Analysis of the distribution of the Alpine Salamander in Austria using a community based approach

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Werfenweng, 7 June 2010

STATUTORY DECLARATION

Herewith I, Ursula Reinthaler-Lottermoser, declare that this submission is my own work, except where due acknowledgement has been made in the text. Furthermore, I confirm that no sources have been used in the preparation of this thesis other than those indicated. I also certify that this thesis has not been submitted to any other organization for an academic qualification and has not been previously published. The document submitted represents a verbatim copy of the version graded by the academic advisor (or digital version).

Werfenweng,7 June 2010

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Ursula Reinthaler-Lottermoser

Danke…

… an meinen Mann, Thomas Lottermoser der mich tatkräftig unterstützt hat, in den entscheidenden Phasen vorangetrieben hat, meine Launen während der Entstehung dieser Arbeit ertragen hat und schlussendlich mein Werk Korrektur gelesen hat.

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1. INTRODUCTION

The Alpine Salamander is a small pitch black amphibian which is endemic to the European Alps and strictly protected according to the European FFH guidelines. The FFH (Flora Fauna Habitat) guideline conserves and to restores biological diversity on European level.

Despite its central role in the alpine ecosystem our actual academic record is limited. In order to resolve this shortcoming this project explores the distribution and population of the Alpine Salamander in Austria. It uses a participatory and community based approach to gather data. Everybody can access our website www.alpensalamander.eu and look at Alpine Salamander observations. This approach allows us to establish an oral history of salamander observations in the past 50 years by conducting interviews in the local community. Since July 2009 the website and salamander report database have been online. From the actual data (more than 5600 records) we already obtained a good overview about the present distribution and data quality. The data are an excellent basis for detailed scientific studies on these remarkable amphibians. With this new and highly interactive approach science and education are combined to initiate protecting measures with the public.

1.1. PROBLEM OUTLINE

My thesis aims at drawing the distribution of the Alpine Salamander in Austria with actual recordings and a focus to Salzburg. A brand new concept will help achieving this goal. There is a lack of academic records about the distribution, ecology and lifestyle of these small amphibians. To solve this problem a community based approach was applied to gather data with the help of the population. Everybody can record their salamander findings on our website www.alpensalamander.eu. The author is interested to find out if it is possible to get significant, useable data from this data base and if it is possible to get a good overview of the distribution of the Alpine Salamanders with the help of the population.

1.2. STRUCTURE OF THE PAPER

First an overview about the Alpine Salamander is provided: its taxonomy, morphology, present distribution, ecology, as well as its behavior and reproduction will be presented.

In the second part I describe the project with the new developed approach. The results will be compared with the literature and be discussed.

The last part provides a summary and an outlook on the future of our project.

2. TAXONOMY

The genus *Salamandra* belongs, together with *Chioglosssa* and *Mertensiella,* to the "true" salamanders within the family of Salamandridae. The family of Salamandridae includes 16 genera and 66 recognized species, representing one of the most diverse groups of existing salamanders. The Salamandridae include the "true" salamanders which are smoothly skinned and the newts which can be described as salamanders with rough keratinized skin. This family has diversified in both terrestrial and aquatic environments. A variety of derived feeding morphologies and courtship behaviors between them has been reported previously (Weisrock et al. 2006; Thiesmeier/Grossenbacher 2004, p. 970).

Genetic data suggest that the earliest phylogenetic split within the Salamandridae separated the "true" salamanders (genera: *Chioglossa, Mertensiella and Salamandra*) from the newts (genera *Cynops, Echinotriton, Euproctus, Neurergus, Notophthalmus, Pachytriton, Paramesotriton, Pleurodeles, Salamandrina, Taricha, Triturus and Tylotoriton*). The morphological adaption to terrestrial life is characteristic for the "true" salamanders (Steinfartz et al. 2005; Veith et al. 1998).

Within the "true" salamanders the relationships are not clearly defined. It can be supported that a primary phylogenetic split separated a clade containing *Chioglossa* and *Mertensiella* from a clade containing *Lyciasalamandra* and *Salamandra* (Weisrock et al. 2006; Thiesmeier/Grossenbacher 2004, p. 970).

The monophyletic origin within Salamandra is still a matter of research. Using D-loop analyses the six phylogenetic groups were defined as follows:

- *Salamandra salamandra* (Europe)
- *Salamandra algira* (Northern Africa)
- *Salamandra infraimmaculata* (Middle East)
- *Salamandra corsica* (Corsica)
- *Salamandra atra* (European Alps including an isolated population in the Dinaric Alps of Serbia and Albania)

- *Salamandra lanzai* (border region between France and Italy)

These six groups have split between 5 and 13 million years ago. Except *Salamandra salamandra*, each of the Salamandra species occupies a distinct geographical area. *Salamandra salamandra* occurs all over Europe. It has been suggested that this was the only species that has recolonized Central Europe after the last glaciations about 18,000 years ago (Würmeiszeit) (Wegner 2002; Steinfartz/Veith/Tautz 2000; Veith et al 1998).

Steinfartz/Veith/Tautz (2000) found out that the two melanistic Alpine Salamander species, *Salamandra lanzai* and *Salamandra atra,* are not grouped together. They discovered that *Salamandra Corsica*, which is not a melanistic form, is the sister group of *Salamandra atra, therefore stating that Salamandra lanzai* is a separate unit. A second major finding claims that the North African species *Salamandra algira* is a sister group to the Central European salamanders, *Salamandra salamandra*. There is no monophylum of the melanistic Alpine Salamander as well of the yellow dotted Fire Salamanders (Thiesmeier/Grossenbacher 2004, p. 970).

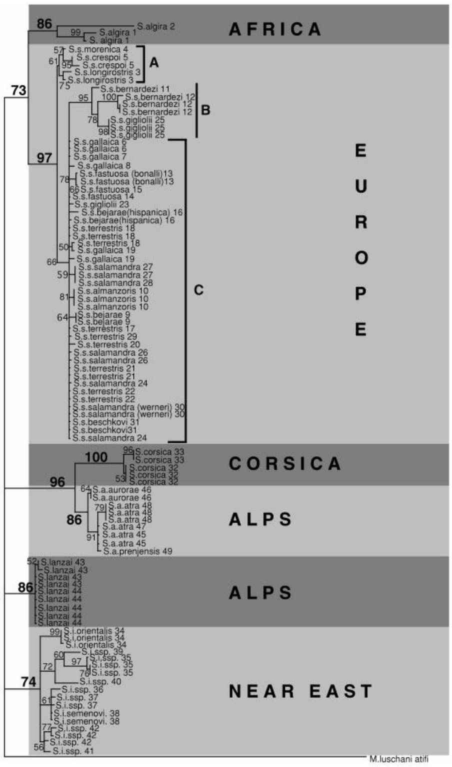

Figure 1 Bootstrap consensus tree of all D-loop sequences.

Source: Steinfartz/Veith/Tautz 2000 p. 401

The estimation about the distance of the split occurs because of the D-loops and calibration of the molecular clock. Mitochondrial D-loop sequences were used to analyze the genetic differentiation between the Salamandra populations because the D-loop (or mitochondrial control region) is usually considered to be the most rapidly evolving part of the mitochondrial genome. Analyzing this region should yield the highest degree of resolution among closely related populations (Steinfartz/Veith/Tautz 2000).

The two sister groups *Salamandra* and *Mertensiella* are expected to have diverged from each other 25 million years ago. 13 million years ago the Near Eastern species *Salamandra infraimmaculata* are expected to have separated from the rest. *Salamandra algira* (African species) are expected to have separated from the *Salamandra salamandra* (European Species) 8 million years ago. Therefore the separation has already taken place before the Strait of Gibraltar was flooded 5.3 million years ago. *Salamandra atra* and *Salamandra Corsica* are expected to have split 5 million years ago (Steinfartz/Veith/Tautz 2000).

Differentiation within the subspecies

These well separated species can be divided into subspecies on the basis of coloration and morphological characteristics. There is a clear difference between *Salamandra atra atra* and *Salamandra atra aurorae*. Both live in a similar montane habitat but *Salamandra atra aurorae* occupies only a small region in the Dolomites. This region is located at the edge of the species distribution area. This region does not appear to overlap with the *Salamandra atra atra* range. *Salamandra atra aurorae* are morphologically very similar, they differ only in color. Thus, they might constitute only a very recently, possibly postglacially, derived variety. However, they are very different from *Salamandra atra atra* which has been shown in molecular analyses. *Salamandra atra aurorae* can be considered as a sister group of *Salamandra atra*. According to the molecular distance the separation took place 0.7 – 1.1 million years ago. *Salamandra atra aurorae* must have recolonized the Alpine area independently after the last glaciations. In contrast the other *Salamandra atra atra* lineages from across the Alps can be grouped more closely together. This includes also the former subspecies *Salamandra atra prenjensis* from Bosnia (Riberon et al. 2001; Steinfartz/Veith/Tautz 2000).

Salamandra atra pasubiensis which can be found only in the Pasubio Massif (Venetian Prealps, North-East Italy) separated from *Salamandra atra atra* more recently, but most probably before the last glacial period. The Pleistocene climatic oscillations probably shaped the current geographic distribution of the three major lineages within *Salamandra atra*. After the last retreat of the ice sheets, *Salamandra atra pasubiensis* and *Salamandra atra aurorae* remained isolated in different prealpine mountain regions. *Salamandra atra atra* successfully recolonized most of the Alps and the Dinaric Alps (Bonato/Steinfartz 2005).

3. MORPHOLOGY AND PHYSIOLOGY

3.1. BODY SIZE

There are many different data relating to body size and weight of the Alpine Salamander. Klewen (1991, p. 95 ff.) provides a good overview based on measurements of measured 1444 Alpine Salamanders. The total length ranges from 4.9 – 14.4 cm within the males and up to 15.1 cm within the females. The most lightweight individual is around 0.9 g, the heaviest (a female) weighs around 15 g. The average increase in weight is 0.5 g/cm within the offspring, 0.8 g/cm within the males and 1 g/cm within the females. The males are in the average smaller and lighter than the females, but there is one exception: a population from the alpine area.

3.2. BODY COLOR

The Alpine Salamander (nominate form) has a glossy black skin. The side is less pigmented and looks dark grey. Some individuals have a dark brown or an olive shiny belly. Additionally, individuals which are partial albino, chocolate brown or which have brown patches have been described (Thiesmeier/Grossenbacher 2003, p. 979; Günther 1996, p. 71; Freytag).

Figure 2 The Alpine Salamander with the typical black skin.

Source: www.alpensalamander.eu

The yellow color of the eggs can shine through the side of the strait body of vitellogenis of pregnant females. Injuries, mycosis and bacterial infections can cause local pigmentary anomalies (Thiesmeier/Grossenbacher 2003, p. 979).

In contrast to the nominate form the subspecies *Salamandra atra aurorae* is characterized by big yellow patches on dark grey or dark brown ground. The patches can be spread onto more than 50 % of the skin, slightly giving the animal the appearance of some subspecies of the Fire Salamander. However, the color of the Fire Salamander is stronger, the yellow is much brighter and the skin is intensive black. The coloration in *Salamandra atra aurorae* ranges from dirty white, grayish to light brown and greenish. The head is mostly yellow with a few black spots. There is a remarkable coloration at the insertion of front legs and rear legs with a yellow patch each. This is a typical feature of the Fire Salamander; in contrast the coloration pattern of the *Salamandra atra aurora* is basically on the dorsal side. Red coloration, which was recorded in the Fire Salamander, is not known in *Salamandra atra aurorae* (Thiesmeier/Grossenbacher 2003, p. 979; Klewen 1991, p. 92).

Figure 3 *Salamandra atra aurorae*

Source: http://www.caudata.org/cc/images/species/Salamandra/S_a_auroraeBakerLarge.jpg

There is a second subspecies of *Salamandra atra atra*, which was described 2005 by Bonato and Steinfartz and is called *Salamandra atra pasubiensis*. The body coloration of this subspecies varies among the individuals of the same population, ranging from uniform black as the nominate form *Salamandra atra atra* to yellow patches comparable to *Salamandra atra aurorae*.

Figure 4 Salamandra atra pasubiensis

Source: http://farm2.static.flickr.com/1216/1021394440_33faa5e42a_o.jpg

The patches in *Salamandra atra pasubiensis* are mainly straw yellow, but can also be brownish. They are only found on the dorsal surface, on the head and the body and most often on the proximal part of limbs. There are much less extended patches than in *Salamandra atra aurorae*, and the patches vary within the individuals (Bonato/Steinfartz 2005, p. 260).

3.3. ATTRIBUTE VARATION

3.3.1. Sex Dimorphism

The cloaca is the most conspicuous/distinct characteristic variation between males and females. In males the cloaca cambers considerably outwards and on the outside it has a compact structure also for the offspring. Furthermore it shows a well apparent right angle from the underside of the tail to caudal, when looking at the cloaca from lateral. The cloaca of the females is flat on the outside and runs acute-angled to the furrow of the underside of the tail. Within bigger and probably older females it is possible the cloaca cambers also considerably to the front, but unlike the male's cloaca it is always smooth. Contrarily to the males, it develops in the inside one lip per side. Other distinct morphological variations are not observed (Grossenbacher/Thiesmeier 2004, p. 992).

In practice, it is possible to differentiate both sexes without looking at the cloaca. This is maybe due to the differences in behavior; for details please refer to chapter 6. Pregnant females are also more corpulent which also facilitates to differentiate between the sexes (Grossenbacher/Thiesmeier 2004, p. 992).

According to Klewen (1991, p. 96ff) the females are longer and heavier than the males. The latter can be explained due to the pregnancy of the females.

3.3.2. Age-related variation

Young salamanders change in appearance when they grow bigger and older, the childish appearance gets lost. It seems that the length-proportion changes;

they appear bony and angular. Steinfartz (1998) noticed an extensive melanization of a female *Salamandra atra aurorae* from large yellow patterned to black within only four months. The contour of the color pattern changes with growth especially within the offspring, but also within adults. Continuous bands of color can be fragmented or can conflate. Compact color dots can change in color, size and form. The pattern does not change for 2 – 3 years or longer, it depends on the individual; almost the same is reported for the Fire Salamander (Grossenbacher/Thiesmeier 2004, p. 992; Freytag 2002, p. 58 ff.).

3.3.3. Seasonable Variation

A seasonable variation is not known (Grossenbacher/Thiesmeier 2004, p. 992).

3.3.4. Subspecies and Geographically Variation

For a long time *Salamandra atra* has been considered as a fully melanistic and monotypic species. Therefore the southernmost populations in the Balkans have been described as the distinct subspecies *Salamandra atra prenjensis*. In contrast to the nominate form *Salamandra atra prenjensis* is smaller and has a different form of the teeth in the mouth, the color is black to brownish and animals differ also in their ecological requirements (Mikšic, 1969; Grossenbacher/Thiesmeier 2004, p. 993).

The validity of this taxon could not be supported because Klewen (1991, p. 89 ff.) analyzed these attributes and found that they are within the range of the nominate form: Morphological and serological data did not support this theory either (Bonato/Steinfartz 2005, p. 253).

In the Altopiano dei Sette Comuni (Venetian Prealps) a chromatically and genetically differentiated form was discovered recently. This form was described as separate subspecies *Salamandra atra aurorae* by Trevisan in 1982. It is characterized by a pattern of large coalescent yellow patches on the dorsal side

(Bonato/Steinfartz 2005, p. 253 f.; Grossenbacher/Thiesmeier 2004, p. 993; Klewen 1991, p 91 f.).

On the Pasubio massif (Venetian Prealps) a new population of *Salamandra atra* was discovered just a few years ago and described in 2005 by Bonato and Steinfartz. This population is only about 20 km southwest of the Altopiano dei Sette Comuni where *Salamandra atra aurorae* was found. Usually the individuals of this population are yellow patched, but the color is variable within the same population and ranges from uniform black (like *Salamandra atra atra*) to yellow-patched (like *Salamandra atra aurorae*). The coloration of the patches ranges from straw-yellow to brownish. The patches can only be found on the dorsal surface, on head and body but most often on the proximal parts of the limbs, especially on front legs and rear legs. In *Salamandra atra pasubiensis* the patches are much less pronounced than in *Salamandra atra aurorae* (Bonato/Steinfartz 2005 253, 260).

4. DISTRIBUTION

4.1. DISTRIBUTION IN EUROPE

Terra typical restricta: Loibl-Paß, Karavanke chain between Carinthia and Krain, according to description of the distribution presented by Laurenti in 1768.

Today the exact distribution area of the Alpine Salamander is unclear. The areas are divided into a northern and a southern part. The northern part consists of the Alps, which seem to be totally populated. The southern part contains the southern Dinaric Alps and northern Albania (Kyek/Maletzky 2006, p. 141; Nöllert/Nöllert 1992, p. 181).

Figure 5 The distribution of the Alpine Salamander throughout Europe.

Source:
http://de.wikipedia.org/w/index.php?title=Datei:Salamandra_atra_dis.png&filetimestamp=20060218192354

Salamandra atra can be found continuously till the Rhone valley, in the North of Lake Geneva. According to Thiesmeier and Grossenbacher the population in Sixt/Samoens, northern Alps of Savoyer, is an isolate. The border to the East is an area through the Waadtländer, the Alps of Bern and Freiburg and Central Switzerland, where the salamander can be found continuously. Wallis in the Central Alps is only populated on two places in higher altitudes in the North. Generally the Alpine Salamander populated the northern slope of the Alps in Switzerland. There are also some view reports from the North of Tessin, but they are not confirmed (Grossenbacher/Thiesmeier 2004, p. 983, Klewen 1991, p. 87).

The Alpine Salamander was also found in lower altitudes at the foothills of the Alps from Emmental, Schwarzenburg District and Entlebuchers, especially around canyons. The distribution area stretches from Central Switzerland, the Glarus Alps and Nordbünden through the Säntismassiv into the Allgaeu, the border region of Baden-Württemberg and Bavaria. The former species in the Argental (Allgaeu) are extinct. An isolated population can be found on the Tau-benberg, situated in the South of Holzkirchen. The area in Germany reaches through the Ammergebirge, Wetterstein and Mangfallgebirge, Chiemgau Alps, Lattengebirge and crosses the border to Austria at the Untersberg between Berchtesgarden and Salzburg. At the same time this area in Germany represents the border to the North (Grossenbacher/Thiesmeier 2004, p. 984; Klewen 1991, p. 85ff.).

The border in Austria is as follows: from the Kolomansberg, the Höllengebirge, Traunstein, Sensengebirge, Voralm, Ötscher to the Schneeberg. The very eastern point in this area is only 50 km SW from Vienna. The eastern border is not well known, it ranges from the Wechsel, the Gleinalpe, Stubalpe, Koralpe, Petzen/Peca (border between Slovenia and Austria), Raduha, Fischalpe to the Julische Alps. The southernmost point of this connected area is the Tarnovaner in the east of Gorizia (Grossenbacher/Thiesmeier 2004, p. 984; Klewen 1991, p. 87).

In the South of these areas there are still some points where the Alpine Salamander can be found: in Istria (Croatia) at the Cicarija and at the border mountains between Slovenia and Croatia (Senznik und Zumberak). They are often found in Velika Kapela and also in Mala Kapela. There is a lack of distribution of 200 km and after that there are several massifs in the South of Sarajevo which are again populated. The population in the Cvrsnica- and Prenj-mountains was described as a subspecies, but recent molecular phylogenetic analyses did not confirm the classification as a separate taxon. Now *Salamandra atra prenjensis* is a nominal subspecies of the *Salamandra atra atra* nominate form (Bonato/Steinfarz 2005, p. 984 ff; Grossenbacher/Thiesmeier 2004, p. 985; Klewen 1991, p. 87, 89 ff).

The border to the South in Italy is not well investigated. In this area the Alpine Salamanders are hardly active above the ground. A reason for this behavior is the warm climate and therefore the Alpine Salamander is rarely found. Grossenbacher and Thiesmeier (2004, p. 985) could not confirm the former reports from the Aostatal and the Ossola-Formazza-area as well as the Val d’Intelvi.

The border to the West in Italy is the area of the Splügen Pass. The Orobischen Alps in the South of Veltlin, are definitely populated. The source in the Adamello-Massiv is not confirmed due to a lack of recent recordings. A population in the area Orobie-Adamello (Central Eastern Alps) bordering the central alpine arroyos Veltin, Vischgau and Etschtal (in the South of Bolzano) is probably an isolate because they represent an unsettled and huge barrier. There are numerous former findings in Italy, but they have not been verified recently (Grossenbacher/Thiesmeier 2004, p. 985; Klewen 1991, p. 87).

The nominate form of *Salamandra atra atra* surly populated the northern Dolomite Alps till the Lagorai-Massiv with the Passo Manghen and Cima d'Asta, as a border to the South. The southern border ranges through the Belluneser Dolomite Alps to the Bosco del Cansiglia (in the North of the Po Valley) forward to the North of the Monte Cavallo till the southern slope of the Carnic Alps (Friaul) and across the Monte Musi and Tolmin in the Julian alps (Grossenbacher/Thiesmeier 2004, p. 985; Klewen 1991, p. 87).

There is also a small area populated by *Salamandra atra aurorae*. This area is located on the plateau of the Sette Comuni between Asiago and the Passo di Vezzena (Provinz Vicenza). A second source is the Monte Pasubio (Venetian Prealps), where the subspecies *Salamandra atra pasubiensis* occurs. These sources are completely isolated from the main distribution area of the *Salamandra atra atra*, because there are huge barriers with deep valleys (Bonato/Steinfartz 2005, p. 260; Grossenbacher/Thiesmeier 2004, p. 985; Klewen 1991, p. 87).

4.2. DISTRIBUTION IN AUSTRIA

According to the “Amphibien- und Reptilienatlas Österreichs” 2001, the Alpine Salamander can be found in all provinces except Burgenland and Vienna. However, the provided data are not very extensive.

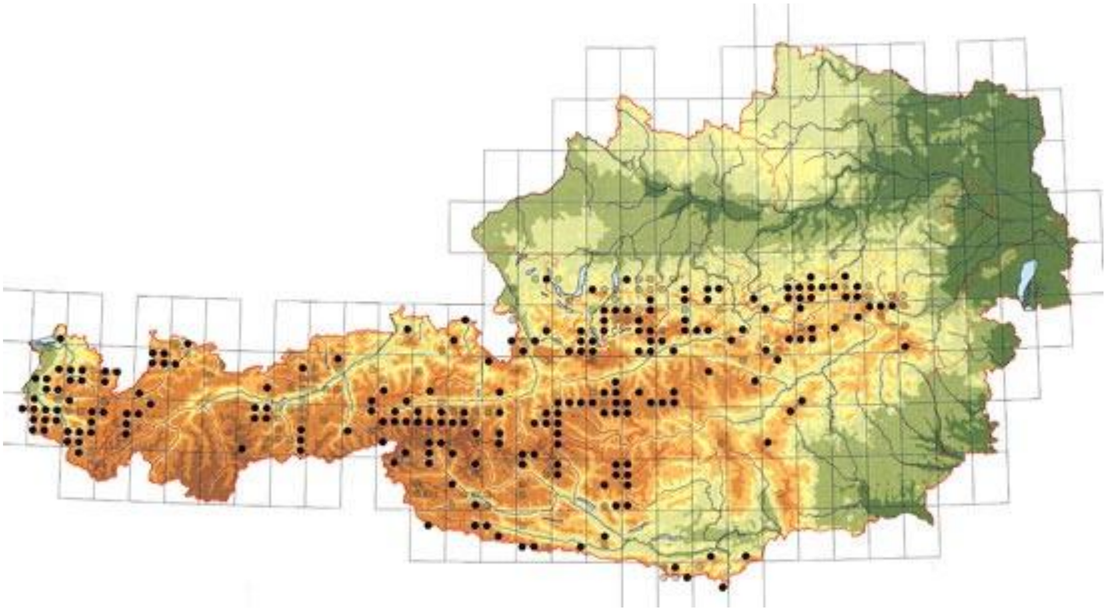

Figure 6 The distribution of the Alpine Salamander in Austria.

Source: Atlas zur Verbreitung der Ampibien und Reptilien Österreichs S. 164

The indicated area reaches from the Kolomansberg, the Höllengebirge, Traunstein, Sensengebirge, Voralm, Ötscher to the Schneeberg. The border to the East is not exactly known. It is not clear why there are so huge lacks of distribution in big parts of western Tyrol, in Salzburg (especially in the some mountain regions in Pinzgau) as well as in the south-eastern part of Carinthia. These missing data can either be related to missing recordings or climatic circumstances, which are not favorable for the Alpine Salamander. The climate is very dry which might explain the lack of distribution (Kyek/Maletzky 2006, p. 141).

The distribution area in Austria is related to the annual amount of rainfall: the salamander can be found in areas where precipitation exceeds 1000 mm. This might explain the lack of distribution in the Ötztal Alps and in southern Carinthia. The fact that no salamander observations are recorded in the northern and southern Inntal is probably the result of a lack of recordings (Grossenbacher/Thiesmeier 2004, p. 985; Klewen 1991, p. 87).

Distribution in Salzburg

In Salzburg the Alpine Salamander is mainly found in the montane regions. In 2006 the northernmost populations were found on the Untersberg and the foothill of the Osterhorngruppe. There are some recordings from the Kapuzinerberg in the city of Salzburg and from the Kolomannsberg in Thalgau which are probably not autochthonous and therefore questionable (Kyek/Maletzky 2006, p. 141).

The main part of the recordings was made in the Central Alps. There are also numerous recordings in the Tennengebirge and in the Hagengebirge. Local spots are known around the Hochkönig area and the Pinzgauer Grasberge (Kyek/Maletzky 2006, p. 141).

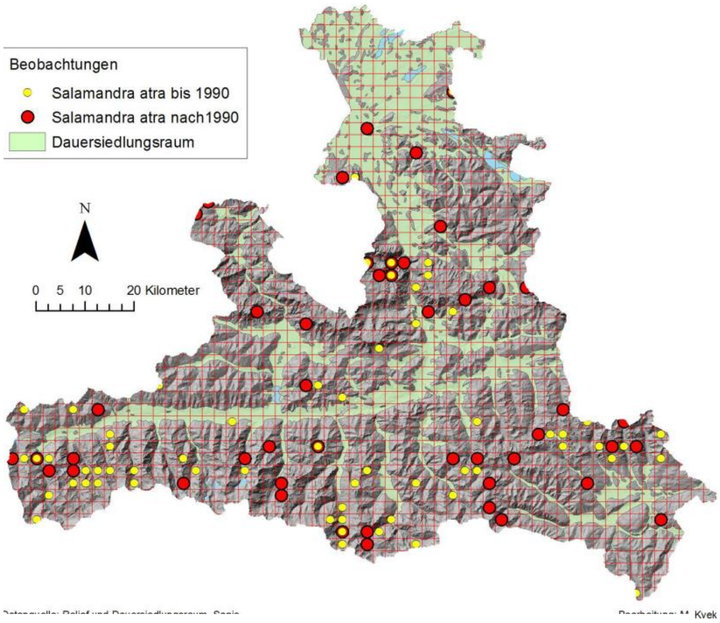

Figure 7 Distribution of the Alpine Salamander in Salzburg.

Source: Atlas und Rote Liste der Amphiben und Reptilien Salzburgs, p. 142

As mentioned before the goal of this thesis is to sketch the distribution of the Alpine Salamander in Austria with the help of actual recordings and a focus to Salzburg.

4.3. ALTITUDE DISTRIBUTION

The Alpine Salamander can be found in altitudes between 433 – 2800 m (Nöllert/Nöllert 1992, p. 182). The lowest known location in Salzburg is the Bluntautal (valley) with an altitude of 507 m. The highest location in Salzburg is Neukirchen am Großvendiger with an altitude of 2500 m (Kyek/Maletzky 2006, p. 143).

5. ECOLOGY

5.1. HABITAT

The most important environmental conditions for the Alpine Salamander are temperature and moisture, followed by soil structure (Thiesmeier/Grossenbacher 2003, p.994).

The selection of the habitat depends on the altitude (Klewen 1991, p. 113). The Alpine Salamander is found in beech groves, in deciduous forests and in mixed deciduous woodland in lower altitudes. Coniferous woodland is only populated in the peripheral region. The animals prefer mixed deciduous woodland with enough hiding places during the day, as indicated in Table 1.

Table 1 Day hiding places of *Salamandra atra atra.* Source: Klewen 1991

Day hiding places	total	%
hollow stones	165	41,1
crevices	65	16,3
stumps	24	6,0
rotten wood	29	7,3
moss	5	1,2
greenery	4	1,0
mouse holes	87	21,8

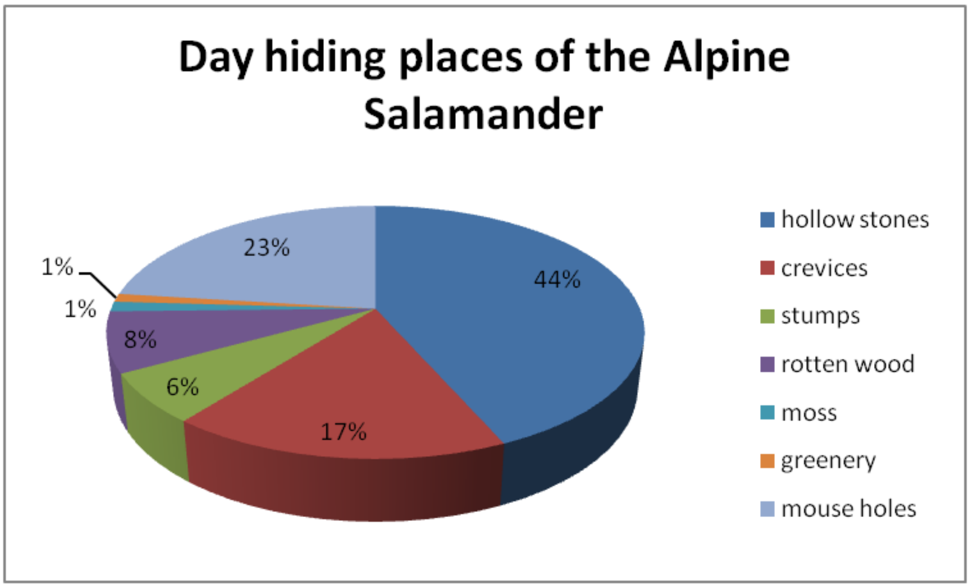

Figure 8 The day hiding places as a graph for a better overview.

Own graph, Source Klewen 1991

Above the tree line salamanders are found on alp grassland and dwarf shrub heath land and also in rock surroundings. Stones, crevices, mouse holes (or similar) and dead/rotten wood are required as hiding-places during the day. In general the Alpine Salamander uses holly stones (51 %) and mouse holes (22 %), as shown in the table above. The temperatures in these places which are often of use as wintering grounds range from 5 to 13° C (Nöllert/Nöllert 1992, p. 182; Klewen 1991, p. 117ff).

The ideal structures for the habitat are overgrown scree, karst formation with deep structures, providing hiding places for the salamander. The Alpine Salamander is rarely found on extreme southern slopes, probably due to too high temperatures which result in dry ground and therefore the salamanders run dry. In winter the protecting snow layer exists only during a short period (Thiesmeier/Grossenbacher 2003, p. 994 f.).

5.2. NUTRITION

Nutrition seems to be very unspecific and has a wide range. Generally it can be said everything that is not to fast or to big for the Alpine Salamander would be frozen. Most often the Alpine Salamander can be observed while eating earthworms, followed by small slugs and different arthropods. Eating earthworms needs more time than eating arthropods, therefore the latter has been observed more often. There is a small difference between to observed food and the analysis of the stomach contents: bugs (Coleoptera) followed by arachnids are found most frequently (Klewen 1991 p. 124 ff).

Table 2 Nutrition: recordings of prey animals. Source: Klewen 1991 p. 124

prey animal	adult	juvenile
Small slugs	23	1
Vitrea subrimata	2	
Lumbricus sp.	41	4
Oniscus asellus	9	
Miramella marginatus	1	
Bembidion sp.	1	
Malthodes sp.	1	
Staphyliniden	6	
Abulina glandon	1	
Cidaria sp.	1	
Formica rufa	3	1
Epemeroptera	5	
Different arthropods	27	3
Maggot	11	3

5.3. PREDATORS

Only a few predators of the Alpine Salamander are known. Klewen (1991) noticed magpies (*Pica pica*) and alpine choughs (*Pyrrhocorax graculus*) while picking Alpine Salamanders. Birds did not touch the back with the poisonous glands. Carrion crows (*Corvus c. corone*) as well as common raven (*Corvus corax*) were observed when looking for the Alpine Salamander as their prey. Also European adder (*Vipera berus*) captures salamanders. In single cases grass snakes (*Natrix natrix*), blindworms (*Anguis fragilis*), hedgehogs (*Erinaceus europaeus*) and jays (*Garrulus glandarius*) were observed while capturing Alpine Salamanders (Thiesmeier/Grossenbacher 2003, p. 996f.; Günther 1996, p. 81; Klewen 1991, p. 125).

Death on street is another case of death nowadays, especially on mountain roads and forest tracks. For behavioral reasons this affects males more than females. The cadavers were taken away by corvids. Concentrated slurry and chemical fertilizer can burn the skin of the animals (Thiesmeier/Grossenbacher 2003, p. 997).

Generally the predation draft has to be very low, especially in the high mountains were the females give birth to 2 young, only every 4 to 5 years. With this slow turnover, the animals need an effective prevention against enemies to guarantee survival of their species (Thiesmeier/Grossenbacher 2003, p. 997; Günther 1996, p. 81).

5.4. CONCOMITANT FAUNA

It depends on the location and the altitude witch species can be found together with the Alpine Salamander.

- alpine newt (*Triturus alpestris*),
- palmate newt (*Triturus helveticus*),
- Fire Salamander (*Salamandra Salamandra*),
- common frog (*Rana temporaria*),
- common toad (*Bufo bufo*),
- natterjack toad (*Bufo calamita*),
- green toad *(Bufo viridis*),
- yellow-bellied toad (*Bombina variegata*),

- obstetrical toad (*Alytes obstetricians*)
- common lizard (*Lacerta vivipara*),
- sand lizard (*Lacerta agilis*),
- blindworm (*Anguis fragilis*),
- grass snake *(Natrix natrix*),
- *Coronella austriaca*,
- *Vipera ammodytes*,
- European adder (*Vipera berus*) and
- aspic viper (*Vipera aspis*)

were detected in areas where the Alpine Salamander was also found (Thiesmeier/Grossenbacher 2003, p. 995f.; Günther 1996, p. 76).

6. BEHAVIOR

6.1. ACTIVITY

The early morning hours between 3:00 and 7:00 (normal time) is the main activity time of salamanders. This activity depends more on the relative air humidity on the ground than on the current temperature. Animals were observed at temperatures between 3 – 5° C and air humidity of more than 90 %. With air humidity less than 70 % the Alpine Salamander can be rarely observed. The best condition for the salamanders is either at the beginning of precipitation or with morning dew. In these conditions they can be observed frequently. The animal does not like wind or daylight. Direct sunlight does not bother the salamanders when the air humidity is high enough. Less activity can be observed after rainfalls lasting for several days. Most animals can be found after long dry periods which are followed by a tepid thunderstorm. This is reflected in local names such as “Regenmanderl” (rainy man). The Alpine Salamanders can often be found shortly before the start of the rain (Thiesmeier/Grossenbacher 2004, p. 1009; Klewen 1991, p. 119).

Klewen (1991, p. 119) recorded the daily rhythm of the Alpine Salamander over a longer period of time (July 5 to August 4, 1980). He measured the amount of precipitation, air humidity, the temperature on the ground and the activities of the Alpine Salamander. The temperature is not limitating until low or high data. The animals could be found at 4 °C, but the ideal temperature seems to be 8 – 15 °C. When the temperature on the ground is higher the salamanders are not active. Air humidity is the key factor for a stay outside of their hiding place. The lowest recorded data is between 86 % and 88 %, whereas the observed standard for activity is higher than 92 % air humidity. As mentioned before the main activity of the animals is between 3:00 and 7:00. This data was collected by Klewen in an outdoor terrarium (Thiesmeier/Grossenbacher 2004, p. 1009f; Klewen 1991, p. 119f).

6.2. ACTIVITY DURING THE YEAR

Observations during/or shortly after snow melting are quite rare. In lower regions at around 600 m the salamanders are rarely found on the surface before the end of April. It looks as if the animals are not active on the surface until a few weeks after snow melting. Thiesmeier and Grossenbacher (2004, p. 1011) mentioned a recording from Vilter et al (1959) who found bigger gatherings of Alpine Salamanders in the late morning hours on snow fields.

In June there is a considerable increase of observations especially from animals which are ready for mating. Most observations are made during July and August. This activity is interrupted if snow falls in summer or may even come to abrupt breakdowns in the late summer. During September the frequency of observations decreases to rare activity of only a few animals at lower regions in the first part of October (Thiesmeier/Grossenbacher 2004, p. 1011).

On a flat route, surrounded by alp grassland (Engisteinen, Kt. Glarus, Switzerland) the sex ratio was 4.4 : 1; on one day 10.3 : 1; and five times only males were observed. Overall, 9 recordings were found in this series (August – September 1981, Thiesmeier/Grossenbacher 2004, p. 1011). The females (31) were all near or under the grass slope. They were inactive or in a defensive position. The males (129) were directly on the flat route.

Table 3 Two observations in Engisteinen, Kt. Glarus, Switzerland.

Source: Thiesmeier/Grossenbacher 2004, p. 1011

Observation	male	Female
1	129	31
2	20	0
3	93	6
Sex ratio is 15.5 : 1		

Table 4 Overview: positions of the males when found

Source: Thiesmeier/Grossenbacher 2004, p. 1011

Position	Percent
"Hochbeinstellung"	53.3
running	11.6
undefined or not observed position	34.9

The "Hochbeinstellung" is the erection of the upper part of the body, with elongated front legs. The eyes are in observant position. This behavior was not noticed in females, only the erection of the upper part of the body without elongated front legs was recorded. This behavior in males was related to the search for a mating partner (Thiesmeier/Grossenbacher 2004, p. 1011).

Figure 9 Shows a Alpine Salamander in Hochbeinstellung.

Source: www.alpensalamdner.eu

The males seem to prefer flat structures which results in a weak position against predators as they are more exposed. Females are more often found on structures which are protective, for example grass-covered stones (Thiesmeier/Grossenbacher 2004, p. 1011).

6.3. HIBERNATION

The animals are not able to get on the surface for five to seven months depending on the snow cover. Their behavior in winter is outside of our observation possibilities. The day hiding places like crevice and mouse holes which reach deep in the ground are used as wintering grounds. It is not clear if the Alpine Salamander builds hibernation communities like the fire salamander (Kleven 1991, p. 120).

Outdoor digs in December down to a depth of 2 meters did not detect salamanders (Thiesmeier/Grossenbacher 2004, p. 1012). At the same place, many animals were found in the summer. The animals may be much deeper in the ground. Migration in fall into wintering grounds or back in spring has not been noticed. In an outdoor terrarium (850 m. Engisteinen, Kt. Glarus) the animals were found on the ground of the terrarium in a depth of 1.5 m. The soil temperature was 5 – 6 °C and the midday outside temperature was -2 °C. When the animals were disturbed they tried to escape or remained in defensive position. This leads to the conclusion that the animals are active even in winter. Alpine Salamanders still survive even if they freeze for a short period of time (Thiesmeier/Grossenbacher 2004, p. 1012; Klewen 1991, p. 120f).

6.4. DEFENSIVE BEHAVIOR

Animals which are disturbed in their hiding place try to escape directly or tighten up s-shaped. The head is more or less pressed to the bottom. In this state they stay still for a while until they try to escape very quickly. When Alpine Salamanders where repeatedly nudged with a pencil they put their body in s-shape and made head beating moves to both sides. The parotids seldom detach a whitely secretion. Alpine Salamanders are mostly but not always covered with this secretion when they are mechanically attacked. It is possible that this secretion may activate defensive behavior. It is sure that the secretion is released when pressure is

Figure 10 S-shape typically defensive behavior.

Source: www.alpensalamdner.eu

applied from the outside. The venom dries fast on human skin, is gluey and changes color from whitish to yellowish because of oxidation (Thiesmeier/Grossenbacher 2004, p. 1012f).

6.5. VENOM

The venom of this secretion belongs to the group of alkaloids. They were synthesized from the precursor cholesterine. This venom cocktail is marked as a convulsant poison, i.e. the venom affects the central nerve system. It irritates the mucous membranes, provokes an increase of the blood pressure and is a local anesthetic. The eventual death of the predator is primarily caused by respiratory paralysis. The following substances can be found in the venom:

- Salamandrin
- Samandaridin
- Samandenon
- Samanin
- Further derivats from this group
- Tryptamin
- Serotonin

The venom of the *Salamandra atra* is similar to the venom of the Fire Salamander, but in another concentration. It is also effective against bacteria and fungi. The antibiotic effect of the secretion is necessary for the survival of the salamanders because of the exchange function between skin and the environment (Thiesmeier/Grossenbacher 2004, p. 1013; Freytag 2002, p. 46f).

6.6. COMMUNICATION

Communicative sounds are not known within the Alpine Salamanders. It can be assumed that salamanders have an olfactory identification or even communication. But this has not been confirmed yet. Their visual attention and the sensibility for vibrations in a close range is remarkable (Thiesmeier/Grossenbacher 2004, p. 1013; Freytag 2002, p. 45).

6.7. MATING BEHAVIOR

Within the genus *Salamandra*, the Alpine Salamanders have an exceptional position in their reproductive behavior. They give birth to fully developed offspring, which is referred to as vivipary. The Alpine Salamander is the only amphibian which is independent from water in its reproduction. The whole development takes place in the uterus until the entire metamorphosis. In alpine spring the mating takes place on earth. The mating behavior is always the same and can be divided into five stages. If a female passes by, the first stage starts. However, Alpine Salamanders are not specific in their choices. The trigger can also be a male, a Fire Salamander or a dummy. Klewen (1991, p. 100) noticed 57 matings during his observations (Thiesmeier/Grossenbacher 2003, p. 998; Günther 1996, p. 77 ff.).

Figure 11 First stage - the male follows the female.

Source: www.alpensalamander.eu

First stage – persecution: The males show their readiness for mating during and after rain. They follow other Salamanders, but not only females. It was observed that males and females were similarly followed. The observed distance to the persecuted animal was between two and twenty-six meters. This is in most cases a longer distance than they cover in the search of food. The male tries to proceed to stage two as soon as it reaches the female. The females move on while the male follows until the female shows its willingness for mating (Günther 1996, p. 79; Klewen 1991, p. 100).

Second stage – ascension and head rubbing: The male gets onto the females back and clasps the throat region with its front legs. Then it rubs his throat on the head of the female. If the male drops off the female during this procedure, the second stage starts again from the beginning. The head rubbing lasts from 5 minutes to one hour before the next stage begins (Günther 1996, p. 79; Klewen 1991, p. 100).

Figure 12 Second stage - ascension and head rubbing.

Source: www.alpensalamdner.eu

Third stage – creeping under, clasping and throat rubbing: The male climbs down and starts to move sideways under the female. With a jerky motion of the head, the male lifts the female. The female looses ground with its front legs, and the male moves completely under the female. The male clasps the female's forelimbs from behind and starts to rub the throat with its head. This is possibly to slow down the female. Many differences can be observed in this stage (Günther 1996, p. 79; Klewen 1991, p. 100 f.).

Figure 13 Third stage "Unterkriechen"

Source: www.alpensalamdner.eu

Forth stage – rubbing the “Schwanzwurzel” and release of the Spermatophore: As soon as the female calms down, the male starts to rub the cloaca of the female with its tail. A reaction was observed in half of the matings, the females made pendulous movements with their abdomen. The male release the Spermatophore immediately. If the female shows no reaction, the male continues the “Schwanzwurzelreiben” for about 5 to nineteen minutes until the Spermatophore is released (Günther 1996, p 79; Klewen 1991, p 103).

Figure 14 Forth stage – “Schwanzwurzelreiben”

Source: www.alpensalamander.eu

Fifth stage – the female accepts the Spermatophore: Directly after stripping of the Spermatophore the male bends the abdomen to the side, so that the abdomen of the female is over the Spermatophore. The female takes the Spermatophore with the cloaca. Both male and female remain in this position for two to seven minutes, afterwards the male releases the female and the animals go in different directions (Günther 1996, p 79; Klewen 1991, p 103).

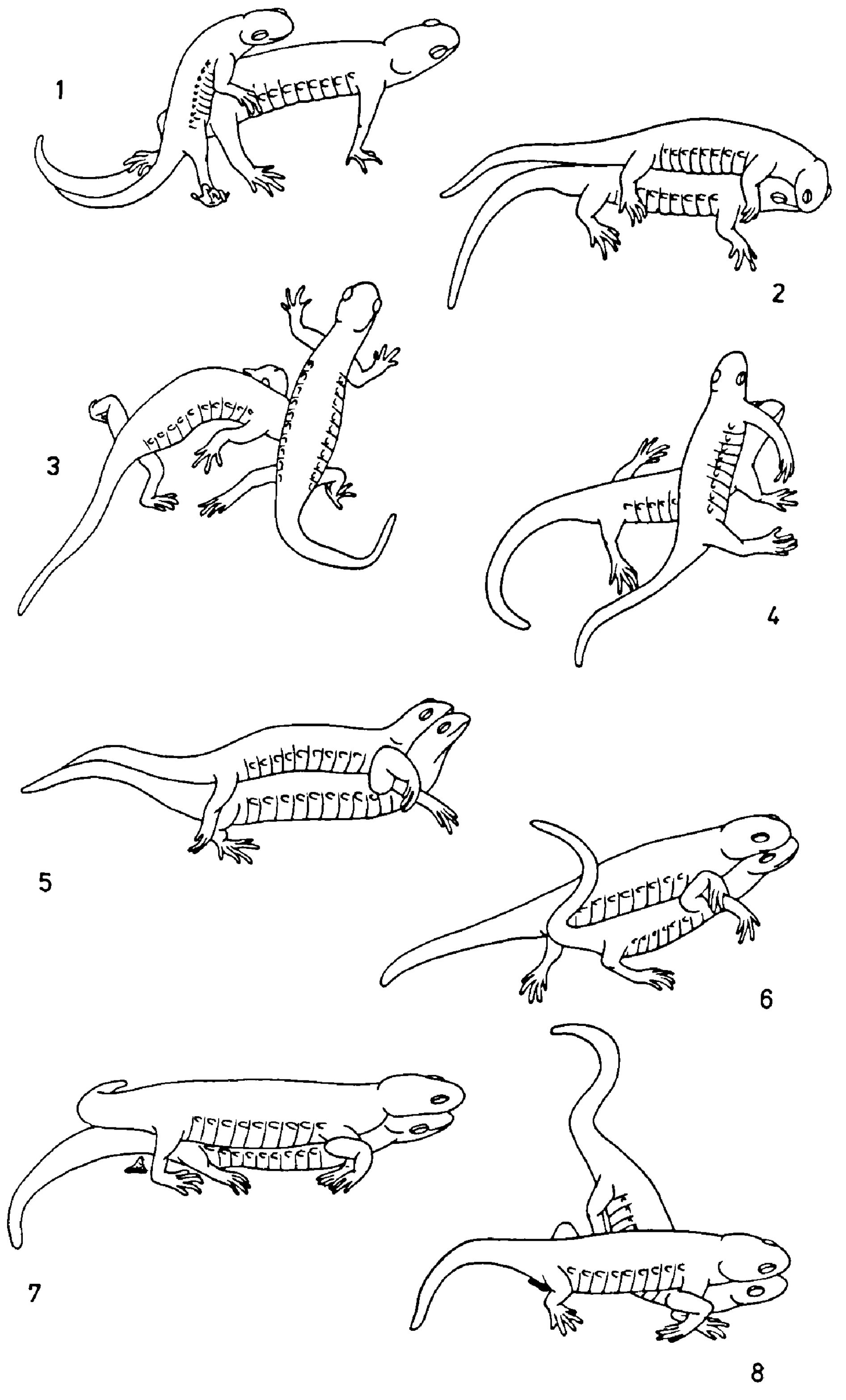

Figure 15 Progress of mating in *Salamandra atra*.

Source: Günther 1996, p. 78

For an overview the minimum, the maximum and the average duration of the individual stages are summarized in the table below.

Table 5 Duration of the different stages of mating

Source: Klewen 1991, p. 103

	duration in min		
stage	**minimum**	**maximum**	**average**
1	5	120	11
2	12	65	24
3	8	113	21
4	3	19	13
5	1	8	2
total mating process	37	268	71

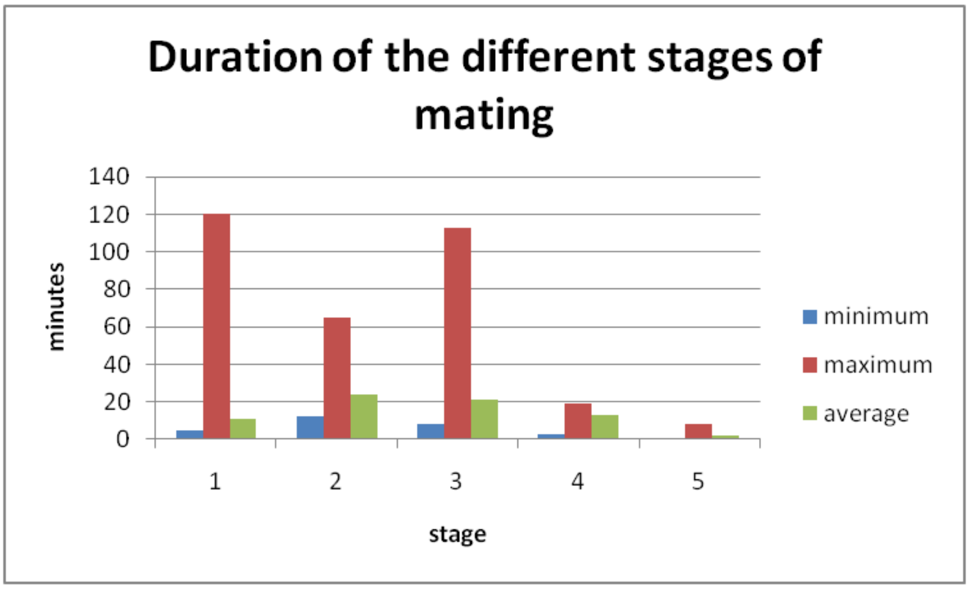

Figure 16 The different stages of mating as an overview.

Source: Klewen 1991, p. 103

According to Klewen (1991, p. 103) and Thiesmeier/Grossenbacher (2003, p. 997), the reproductive behavior of the Alpine Salamander has been described differently in the literature. Former descriptions mention a direct sperm transfer. Therefore a contact of the abdomen and the cloacae is needed. This position can be observed in homosexual mating attempts, never in “normal” matings. Therefore the possibility of a direct sperm transfer from cloaca to cloaca can be excluded.

As mentioned above, Alpine Salamanders have no specific picture of their mating partners. This leads frequently to matings with the wrong partner (e. g. males and males). Klewen (1991, p. 104) observed 28 mating attempts between male and male. The mating habits are the same as in a normal mating. At the beginning the male follows the supposed female. A special behavior during the mating game allows the salamanders to detect the right partner. In this case one male drops off the other, as described in the second stage. The male above does not succeed in clasping the other one behind the forelimbs and not behind the head, as in the normal mating. If the other male has not the possibility to run away, it tries to escape with winding movements and throwing itself on different sides of its body axis. The direct sperm transfer was assumed because of this behavior (Klewen 1991, p. 104 f.).

Alpine Salamander and Fire Salamander show similar behaviors in their mating. In several tests and observations, in a terrarium as well is in their native habitat it was shown that the mating willingness is not affected by seasonal changes: it could be observed during rain, especially after long dryness. The frequency in the native habitat is reduced in comparison to the terrarium. Klewen (1991, p. 105) mentioned two reasons for this observation. First rainy days with the right temperature are rare and second the possibilities for mating are limited to a few days during the year in the harsh alpine climate conditions. By using all adequate weather conditions for mating, the animals secure the reproduction and optimize their fitness. Females get selected randomly as their partner has no specific picture. The females are ready for pregnancy every four years in the alpine level and in the subalpine level every three years (Thiesmeier/Grossenbacher 2003, p. 998; Klewen 1991, p. 105).

As mentioned above the Alpine Salamander is independent from water during to its reproduction process. The sperms are devolved indirectly, as developed in soil animals which live in water substrates. This highly developed behavior as described above shows that the insemination is not primitive. After the female has accepted the Spermatophore, the sperms are stored in the spermathacae till ovulation (Thiesmeier/Grossenbacher 2003, p. 998; Klewen 1991, p. 105).

7. REPRODUCTION

Within the genus Salamander the reproduction type vivipary has been known for longer. In this type of reproduction the offspring is carried in the mother's body during the entire period of development or during a major part of development. Only members of the family Salamandridae are obligatory viviparous within the urodeles (Thiesmeier/Grossenbacher 2003, p. 997; Greven 1998, p. 507).

The insemination takes place inside the female, i.e. the sperms get in contact with the eggs, ready for fertilization, inside the body. It has been unclear for a long time how the sperm transfer works because there is no organ for this purpose. The theory of the mating belly to belly could be maintained till the 20th century. As you can see in stage five of the mating behavior on page 31, this theory can be confuted. In some regions the appearance of the Alpine Salamander is abundant. Different developmental stages were found in females from the same habitats. Therefore it can be assumed that there are several pregnancies per year. Recent analyses showed that the pregnancy takes several years (Thiesmeier/Grossenbacher 2003, p. 997 f.).

The whole reproduction process is independent of water. The development of the offspring occurs in the uterus until the entire metamorphosis is completed. After accepting the Spermatophore, the female stores the sperms in the spermathacae until ovulation.

The oviducts of the Fire Salamander and the Alpine Salamander have been studied most thoroughly, in the genus *Salamandra*. The Alpine Salamander gives birth to only two fully developed young animals. On the other hand the Fire Salamander gives birth to numerous gill-bearing larvae. In urodeles the oviducts (or Müllerian ducts) are convoluted organs like a tube. At the beginning there is a ciliated funnel, called ostium, which opens into the cloaca. Their walls consist of:

- the outward lumen
- a mono layered epithelium
- a vascularized layer of connective tissue
- smooth muscle fibers and
- a thin covering of peritoneum.

In the caudal part there are more muscle fibers and blood vessels. The transport from the eggs through the tubes works as follows: the ostium takes the eggs from the ovary and with the help of cilia, the eggs are transported. In the ovary the vitelline coat is formed. The duct glands provide different types of mucous secretions and the eggs are enwrapped. In viviparous species the oviduct is shorter and less convoluted than in oviparous species. There are fewer glandular cells with less secretion of jelly (Thiesmeier/Grossenbacher 2003, p. 998; Greven 1998, p. 508; Günther 1996, p. 79 f.; Klewen 1991, p. 108).

The internal fertilization takes place during oviposition when the eggs pass through the cloaca. There are significantly fewer eggs in viviparous species than in oviparous species. The number of eggs varies from 28 to 104 eggs per ovary. The size of the eggs ranges from 1.0 to 3.0 in diameter (Thiesmeier/Grossenbacher 2003, p. 1001; Greven 1998, p. 513; Klewen 1991, p. 108).

The sercetory products were released from the gland from the first eggs passing through the oviduct. A complete set of envelopes normally surrounds one egg per uterus. They are approximately two– to three

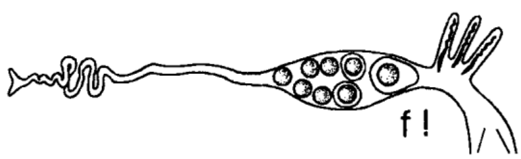

Figure 17 shows the site of fertilization (f!) in Alpine Salamanders.

Source: Greven 1998 p. 515

times as thick as the diameter of the oocyte. The fertilization takes place in the cloaca.
In some cases there is not enough jelly for the rest of the eggs, because they have incomplete envelopes or lack jelly. They form a mass of nutrient yolk (= embryotrophic eggs) when they gradually disintegrate (Greven 1998, p. 515; Klewen 1991, p. 108).

7.1. FERTILIZATION

The layer of the uterus contracts and the embryonic egg is pressed against the mouth of the uterus. Now jelly protrudes into the cloaca from the caudal side of the yolk coat the. The mouths of both uteri are in the right angle in the opposite of the openings from both spermathacae. With little motions of the tail or contractions with the wall of the cloaca it comes to a contact with the openings of the uterus and the spermathacae. The sperms move up across the jelly. Normally only one egg per uterus is fertilized, the embryothropic eggs are not fertilized. The jelly envelope seems to be necessary not only for the mechanical integrity, but also for fertilization. After ovulation corpora lutea were built from the follicles. They persist till the end of Schwalbe's stage II and decline in size and number during Schwalbes's stage III (Thiesmeier/Grossenbacher 2003, p. 1002; Klewen 1991, p. 108).

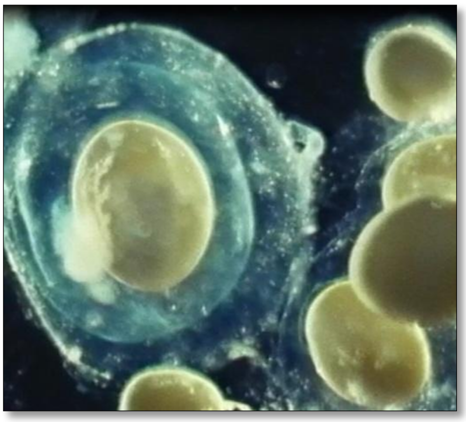

Figure 18 Only one egg is wrapped with a complete cover (the egg in the left). The other eggs are the embryotrophic eggs and become the nutrition for the larvae.

Source: Fachbach (1990)

7.2. EMBRYONAL DEVELOPMENT

Salamandra atra and *Salamandra atra aurorae* are matrophic, i.e. the embryotrophic eggs are fed by the embryos by resorbing their own yolk. Finally the embryos are fed on a special trophic epithelium in the cranial portion of the uterus (Greven 1998, p. 516).

The Alpine Salamander gives birth to a limited number of offspring. They are metamorphosed and relatively large, 4 – 5 cm. The gestation period depends on the climatic conditions and altitudes. At high altitudes it may last up to five years (Glandt 2009, p 187; Greven 1998, p. 517).

The development of the larvae can be divided into three stages. They are called Schwalbe's stages I – III, named after the German anatomist Gustav Schwalbe.

- First stage: the embryo is within the egg jelly
- Second stage: the hatched larva is surrounded by disintegrated eggs
- Third stage: the larva shows signs of metamorphosis and the trophic egg mass have disappeared.

The uterine epithelium changes during gestation. It is also an efficient transport epithelia which regulates the water balance, the concentration of the electrolytes and the uterine milieu. There is an increase of cell and nuclear volume in stages I and II because the egg jelly absorbs water. The nuclei seem also to be active in this stage. The nuclei are euchromatic and the cells are more voluminous in stage II. In the connective tissue capillaries appear distended. Within a few weeks the embryo develops till "Schlupfreife". The embryothropic eggs disintegrate with the mechanical help of the hatched embryo and decay to a unstructured mass. That mass is fed by the embryo with the help of a mechanism called Suction feeding (Saugschnappen).

Suction feeding is a method of ingesting a prey item in fluids by sucking the prey into the predator's mouth. The predator expands the volume of its oral cavity and/or its throat. The result is a pressure difference between the outside environment and the inside of the mouth. The prey is carried with the fluid flow in the mouth of the predator, when the mouth is opened and the water flows into the predator's mouth because of the pressure difference (Wikipedia 2010, online).

In fibroblasts of the connective tissues underlying the epithelium cell death occurs autonomously. Hence the epithelial cells can detach because the integrity of the collagen bundles is loosened. The larvae envelop these cells which are floating free in the lumen (Thiesmeier/Grossenbacher 2003, p. 1002f.; Greven 1998, p. 519).

In the late phase of stage II, teeth develop on the maxilla and on the mandible. The teeth are arranged in areas instead of being monostichous like in the Alpine Salamander. The frontal teeth form a caudally positioned grater. With the help of the mono- and bicuspid teeth the larvae appear to feed directly, facing the trophic zone. In the same phase the lateral lips, which allow the "Saugschnappen", are reduced. The head begins to expand. This is a hint for the beginning of the metamorphosis (Thiesmeier/Grossenbacher 2003, p. 1003; Greven 1998, p. 519).

At the beginning of stage III, irregular giant epithelial cells, which are clearly distinguishable from the more or less flat cells of the remaining uterus, develop in a small cranial part of the uterus. The size of the areas in the trophic zone without epithelial cells differs. It depends on the position of the larvae, which are stationary during the transition from stage II to stage III. When the heads face the trophic area (larvae are in rump position), up to 50 % of the area shows a lack of cells. When the head is turned toward the cloaca (larvae are in head position), this number is reduced to 10 to 20 % of the surface. There is no basal

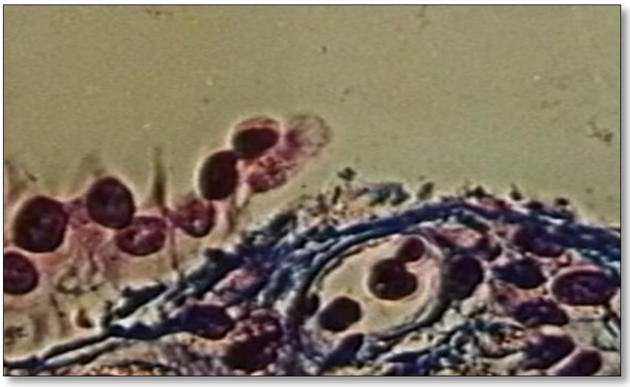

Figure 19 Zona trophica in the uterus epithelium, at the left side with epithelial cells (red) and at the right side without epithelial cells. The larvae have already eaten it.

Source: Fachbach (1990)

lamina and bundles of collagen fibers protruded into the uterine lumen in such denude regions (Greven 1998, p. 519).

During pregnancy the connective tissue as well as the trophic epithelium must regenerate. The regeneration of the epithelium starts with mitotic divisions in the intact area of the trophic zone. There are migratory cells and fibroblasts involved. The new epithelial cells overgrow the collagen bundles. The fetal dentition cannot damage these cells because they are too flat (Greven 1998, p. 519).

In the following section a short summary of the most important features of the trophic zone and the changes during the reproductive cycle is provided:

- *The epithelium of the prospective trophic zone does not differ from that of the remaining uterus, either in the non-gravid uterus or in early pregnancy.*
- *The tropic epithelium in the cranial portion of the uterus develops only in the presence of stage III larvae.*
- *Simultaneous necrosis and apoptosis, as well as regeneration, occur continuously until birth. Final regeneration takes place after birth (Greven 1998, p. 519).*

8. CONSERVATION STATUS

The Alpine Salamander belongs to the completely protected animals in Salzburg. On European level it is mentioned in the annex IV of the FFH guidelines as well as in the annex III of the Berne Convention (*Convention on the Conservation of European Wildlife and Natural Habitats*) (Kyek/Malezky 2006, p. 146).

8.1. FFH-GUIDLINE

"The correct German designation of the FFH guideline reads guideline 92/43/EWG of the advice of 21. May 1992 for the preservation of the natural habitats as well as the animals and plants living in the wild." (Economy-point.org, 2006, online).

The main goal of the FFH guideline- Fauna (= animals), Flora (= plants) and Habitat (= habitat) - is to conserve and to restore biological diversity. With the establishment of protective areas named Natura 2000 this goal should be reached. The member states have to determine areas where special habitats and species appear. These areas have to be conserved and protected (Umweltbundesamt 2009, online).

Contents of the annexes of the FFH guidelines:

- "ANNEX II: SPECIES OF COMMUNITY INTEREST WHOSE CONSERVATION REQUIRES THE DESIGNATION OF SPECIAL AREAS OF CONSERVATION
- ANNEX IV: SPECIES OF COMMUNITY INTEREST IN NEED OF STRICT PROTECTION
- ANNEX V: SPECIES OF COMMUNITY INTEREST WHOSE TAKING IN THE WILD AND EXPLOITATION MAY BE SUBJECT TO MANAGEMENT MEASURE (CIRCA 2009, online)

8.2. IUCN RED LIST

In the IUCN list of threatened species from 2008, the Alpine Salamander is listed as least concern (LC).

"A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category." (International Union for Conservation of Nature and Natural Resources 2009, online)

"Listed as Least Concern in view of its wide distribution, tolerance of a degree of habitat modification, presumed large population, and because it is unlikely to be declining fast enough to qualify for listing in a more threatened category." (International Union for Conservation of Nature and Natural Resources 2009, online)

*"The subspecies **Salamandra atra aurorae** qualifies for listing as Critically Endangered under criterion B1ab(iii) because its Extent of Occurrence is probably less than 100 km2, all individuals may be in a single location, and there is continuing decline in the quality of its habitat in the Bosco del Dosso."* (International Union for Conservation of Nature and Natural Resources 2009, online)

9. ABOUT THE PROJECT

To check the Salamander distribution more effectively we started by designing a website everybody can access and register observations of Alpine and Fire Salamanders. This is a brand new concept for Austria. The website **www.alpensalamander.eu**, based on web 2.0, has been online since July 2009. This website provides information about the salamanders, the project as well as the team.

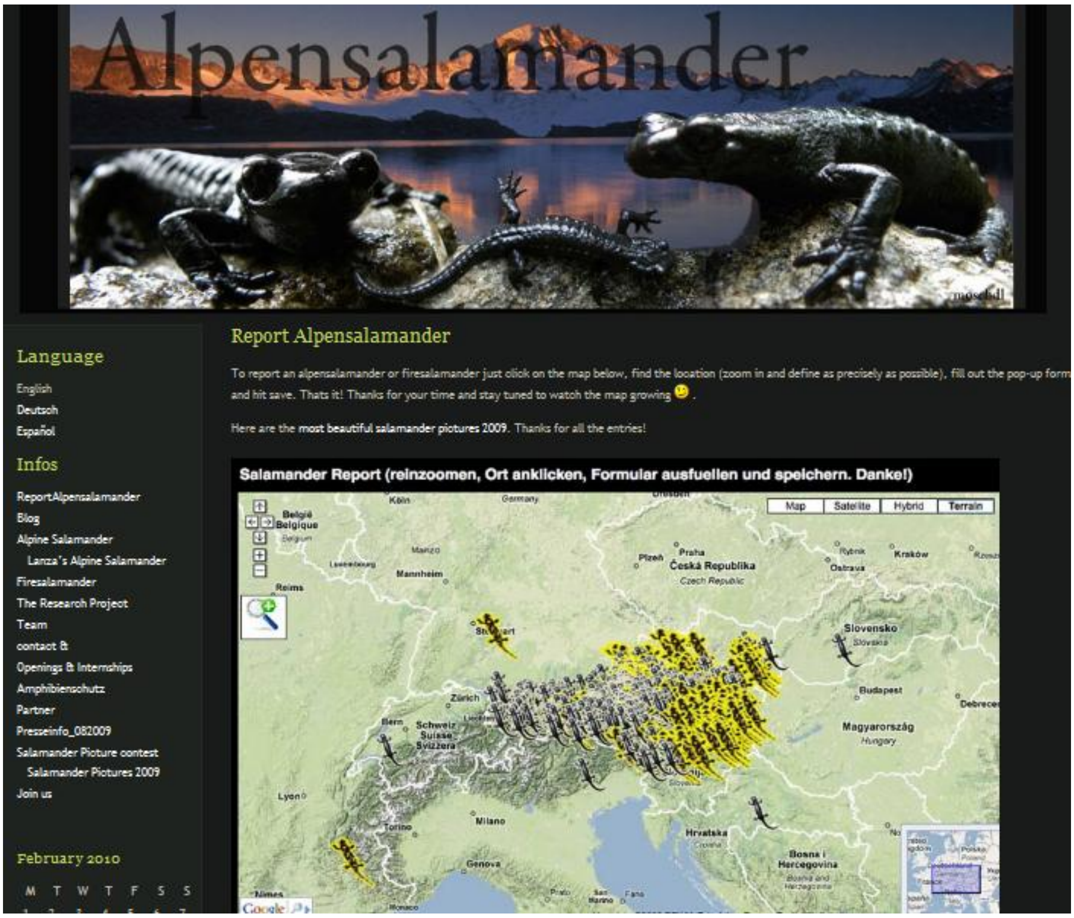

Figure 20 Our website www.alpensalamander.eu. A main part is the map for the Salamander Report.

Source: www.alpensalamander.eu

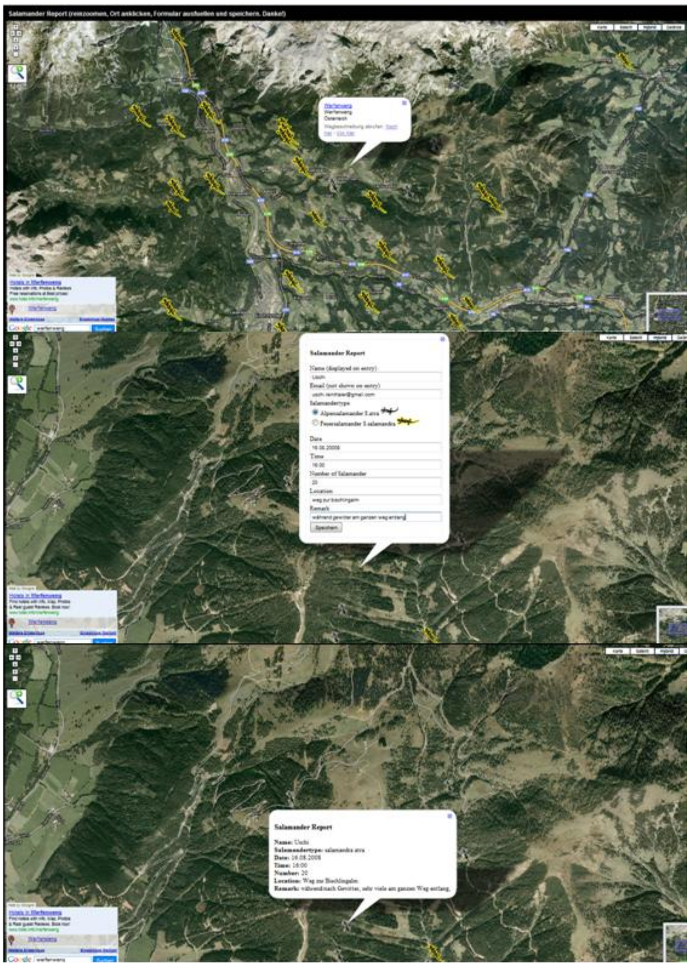

Figure 21 How to report a Salamander

Source: www.alpensalamander.eu

Reporting a Salamander is simple. With the help of Google maps it is possible to select the region at the exact location where the Alpine Salamander was found. The next step is a double click and a form opens, which consists of the following fields:

- name
- email address
- type of salamander
- date
- time
- number of salamanders
- location
- remark

After filling in the form it has to be saved and the record is stored in the database and immediately visible on the map.

The location should be described as exact as possible, for example: The Salamander was found on a hiking trail about 50 meters from the Hackel Hütte (= alpine cabin). In the comment field the weather or something unusual can be noticed. Most remarks are related to the weather. This community based approach enables the combination of research, education and dissemination by interactive participation. In addition it builds a network of people with a common goal who can help to protect these animals by looking around in the nature and informing us about salamander observations.

We check the records ourselves for credibility and completeness. If there are questions we contact the user who made this report and verify the information.

If something went wrong the records are deleted. Information which can easily identified as wrong, for example recording points directly in a lake or a river, are deleted immediately.

The second part of this project is to record the oral history of Alpine Salamander observations of the past 50 years to gain a better overview of the development of the population size over the years. We evaluate if a trend can be recorded, if there is a decrease in population or if the population i remains the same. To verify this information interviews with rangers in national parks, farmers, alpinists, mineral collectors as well as with people who are interested in nature were made. These interviews were made with the form of the Salamander report from our website. Therefore the questions which were needed to complete the database were asked. Eventually the gathered data was entered in the database on our website.

To spread news about our project various articles in national (Presse, Standard, Salzburger Nachrichten) and regional (Pongauer und Pinzgauer Nachrichten) newspapers were published. The people were invited to join us, keep the eyes open for salamanders and record the findings on the website. Another question was if they know places from the past where many salamanders occurred. In addition we will collaborate with several national parks (Hohe Tauern, Berchtesgaden) and museums (Haus der Natur) to establish the project in schools, wildlife and mountaineering organizations.

Further parts of our work were field studies. In adequate climate conditions we went in the mountains to check some regions for salamander occurrences. During summer the regions around the Tennengebirge, the Hochkönigmassiv, Filzmoos, Kleinarl as well as the Bluntautal were observed. Some valuable data could be obtained and will be presented below.

To get better conclusions about the distribution, we took the data from the website and consolidated it with different maps (temperature, climate, geology and land covered areas). These data is the basis for our further analysis.

10. RESULTS

Website and salamander report database have been online since July 2009. As of December 2009 more than 5600 reports from salamander findings (Alpine and Fire Salamander) all over Europe were gathered. Until now there are 1300 different users and the community is still growing. 860 persons entered more than one recorded, 80 users recorded more than 5 times. There were 2600 reports of the Alpine Salamander throughout Europe and 2117 records in Austria. These records are displayed as 576 clusters for a better clarity. Although the project is still in the initial stage, the data already picture a preview of the Alpine Salamander distribution in Austria and allow for a preliminary analysis including the assessment of data quality. All records were evaluated manually and obviously questionable reports, like coordinates in a lake, were checked by contacting the user and corrected or deleted.

10.1. THE DISTRIBUTION OF THE ALPINE SALAMANDER IN AUSTRIA

A graph of the distribution of the Alpine Salamander between the Austrian federal states was built with the records of the database. The 2117 records were displayed as 576 clusters and analyzed. Most of the records were made in Salzburg (273 clusters), followed by Tyrol (109 clusters) and Styria (81 clusters). Only a few findings were made in Carinthia (33 clusters) as well as Upper (23 clusters) and Lower (38 clusters) Austria. There are no records in Burgenland.

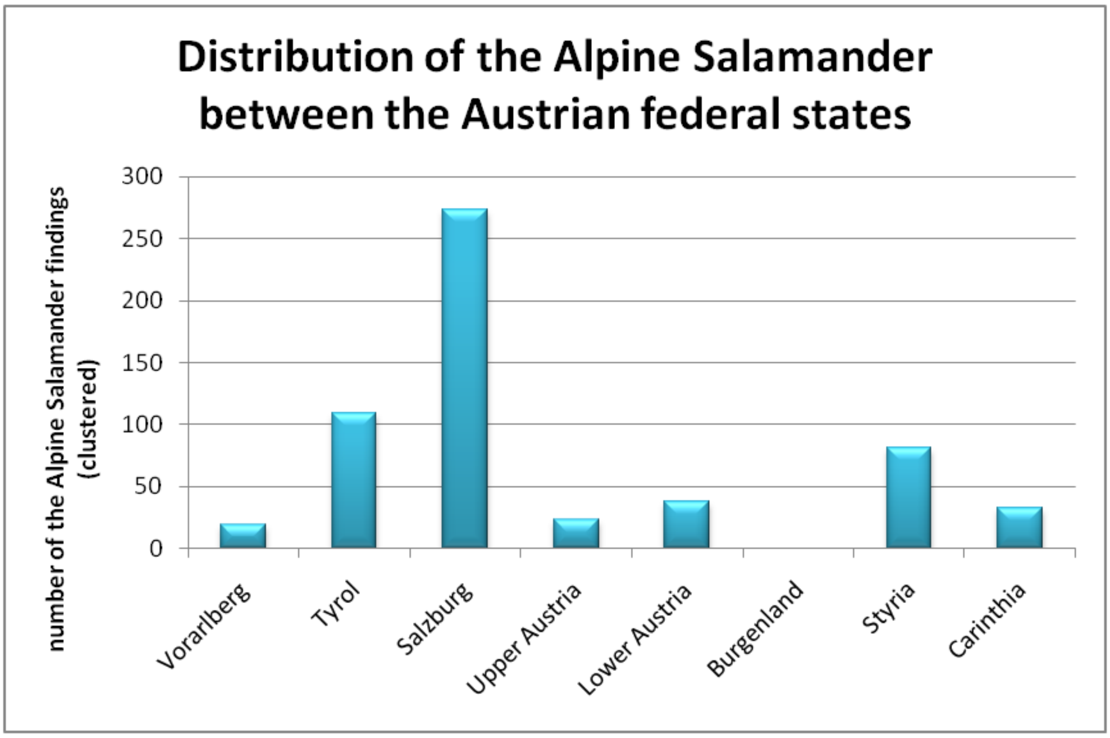

Figure 22 the distribution of the Alpine Salamander between the Austrian federal states. The graph shows the number of recordings in the individual federal states clustered.

Source: own diagram, www.alpensalamander.eu

10.2. COMPARISON OF THE DISTRIBUTION WITH THE AUSTRIAN CLIMATE TYPES

10.2.1. Austrian climate types

Four different Climate Types can be distinguished in Austria:

- Alpine climate
- Middle European transitional climate
- Pannonian climate
- Illyric climate

10.2.2. Alpine climate

The main characteristic of the alpine climate are short and cool summers and long cold winters; heavy rainfalls are observed especially at the northern edge of the Alps. The climate is gentle in the valleys and the rainfalls are lower. A further characteristic is the foehn and especially in winter “Kälteseen” with temperature inversion (Salzburg Portal 2010, online).

10.2.3. Middle European transitional climate

The influence of the oceanic climate decreases from the West to the East; instead the continental influence increases. Hence the rainfall in the west is higher than in the east. In higher regions, especially in the Mühl- and Waldviertel, it is colder and clammy (Salzburg Portal 2010, online).

10.2.4. Pannonian climate

The continental influence is noticeable. It is much drier than in the rest of Austria. It is hot and dry in summer and cold with less snow in winter (Salzburg Portal 2010, online). The Pannonian climate is found in parts of Lower Austria and Burgenland.

10.2.5. Illyric climate

There is an influence of subtropical climate (Mediterranean climate). There are many days of sun, gentle autumns and heavy rainfall from the Mediterranean region in winter (Salzburg Portal 2010, online). This climate type can be found in parts of Styria and Burgenland.

At first the distribution of *Salamandra atra* is compared with the Austrian climate types. 95.8 % of the recorded salamanders can be found at an alpine climate. This climate predominates mostly in the alpine regions of the Austrian federal states Vorarlberg, Tyrol, Salzburg, Carinthia as well as parts of Styria, Upper- and Lower Austria.

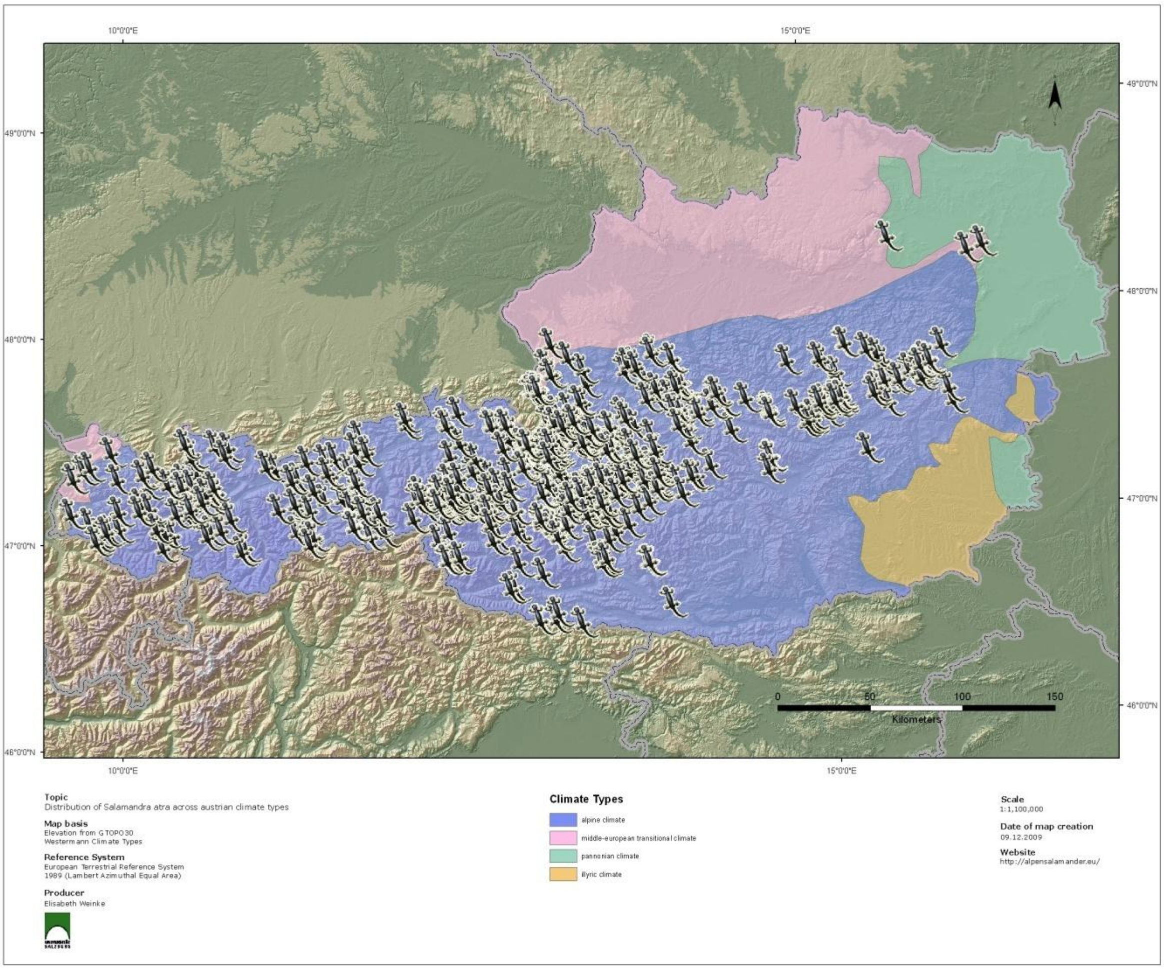

Figure 23 Distribution of the Alpine Salamander compared with the different climate types of Austria.

Source: www.alpensalamander.eu

The other 4.2 % were recorded in middle European transitional climate. These observations took place in Lower Austria, some spots in Upper Austria and in the West of Vorarlberg. There are no records in Burgenland, where the climate is too dry and too hot for an appearance of the Alpine Salamanders.

10.3. DISTRIBUTION ACROSS LAND COVERED AREAS

The second map shows the distribution of *Salamandra atra* across land covered areas. This map was built based on the CORINE (Coordination of Information on the Environment) Landover classification 2000. This is a program of the

European Union to check land use and function throughout Europe (Hölzl, 2003).

In this map Austria is classified as level 1 of CORINE classification. This is the largest level with 5 classes containing several subclasses of level 2. For further information please refer to Annex 1 (Hölzl, 2003).

You can see that over 91.5 % of the Alpine Salamander prefer forests or semi natural areas. Only 5 % were found on agricultural areas and 3.1 % were found on artificial surfaces.

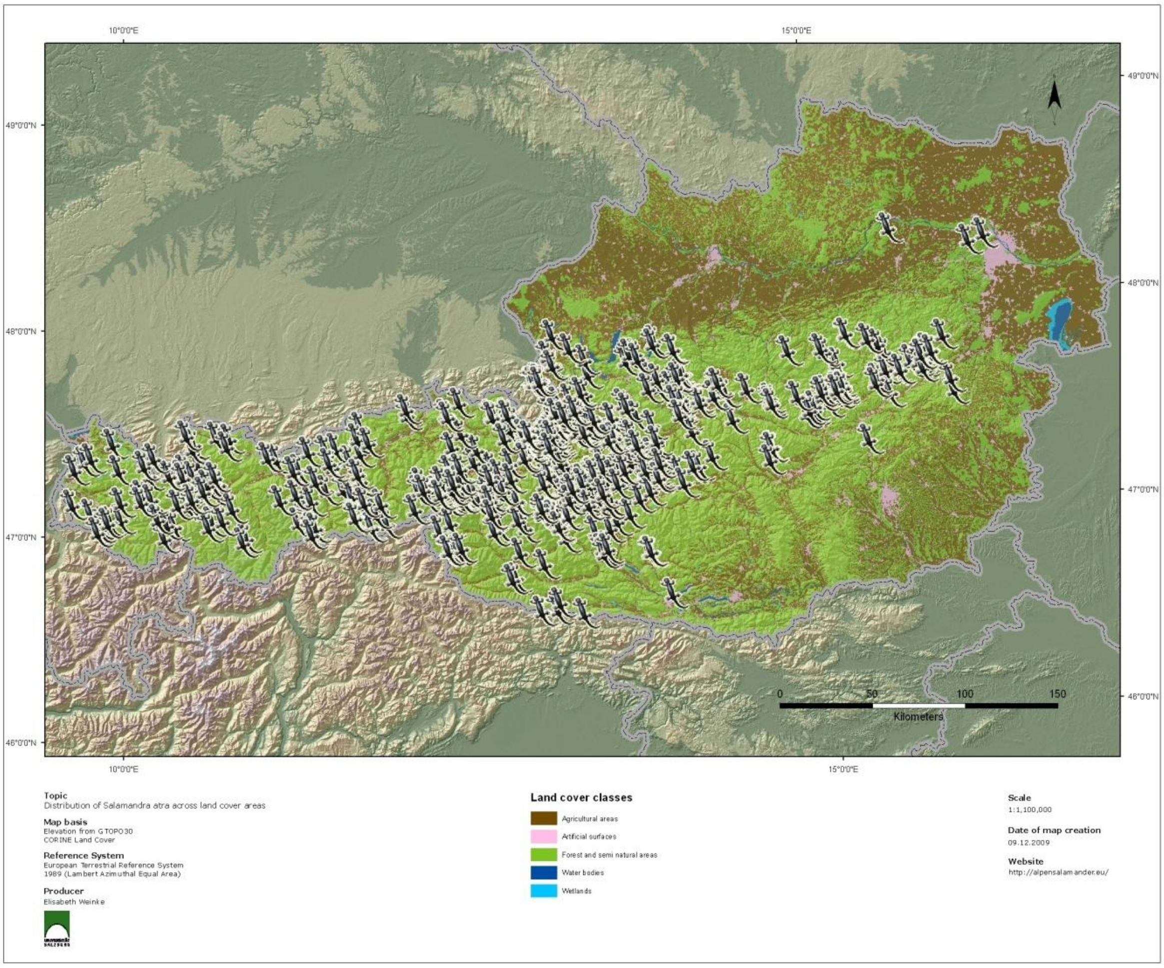

Figure 24 Distribution of the Alpine Salamander compared with the land cover classes, according to the CORINE Level 1 (5 classes).

Source: www.alpensalamander.eu

The third map shows the distribution of *Salamandra atra* per altitude. Most of the Alpine Salamanders (42.6 %) were found on altitudes between 1500 and 2000 meter a. s. l., 33.8 % were found on lower altitudes at 1000 – 1500 m. Only 0.3 % were observed at high altitudes between 2500 – 3000 m. In lower regions, ranging from 115 – 500 m, 5 Salamanders (0.9 %) were recorded.

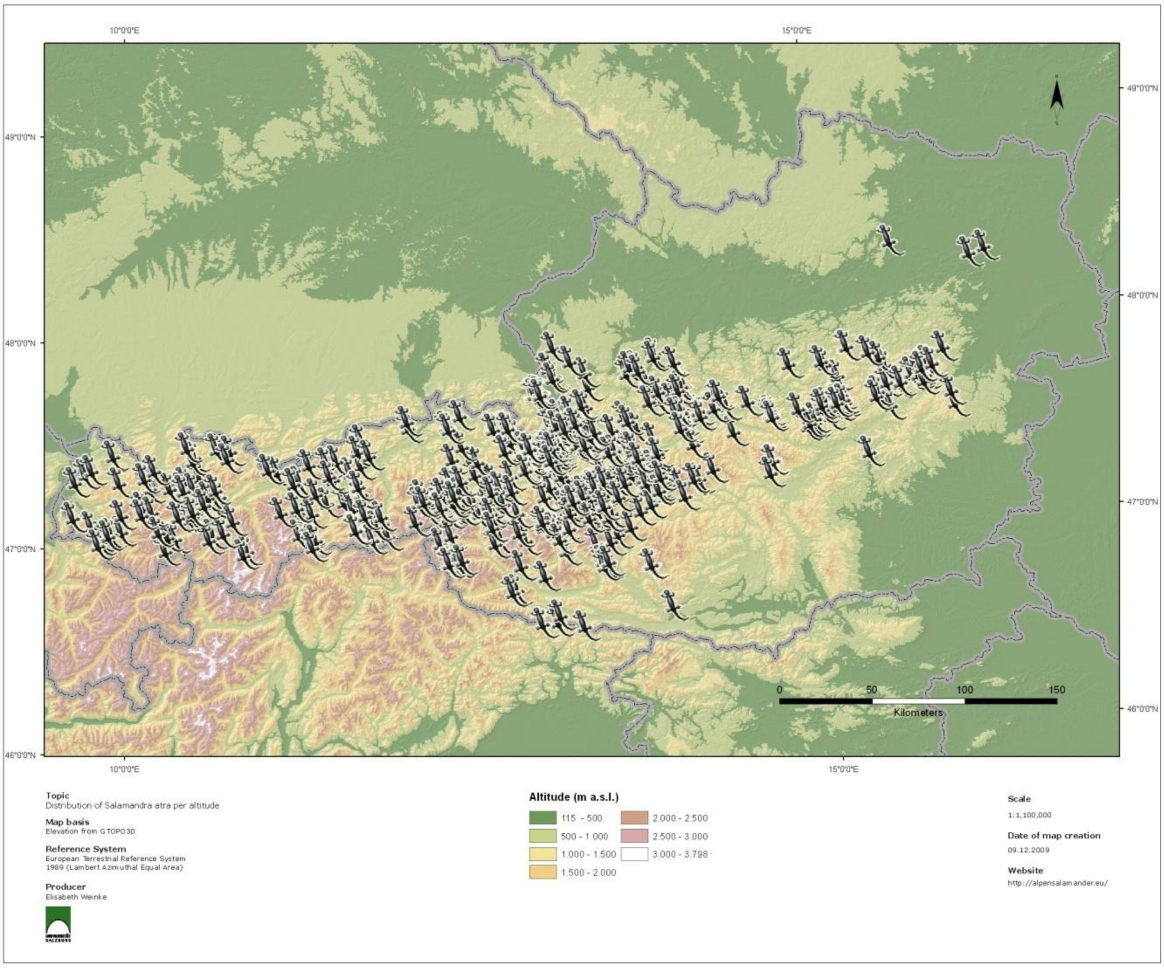

Figure 25 The distribution of the Alpine Salamander correlating with altitude.

Source: www.alpensalamnder.eu.

The records correlate with increasing altitude, the best altitude for Alpine Salamander observations seems to be between 1500 and 2000 meters.

10.4. THE GEOLOGY OF AUSTRIA

10.4.1. Eastern and South-eastern Foothills of the Alps

To this region belong:

- The lowland of northern Burgenland
- The wide low- and hillcountry of the “Grazer Bucht”

The Pannonian climate is predominating in this region (Haas/Tschurlovits 2000, online 1).

10.4.2. Foothills of the Alps

The Foothills of the Alps reach from the beginning of the Alps until the Danube in the Basin of Tulln. It contains the Austrian Federal states Salzburg as well as Upper and Lower Austria. The Foothills are mainly without forest and are one of the most densely populated regions because the ground is profitable and it has excellent access to the road (Haas/Tschurlovits 2000, online 2).

10.4.3. Flysch Zone

The Flysch Zone is found on the northern edge of the Alps. The name Flysch comes from the Swiss dialect and means “to flow”. The stronger relief is coined of clay and grit sediments which leads to slumping. The sandstone zone is water impermeable; there is a dense steam network. A big part of the rainfall drains off immediately. On the hillside deciduous forest and mixed forest were found (Haas/Tschurlovits 2000, online 3).

10.4.4. Grauwacken Zone

This zone is the geological basis of the eastern Alps and is located between the Northern Limestone Alps and the Central Alps. These mountains are on an average altitude. The stones of the Grauwacken Zone are schist and phyllite. These mountains are sparsely wooded and the bigger parts are pasture and grassland which gives this region the name “Grasberge” (grass mountains). Characteristics for this region are:

- animal husbandry
- alpine pastoral systems
- ski–tourism
- rich in mineral recourses (mining) (Haas/Tschurlovits 2000, online 4).

10.4.5. Central Alps

The Central Alps are located between the northern and southern Alps. The beginning of the Central Alps is the “Brennerlinie”. The altitude decreases from the West to the East with an increasing the space between the mountain range. There is enough space for bigger basin-landscape because the valleys become wider.

For a big part the Central Alps consist of crystalline (granite, gneiss, schist, phyllite and lime). The stones in the Central Alps are water-impermeable and so a dense stream network can be found (Haas/Tschurlovits 2000, online 5).

10.4.6. Northern and Southern Limestone Alps

Limestone predominates in this region. This landscape is xeric and only a thin layer covers the ground because limestone is water permeable. The ground has less ability to store water. It dries out immediately because the water drains away in the underground. Karstformation is often found in the Limestone Alps as well as numerous caves (for example Eisriesenwelt, Dachsteinhöhlen). Screeds are typically observed in these regions (Haas/Tschurlovits 2000, online 6).

The Southern foothills of the Alps are characterized by a gentler climate and there is more vegetation (Haas/Tschurlovits 2000, online 7).

Compared to the geology (Figure 25) the main distribution of the Alpine Salamander is in the Northern Limestone Alps (47.2 %) and the Central Alps (42.7

%). 6.6 % were observed in the Grauwackenzone and 2.6 % in the Flysch zone. Only a few findings were in the Southern Limestone Alps (0.15 %) as well is in the Foothills of the Alps (0.15 %) and the Granite and Gneiss Upland (0.3 %).

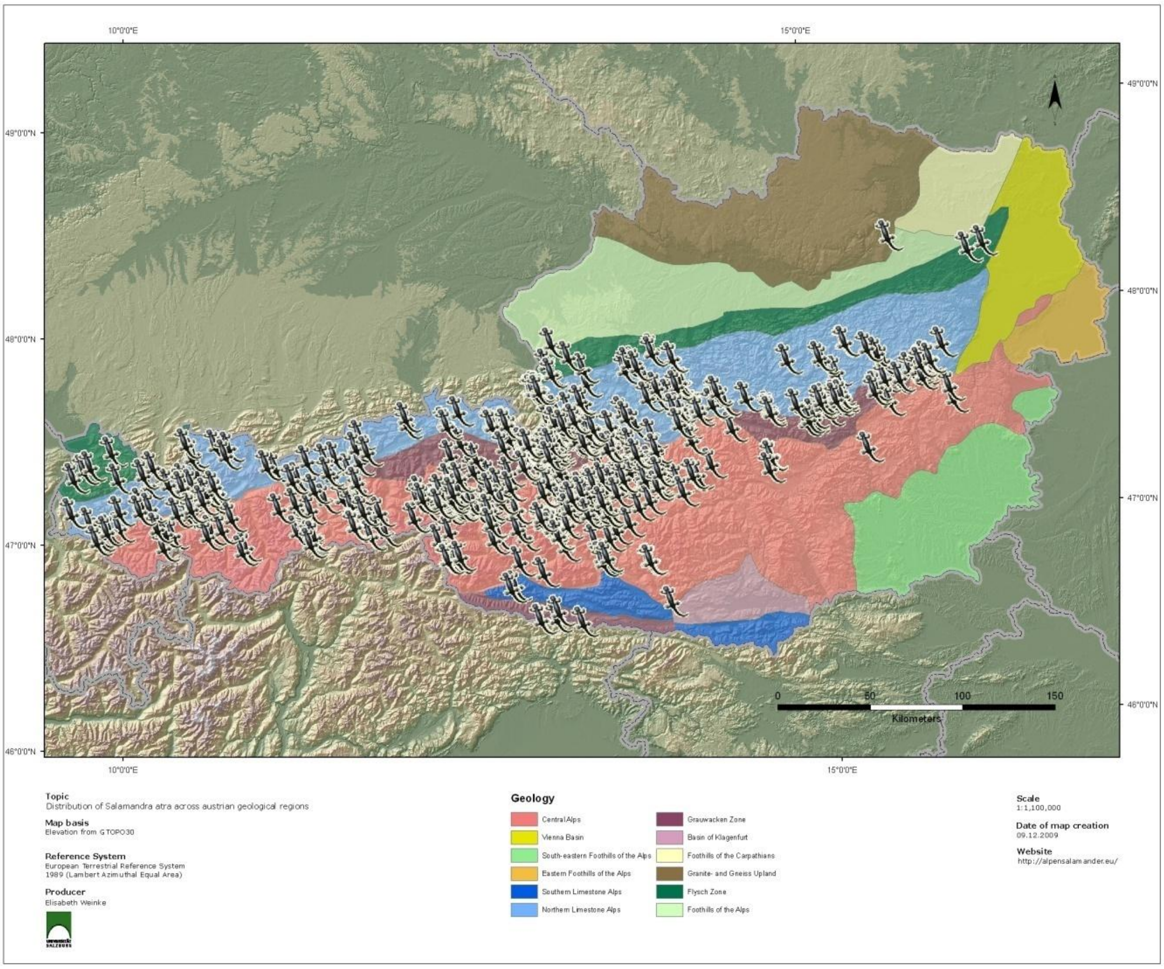

Figure 26 The distribution of *Salamandra atra* compared with the geology of Austria.

Source: www.alpensalamander.eu

The same results can also be found in the literature (f. e. Steinfartz & Grossenbacher 2003). This confirms that the salamander observations from the public are of high quality and adequate for monitoring.

10.5. RESULTS OF THE FIELD STUDIES

The occurrence of the Alpine Salamander around the Tennengebirge can be confirmed. There were several hints from the hunter of this region as well as from workers of the Eisriesenwelt.

This confirmed that the Alpine Salamander occurs also on the south-west of the Tennengebirge (Eishöhlensteig). On the north-east (Abtenau) there are hardly any recordings and we have no information about the presence of the animals. Some single records were made in Werfenweng, most of the time in the early morning hours (appr. 5 – 6 sights). There is one exception on the trail from the Ladenberg to the Bischlingalm where more than 20 individuals can be found after heavy summer rains.

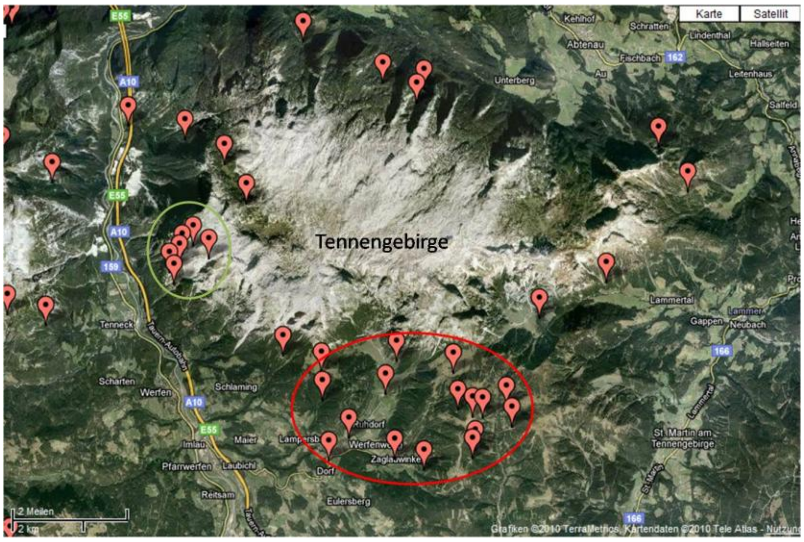

Figure 27 Occurrence of the Alpine Salamander around the Tennengebirge. Red: surrounding of Werfenweng; Green: Eishöhlensteig.

Source: www.alpensalamander.eu

In Kleinarl many Salamander records were made on the trail to the Tappenkarsee.

Figure 28 Alpine Salamander records on the trail to the Tappenkarsee (Kleinarl)

Source: www.alpensalamander.eu

The climate conditions during observation of the animals were nearly did not matter; the Salamander was equally found during rainy as well as good weather. In nearly every interview we made people told us that the Salamander occurs frequently in the region.

The occurrence of the Alpine Salamander in the Bluntautal (Golling) can be confirmed. There are a few records in the “Biodiversitätsdatenbank” (biodiversity database). In our field work we found several animals. The surrounding is shady and damp, i.e. the best condition for the Alpine Salamander.

Figure 29 Alpine Salamander findings in the Bluntautal, Golling.

Source: www.alpensalamander.eu

11. DISCUSSION

General remarks about the new approach of data collection

Our completely new approach which includes the population is controversial. According to many experts, the data is not meaningful because everybody can register a salamander report. Moreover they think that we got many false reports because many of our users are not able to differentiate between Alpine Salamander and Italian crested newt (*Triturus carnifex*) or a sand lizard (*Lacerta agilis)* or they even made a joke by entering a false record in the database. A second point of criticism is that we did not have the exact GPS data of the location, nor do we have the exact description of the location and the surrounding.

However, this approach is not designed to gather scientific data. Its main goal is to quickly obtain a good overview of the distribution of Alpine Salamanders and to build a community of people who care about these animals and are willing to help to protect them.

There are several points in favor of our new approach:

- In this very short time (only six months) since the website has been launched more than 2100 database records were made.
- With the help of the population many animals could be recorded. As mentioned before, it is very difficult to find these animals, because they are only on the surface in the right conditions. The temperatures as well as the humidity have to be adequate to elicit the animals from their hiding places.
- The database on www.alpensalamander.eu is open to the public, there are no significant costs, and everybody can check the data.
- Exact GPS data from animals are difficult, because they are not on the same place throughout their whole life. GPS data is necessary from the spawn waters (Laichgewässer), but these data can also be obtained from google maps.

Our new approach to involve the community in a science process is a step in the right direction. Since July 2009 we were able to record 2117 salamander reports. These records were displayed as 578 clusters.

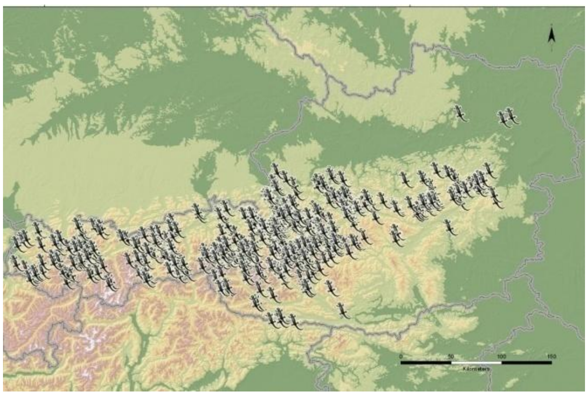

Figure 30 map of the salamander records since July 2009.

Source: www.alpensalamander.eu

A broad community was built in a short time with the help of 1300 different users and this community is still growing.

Till 2001 the biodiversity database of the Natural History Museum in Vienna lists 754, until now there are 958 records of the Alpine Salamander (information Mag. Schweiger from 28. Jan. 2010).

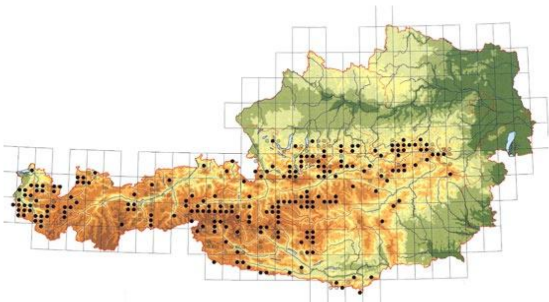

Figure 31 Distribution of the Alpine Salamander.

Source: Atlas zur Verbreitung und Ökologie der Amphibien und Reptilien in Österreich (2001)

This is much less than in our data base. The database from the Natural History Museum has existed for more than 50 years, and the data is quite short. This is not astonishing because recording a salamander in the biodiversity database needs much effort. A special form (Kartierungsbogen für die Herpetofauna Österreichs) has to be filled in and hardly anybody knows about this. A second point is that this database is not open to the public. The data is published only every few years in the *Atlas zur Verbreitung und Ökologie der Amphibien und Reptilien in Österreich* (1996, 2001).

There is also a database (GBIF-Austria) from the Umweltbundesamt (Environment Agency Austria). This database was launched in 2004 and contains 21 data sets (GBIF-Austria 2008, online).

Figure 32 Map of the database of the GBIF-Austria. This database contains 21 data sets, the recordings were all made in Vorarlberg.

Source: GBIF-Austria http://www5.umweltbundesamt.at/gbif/go.do;jsessionid=B7F3C11740502643649B06ECC99790B2?cgiproxy_skip

We evaluate the records of our database ourselves to obtain data in adequate quality. As mentioned before the records were checked and obviously wrong data was deleted. In the records the email addresses of the users are collected and so we are able to contact them if there are questions about the record. With the vast amount of records it is possible to plan further monitoring activities much more efficiently. Some positive effects of this data are:

- We know where many salamanders can be found and now we are able to use these findings.
- Hot spots in salamander appearance can be used for genetic monitoring to analyze the relations between the individuals.

- No long (lag time and) salamander search is necessary; we can take the data from the website to find them quickly.

As mentioned above, we started publishing reports in different national and local newspapers. In these articles we invited the population to report salamanders when they find some. The feedback was amazing. More than 40 persons contacted us (per telephone), a few of them even more than once. 22 Alpine Salamander records were made; the rest of the people who phoned us reported Fire Salamanders. The number of recorded Alpine Salamanders after the newspaper report is about 50 individuals. It is remarkable that several times aggregations of Alpine Salamanders with 10 – 20 individuals at the same time were found. Ten were found in Hüttschlag at the Schrödersee and ten at the Karalm on the Rossbrand in Filzmoos.

There is a growing awareness within the population towards the small black salamanders and so it gets easier to protect these animals. This is a second positive effect.

About the maps

With the different geological maps, which are shown in the results, it becomes obvious that these animals mainly appear in the alpine climate on altitudes between 1500 and 2000 meters. The Salamander observation correlates with increasing altitude.

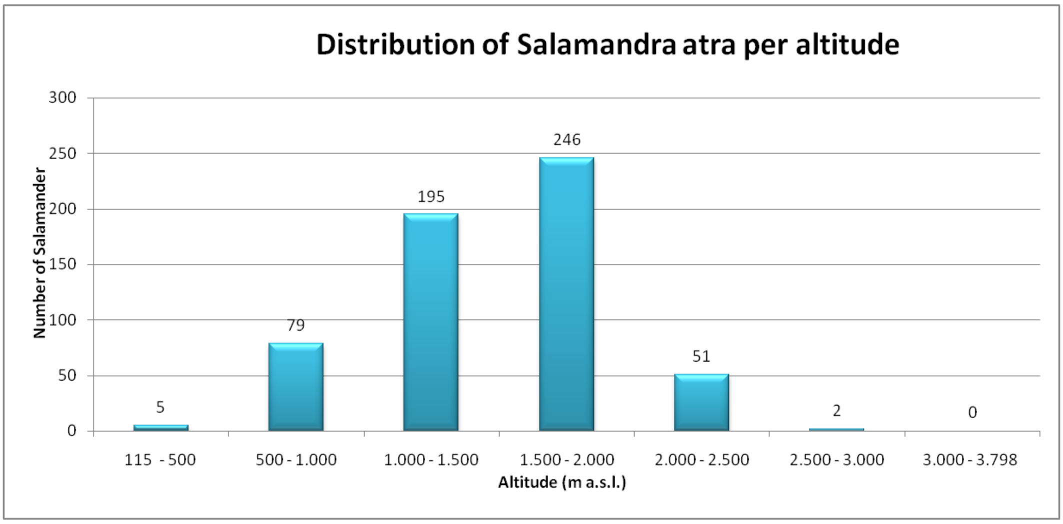

Figure 33 Distribution of *Salamandra atra* per altitude. The 578 clusters are plotted in the differ altitudes.

Source: own diagram, www.alpensalamander.eu

At 1500 – 2000 above sea level the occurrence reaches the maximum (Figure 24). The next graph shows that 95.8 % of the whole distribution is found on this level.

The next level is 1000 – 1500 meter above sea level.

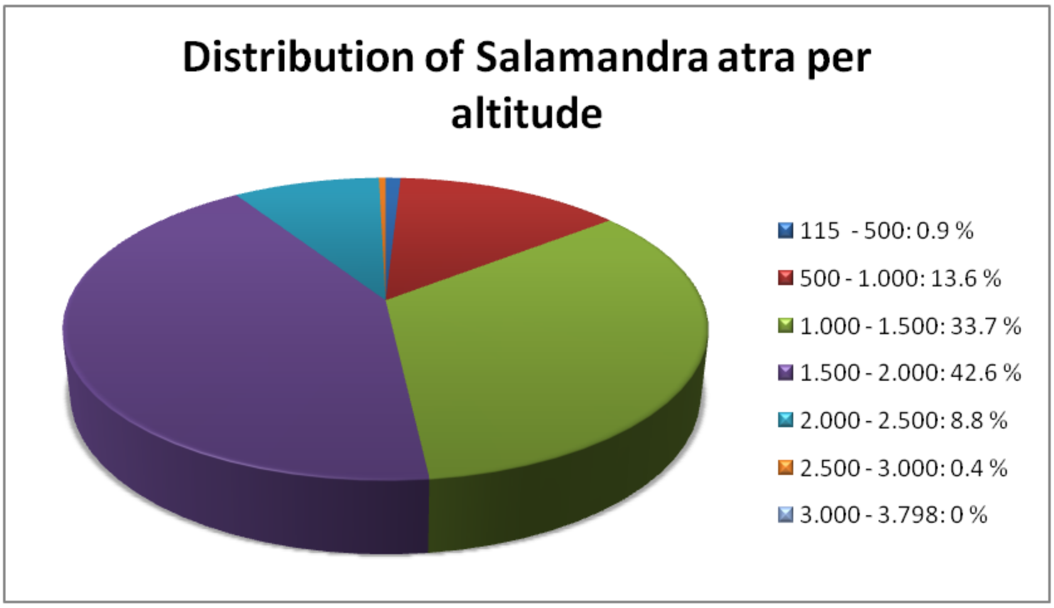

Figure 34 Distribution of *Salamandar atra* per altitude. A pie-chat for a better overview shows the parts in percent.

Source: own diagram, www.alpensalamander.eu

The same results can also be found in different literature (f. e. Steinfartz/Grossenbacher 2003) and so we are able to exclude one major criticism of this approach - that many users of our website considered this site as a joke and entered wrong reports. These altitudes are the best climate conditions (low temperature, high humidity) for the animals. The influence of humans decreases at this altitude; there are only a few rural communities in the lower altitudes (1000 – 1500 m). This area of 1500 – 2000 m is mostly used as mountain pasture and in the winter as ski areas.

By comparing the distribution with the climate it is obvious that 96 % of the findings are in the alpine climate.

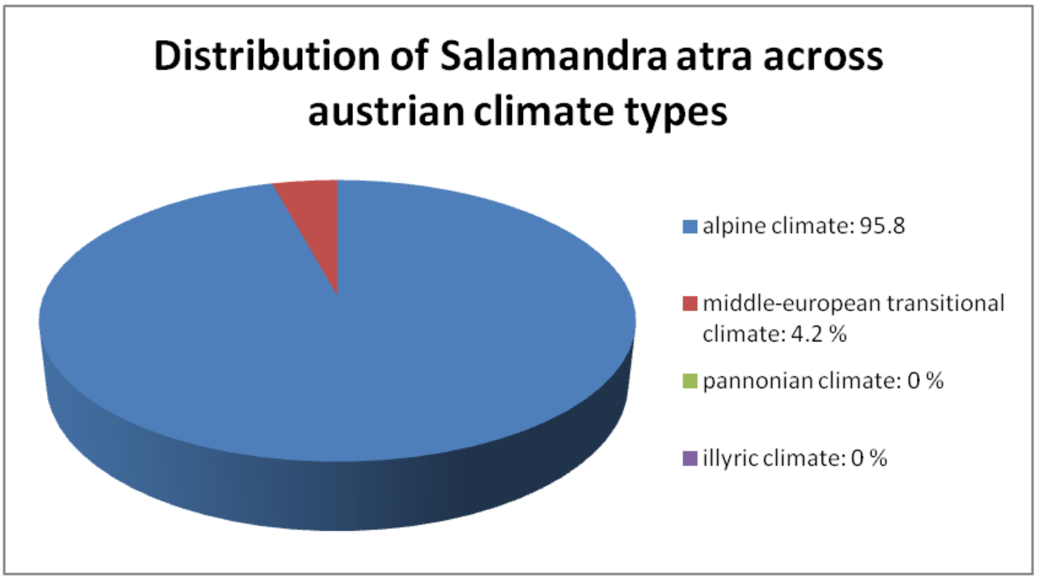

Figure 35 Distribution of *Salamandra atra* across the Austrian climate types. The pie-chat for a better overview shows the parts in percent.

Source: own diagram, www.alpensalamdner.eu

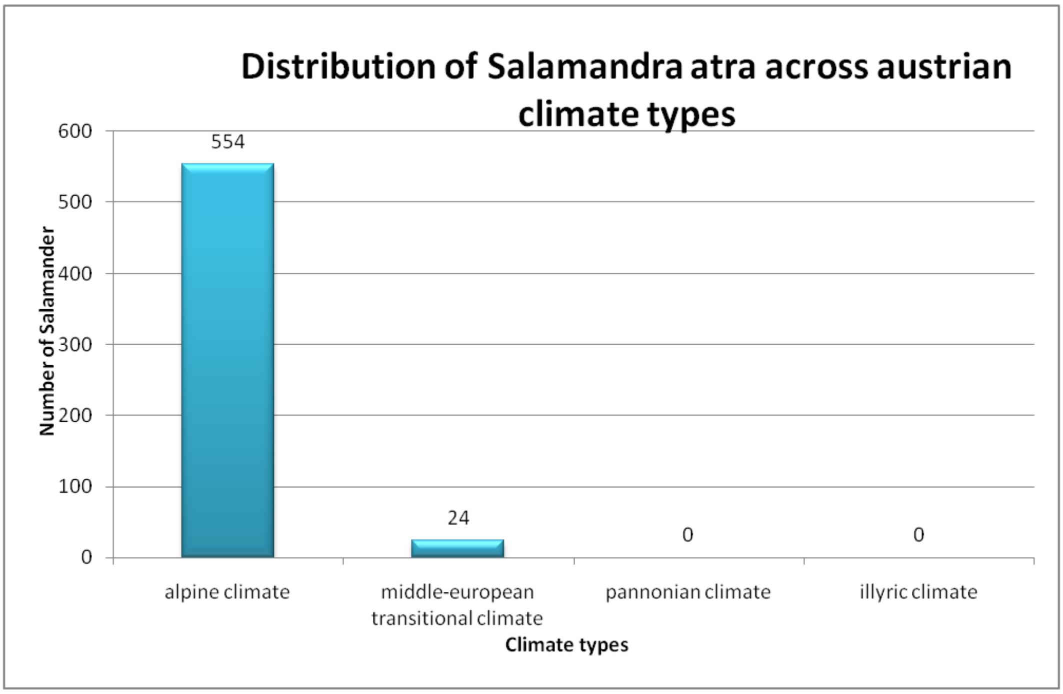

Figure 36 Distribution of *Salamandra atra* across Austrian climate types. The 578 clusters are plotted against the four Austrian climate types.

Source: own diagram, www.alpensalamander.eu

This distribution is not astonishing, because as described above the animals are mostly found on altitudes between 1500 – 2000 meters, where the alpine climate is predominant. The distribution across the Austrian Federal states is in correlation with the climate. The main occurrence is in Tyrol and Salzburg where the alpine climate is predominant. Some stray occurrences are in Upper- and Lower Austria as well as in Styria at the foothills of the Alps. There are no records of Alpine Salamander findings in Vienna and in Burgenland recorded. Especially in Burgenland the climate is too dry and too hot for the Alpine Salamanders. These results can be confirmed by Steinfartz/Grossenbacher, 2003.

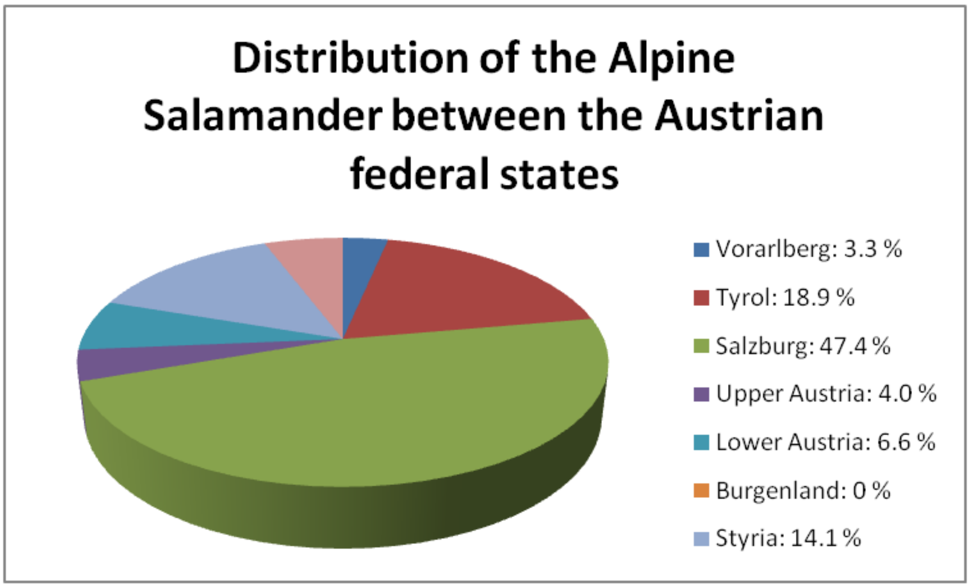

Figure 37 Distribution of the Alpine Salamander between the Austrian federal states. The pie-chart shows the parts in percent.

Source: own diagram, www.alpensalamdner.eu

Compared with the distribution between the Austrian federal states over 47 % of the records were made in Salzburg, followed by Tyrol with 18 % and Styria with 14 %. This supports the interpretation of the Austrian climate types as well as the distribution per altitude.

The Salamanders prefer forests of semi natural areas, over 91.5 % of the recordings were made in this area. Only 5 % were found on agricultural areas and 3.1 % on artificial surfaces.

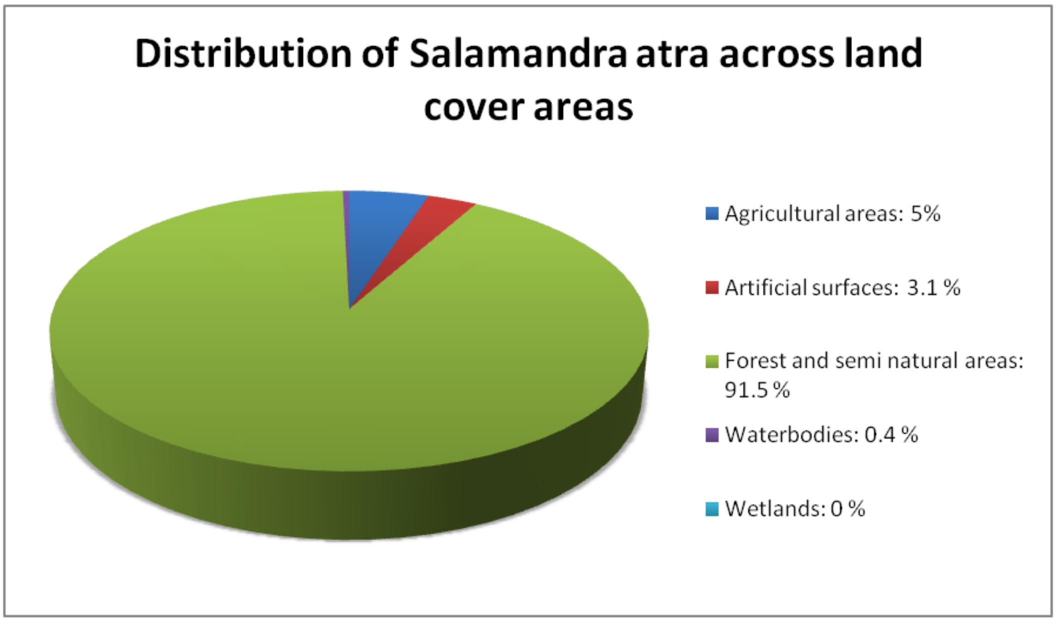

Figure 38 Distribution of *Salamandra atra* across the land covered areas. The pie-chat for a better over-view shows the parts in percent.

Source: own diagram, www.alpensalamander.eu

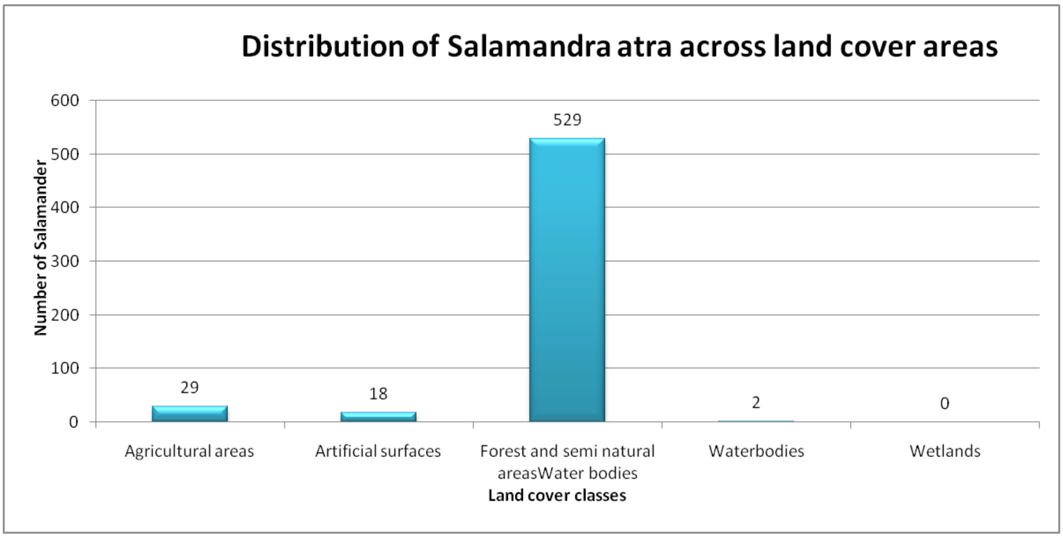

Figure 39 Distribution of *Salamandra atra* across land covered areas. The 578 clusters are plotted against the CORINE Level 1 (5 different classes).

Source: own diagram, www.alpensalamander.eu

The protection of these animals becomes more important because extensive land use leads to changes in ecosystems, the environment and in landscapes.

Urban areas and related infrastructure are the fastest growing land consumers. The main goal is to get more productive agricultural land. Because of agriculture intensification, forest exploitation and land abandonment rural landscapes are changing. Especially mountain areas are undergoing profound changes for intensive tourism and leisure activities (EEA 2010, online).

Compared with the different geology types of Austria, the Salamander distribution shows a preference to the Northern Limestone Alps with 47.2 % and the Central Alps with 42.7 %. This distribution can be also found in the literature (i.e. Nöllert/Nöllert 1992).

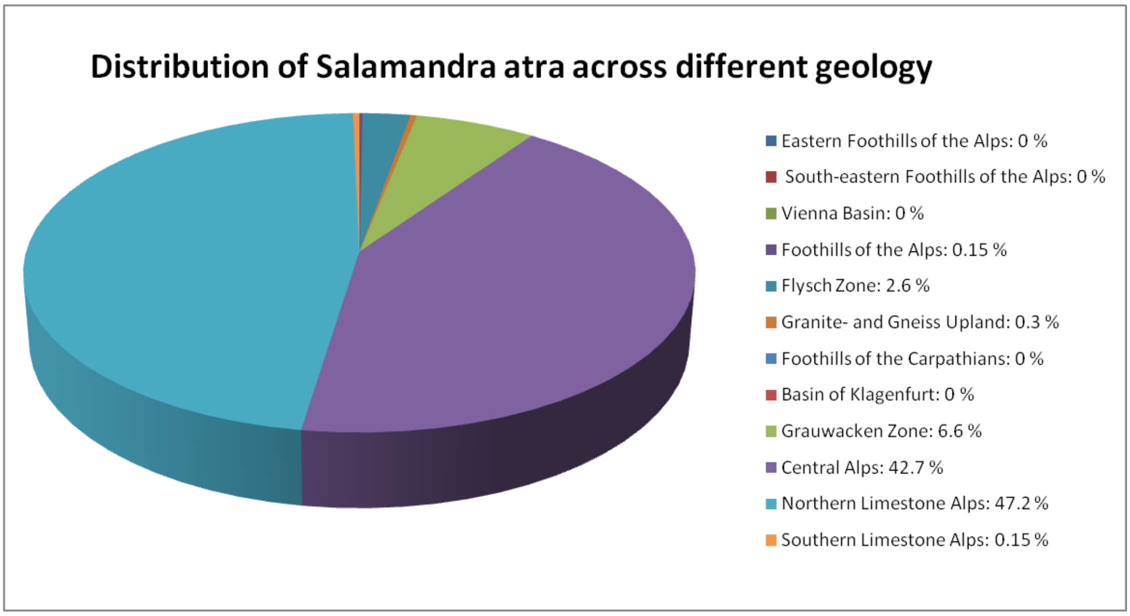

Figure 40 Distribution of *Salamandra atra* compared with the different types of geology in Austria. The pie-chat for a better overview shows the parts in percent.

Source: own diagram, www.alpensalamander.eu

In the Central Alps with crystalline surface the Alpine Salamander can be found in higher altitudes. Water is abundant in the region and so the Salamanders find enough nutrition in higher regions. In the Limestone Alps there is less water because limestone is permeable to water. Alpine Salamanders were found on scree slopes in the morning. Early morning fog and dew are the best conditions for the Salamanders.

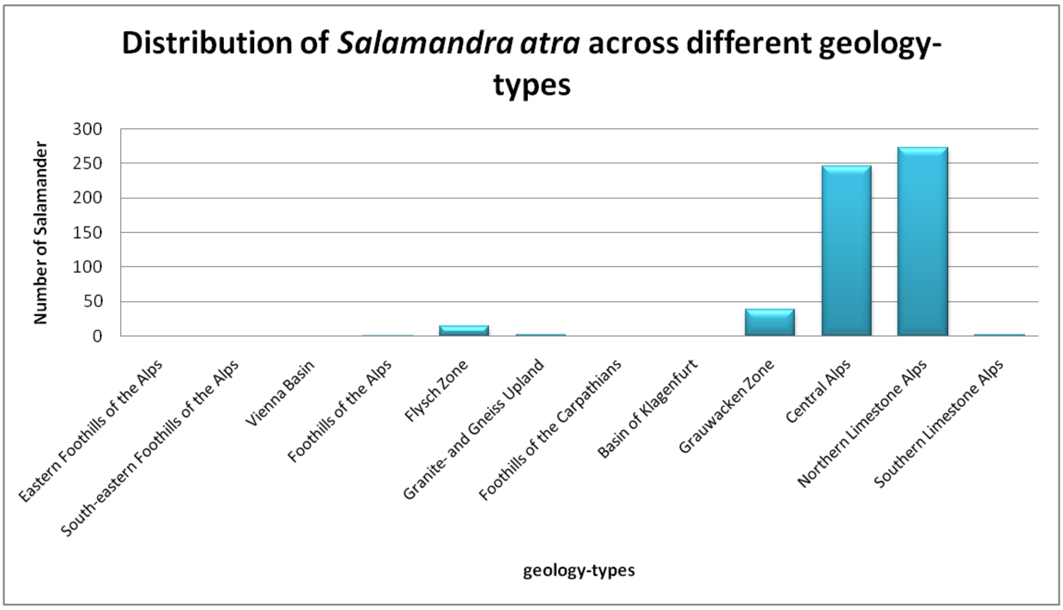

Figure 41 Distribution of the Alpine Salamander compared with different geology types. This graph shows the clustered number of Salamander findings.

Source: own diagram, www.alpensalamander.eu

12. CONCLUSION AND RECOMMENDATIONS

Taken together, our new approach which involves the community in a scientific project proofs to be very successful for monitoring the Alpine Salamander in Austria. Since July 2009 we have been able to record 2117 salamander reports. A broad community was built in a short time with the help of 1300 different users and the community is still growing. The records on our website increased in correlation to our degree of popularity. A second positive effect is that the population is getting more attentive on the small black salamanders and so it gets easier to protect those animals.

Our community based approach generates much more data than for example the biodiversity database of the Natural History Museum and immediately publishes the data. On our website everybody can report findings of salamanders. The Alpine Salamanders come only to the surface when the weather is adequate, i.e. in the early morning hours or while/after a summer rain, so it is very difficult to find them.

The vast amount of records allows to plan further monitoring activities much more efficiently. Some positive effects of these data are:

- A salamander distribution map was generated with almost no cost for Austria.
- The map is continuously updated and allows monitoring salamander populations.
- Salamander hotspots and peculiar observations (like high altitude populations) can be used for research studies like genetic monitoring to analyze the relations between the individuals.

The Alpine Salamander mainly appears in the alpine climate on altitudes between 1500 and 2000 meter. This is shown in the results with the help of different geological maps; this finding is confirmed in the literature (i. e. Steinfartz/Grossenbacher, 2003). It can be said that the data from the public are of high quality and the abuse of the database is negligible.

The main distribution area of the Alpine Salamander is in the alpine area. So it is necessary to build awareness among the population, and especially the children, and to raise their interest for these amazing animals. The project is still at the beginning, but we have several plans. One goal is to go to schools and bring those special animals of our country to the children’s minds, because the children are the future. In cooperation with museums and schools we will reach this goal.

The community based approach tries to get an increasing number of records with the help of the population, to get more knowledge about the distribution, the existence, the habitat and the activities of the salamanders. Suggestions about arrangements for the protection as well as protected areas should be developed.

In addition and based on our initial data we will develop a monitoring method to evaluate the emigration rates between the subterranean and surface populations and determine the parameters which influence it. For this monitoring project, we have selected locations in geographically and geologically different alpine areas. These areas will be monitored periodically, and it also includes the observation of other amphibians like the Fire Salamander (*Salamandra salamandra*) to investigate the ecological relationship among these species.

Taken together we show that the web portal www.alpensalamander.eu is a suitable tool for the collection of salamander observations by the public which serves two main purposes

1. data collection for new scientific project initiatives and
2. education of the public through direct and interactive information.

We believe that protection of amphibians and their habitats is only possible by actively involving the population, as participatory research has shown.

The Alpine Salamander is one of the heraldic animals of Europe and it is our obligation to put every effort into this research in order to preserve these amazing animals for future generations.

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14. APPENDIX

Appendix 1: CORINE Landcover Nomenklatur (Level 1- 3)

Source: Hölzl, M. 2003

1. Bebaute Fläche	1.1. Städtisch geprägte Flächen	1.1.1. durchgängig städtische Prägung 1.1.2. nicht durchgängig städtische Prägung
	1.2. Industrie-, Gewerbe- und Verkehrsflächen	1.2.1. Industrie/Gewerbeflächen 1.2.2. Straßen/Eisenbahnnetze, funktionell zugeordnete Flächen 1.2.3. Hafengebiete 1.2.4. Flughäfen
	1.3. Abbauflächen, Deponien, Baustellen	1.3.1. Abbauflächen 1.3.2. Deponien, Abraumhalden 1.3.3. Baustellen
	1.4. Künstlich angelegte nicht landwirtschaftlich genutzte Flächen	1.4.1. Städtische Grünflächen 1.4.2. Sport/Freizeitanlagen
2. Landwirtschaft	2.1. Ackerflächen	2.1.1. Nicht bewässertes Ackerland 2.1.2. Regelmäßig bewässertes Ackerland 2.1.3. Reisfelder
	2.2. Dauerkulturen	2.2.1. Weinbauflächen 2.2.2. Obst/Beerenobstbestände 2.2.3. Olivenhaine
	2.3. Grünland	2.3.1. Wiesen und Weiden
	2.4. Heterogene landwirtschaftliche Flächen	2.4.1. Einjähr. Kulturen in Verbindung mit Dauerkulturen 2.4.2. Komplexe Parzellenstruktur 2.4.3. Landwirtschaftlich genutztes Land mit Flächen natürlicher Vegetation von signifikanter Größe 2.4.4. Land/Forstwirtschaftliche Flächen
3. Wälder und naturnahe Flächen	3.1. Wälder	3.1.1. Laubwälder 3.1.2. Nadelwälder 3.1.3. Mischwälder
	3.2. Kraut/Strauchvegetation	3.2.1. Natürliches Grünland 3.2.2. Heiden und Moorheiden 3.2.3. Hartlaubbewuchs 3.2.4. Wald/Strauch Übergangsstadien
	3.3. Offene Flächen ohne oder mit geringer Vegetation	3.3.1. Strände, Dünen, Sandflächen 3.3.2. Felsflächen ohne Vegetation 3.3.3. Flächen mit spärlicher Vegetation 3.3.4. Brandflächen 3.3.5. Gletscher/Dauerschneegebiet
4. Feuchtflächen	4.1. Feuchtflächen im Landesinneren	4.1.1. Sümpfe 4.1.2. Torfmoore
	4.2. Feuchtflächen an der Küste	4.2.1. Salzwiesen 4.2.2. Salinen 4.2.3. In der Gezeitenzone liegende Flächen
5. Wasserflächen	5.1. Wasserflächen im Landesinneren	5.1.1. Gewässerläufe 5.1.2. Wasserflächen
	5.2. Meeresgewässer	5.2.1. Lagunen 5.2.2. Mündungsgebiete 5.2.3. Meer und Ozean