AN INVESTIGATION INTO ECOLOGY AND MITIGATION OPTIONS FOR *VIPERA URSINII RENARDI* IN KAZAKHSTAN

TODD R. LEWIS

Edmunds House, 40 S Bar St, Banbury OX16 9AE

SUMMARY

Kazakhstan has 51 species of reptile. The *Vipera ursinii renardi* (The Meadow Viper) is one of the countries rarest and most cryptic venomous viper species. It is protected under Kazakhstan and international law that seeks to prevent the species' demise in wild habitats. The species exists in a range of steppe habitat, from steppe forest edge through to low steppe and open grass. It can also survive within microhabitat features in remnant and secondary-improved steppe habitat.

This desktop investigation considers *Vipera ursinii renardi* and discusses possible mitigation for the species in light of its status and current knowledge. Mitigation techniques of long term fencing and line transect capture techniques are recommended. Potential habitat improvement measures to benefit the species post-mitigation are also discussed. Long term approaches to regeneration of steppe habitat with a view to prey and niche requirements for *Vipera ursinii renardi* are recommended.

SPECIES SYNOPSIS

Status, Protection and Distribution

Kazakhstan has 51 known species of reptile and 15 amphibians (Earth Trends 2003). Of these, 10 reptiles and 3 amphibians are of conservation concern by IUCN and Kazakhstan red-book listing (United Nations 2000). Within the 10 red-listed reptiles 3 species of Viperidae are of conservation concern; *Gloydius halys caraganus*, *Vipera berus berus*, *Vipera ursinii renardi*. *V. ursinii* is classified as 'Endangered' under IUCN red-listing (IUCN 2007). *V. ursinii* is also listed on CITES Appendix I, and is threatened with extinction if trade is not halted. It is also a strictly protected species under the Berne Convention (Appendix II). In Europe the species is protected under individual country laws. Many of these country specific designations relate to or are transposed from the European Union Habitats Directive (1994) providing protection for the species' habitat.

Vipera ursinii is a widespread but 'at risk' species and found from France to Asia (McDiarmid *et al.* 1999). Exact locations include southeastern France, eastern Austria, Hungary, central Italy, Croatia, Bosnia-Herzegovina, northern and northeastern Albania, Romania, northern Bulgaria, Greece, Turkey, northwestern Iran, Armenia, Azerbaijan, Georgia, Russia and across the Kazakhstan, Kirgizia and eastern Uzbekistan steppes to China (Xinjiang Region).

Its range in a number of countries is confirmed but there is limited population information for the species due to its patchy distribution (Corbett 1989; Nilson & Andrén 2001). The IUCN designation indicates an estimated population reduction of at least 80% over the last 10 years or three generations, whichever is the longer, based on a decline in areas of occupancy, extent of occurrence and/or quality of habitat. For the same reason, a population reduction of at least 80% is projected or suspected within the next 10 years or three generations. Recent research has suggested that the total abundance of the wild population is decreasing abnormally and populations are declining rapidly (SEH 2005).

Taxonomy

Common names for *Vipera ursinii* include; Meadow Viper, Ursinii's Viper, Meadow Adder, Orsini's Viper, Field Viper and Field Adder. The species has high genetic variability and previously has had a range of divided subspecies proposed (see Hellmich (1962); Steward (1971); Golay *et al.* (2003), Mallow *et al.* (2003), Arnold & Ovenden (2004), ITIS (2006), Joger & Stümpel (2005) for reviews).

Historically they have included the following;

- *Acridophaga uralensis* REUSS 1925
- *Pelias Ursinii* BONAPARTE 1835
- *Vipera anatolica* WELCH 1994; VENCHI & SINDACO 2006
- *Vipera macrops* MÉHELY 1911
- *Vipera macrops macrops* WELCH 1994
- *Vipera macrops graeca* WELCH 1994
- *Vipera (Pelias) ursinii* VENCHI & SINDACO 2006
- *Vipera ursinii* BOULENGER 1893; ENGELMANN *et al.* 1993; MCDIARMID *et al.* 1999
- *Vipera ursinii anatolica* EISELT & BARAN 1970
- *Vipera ursinii ebneri* KNÖPFLER & SOCHUREK 1955
- *Vipera ursinii graeca* NILSON & ANDRÉN 1988
- *Vipera ursinii macrops* MÉHELY 1911
- *Vipera ursinii moldavica* NILSON, ANDRÉN & JOGER 1993
- *Vipera ursinii parursinii* NILSON & ANDRÉN 2001
- *Vipera ursinii rakosiensis* MÉHELY 1893
- *Vipera berus rakosiensis* MÉHELY 1893
- *Vipera ursinii renardi* CHRISTOPH 1861
- *Vipera ursinii tienshanica* NILSON & ANDRÉN 2001
- *Vipera ursinii wettsteini* KNÖPFLER & SOCHUREK 1955

Many of the subspecies were divided using elements of physiology and geographical location. Some specimens are found only in specific type localities, for example;

- *V. u. anatolica*: Southern Turkey; Terra typica: Ciglikara Ormani, 50 km SSW of Elmali, Turkey.
- *V. ursinii*: Central Italy; Terra typica: monti dell'Abruzzo prossimi alla provincia d'Ascoli (mountains of Abruzzi, near Ascoli province, Italy).
- *V. u. ebneri*: Iran
- *V. u. moldavica*: Romania
- *V. u. parursinii*: Mountain steppes in N Xinjiang, NW China.
- *V. u. rakosiensis*: East Austria, Hungary, Slovenia, Croatia, Serbia, Southern Romania, North Bulgaria.
- *V. u. tienshanica*: Tien Shan mountains in Kazakhstan, Kyrgyzstan and Northwest China.
- *V. u. wettsteini*: Southeast France

Today only 9 subspecies are recognised (see below) due to many previously identified species having genetic synonymy (SEH 2005). Some are still considered to be invalid based on limited specimens from type localities and expired techniques used in their taxonomic division. According to up to date taxonomic sources the following subspecies are accepted in their type ranges (Joger & Stümpel 2005). Further revisions are likely;

- *Vipera u. anatolica*
- *Vipera u. eriwanensis*
- *Vipera u. graeca*
- *Vipera u. macrops*
- *Vipera u. moldavica*
- *Vipera u. parursinii*
- *Vipera u. rakosiensis*
- *Vipera u. renardi*
- *Vipera u. ursinii*
- *Vipera u. tienshanica*
- *Vipera u. wettsteini*

Description

Adults of *V. ursinii* of all species are variable but usually less than 50cm (Total Length/TL). The species has a small, thick body typical of similar vipers (Plate 1.0). It has a narrow head and often has a rough appearance. Pattern in *V. ursinii* is not especially variable. It is greyish, pale brown, or yellowish with a dark zig-zag dorsal stripe that is usually edged with black and may be broken into spots. The dorsal flanks are often dark with a black, whitish, or dark grey underside.

V. ursinii is only likely to be confused within subspecies or with the Asp Viper (*Vipera aspis*) and Adder (*Vipera berus*) (Plates 1.1 & 1.2). It is distinct in marking from *Agkistrodon halys* (Plate 1.3). It differs strongly from the Asp Viper by lacking an upturned snout (rostral scale), presence of several large scales on the head (frontal parietals) and low numbers of dorsal scales (19 across mid-body). It differs from Adder in size (Adder up to 65cm) and has a narrower head, tapering snout and only a single apical scale in contact with its rostral scale. Often it has fewer scales on the top side of the snout (no more than 12), a smaller nostral and nasal scale, and a preocular scale in contact with its nasal scale. It also has fewer back scales than Adder (19 as opposed to 21). Scales are often wavy in cross section and exhibit a more pronounced keel.

***Vipera ursinii* in Kazakhstan**

Kazakhstan populations of *V. ursinii* have been assigned to the *V. u. renardi* subspecies (Nilson *et al.* 1993; Nilson & Andrén 2001; Joger & Stümpel 2005). *V. u. renardi* occurs in Ukraine, Russia and eastwards to China. Ukrainian populations in Crimean montane regions have been found that do not typically key to *V. u. renardi* and thus in some regions near Kazakhstan the taxonomy debate continues (Kukuskin & Zinenko 2006).

V. u. renardi looks visually similar to other *V. ursinii* subspecies (Plate 1.4) but differs from standard descriptions of *V. ursinii* by presence of 21 dorsal scales at mid-body and like *V. u. moldavica,* it possesses raised canthi, exhibiting a slightly concave snout. Melanistic individuals also occur. Quantitative population information for *V. u. renardi* in Kazakhstan is poorly published and distribution accounts for the species are lacking (Lambert 2002).

Plate 1.0 *Vipera ursinii.*

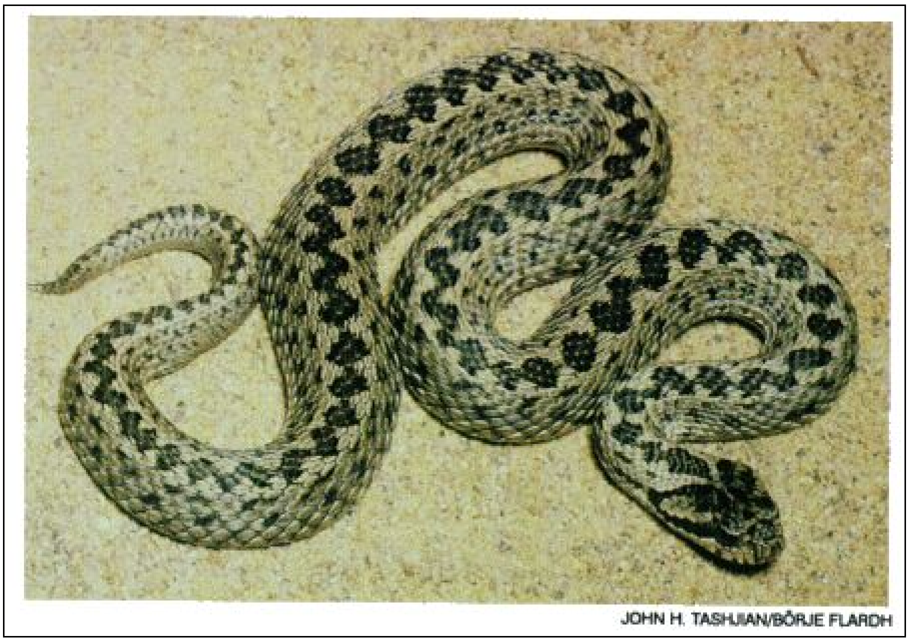

Plate 1.1 *Vipera aspis*

Plate 1.2 *Vipera berus berus.*

Mike Sharp / RSK Carter Ecological

Plate 1.3 *Gloydius halys caraganus.*

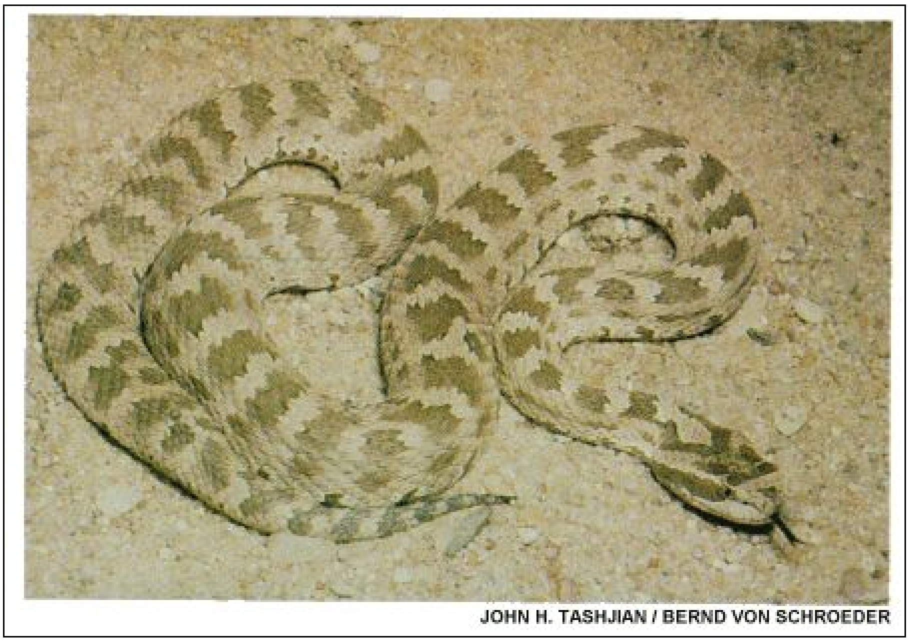

Plate 1.4 *Vipera ursinii renardi.*

Ecology of *Vipera ursinii*

Despite recent efforts the biology and ecology of the *V. ursinii* subspecies complex is poorly known, in part due to its rarity and cryptic habits (Corbett 1989; Újvari *et al.* 2000; Lambert 2002; Arnold & Ovenden 2004; SEH 2005).

This species typically occurs between 1000m – 2700m in a mix of lowland and montane habitats, although may occur as low as 700m. Habitats mostly include open meadows, steppe habitat and edge hillsides (Arnold & Ovenden 2004). It is one of the most cold tolerant vipers in Asia and can therefore survive with low metabolic cost and a short growth and development season (Arnold & Ovenden 2440).

Adult food comprises lizards and small mammals but also, unusually, large species of Orthopterans. Juveniles of *V. u. rakosiensis* almost exclusively feed on Orthopterans but will also take a range of smaller bodied mammal and lizard prey (Újvari *et al.* 2000; Arnold & Ovenden 2004). Some Ukrainian populations eat fledgling ground nesting birds (Arnold & Ovenden 2004; Kukuskin & Zineko 2006). Prey is swallowed either live or after short envenomation. Diet is seasonally restricted for *V. ursinii.* Small birds are eaten early in the season and insects are invariably summer prey items.

Unlike other vipers this species complex has relatively weak venom. It is also fairly docile and rarely bites upon capture which has amplified its risk to illegal collectors (Arnold & Ovenden 2004).

V. ursinii, like other temperate vipers with seasonally restricted activity, exhibits strong site fidelity and cryptic thermoregulation behaviour (Újvari *et al.* 2000; Tomović *et al.* 2004). Adults use and live close to hibernation areas that can be as short as 100-200m from their foraging grounds, although whether this is indicative of the maximum movement range of the species is unknown (Kovács *et al.* 2002). Densities for some subspecies are reported to be as low as 0.2/ha or as high as 20-30/ha in undisturbed areas although exact density information for every subspecies of *V. ursinii* is not known (Kovács *et al.* 2002; Arnold & Ovenden 2004).

Adults typically emerge after winter (late March) in much of their range (sometimes later for montane subspecies). Mating takes place in May (depending on weather), parturition at the end of July, August or beginning of September and hibernation in October or November (Saint Girons 1992; Újvari & Korsós 1999).

Mating likely occurs biennially in *V. ursinii* as for other temperate viviparous vipers (Aldridge 1979; Luiselli 1990; Höggren & Tegelström 1995) and fecundation takes place only when body conditions are appropriate, as per other temperate European snakes (Újvari *et al.* 2000). Clutch size varies from 2-22 depending on altitude preference of subspecies (higher altitude = lower clutch size) and neonates are relatively large in comparison with other viper species (Luiselli 1990; Újvari *et al.* 2000).

Habitat Composition of *Vipera ursinii*

The *V. ursinii* subspecies complex is primarily associated with scrub meadows, steppe habitat and montane hillsides (Arnold & Ovenden 2004).

In Macedonia biotopes, *V. ursinii* subspecies live mostly in grassy habitats that represent typical mountain pastures with scattered stone piles and bushes of *Juniperus communis* and *Vaccinium myrtilus* (Sterijovski 2006) (Plate 1.5).

Plate 1.5 Habitat of *Vipera ursinii* in the Bistra Mountains, Macedonia (Sterijovski 2006).

In the Ukraine, *V. u. renardi* main range region is the Chatyrdag, Low Mountains. Here the vipers occur up to 900-1100m above sea level in;

- Bushes (*Pyrus eleagnifolia, Prunus stepposa*, *Crataegus* sp., *Rubus* sp., *Juniperus oxycedrus*).

- Open sites in broadleaved forest (*Quercus petraea* + *Carpinus betulus*, *Fraxinus exselsior* + *Acer campestre*, *C. betulus* + *Fagus orientalis*).
- Stony forest-steppe near mountain plateaus with dominance of European-Mediterranean, Fore Asian, Crimean-Caucasian and endemic Crimean elements (*Quercus pubescens, Carpinus orientalis, Sorbus graeca, Cornus mas, Cotinus coggygria, Acer steveni, Cotoneaster tauricus, Ligustrum vulgare, Spiraea hypericifolia, Jasminum fruticans, Juniperus hemispherica, J. foetidissima, Asphodeline taurica, Cerastium bibersteinii, Thymus tauricus, Stipa lithophila*, etc.).
- Mountain-meadow steppe (*Festuca rupicola* + *Carex humilis*) (Kukuskin & Zineko 2006).

Also in Ukraine, populations of *V. u. renardi* at Cape Chauda inhabit semi-desert and meadow steppes with dominance of *Artemisia taurica, A. lerchiana, Festuca valesiaca, Lynosiris villosa, Limonium meyeri, Achillea nobilis, Ferula caspica, Malabaila graveolens*. In the pre-Sivash and Western regions of Crimea (Ukraine) *V. u. renardi* further occupies broad habitats such as lowland semi-desert steppes and halophytic meadows, and more rarely psammophytic steppes (Kukushkin 2004).

In the Grindul Perisor reserve in Romania *V. ursinii* is found among a mosaic of higro-halophilous and xero-thermophilous meadows. The ground is build up by sand with many fragments of shells (marine snails and shells). The dominant vegetal species is *Juncus maritimus*. Next to this species there are several other plants adapted to sandy environments (*Leymus sabulosus, Lactuca tatarica, Centaurea arenaria, Euphorbia sequeriana, Cynodon dactylon, Linum austriacum*) or salty soils (*Salsola tragus, Suaeda maritima, Gypsophila perfoliatum, Artemisia santonicum*). On high dunes, close to the Black Sea shore there are bushes of *Tamarix ramosissima* and *Eleagnus angustifolia* (Torok 2002).

In the Hanság Nature Reserve on the Hungarian Plains *V. ursinii* inhabits vegetation that is characterized by non-uniform distribution of clumps of different grass species like *Molinia coerulea, Festuca sulcata, Koeleria gracilis, Chrysopogon gryllus* and *Stipa* spp., that are organized in a way giving micro-levels and coarse-grained, mosaic structure to the habitat (Kovács *et al.* 2002). In Kovács *et al.* (2002) T. Kotenko also records *V. u. renardi* as occurring in virgin steppes, some meadows (usually on sodic soils), sand dunes and beach barriers with psammophytes, idle fields and vineyards, dams, swells, hills and road shoulders with steppe and weed vegetation, wind forest strips and natural light forests.

In the Biogradska Gora National Park, eastern Montenegro *V. u. macrops* inhabits grassy sites with stone piles distributed haphazardly among scattered juniper (*Juniperus communis* ssp. *sibirica*) and bilberry (*Vaccinium myrtilus, V. uliginosum*). Tomović *et al.* (2004) studied microhabitats of *V. u. macrops* in the park and discovered that specific areas were used that included stones and *Juniperus* bushes between 4 and 6 m in diameter; stones and *Juniperus* bushes <4 m in diameter; stones and open grass; open grass; open grass and *Juniperus* bushes between 4 and 6 m in diameter; open grass and other bushes (*Vaccinium*); stones, *Juniperus* bushes <4 m in diameter and open grass; *Juniperus* bushes <4 m in diameter, open grass and other bushes (*Vaccinium*).

In the Kiskunság area southeast of Budapest, Hungary, populations of *V. u. rakosiensis* consistently reside in habitat comprising wet, closed grassland (Molinietum community) that is uneven in structure and is characterised by *Molinia coerulea, Schoenus nigricans, Chrysopogon gryllus* and *Stipa* sp of grass. The structure of the vegetation is arranged into microlayers, interspaced by tussocks of grass of different ages.

In upland regions of Kazakhstan, *V. u. renardi* is generally found on well drained rocky hillsides, steppe and meadows. In lowland areas it is found in either steppe, or dry or damp meadows. Lowland specimens are sometimes found in marshy areas.

Legal Protection in Kazakhstan

Statutory protection for wildlife in Kazakhstan can be recognised through a range of legal instruments that include;

- Law on Environmental Protection, 1997
- Law on Ecological Expertise, 1997
- Decree on Licensing, 1993
- Law on Specially Protected Natural Territories, 1997
- Law on Air Protection, 1981
- Law on the Protection, Reproduction and Use of Animals, 1993
- Forestry Code, 1993
- Water Code, 1993
- Decree on Land, 1996
- Decree on Underground Resources and their Use, 1995
- Law on Oil, 1995
- Law on the Social Protection of Citizens Harmed by the Environmental Disaster near the Aral Sea, 1992
- Law on the Social Protection of Citizens Harmed by Nuclear Testing in the Semipalatinsk Nuclear Testing Polygon, 1993
- Law on Radiation Safety, 1998

Draft laws in preparation include;

- Draft law on the control of environmental protection and natural resources use
- Draft law on production and consumption waste
- Draft law on payments for bioresource use
- Draft law on biodiversity
- Draft law on climate and zone layer of earth

The Law on Environmental Protection, 1997 views environmental protection as a precondition for sustainable development. Its declared aims are to maintain ecological safety, prevent entrepreneurial and other activities from having a harmful effect on natural ecosystems, preserve biodiversity and ensure the efficient use of nature. The Law defines the rights and responsibilities of citizens and social associations. It describes the duties of governmental bodies, the requirements of nature use and its regulation, and measures to prevent and clean up environmental pollution.

The Law also designates organizational structures for environmental protection and establishes the basis for environmental standards and requirements. It contains measures for licensing procedures, permitting, environmental auditing, economic incentives for nature and environmental protection. It also creates a framework for international environmental protection.

The provisions on liability for environmental damage are not included in the Law on Environmental Protection, but are part of administrative, civil and criminal law. The only general provision is in article 86 of the Law on Environmental Protection, which states that natural and legal persons that have damaged the environment, health or property of the population by breaking the environmental legislation are liable under the law.

The National Environmental Action Plan for Sustainable Development (NEAP/SD) was created as a plan for solving the priority environmental issues for the period 1998-2000. Today, the NEAP/SD continues and assists in defining the environmental policies and action programmes.

The priorities originally identified by NEAP/SD are;

- Reduction of industrial pollution
- Introduction of resource-saving technologies
- Combat of desertification
- Stoppage of topsoil destruction
- Rational use of water resources
- Avoidance of water pollution
- Stopping the loss of forest
- Biodiversity protection
- Protection against radioactive pollution
- Health protection

Environmental monitoring of species is prescribed through the Law on Environmental Protection. Although by-laws for establishing a unified monitoring system have not yet been prepared, data collection and dissemination of biodiversity information is achieved by institutions that hold environmental data. They are;

- The National Environmental Centre for Sustainable Development
- MNREP
- The Republic’s Centre for Geological Information
- Kazhydromet
- The Ministry of Agriculture
- The Agency on Statistics

The Law on Environmental Protection broadly covers *V. u. renardi* but does not specify a species specific plan to target enhancement for the species. The NEAP/SD is suggestive of broad goals of action plans that would assist in bolstering long term survival of the species.

Threats to *V. ursinii*

Threats to the *V. ursinii* subspecies complex include (IUCN 2007);

- Illegal collection
- Over harvesting for medicinal uses.
- Habitat fragmentation, degradation and destruction.
- Urbanization of habitat.
- Low abundance and poor genetic variability within populations.
- Unrealised natural reproduction, because of poor demographic knowledge.
- Lack of compensation for damaging actions to habitat and species.

The sensitivity of all subspecies of *V. ursinii* to habitat alteration and human disturbance is quite dramatic (Újvari *et al.* 2000). Due to their seasonally restricted physiologically requirements, tight microhabitat niches and site fidelity, populations are subject to short term stochastic threats like cold winter and high soil water level as well as long term natural threats like isolation, genetic drift and inbreeding (Újvari *et al.* 2000; Arnold & Ovenden 2004; Tomović *et al.* 2004; SEH 2005; Kukushkin & Zinenko 2006; Tomović *et al.* 2008).

Nearly all *V. ursinii* subspecies are immediately and most significantly threatened by human agricultural activities like intensive grazing, burning, machine mowing and general land take (see more details in Korsós & Fülöp 1994; Péchy *et al.* 1996; SEH 2005).

Surveying for *V. ursinii*

Very little demographic data is available for *V. ursinii* but what data is known includes exact population size, age structure, age specific survival, mortality rates and metapopulation structure. This ecological information is often easy to collect in this species due to its high site fidelity and low range movement (Kovács 2002). However, a general absence of standardized methods for demographic data collection complicates comparisons among the sparse data (SEH 2005).

Typically, snakes spend long periods of time in single locations (Weatherhead & Charland 1985). Vipers are no exception and exhibit strong site fidelity to hibernation, breeding and feeding resources (Reinerth & Kodnch 1982; Neumeyer 1987; Brito 2003). Home ranges and seasonal variations in habitat use have also been recorded in many viper species (Gregory *et al.* 1987; Naulleau *et al.* 1998; Brito 2003).

In its preferred natural environments *V. ursinii* body temperature is correlated with substratum temperature as well as with the interaction of air and substratum temperature (Tomović *et al.* 2004).

In some studies, *V. ursinii* were recorded between hours 11.00 and hours 13.00, and were more frequently found on the south-western and southern facing slopes, than on the south-eastern and eastern slopes on hillsides (Korsós & Fülöp 1994; Péchy *et al.* 1996; Újvari *et al.* 2000; Tomović *et al.* 2004; SEH 2005). Some studies surveyed for *V. ursinii* earlier in the morning between 07:00 and 12:00 and their subsequent detection on site was likely due to lower altitudes and warmer conditions that triggered activity (Korsós & Fülöp 1994; Péchy *et al.* 1996; Újvari *et al.* 2000; Tomović *et al.* 2004; SEH 2005).

In many studies *V. ursinii* was surveyed using Visual Encounter Surveys (VES), quadrats and line transects. However, unlike for many other temperate vipers, densities and survey effort was variable and did not especially reflect consistency to detect for species presence (VES 2005).

Habitat Management for *V. ursinii*

Previous habitat management for enhancement of *V. ursinii* is chronically understudied and infrequently applied. Where habitat management has occurred, it has often been applied only to natural/primary areas of land, among known populations. Management prescriptions included;

- Habitat (tussock) management.
- Creation of buffer zones by promotion and management of habitat succession.
- Control of number of grazing animals.

Successful outcome of habitat management has not been measured for *V. ursinii*. Kovács (2002) and SEH (2005) recommend that future studies or implementation of management should seek to;

- Avoid damaging meadows with *V. ursinii* populations.
- Refine methods of optimal / practical management.
- Create buffer zones to suitable and used microhabitat features.
- Limit number of grazing animals; define species; races of domestic animals and the grazing season and duration.
- Design possible tussock maintenance methods.

Mitigation for *V. ursinii*

Mitigation for this species should ideally reflect its population status and ecology and be designed by an ecologist. A likely capture translocation protocol for this species would require a range of detection survey methods ranging from visual encounter surveys to selective and strategic artificial cover object (ACO) use. The ACO layout and use on site should be carefully implemented so not to disrupt natural activity by the organism. ACO placement should be temporary as such methods can attract small mammals. This provision of extra prey may bias a survey for such a prey dependant species and may disrupt natural foraging and biorhythm of the species. This is an important consideration as *V. u. renardi* has a short activity season.

Eventual detection for this species (given its cryptic nature) may take specialist surveyor experience and extensive effort. However, given the species tendency for site fidelity, densities may be successfully realised. In similar studies of cryptic temperate species Kéry (2002) achieved detection in the cryptic snake *Coronella austriaca* in 16-19 survey visits. Detection of snakes by survey effort alone can be deceptively longer, even for species that can be considered widespread (Cranfield & Lewis 2006). This could take as long for this species.

Distance of translocation for this sedentary species should ideally be kept to a minimum due to its high site fidelity. Timing of translocation and pre-preparation of habitat would be crucial in avoiding a drop in body index during relocation which could lead to death of individual during winter or a fallow breeding season.

Additional habitat recreation as a mitigation strategy in combination would need consultation with specialist ecologists. The *V. ursinii* subspecies complex, including *V. u. renardi*, is primarily associated with open meadows, steppe habitat and montane hillsides (Arnold & Ovenden 2004). Therefore, steps to practically mitigate for the species should ideally consider the species habitat and niche requirements as a prerequisite. The following would likely suit *V. ursinii* (in order of priority);

- Estimation and retention of existing microhabitats.
- Enhancement of existing botanical habitat to encourage succession.
- Retention/management for the creation of edge/dynamic habitat.
- Enhancement of existing microhabitat features.
- Protective measures against non-natural disruptors.
- Provision and enhancement of new botanical habitat to encourage succession.
- Creation of new edge/dynamic habitat.

Provision of new and/or enhancement of existing habitat is likely to be a specialist activity that requires commitment to consultation with botanical experts and monitoring of populations by ecologists.

The provision of new or enhancement of habitat as mitigation must also allow for the vipers dynamic prey base and therefore must also include management of habitats for enhancement of invertebrates and small mammals. If prey base in a suggested area is not sufficient the population could be placed at risk after several years. Viper species that exhibit high site fidelity and longevity must achieve maximum body index condition to keep a population in breeding condition and minimise survival losses during hibernation (Andrén 1982; Seigel & Collins 1993).

Potential Mitigation Schedule

Season 1 (possibly further seasons).

1) Population survey in spring followed by analysis of population data and habitat use through single or multiple seasons.
2) Habitat enhancement or recreation of new habitat (concurrent with survey and population season).
3) Monitoring of newly created habitat (including prey base resource) and *V. u. renardi* populations.

Season 2 or 3 (possibly further seasons).

4) Monitoring of newly created habitat (including prey base resource) and viper populations.
5) Isolation of works site using drift/enclosure fencing.
6) Translocation survey of *V. u. renardi*.
7) Translocation of *V. u. renardi.*
8) Habitat enhancement or recreation of existing habitat.

Season 3 - 6 (possibly further seasons).

9) Monitoring of newly created habitat (and prey base resource) and viper populations.
10) Habitat enhancement or recreation of existing habitat.

Note: Due to the lack of knowledge associated with mitigation and translocation for this species, and its fragile population status, flexibility in these processes would be required, and is recommended. If successful, such activities would be exemplary as a case study of such a mitigation process.

REFERENCES

Aldridge R D (1979). Female reproductive cycles of the snakes *Arizona elegans* and *Crotalus viridis*. *Herpetologica*, 35, 256-261.

Andrén C (1982). Effects of prey density on the reproduction, foraging and other activities in the Adder, *Vipera berus*. *Amphibia-Reptilia,* 3, 81-96.

Arnold E N & Ovenden D W (2004). *A field guide to the reptiles and amphibians of Britain and Europe*. Harper Collins, London.

Brito J C (2003). Seasonal variation in movements, home range, and habitat use by male *Vipera latastei* in northern Portugal. *Journal of Herpetology*, 37 (1), 155-160.

Corbett K (1989). *Conservation of European reptiles and amphibians*. IUCN SSC, Christopher Helm Publishers Ltd, London.

Cranfield J & Lewis T R (2006). A pilot survey for the grass snake *Natrix natrix helvetica* on the Island of Jersey (Channel Islands). Herpetologic Ltd. 1-14.

Earth Trends (2003). Accessed February 2008.

Korsós Z & Fülöp T (1994). One hundred years of the meadow viper (*Vipera ursinii rakosiensis* Méhely, 1893). *Állatt. Közlem.*, 78, 31-38 (in Hungarian, with English summary).

Golay P, Smith H M, Broadley D G, Dixon J R, McCarthy C, Rage J-C, Schätti B & Toriba M (1993). *Endoglyphs and other major venomous snakes of the world: a checklist*. Geneva: Azemiops.

Gregory P T, MacCartney J M & Larsen K W (1987). Spatial patterns and movements. *Snakes: ecology and evolutionary biology*. (Ed by R A Seigel, J T Collins & S S Novak), pp. 366-395, McGraw-Hill, New York.

Hellmich W (1962). *Reptiles and amphibians of Europe.* Blandford Press, London.

Höggren M & Tegelström H (1995). DNA fingerprinting shows within-season multiple paternity in the adder (*Vipera berus*). *Copeia*, 1995, 271-277.

Integrated Taxonomic Information System, ITIS (2006). Accessed on 19 August 2006.

IUCN Red List (2007). Accessed 2 September 2007.

Joger U & Stümpel N (2005). Schlangen 3 – Vipern. *Handbuch der reptilien und Amphibien Europas*. (Ed by von W Böhme, K Grossenbacher & B Thiesmeier, Verlag, Weibelsheim, Germany.

Kéry M (2002). Inferring the absence of species – a case study of snakes. *Journal of Wildlife Management*, 66 (2), 330-338.

Kovács T, Korsós Z, Rehák I, Corbett K & Miller P S (2002). Population and habitat viability assessment for the Hungarian Meadow Viper (*Vipera ursinii rakosiensis*). Workshop Report. Apple Valley, MN, IUCN/SSC Conservation Breeding Specialist Group.

Kukushkin O V (2004). Rasprostranenie, reproduktivnye osobennosti, razmerno-vozrastnaya struktura i sovremennoe sostoyanie populatsii stepnoĭ gaduki, *Vipera renardi* (Christoph, 1861), v Krymu [Distribution, reproductive peculiarities, size-ages structure and contemporary state of the populations of the Steppe Viper, *Vipera renardi* (Christoph, 1861), in the Crimea]. *Istoria, geologia, botanika, zoologia, kniga 1*, (Ed by Karagov O), pp 397-424. Sonat, Russia.

Kukushkin O V & Zinenko O I (2006). Morphologcal peculiarities and their possible bearing on the taxonomic status of the Crimean montane populations of the Steppe Viper, *Vipera renardi* (Christoph, 1861). *Herpetologia Bonnensis II, Proceedings of the 13th Congress of the Societas Europaea Herpetologica*. (Ed by M Vences, J Köhler, T Ziegler & W Böhme), pp 61-66, SHE, Bonn, Germany.

Lambert M R K (2002). Preliminary observations on herpetofaunal diversity in the Almaty region, Southern Kazakhstan (September 1998). *Herpetological Bulletin*, 79, 7-13.

Luiselli L (1990). Captive breeding of *Vipera ursinii ursinii* (Reptilia, Viperidae). *British Herpetological Society Bulletin*, 34, 23-30.

Mallow D, Ludwig D & Nilson G (2003). *True vipers: natural history and toxinology of Old World vipers*. Krieger Publishing Company, Malabar, Florida.

McDiarmid R W, Campbell J A & Touré T (1999). *Snake species of the world: a taxonomic and geographic reference*. Vol. 1. Herpetologists' League.

Naulleau G, Duguy R & Saint-Girons H (1998). Le systeme espace-temps au cours du cycle annuel chez les viperinae. *Bulletin de la Societe Zoologique de France*, 123, 53-60.

Neumeyer R (1987). Density and seasonal movements of the adder (*Vipera berus* L. 1758) in a subalpine environment. *Amphibia-Reptilia*, 8, 259-276.

Nilson G, Andrén C & Joger U (1993). A re-evaluation of the taxonomic status of the Moldavian steppe viper based on immunological investigations, with a discussion of the hypothesis of secondary intergradation between *Vipera ursinii rakosiensis* and *Vipera (ursinii) renardi*. *Amphibia-Reptilia*, 14, 45-57.

Nilson G & Andrén C (2001). The meadow and steppe vipers of Europe and Asia - the *Vipera* (Acridophaga) *ursinii* complex. *Acta Zoologica Academiae Scientiarum Hungaricae*, 47 (2-3), 87-267.

Péchy T, Korsós Z & Újvári B (1996). Recovery program for the meadow viper in Hungary. Hungarian Ornithological and Nature Conservation Society, Budapest.

Reinerth K & Kodnch W R (1982). Movements and habitat utilization by the Massasauga, *Sistrurus catenatus catenatus*. *Journal of Herpetology,* 16:162-171.

Saint Girons H & Naulleau G (1981). Poids des nouveau-né s et stratégies reproductrices des vipères européennes. *Terre et Vie*, 35, 597-616.

Seigel R A & Collins J T (1993). *Snakes: ecology and behavior*. The Blackburn Press, New Jersey.

Societa Europaea Herpetologica (SEH) (2005). Global reptile assessment regional workshop – non-Mediterranean reptiles of the western Palearctic. SEH General Meeting Vol. 2, Bonn, Germany.

Sterijovski B (2006). A new record of *Vipera ursinii* (Reptilia: Serpentes) from Macedonia. *Herpetologia Bonnensis II, Proceedings of the 13th Congress of the Societas Europaea Herpetologica*. (Ed by M Vences, J Köhler, T Ziegler & W Böhme), pp 181-182, SHE, Bonn, Germany.

Steward J W (1971). *The snakes of Europe*. Associated University Press, Cranbury, New Jersey.

Tomović L, Crnobrnja-Isailoví J & Ajtí R (2004). A preliminary study of the population ecology of *Vipera ursinii macrops* from eastern Montenegro. *Amphibia-Reptilia*, 25, 316-320.

Tomović L, Carretero M A, Crnobrnja-Isailoví J & Ajtí R (2008). Evidence for post-natal instability of head scalation in the meadow viper (*Vipera ursinii*) – patterns and taxonomic implications. *Amphibia-Reptilia*, 29, 61-70.

Torok Z (2002). Potential management plan conservation of *Vipera ursinii* from the Danube Delta Biosphere Reserve (Romania). *Scientific Annals of the Danube Delta Institute for Research and Development*, 31, 174-186.

United Nations (2000). Environmental performance reviews series No. 8: Kazakhstan. Economic Commission for Europe, New York and Geneva.

Újvari B & Korsós Z (1999). First observation in situ on the hibernation of the Hungarian Meadow Viper (*Vipera ursinii rakosiensis*). *Current studies in herpetology*. (Ed by C Miaud, & R Guyétant), pp. 435-438, Le Bourget du Lac (SEH).

Újvari B, Korsós Z & Péchy T (2000). Life history, population characteristics and conservation of the Hungarian meadow viper (*Vipera ursinii rakosiensis*). *Amphibia-Reptilia*, 21, 267-278.

Weatherhead P J & Charland M B (1985). Habitat selection in an Ontario population of the snake, *Elaphe obsoleta*. *Journal of Herpetology*, 19, 12-19.

Report to be cited as:

Lewis, T.R. (2008). An investigation into ecology and mitigation options for *Vipera ursinii renardi* in Kazakhstan. RSK Carter Ecological Ltd, Oxford. 16 pp.