests on the nesting site „Alte Wiese“ can be valued as a new aspect and a positive result of the project measures. The nesting site "Wildblumenwiese" was earlier used by 1-2 females, but due to the intensive agricultural use no reproduction success was possible till 2008. During the project a new habitat was created which guarantees successful reproduction now.



Fig. 23: Main nesting site of *Emys orbicularis* in Poratz Da03

Tab. 6: Usage of the nesting sites by *Emys orbicularis* females and the conditions for reproduction success in Poratz Da03

| Nesting site | „Südhang“ (no. 1) | | „Alte Wiese“ (no. 2) | | „Kaninchenberg“ (no. 3) | | „Wildblumenwiese“ (no. 4) | |
|--|----------------------------------|-----------------------------|----------------------------------|-----------------------------|----------------------------|-----------------------|------------------------------|--------------------------|
| | 2005 | 2009 | 2005 | 2009 | 2005 | 2009 | 2005 | 2009 |
| Year | 2005 | 2009 | 2005 | 2009 | 2005 | 2009 | 2005 | 2009 |
| Number of females | 0-1 | 1-2 | 0 | 0-1 | 2-4 | 2-4 | 0-1 | 1-2 |
| Qualifications of the habitat for the reproduction success | medium to good | very good | bad | very good | good | very good | bad | very good |
| Determining factors of the location | dates of field work unfavourable | dates of field work adapted | dates of field work unfavourable | dates of field work adapted | micro-climate suboptimal | micro-climate optimal | intensive usage (field) | extensive usage (meadow) |



Fig. 24: Meadow as nesting site of *Emys orbicularis* in Poratz Da03

Climatic conditions of the reproduction and reproductive success in the period from 2005 to 2008

In Poratz Da03 the specific ground temperatures of the traditional and important nesting sites "Kaninchenberg" and "Südhang" were registered. The climatic conditions of the respective years and locations are summarised in the table 7.

In the project period (2005-2009) favourable climatic reproduction conditions occurred in 2006. The summer 2005 reached just the favourable state concerning sunshine duration and ground temperatures. However, the next winter had some colder phases with ground temperatures around -5°C . At least some of the hatchlings have fallen victim to these temperatures. The summer 2007 was relatively poor in sunshine duration, too chilly and rainy, so that no reproduction occurred in the open land. With a nesting site's control on the 13th November 2007 intact eggs could be still rescued. The juveniles hatched a few days later in the incubator. In addition, two nests (1x field location, 1x injured female) were successfully incubated in the breeding station. Although in 2008 the summer was relatively warm over all and very sunny, several moist phases appeared especially in early summer. This apparently impaired the embryo genesis what led to a disease of the majority of the embryos.

Tab. 7: Climatic conditions for the reproduction of *Emys orbicularis* on the basis of ground temperatures in Poratz Da03

| Nesting site | Year | Conditions of reproduction | | | | | Number of controlled clutches in open land (n) | Reproduction success |
|-----------------|------|----------------------------|-------------------------------|--------------|----------|------------|--|--|
| | | Summer | | | Winter | | | |
| | | T-sum | Specific aspects | Evaluation | T-minima | Evaluation | | |
| „Südhang“ | 2005 | 330 | | favourable | -4,6°C | medium | 0 | 20-30 % (?)*** |
| | 2006 | -, * | | favourable** | -3,2°C | favourable | 0 | 60-80% (?) |
| | 2007 | 274 | intense rainfall in midsummer | unfavourable | 0,9°C | favourable | 0 | 0 |
| | 2008 | 412 | intense rainfall in June | medium | -3,8°C | medium | 2 | Ca. 20-30% |
| „Kaninchenberg“ | 2005 | 319 | | favourable | -4,8°C | medium | 0 | 20-30% |
| | 2006 | 481 | | favourable | -2,5°C | favourable | 3 | 60-80% |
| | 2007 | 234 | intense rainfall in midsummer | unfavourable | -0,5°C | favourable | 2 **** | 0 (3 individuals in Nov. still hatched in incubator) |
| | 2008 | 391 | intense rainfall in June | medium | -4,2°C | medium | 1 | Ca. 20-30% |

*: Datalogger turned out

** Cf. Kaninchenberg

*** Data of comparable locations are available

**** two clutches were incubated in the breeding station

Predation

In the area of the nesting sites a consistent hunting of potential predators (wild boar, fox, raccoon dog, racoon ...) took place during the whole project, because there is a support by the responsible local hunter's union. Known nests were weathered and covered with wire nettings immediately after the egg-laying. In contrast to former years no signs of nest predation could be found in the project period.



Fig. 25: Nest of *Emys orbicularis* protected by means of wire netting in the main nesting site in Poratz Da03

Summary

The habitat suitability and the conservation state of all nesting sites in the project area Poratz Da03 were decisively improved during the project. The monitoring of climate confirmed that the nesting sites are in climatic favourable regions and in microclimatic suitable locations. All important nesting sites and, in addition, a number of farther potential nesting habitats can be counted as secured for long term at the end of the LIFE project. The land purchase was an important basis for this. The change of 3 ha intensely used field area into extensively used meadowland is especially gratifying. In south hillside situation a new nesting site was created on a low in nutrient area, directly accompanied by the aquatic habitats of the pond turtle population.

3.3.2.2 Kölpinsee Da04

General habitat suitability and conditions of the nesting sites

In the project area Kölpinsee Da04 2 nesting sites exist (fig. 26+27). The conditions of the nesting sites were considerably improved during the project. This was achieved by the increase of extensive land use as well as a hedge plantation. The hedge plantation affects a windbreak and therefore the

improvement of the microclimate on the nesting site (fig. 27). Today, both habitats are to be valued with A (very good) concerning their conservation state (tab. 8).

Tab. 8: Evaluation of the nesting site's conditions of *Emys orbicularis* in Kölpinsee Da04

| Nesting site | „Waldrand“ (no. 1) | | „Hangwiese“ (no. 2) | |
|---|--------------------|------|---------------------|------|
| | 2005 | 2009 | 2005 | 2009 |
| Year | 2005 | 2009 | 2005 | 2009 |
| Distance to the pond | A | A | A | A |
| Microclimate (sun exposition, south exposed slope, windbreak) | B | A | B | A |
| Relative number of potential nesting sites | B | A | B | A |
| Danger of predation | B | A | C | A |
| Succession | A | A | A | A |

Usage of the nesting sites by pond turtles

Female observations and telemetry during nesting period showed that the nesting sites "Hangwiese" and "Waldrand" are significant, traditional nesting sites of the population. Both nesting sites offer favourable breeding conditions for a bigger number of clutches. However, the number of adult females is dropped on a minimum (n: 1-2) nowadays as a result of a high predation pressure by racoons.



Fig. 26: Nesting site of *Emys orbicularis* in Kölpinsee Da04

Climatic conditions for the reproduction and reproductive success from 2005 to 2008

In the project area Kölpinsee Da04 the specific ground temperatures of the nesting site "Waldrand" were registered. The climatic conditions in the respective years and locations resemble those in the site Poratz Da03 and are summarised in table 9.

Tab. 9: Climatic conditions for the reproduction on the basis of ground temperatures in Kölpinsee DA04

| nesting site | year | conditions of reproduction | | | | number of controlled clutches in the open land (n) | reproduction success | |
|---------------------------|------|----------------------------|-------------------------------|------------|----------|--|----------------------|------------|
| | | summer | | winter | | | | |
| | | T-sum | Specific aspects | evaluation | T-minima | evaluation | | |
| „Waldrand and „Hangwiese“ | 2005 | 357 | | favourable | -2,2°C | medium | 1 | 30 % |
| | 2006 | 506 | | favourable | -5,2°C | favourable | 0 | 60-80% (?) |
| | 2007 | 328 | intense rainfall in midsummer | medium | -1,5°C | favourable | 0 | 0 |
| | 2008 | 392 | intense rainfall in June | medium | - | * | 1 | 0 |

In the project period (2005-2009) favourable climatic conditions on the reproduction appeared in 2006. The summer 2005 offered favourable conditions concerning sunshine duration and ground temperatures. Vital juveniles (1 controlled clutch) hatched out of 5 of 15 eggs (10 fertilized). The summer 2007 was relatively poor in sunshine, too chilly and rainy, so that no reproduction occurred in the open land. Although in 2008 the summer was relatively warm over all and very sunny, several moist phases appeared especially in early summer. This impaired the embryo genesis. Only one egg of the controlled clutches (8 eggs) was fertilized. The embryo already died in an early development stage.

Predation

In the area of the nesting sites a consistent hunting of potential predators (wild boar, fox, raccoon dog, racoon ...) took place during the whole project, because there is a support by the responsible local hunter's union. Known nests were weathered and covered with wire nettings immediately after the egg-laying. In contrast to former years no nest predation was recognized during the project.



Fig. 27: Hedge plantation near one nesting site of *Emys orbicularis* in Kölpinsee Da04

Summary

The habitat suitability and the conservation state of both nesting sites in the project site Kölpinsee Da04 was clearly improved in the course of the project period e.g. the hedge plantation in 2008 (windbreak and prevention of egg-layings on the adjoining field) (fig. 27). The monitoring of climate confirmed that the nesting sites are in a climatic favourable region and in microclimatic suitable locations. Both nesting sites can be counted as secured for long term at the end of the LIFE project. The land purchase was an important basis for this. The change of about 1 ha intensely used field area into extensively used meadowland already took place before the beginning of the LIFE project.

3.3.3 Project areas suitable for the resettlement of *Emys orbicularis* in Brandenburg/Germany

3.3.3.1 Frauenhagen Da01

During the project it could be confirmed that the historically known occurrence of *Emys orbicularis* is disappeared in this area. The last adult female was proved in 1994 (SCHNEEWEISS 2003).



Fig. 28: Historical nesting site of *Emys orbicularis* in Frauenhagen Da01

3.3.3.2 Märkische Schweiz Da02

During the project term it has been confirmed that the European pond turtle has become extinct in this project site. Besides the loss of the residential ponds the high density of predators is one of the main causes in particular racoons (immigrating since the 1950s). Furthermore, the lack of nesting sites is another important factor for the extinction of the species in Da02.

On condition of a consistent hunting of the predators (especially racoon, raccoon dog, wild boar and fox) the area west of the lake "Klobichsee" is favoured for a resettlement of *Emys orbicularis* in the project site. Besides numerous suitable ponds and alder swamps, open predominantly sandy hilltops are also found which were agricultural used up to now (tab. 10).

3.3.3.3 Brodowin - Parstein Da05

The project investigations on the occurrence of *Emys orbicularis* in Brodowin-Parstein Da05 showed that the species has already become extinct. Nevertheless, the existence of some single individuals can be assumed in Breitefenn, where the last nesting female was observed in the end of the 1990s (SCHNEEWEISS 2003). This area absolutely appears suitable for the resettlement of *Emys orbicularis* - under certain conditions. Concerning its climatic (the most eastern/ sunniest nesting site) and microclimatic (windbreak, south-exposed hillside situation) qualities this nesting site is the most favourable in the whole Brandenburg project area (fig. 28). The present conditions of the nesting site are evaluated as excellent (A) (tab. 10).



Fig. 29: Fenced nesting site of *Emys orbicularis* in Brodowin - Parstein Da05

3.3.3.4 Summary concerning the creation or maintenance of nesting sites in resettlement areas for *E. orbicularis*

One area in the site “Märkische Schweiz” and two areas in the “Uckermark” offer nowadays the necessary conditions for the resettlement of the European pond turtle. The species existed there till the end of the 20-th century. Beside the pond habitats special attention within the scope of the LIFE project is applied especially to the creation or improvement of nesting habitats. Now it

can be assumed that there are available nesting sites in excellent condition in three areas (tab. 10).

Merely, measures for the protection of the nests against predators are necessary in the prepared nesting sites of “Märkische Schweiz” and in the site “Frauenhagen” at the moment when the first turtle females are released in the sites in the course of a settlement.

Tab. 10: Evaluation of the conditions of prepared potential nesting sites for the resettlement of *Emys orbicularis* in different project areas

| Nesting site | „Am Kleinen Klobichsee“ | | „Breitefenn“ | | „Welsehänge“ | |
|---|-------------------------|------|--------------|------|--------------|------|
| | 2005 | 2009 | 2005 | 2009 | 2005 | 2009 |
| Year | | | | | | |
| Distance to the pond | A | A | A | A | A | A |
| Microclimate (sun exposition, south exposed slope, windbreak) | A | A | A | A | A | A |
| Relative number of potential nesting sites | C | A | B | A | B | A |
| Danger of predation | C | C | C | A | B | B |
| Maintenance/ management | C | A | B | A | A | A |
| Succession | - | A | B | A | B | A |

3.3.4 Existing and potential nesting areas of *Emys orbicularis*

Currently used nest-sites exist only in Da03 and Da 04 (“Extensively used” means 1-2 times per year mowed).

- 5 nesting sites [2 on extensively used meadows (semi-natural dry grassland), 2 on fallow-land, earlier (12 years ago) arable land, today extensively used meadows (semi-natural dry grassland), 1 on actually fallow-land, earlier arable land and freshly sowed meadow (extensively used), ecological type fallow arable land (development objective: semi-natural dry grassland)] in Poratz Da03 (fig. 23+24),
- 3 nesting sites [1 on extensively used meadows (sandy dry grassland), 2 on fallow-land, earlier (10 years ago) arable land, today extensively used meadows, semi-natural dry grassland] in Kölpinsee Da04 (fig. 26+27),

- 1 historical nesting site (last female observed 1994) in Frauenhagen Da01 (fig. 26),
- Several potential suitable nesting sites in Märkische Schweiz Da02,
- 1 potential very suitable nesting site in Brodowin – Parstein Da05 (fig. 29).

4. Summary and Conservation Conclusions

4.1 Nesting behaviour of *Emys orbicularis*

During nesting period females leave the ponds in the daytime and move to the nesting sites. In some cases they start their migrations one or some days before nesting. Usually, searching of a suitable nesting site and nesting occurs in the late afternoon and evening and lasts several hours (MEESKE 1997b). With finishing the search of a suitable site, females start to dig the nest chamber with their hind legs. They lay up to more than 20 eggs. After egg deposition, turtles close the nests and move to their home or summer ponds. Often they spend the night after egg deposition on land in a hidden place near the nest.

Weather conditions influence not only the start and duration of the nesting period but also the starting time of the real nesting (searching, digging, egg-laying). Mostly, on colder days females begin earlier with their nesting activities. On too cold or rainy days, they do not lay eggs at all e.g. $< 15\text{ C}^{\circ}$ vespertine air temperature (MEESKE 2006).

Usually, nesting site fidelity is described for *Emys orbicularis* in the project countries Germany (SCHNEEWEISS & STEINHAEUER 1998) and Poland (MITRUS & ZEMANEK 2000) as well as in other European countries like Italy (ROVERO & CHELAZZI 1996). Interestingly, females of the Lithuanian local population Kučiuliškė showed different strategies for finding suitable nest sites (fidelity-and shifting-strategy). The number of “shifting”-females in several years was about 38 %, but the real number of “shifting”-females should be higher as determined now. This assumption is based on the increase of observations of shifting females with the increase of observation years. Consequently, a high percentage of „shifting“-females is registered at the northern border of the species range. The Lithuanian findings could elucidate those extreme conditions at the northern border of the species range effect good adaptations to changing habitat conditions (shifting strategy) for preventing extinction of local populations (MEESKE 2006).

4.2 Requirements for nesting sites of *Emys orbicularis* in the North European lowlands

The quality and the suitability of the microclimate at a nest site decide on the reproduction success of a female (MORREALE et al. 1984, SCHNEEWEISS 2003). At the same time SCHNEEWEISS (2003) points out that in regions with an unfavourable climate a successful incubation is possible at sites with a suitable microclimate. Different characteristics influence the microclimate e.g. exposition, inclination, windbreak, substrate, vegetation, etc.. Furthermore, the availability of suitable nest sites is a critical factor referring to the population dynamic (ROVERO & CHELAZZI 1996).

The following text describes important criteria for suitable nesting sites on the basis of collected data in different studies before and during the project period in the project areas. In the North-European lowlands nests of *Emys orbicularis* are found in places with eastern (lots of morning sun) up to western expositions (lots of setting sun) (80-280°), but most of the nests are located in places with southern, south-eastern and south-western expositions. Generally, southern and south-western/-eastern slopes heat better up than western, eastern and northern slopes or plateaus.

Emys-females of the northern boundary of distribution search for nest sites in flat, slightly and strongly inclined areas (0-20°). In exceptional cases, single nests are dug in steeper ground (up to 40-50°), too [Germany: 3,5-19,5° (ANDREAS 2000), 3-39° (SCHNEEWEISS 2003); Lithuania: 0-20° (MEESKE et al. 2002, MEESKE 2006)]. In slightly and strongly inclined places stagnant moisture is prevented (ANDREAS 2000, RÖSSLER 2000) and a better warming up of the soil occurs than in flat places with the same exposition. Thus, at southern slopes the soil temperature is significantly higher than in flat areas (BREITENBACH et al. 1984, MÜCKENHAUSEN 1985).

In the North-European lowlands nests can be found in places with a vegetation cover of 5 up to 95 [Germany: 5-80 % (SCHNEEWEISS et al. 1998, SCHNEEWEISS 2003); Lithuania: 5-95 % (MEESKE 2006)]. A vegetation cover reduces variation of soil temperature (MÜCKENHAUSEN 1985) and could have advantages referring to the incubation period. The incubation period extends under artificial conditions with day- and night-variation of temperature in comparison with constant temperatures (SCHNEEWEISS 2003). Consequently, in the northern regions the incubation should last as short as possible to guarantee a hatching success. Furthermore, most of the plant species occurring at these nesting sites had a short growth or were single grass which does not or shade only a little the nests (comp. MEESKE et al. 2002, comp. MEESKE 2006).

In the German project areas it was investigated, how the sunshine duration between June and August influences incubation results [total sunshine duration < 580 h, daily average < 6:15 h: insufficient; total sunshine duration 580-675 h, daily average 6:20-7:20 h): moderate to medium; total sunshine duration > 675 h, daily average > 7:20 h: favourable (SCHNEEWEISS 2003, 2004)]. At the northern boundary of species distribution it is assumable that the necessary temperature sum for the incubation can be guaranteed with longer sunshine duration. In summers with less sunshine duration clutches at less shaded nesting areas should be favoured and more shaded nesting areas could decide on incubation success or incubation failure of a clutch. On the other hand a good ability of heat storage of the substrate can compensate certain differences of insolation at nesting sites.

In most of the North European areas with *Emys orbicularis*-populations a high predation rate on nests is known (up to 70-90 %). A protection of eggs and hatchlings against predators inside the nests can prevent big losses of offspring.

A summary of requirements for nesting sites is described in table 11.

Tab. 11: List of requirements for suitable nesting sites of *Emys orbicularis* in the North European lowlands

| Characteristics | Requirements |
|------------------------------------|--|
| Minimum size per site | 300 m ² |
| Exposition | south, south-western, south-eastern |
| Inclination | flat, slightly or strongly inclined areas (0-20°) |
| Substrate | sandy, sandy-loamy |
| Structure | dry nutrient-poor locations e.g. sandy dry grasslands |
| Vegetation and vegetation cover | graminaceous and herbaceous plants, half-shrubs, etc.; lower (5 up to 50 %), in case of higher vegetation cover (up to 95 %) it should be vegetation with short growth/height to prevent shading of the ground |
| Microclimate | xerothermic, protected position with heat storing function and windbreak as well as without strong temperature fluctuations (e.g. in near/front of forest edges, in bigger clearings) |
| Lighting conditions | unshaded up to partly shaded, several hours sunshine per day should be guaranteed (daily average > 7:00 h) |
| Distance to the next water habitat | < 300 m |
| Position (aspect: disturbances) | protection from disturbances, as a rule, hardly accessible locations |

Aquatic habitats in small distances to the nesting sites (< 300 m) are very important, because they supply resting and hiding sites for nesting females as well as first ponds for hatchlings after leaving the nests. Furthermore, the predation risk especially for hatchlings is much lower in water than on land. This means that ponds nearby nesting sites prevent longer migrations on land and reduce the predation risk. In particular, small, shallow and highly structured ponds, ponds with shallow highly structured zones or flooded areas e.g. swamps and high moors near the nesting sites are very suitable for hatchlings during their first weeks and months of life. Such water habitats offer higher water temperatures, suitable prey, less competition and more hiding sites.

Sizes of nesting sites can be very different (< 10 m² up to several 100 m²). The size of suitable nesting sites should not be so small so that several females can lay eggs in the same place, and these places are not so threatened by fast overgrowth.

4.3 Threats for nesting *Emys orbicularis*

Threats for nesting females are human activities e.g. hay cutting. If these activities are done close or in the nesting areas and in the migration routes during nesting time, female turtles can get hurt or even be killed by agricultural machines. On the other hand animals “only” disturbed by humans during searching or digging are already stressed and interrupt their activities for hours or days. If the worst come to the worst disturbed individuals completely capitulate nesting and release their eggs in water. In areas with a lack of suitable places for nesting, females are forced to move longer distances on land to remote places where they have a bigger risk to be killed by predators or by cars in case of crossing roads. In general, the building of settlements and roads near turtle ponds and nesting sites is a common threat for the animals. This means also that most of the direct and indirect human activities in turtle habitats lead to a loss of reproduction (loss of adult females and nests). In particular, very small local populations are not able to survive with a regular deficit of reproduction.

4.4 Conservation conclusions for nesting sites of *Emys orbicularis*

Generally, the viability of northern populations of *Emys orbicularis* depends on successful reproduction. In the North-European lowlands, turtle populations are

mostly small or even very small consisting of some single individuals. Therefore, a successful reproduction is essential to prevent these small populations from extinction. On the other hand the species lives here under extreme climatic conditions including short summers and cold winters which cause an arduous reproduction (SCHNEEWEISS & JABLONSKY 2000). In areas along the northern border of distribution, the unfavourable climatic conditions can be compensated by places with a favourable microclimate. This means that nesting areas are a decisive or even a limiting factor for the survival of populations. Consequently, suitable nesting sites are one important fact for saving the last turtle populations in the extreme climatic conditions in the North-European lowlands.

Due to the general habitat destruction there is a lack of open areas in the three project countries. Besides the habitat destruction in Lithuania, abandoned areas destroy open places and adequate nesting sites. The general migration of people into cities leads to the lack of agricultural cultivation and land use. Abandoned land overgrows quickly with bushes and trees e.g. pines (*Pinus sylvestris*). Consequently, a successful incubation is impossible in shaded areas. On the other hand, females can be forced to lay eggs in unsuitable open places because of the lack of suitable sites e.g. on agricultural land, field and forest paths or roads as well as in remote places (4-5 km away from home ponds) where nests can be demolished by agricultural machines and cars. Furthermore, females can be stressed, hurt and killed by longer overland migrations due to the risk of traffic and a higher risk of predation. Therefore, the prevention of the loss of open areas is one important part in the frame of habitat management for *Emys orbicularis*.

In particular, thermic advantaged areas especially southern slopes should be kept open for nesting in smaller distances to water bodies (< 300 m). Grazing or hay cutting as well as bush and tree cutting should be done regularly. However, smaller shrubs and deadwood can be left near the sites as hiding sites for females during their nesting migrations (before and after nesting). In case of grazing, cattle and horses should be established only in general open areas because they can destroy nests and suitable sites by trampling and scratching with their hooves. However, sheep are suitable for grazing directly on the nesting areas but not in smaller fenced areas. The real nesting sites should be kept open by loosening the substrate, too. Additionally, fenced nesting areas require specific habitat management against overgrowth because of the missing grazing of game.

A high predation rate on nests is another very important fact which impacts the reproduction success. Hence, nests and nesting sites should be protected against predators to facilitate the long-term survival of the small North

European populations. The fencing of main nesting areas can inhibit the big loss of nests during incubation. In areas, where intensive turtle observations are possible, single nests can be protected with the help of wire nettings. Additionally, a management of predators in cooperation with the hunters should be led to reduce the predator density and the predation pressure as it is already successfully done in Germany. Therefore, the cooperation with the hunters should also prevent the attraction of wild boars to turtle habitats with feeding (bait), because wild boars are one of the main predators on turtle nests and can be even dangerous for adults.

Hay cutting and other agricultural or forestal activities with heavy machinery should not be conducted close to turtle nesting habitats during nesting period (middle of May up to the end of June), because nesting females will be heavily disturbed and stressed as well as females can get hurt or even killed by these machines. Leisure activities should be not allowed close to aquatic and terrestrial habitats of *Emys orbicularis* especially not during active season of turtles (March-October). In addition, land use in unprotected turtle habitats should always be agreed and adapted with landowners in consideration of the requirements of *Emys orbicularis*.

The availability and sizes of suitable nesting sites should be not too small so that several females can choose between different places for egg-laying. Bigger places for nesting are easier to manage and protect against predation. Furthermore, a bigger choice and bigger sizes of suitable sites can easier compensate unsuitable sites and unsuitable parts of sites for nests e.g. in case of intense habitat changes or less management activities in some years. Thus, it is no need for females to leave totally their habitats.

In order to create, restore or maintain places for nesting of *Emys orbicularis*, the requirements for suitable sites should take into account. Management plans have to be developed and adapted to the specific sites, the status of the local populations and the changing conditions including right time and exact places for habitat management of nesting habitats of *Emys orbicularis*. In ideal case, preparatory and accompanying studies allow the knowledge on nesting ecology (utilization of nesting sites and reproduction frequency) before habitat actions will be started and help to evaluate the effects of management.

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