

Bodensee Vergissmeinnicht (*Myosotis rehsteineri*) – Austria



Conservation status	IUCN Global: Endangered IUCN EU27: Endangered AT: FV
Protection status	HD: Annex II and IV Bern Convention: Annex I and Resolution 6 Annex I
Population (2007-12)	EU27: 218,500 – 331,000 individuals AT: 100,000 – 110,000 individuals
MS with genuine improvement	AT
Other MS	DE, IT

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Summary: The endemic glacial relic species *Myosotis rehsteineri* occurs on the edges of a glacier-fed lake in Austria, Germany and Switzerland, and is adapted to the annually fluctuating water level. Until recently it was classed as Critically Endangered in these countries, but Austria assessed the EU conservation status in the alpine region as favourable with an improving trend in the 2007-2012 period. This improvement is primarily driven by targeted conservation measures in the designated Natura 2000 areas, combined with the recovery of good water quality in the lake and the ending of gravel and sediment extraction along the lake shore, which had led to beach erosion.

Key targeted conservation measures were beach and river restoration to recreate shallow beaches and river restoration to recreate gravel banks. Over time, German and Austrian projects have had mixed success, which has produced an understanding of the way to restore beaches such that *M. rehsteineri* can colonise. These measures have been accompanied by ex situ cultivation of the plant, which allowed reintroduction into the newly created habitats, and control of visitor pressure through fencing, signage and a summer warden scheme. These measures were initiated with LIFE funding by the federal state and the local authority, who subsequently increased funding allocations to continue the measures. A network of local experts (consultants and researchers) carries out monitoring and research.

Key drivers of wider improvements in the lake and river environment were the EU Water Framework Directive and the Urban Waste Water Treatment Directive, with international coordination by the International Water Protection Commission for Lake Constance and the International Commission for Protection of the Rhine.

Background

Status and EU occurrence

*Myosotis rehsteineri*¹ occurs within its natural range in Austria, Germany, and Switzerland in the Alpine and Continental biogeographic regions. It occurs on the edges of large glacier-fed lakes on the northern edge of the Alps. The species has lost nearly 90% of its original area of distribution due to development and water pollution (Dienst, Peintinger and Strang, 2004). It is classed as Critically Endangered in the national red lists of Austria, Germany and Italy, and as Endangered in Switzerland (Gygax et al 2011). It now has an area of occupancy of less than 500 km² and is found at fewer than five locations, primarily around Lake Constance (Gygax et al 2011). It is also found at the Starnbergersee in Germany, but this population is considered to have resulted from deliberate transplanting (BfN 2017). It was also considered native in Italy but there have been no collections since the 1980s

¹ Natura 2000 species code 1670

(Gygax et al 2011), and there is doubt as to whether the populations were taxonomically the same as *Myosotis rehsteineri* (Brackel 2010). In Switzerland it occurs at Lake Constance, but is extirpated at all the other locations where it was recorded (BfN 2017, Brackel 2010). The populations are currently stable, but the species experiences extreme natural fluctuations in population.

The species was thought to be extinct in Austria but was rediscovered in the 1980s. Its status in Austria (and the Alpine biogeographic region) was reported as favourable over the 2007-2012 period, with an improving trend; therefore a genuine improvement from the unfavourable-inadequate status reported for 2001-2006. The population in Austria was assessed as being 30,000 individuals (rosettes) on 29 km of shoreline in 2017 (UMG Umweltbüro Grabher, 2017), which is a 40% increase on the population in 2002 (Loacker et al 2010).

The conservation status of the species in Germany (and the Continental Biogeographic Region) was considered to be unfavourable-inadequate in 2007-2012, with a stable trend. This is in part a genuine improvement from the unfavourable-bad status in 2001-2006, but is also a result of improved monitoring, so was reported by Germany as a change due to more accurate data or improved knowledge. The population on the Baden-Württemberg section of the German shoreline was assessed as around 225,000 rosettes in 2011-2012, which represents around the same population as in 1991, but with a significant increase in the number of sites colonised (Dienst and Strang, 2012). The population on the Bavarian section of the German shoreline was surveyed in 2010; only two rosettes remained from the transplantation of ex situ propagated plants, but several new populations have become established in other areas (Brackel, 2012). They are however highly vulnerable to extinction. The populations in Switzerland increased significantly from a few m² in 1994 to around 30 m² in 2009 (Dienst, Niederer and Strang, 2011).

The difference in the conservation status assessments for the species in Austria and Germany is in part because Austria has defined the favourable reference the population when surveyed in 2002 (Ellmauer et al, 2015), whilst Germany has defined it as the population in 1994 when the Habitats Directive came into force, pending a systematic review of reference values.

Ecological requirements

This perennial species is adapted to the narrow strip of periodically flooded gravel on the edges of large lakes fed by glacier and snow meltwater on the northern and southern edges of the Alps. It is a typical species of the habitat 3130 Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* (but it does not occur in the subtype *Isoeto-Nanojuncetea*). It survives complete submersion under the water for up to five months of the year, and grows during the months of November to May when water levels are at their lowest, flowering in April and May before the water level rises. The plant is dependent on a fluctuating water level, as otherwise it disappears due to succession of the vegetation to sedge and reed communities (Brackel 2010).

Lake Constance has an annually fluctuating water level that is only slightly modified by human intervention (even though there are several hydroelectric power stations and a 100 million m³ dam on the Upper Rhine). The duration and height of flooding varies considerably from year to year, averaging around 2m.

The perennial plant is small (3-10 cm height) and forms cushions or loose carpets up to 30cm across. It is very similar in appearance to Water Forget-me-not (*Myosotis scorpioides*) which occurs in the same habitats. It forms part of the *Deschampsietum rhenanae* vegetation community (Strandschmielen-Gesellschaft), together with other rare and endemic plant species. It can also occur in low densities in the neighbouring small sedge and reed communities, but is quite quickly shaded out.

The species is very sensitive to summer drought if it is not flooded over, and so tends to be restricted to areas of gravel that are influenced by groundwater as these remain moist during the summer. Plants that are covered by water for a period longer than five months can die due to overgrowth with algae. The populations can therefore fluctuate strongly in response to changes in the seasonal flood regime of the lake.

Pressures and threats

Austria reported the **pressures** on *Myosotis rehsteineri* in 2007-2012 as: beach erosion and competition from other plant species (high importance), changes in the flooding regime (medium importance), surface water pollution and leisure activities (low importance) (ETC-BD, 2018).

Germany reported the main pressures as: water flow changes, water pollution, recreation (nautical sports, camping and caravans, and trampling and overuse), and intensive cleaning of beaches (ETC-BD, 2018). Other expert reports identify the major pressure as the accumulation of biomass on the foreshore through wave action

and flooding, with algal biomass dominant in Baden-Württemberg (Dienst and Strang, 2012) and deadwood on the beaches of Bavaria (Brackel, 2010).

A key constraint on the species habitat is beach erosion caused by gravel and sediment extraction, that creates beaches with steeply sloped gravel banks that prevent flooding further up the slope and that are too mobile under the influence of waves to allow colonisation. Gravel extraction took place from the 1940s to the 1980s causing a steepening of the foreshore. Wave action on the steep shoreline creates ridges of gravel that cover up areas of potentially suitable habitat. This has been exacerbated by beach restoration that has increased the steepness of the shore (Ostendorp, 2012). Trampling is a less important pressure, but intensive beach use and recreational activities such as swimming, boating, sailing, camping, and beach fires disturb the species.

The species is very sensitive to eutrophication and the resultant competition with other plants and the algal growth that smothers the plant when underwater. In the past, algal blooms resulted in large quantities of biomass dumped on the beaches by wave action. Competition with grasses, and particularly *Agrostis stolonifera* which has a certain flood tolerance, are key limiting factors further up the lakeshore outside the area regularly covered by summer flooding, whereas *Myosotis rehsteineri* is faster to colonise the areas freed of vegetation by floods and so moves further out into the lake during periods of low flood duration (Winkler, Dienst and Peintinger, 2011). The plant is also under pressure from competition with *Carex acuta*, which is rapidly expanding in the periodically flooded zones, perhaps because of recent genetic evolution.

The major **threats** to the species in the future are changes to the water regime and water extraction and pollution (ETC-BD, 2018). The hydrology of Lake Constance is decisive for the maintenance of *Myosotis rehsteineri*. The plant is adversely affected if it is submerged whilst it is still flowering by early summer flooding following early snow melt. A 27-year continuous monitoring data series was used in a model to analyse the effects of varying environmental conditions on the species population in Germany (Winkler, Dienst and Peintinger, 2011). The modelling showed that extinction risk will increase if flooding regimes change. Flooding duration is expected to become even more variable and to decrease further, with increasingly frequent extreme low water in summer, due to the lack of summer glacier melt water in the river (BodenseeWeb 2017). It is possible that the current annual 2 m variation in sea level will decrease, which will significantly shrink the available range (Dienst, Niederer and Strang, 2011). However, the impact of climate change on the future flooding regime of the lake is still uncertain due to the complexity of the processes involved (IGKB, 2015).

The current hydroelectric power stations have a significant negative effect on fish populations, but do not currently have a significant impact on the flooding regime of the lake. There are however plans to build new hydroelectric dams on the Upper Rhine. Sand and gravel extraction upriver might be a possible threat.

Although most of the populations are found in Natura 2000 sites, beach restoration projects for amenity or tourism are a potential threat to populations and suitable habitat outside the protected zones, because many of the restoration projects produce beaches that do not have suitable habitat (Ostendorp, 2012).

Drivers of improvements: actors, actions and their implementation approaches

Organisers, partners, supporters and other stakeholders

- Organisers: Regional and local public authorities responsible for Natura 2000 sites
- Partners and supporters: Consultants and conservation experts, researchers; Private landowners in Natura 2000 sites – recreation and tourism businesses (camping sites, hotels, sailing clubs etc), private residents
- Stakeholders: Recreational users and tourists

The shoreline of Lake Constance is divided into stretches in private ownership and public land, with private land along most of the shore but beaches with *M. rehsteineri* habitat primarily under public ownership and/or access.

The organisers of the targeted improvements were the Vorarlberg Federal State and the city of Bregenz, with important impetus and expertise coming from researchers and consultants.

Contributions / relevance of strategic plans

International Rhine and Lake Constance Commissions and EU Water Framework Directive

The species recovery and recolonization of restored habitat was only possible because wider measures to improve the ecosystem status of the Rhine river and lake have been put in place, coordinated by the International Water Protection Commission for Lake Constance and the International Commission for Protection

of the Rhine (Ibisch et al, 2017). They work together with other partners to implement the EU Water Framework Directive and related legislation, and Lake Constance has now achieved good water quality status.

The International Water Protection Commission for Lake Constance action plan 2004-2009 set out best practice guidelines for shore restoration in order to increase the nature conservation benefit; however, some restoration projects on the German side have not followed the guidance, and parts of it lacked clarity (Ostendorp, 2012).

Measures taken and their effectiveness

The measures reported by Austria for the conservation of the species in 2007 to 2012 are listed below.

Application of conservation measures for *Myosotis rehsteineri* for 2007-2012 in Austria

Measure	Type	Ranking	Inside/outside N2k	Broad Evaluation
4.4 Restoring coastal areas	One off	High	Inside	Enhance
7.4 Specific single species or species group management measures	Recurrent	High	Both	Enhance

Source: Austria Article 17 report 2012 available at <https://bd.eionet.europa.eu/article17/reports2012/>

Two (of the three) Natura 2000 sites on the Austrian shore (Mehrerauer Seeufer-Bregenzermündung and Rheindelta) are designated for *Myosotis rehsteineri*, including most of the current plant populations. However, several populations have recently developed on an undesignated beach at Lochau. The German shore has four Natura 2000 sites, all of which are designated for the species.

The Mehrerauer Seeufer-Bregenzermündung area has been nationally protected since 1991 and as Natura 2000 site since 2003 (with nomination as SCI in 1995) (Aschauer et al 2007). The Rheindelta area was protected by a national statute since 1975 and as Natura 2000 area since 1995.

Restoration measures have included:

- stabilisation of the foreshore against erosion through laying a line of coarse pebbles along the current low-water mark (to absorb the shock of the breaking waves), then filling the space between this line and the original shoreline with a thin layer of finer gravel similar to the shore sediment previously found at that site;
- removal of accumulated gravel banks on the upper shore;
- creation of gravel banks in the Rhine mouth (as the river no longer carries and deposits gravel);
- restrictions on pedestrian access and measures to steer visitors away from plant colonies during the flowering season; and
- information and awareness raising actions targeted at recreational stakeholders

The LIFE Nature project LIFE00 NAT/A/007069 (2001 to 2005) restored a 2,600 m stretch of eroding lakeshore with the largest plant population in Austria, in order to safeguard and improve the *Myosotis rehsteineri* habitat within the Natura 2000 site Mehrerauer Seeufer-Bregenzermündung.

A series of restoration projects in the two river mouths of the Rhine (including the Interreg IIIA restoration project 2006-2008) restored the shorelines by removing hard banks. The restoration in the old Rhine mouth has created a number of new shallow beaches with gravel banks that are suitable habitat and that have been spontaneously recolonised by the plant. The restoration in the mouth of the new (canalised) Rhine has not been optimal for *Myosotis rehsteineri*, and as the canalised river carries only fine sediment it is not creating new gravel banks. However, planned restoration works will be better adapted to the species requirements. An existing shoreline near the new Rhine mouth has been planted with *M. rehsteineri* plants that were propagated ex situ, which has created a new population centre within the Natura 2000 site Rheindelta. The point at which the Bregenz Ach enters the lake is no longer excavated, so the river mouth is developing new sediment banks that could also be colonised by the plant community in future.

Due to the building of water purification plants around Lake Constance, the water quality has now returned to the nitrogen and phosphorus levels typical of an oligotrophic lake, and the quantity of algal deposits has declined (Winkler, Dienst and Peintinger, 2011).

Restoration actions have made areas of the shoreline more attractive for recreation, and so have increased the pressure from footfall, picnics and other recreational activities. This generated a need for better visitor guidance. In the Natura 2000 site near the city of Bregenz, the LIFE project established ongoing awareness raising actions and stakeholder liaison with the beach users and caravan sites, including seasonal employment of rangers along

the beaches and erection of fencing and signage during the plant's growing season (UMG Umweltbüro Grabher, 2017). The rangers receive nature conservation training and have the power to impose fines or prosecutions against people found destroying plants or their habitat in the Natura 2000 site. Sailing clubs and caravan sites are distributing information and informing their visitors or members about the site and the sensitive species.

The Austrian LIFE project was able to benefit from the mixed experiences in beach restoration gained on the German side, including the earlier LIFE Nature project LIFE99 NAT/D/005940 (1999-2004).

Funding sources (current and long-term) and costs (one-off and ongoing)

National funds and local authority funds have been the main funding sources. The Vorarlberg federal state in Austria has allocated €50,000 from its nature conservation fund to maintain the ongoing warden, awareness raising and stakeholder liaison activities. The city of Bregenz co-funds the regular monitoring programme with the Vorarlberg region.

The LIFE Nature project LIFE00 NAT/A/007069 (2001-2005) had a budget of €2.04 million with 50% co-funded by the Vorarlberg federal state and the city of Bregenz.

Switzerland has provided 20 million CHF (approximately €17 million) for Rhine mouth restoration under the International Rhine Convention between Austria, Liechtenstein and Switzerland. An Interreg IIIA restoration project (2006-2008) had a budget of €300,000, with co-funding from the Swiss and Austrian governments, the Vorarlberg region, the local authorities Hard and Fußach, the fishing associations of Hard and Rheindelta, the international Lake Constance fishing association, and the Rheindelta nature conservation NGO.

Some of the camping sites contribute to the production and distribution of information to their clients and to users of their stretches of beach. The sailing club also informs its members about the Natura 2000 site and the plants.

The University of Constance has co-funded a research project on constraints on the species reproductive success (Dienst and Strang, 2012; Brackel, 2012).

Future actions

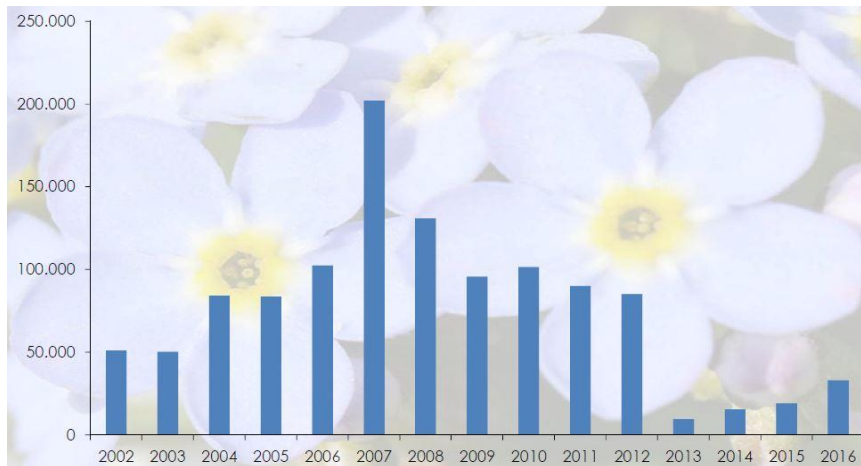
The LIFE Nature project defined site conservation measures for the Natura 2000 site Mehrerauer Seeufer-Bregenzerachmündung. The monitoring of the plant community and the seasonal ranger activities will continue in the future, as the city and region continue to provide the funding. Since mid-2017, one Natura 2000 manager is the contact person for the three Natura 2000 sites around the lake, on behalf of Vorarlberg federal state (Amt der Vorarlberger Landesregierung 2017). The manager is tasked with improving coordination and contacts between all stakeholders, including the local authorities, land owners, land managers and residents.

Achievements

Impacts on the target species

As the species population fluctuates so greatly from year to year, it can be misleading to compare numbers of individuals in particular years without taking account of the long-term trend in the number of locations that are colonised. The population in the Natura 2000 site Mehrerauer Seeufer-Bregenzerachmündung on the Austrian shore has been monitored continuously along fixed transects since 2002 (UMG Umweltbüro Grabher, 2017), with several earlier ad hoc surveys from the 1980s onwards. The population in the Natura 2000 site increased from three colonies of a few square metres in size in the 1980s before the Habitats Directive came into force to over 200,000 in 2007, a year with particularly good conditions for the species. The population remained stable to 2012 then declined sharply in 2013 due to the prolonged flood period that year, and has since followed a recovering trend (). In spring 2017, the whole Austrian shore was surveyed for the species and the total population was assessed as 30,000 individuals (rosettes) and there is an increasing trend in numbers of sites colonised (UMG Umweltbüro Grabher, 2017).

Figure 1 Graph of *Myosotis rehsteineri* estimated population (rosette number) in Mehrerauer Natura 2000 site 2002-2016



Other impacts (e.g. other habitats and species, ecosystem services, economic and social)

The conservation measures have also benefited other threatened plant species in the *Deschampsietum rhenanae* vegetation community, namely *Ranunculus reptans* (Creeping Spearwort) and *Littorella uniflora* (Shoreweed, Strandling). However, they have failed to benefit *Deschampsia rhenana* (Bodensee-Schmieie). *Deschampsia rhenana* is also endemic to the Lake Constance shore plant community and is more critically endangered than *M. rehsteineri* but not legally protected. The beach restoration actions have created some new recreational spaces, together with public information about the nature conservation value of the area, which has created some public benefit; but they have removed larger areas from public access during the summer months, which led to some opposition by local stakeholders.

Conclusions and lessons learnt

The key targeted conservation measures that led to the improvements

- The beach restoration technique using an underpinning line of coarse pebbles along the low-water mark (to absorb the shock of the breaking waves), followed by infilling with gravel, creates a larger beach area covered by season flooding and therefore suitable plant habitat. It is important that the choice of grain size of the gravel to be used for the outer border and the shallow infill corresponds to the inclination of the slope and the wave forces to be expected at that point (Ostendorp et al, 2010).
- The successful ex situ propagation and planting out enabled the establishment of new population centres on newly created habitat in the Austrian Natura 2000 site Rhine delta, where the species had disappeared.
- The ranger programme and the information provision on the Austrian shoreline have significantly increased public awareness amongst residents of the unique beach plant community and the importance of not walking on the vegetation during the winter and spring.

Conservation measures that have not been sufficiently effective

- The river restoration actions in the mouth of the new Rhine have failed to create suitable habitat for the species so far, although the planned actions are better aligned with the species requirements than past actions.
- A German LIFE project restored two populations through beach restoration, re-routing of public access and planting of seedlings. However, most beach restoration projects on the German side have failed to create suitable habitat for the species (Ostendorp, 2012).
- Beach restoration has failed to increase the population of the threatened species *Deschampsia rhenana* dependent on the same habitat.

Factors that supported the conservation measures

- The species recovery and recolonization of restored habitat was only possible because the lake water quality is now in good ecological status, due to the significant reduction in nitrogen and phosphorus entering the lake, which was driven by the WFD and related legislation.
- Restoration actions on the shoreline and in the river mouths are able to recreate long-term habitat because of the ending of gravel and sediment extraction.
- The continuous monitoring programme that was started by the LIFE project has provided valuable information on the location of populations and population trends along the Austrian shoreline, and has located some new or previously unknown populations.
- The combined efforts of those responsible for nature conservation in Vorarlberg federal state and the City of Bregenz, together with researchers from universities in Switzerland and Germany, and private consultancies, have been instrumental in initiating and maintaining the species recovery programme.

Factors that constrained conservation measures

- Restoration actions have made areas of the shoreline more attractive for recreation, and so increased the pressure from footfall, picnics and other recreational activities. This generated a need for visitor guidance. The resulting ranger scheme is benefiting both the species and public awareness of Natura 2000 and nature conservation.

Quick wins that could be applied elsewhere for the species

- The beach restoration technique should be established as best practice in all future planning applications along the lake shore. Other beach restorations have generally not created suitable habitat as the beach remains too steep and the gravel is too unstable (Ostendorp, 2012). Lack of knowledge and/or weak planning constraints on beach restorations outside Natura 2000 areas mean that the restorations have usually failed to take account of the species requirements and therefore fail to produce suitable habitat.

Examples of good practice, which could be applied to other species

- The ex situ propagation and planting out enabled the establishment of new population centres on newly created habitat in the Rhine delta Natura 2000 site, where the species had disappeared. Research has shown that it is also possible to propagate and plant out *Deschampsia rhenana*, so this species could also be restored. A project funded by the German, Austrian and Swiss regional authorities and run by a conservation expert group (AGBU 2017) is now taking place (2016-2019).
- The summer ranger's steering of beach visitors and recreational activities has had positive benefits for other coastal vegetation (the *Molinia* meadows and the sedge meadows). The ranger scheme, set up by the LIFE project, is now co-funded by the city and the region, whereas previous to the project it was very difficult to persuade them to allocate funding to Natura 2000.
- The cooperation between the nature conservation experts in research institutes and private consultancies who have implemented the projects is strong, and they have built up an international working group with an ongoing knowledge exchange and public presence. In contrast, there are problems with cooperation between the nature conservation authorities in the different countries bordering the lake and between the two German federal states.

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Authorship

Prepared by Evelyn Underwood of IEEP, as part of the European Commission study on identifying the drivers of successful implementation of the Birds and Habitats Directives (under contract ENV.F.1/FRA/2014/0063), carried out by the Institute for European Environmental Policy, BirdLife International, Deloitte, Denkstatt, Ecologic, ICF Consulting Services and PBL Netherlands Environmental Assessment Agency.

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Annex 1. Status of Bodensee Vergissmeinnicht (*Myosotis rehsteineri*) at Member State and biogeographical levels

Favourable	FV	Unknown	XX	Unfavourable - inadequate	U1	Unfavourable - bad	U2
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Qualifier (+) improving (-) deteriorating (=) stable (x) unknown (n/a) not reported

	2001-06	2007-12				
	Overall	Range	Population	Habitat for species	Future	Overall (with trend)
AT (ALP)	U1 (+)	FV	FV	FV	FV	FV
EU (ALP) overall	U1	FV	FV	FV	FV	FV (+)
DE (CON)	U2	FV	U1	U1	FV	U1 (=)
IT (CON)	U1	N/A	N/A	N/A	N/A	N/A
EU (CON) overall	U2	FV	FV	U1	FV	U1 (=)

Source: Member State Article 17 reports as compiled by ETC-BD on EIONET <https://bd.eionet.europa.eu/article17/reports2012/>

Annex 2. LIFE Nature Projects in Austria that aimed to help conserve Bodensee Vergissmeinnicht (*Myosotis rehsteineri*)

Project Title	Project N°	MS	Type Of Beneficiary	Time period
Myosotis Bregenz - Protecting the habitat of <i>Myosotis rehsteineri</i> in Bregenz	LIFE00 NAT/A/007069	AT	Local Authority	2001-05

Source: Life Programme database, projects with *Myosotis rehsteineri* listed as a key word