ALPINE WINDHARVEST

An Interreg III B
Alpine Space Programme

Work Package 9 - Impact on wildlife and plant life

Summary

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1 Literature Review

As with any construction project or large structure, wind energy can impact plants and animals, depending on the sensitivity of the area. Among the concerns associated with wind energy development are direct fatalities from collisions or electrocutions and loss of wildlife habitat and natural vegetation. Therefore an environmental impact assessment has to be made before the construction of wind power plants. The rules for the impact assessment are dependent on the conservation purpose as well as on the affected country and their legislation.

1.1 Impact on habitats

Wind power plants are a risk in ecological sensitive areas like the alpine ecosystem is because the effects on the natural balance are not known yet. Loss or damage to habitats is caused by turbine bases, substations, access roads and transmission line corridors. It has to be noted, however, that only the access roads and a very small area around the tower of a wind turbine are lost (HOHMEYER *et al.* 2003).

1.2 Affects on vegetation

The impacts of wind power plant's on plants seem to be negligible in as much as no protected species or biotopes are affected by the construction of the wind power plant and the required infrastructure (MAISLINGER 2002). In single cases a disturbance is possible if the construction of the wind power plant is located close-by ecological significant vegetation communities. Generally the alpine flora is extremely sensitive, especially alpine sedge meadows (*Curvuletum*, *Firmetum*) and vegetation associations like *Loiseleurietum* and *Elynetum* because of their long regeneration periods. The construction of service roads could initiate and/or activate old landslides, debris flow, surface erosion as a result of clearing vegetative cover, cutting slopes, and diverting surface runoff.

*1.3 Impacts on fauna **

The conflict between animals in common and the increasing way to produce electric power by the use of modern wind power plants (single or multi park wind turbines sets with tower heights up to 130 meters and rotor diameters up to 90 meters) is controversially discussed by numerous scientific investigations. With no doubt birds (and bats) seem to have the biggest impact which is revealed in many studies worldwide. Conflicts can occur during birds are on migratory period diurnal or nocturnal cross wind power fields. For birds which breed and forage in the near of wind turbines sometimes a higher conflict potential can also be expected in a species specific way.

Nevertheless birds often avoid these areas and try to assure that safety distances between flight route and wind turbines. This results in longer migratory routes, changes in stopover decisions, loss in breeding and foraging grounds. The most significant problem with wind power plants is that if many turbines are proposed to line up in long chains obvious interruption potential and cuts in landscape can be predicted.

*1.4 Impacts on birds **

Since several field studies for determining the potential risk of bird strike and bird mortality caused by wind turbines have been carried out during the last 10 to 15 years there is convincingly no doubt that birds (and bats) seem to have the biggest impact within the animal kingdom. The potential death of species which do reproduce in K-manner (low reproductive success or low produced offspring) can easily result in declining of their own population density. The rotating barriers of wind turbines are a risky factor for the duration of birds crossing during migrating or do foraging or territorial flights in these particular areas. Birds do regularly migrate between breeding grounds and wintering areas. To tackle this efforts birds have evolved special migration strategies. Most smaller and passeriform birds do migrate in

broadband way towards South at night at an overall altitude of 1000 to 2000 m ASL. Autumn migration is much more aggregated than spring migration. Birds of Pray and greater birds which uses soaring flights do general migrate during daytime and use landmarks and up winds for travelling. This is often shown during Autumn day migration at particular locations of great importance to cross ecological borders like e.g. High alpine regions, the Mediterranean See, Desert and many more. This entrained behaviour of Birds is shown doubtless since bird migration is under research.
As a result of many investigations in the last 10 years the impact on birds which is conveniently provided by the implementation of wind power plant in is proven to be a conflict field for bird mortality and loss of breeding and foraging grounds. From the first studies that have been carried out to the latest investigations with even more modern approaches (e.g. Infrared Technology, Radar Observations, Bird Strike and Collision Detection Systems) to measure bird collisions we have learned that birds do collide (and mostly deadly) with rotor blades, electric wires, wind mill towers, etc. in various and often based on their species specific behaviour. To measure the local influence on a determined population of birds mathematical models were established.
The biggest impact on raptors was analysed at the Altamont pass in the US. In this case study 0.06 raptors per turbine and year was estimated (THELANDER and RUGGE, 2000). In Spain the sensitive Gibraltar region a higher bird mortality rate was analysed up to 49 and more (75 before the study period) larger birds per location and study period (Barrios and Rodriguez, 2004). In comparison low bird mortality rate was estimated by BERGEN (2000). In middle mountainous regions of Germany no real detectable bird mortality was analysed. As compared to wind power plants in lowlands of the Netherlands a bird mortality was estimated by approximately 0.5 to 1.5 birds per turbine and day (WINKELMANN , 1995).

*1.5 Impacts on Insects**

There is very little information available on possible impacts of wind turbines on insects. In generally insects migrate as well as birds. This is considerable examined in alpine regions. Weather migratory routes are detectable effected or mortality rates are considerable high is not investigated till now.

In Germany, the North German Academy for Nature Protection examined 11 wind farm sites on the North Sea, measuring the density of insect splatters on turbine blades. This was more an attempt to assess the removal of food supply for birds than concern for insects, but the conclusion was that the effect was negligible. In Ohio, the U. S. Dept. of Energy filmed the release of honeybees and blowflies near the turbine at Sandusky, to try to determine the interaction. There was little observed impact (GIPE, 1995).
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*1.6 Impacts on Mammals**

Very little information is available on mammals. In general there may be a slight disturbance very close to turbines (ORLOFF, 1992). MENZEL and POHLMEYER (2000) investigated for three years the impact of wind turbines on local habituated mammals like the Red Fox (*Vulpes vulpes*), the European Hare (*Lepus europaeus*) and the Roe Deer (*Capreolus capreolus*) at a wind park in North Germany (Bremen and Hannover). No significant disturbance was recorded.

Investigations from HAßLINGER (2004) have shown that European Deer (*Cervus elaphus*) show significant changes in behaviour. They origin deer pass was lost and the animals practice a safety distance of at least 150 metres to the wind turbine area. A considerable impact on bats is show by BRINKMANN (2003). In this report the author comes to the final conclusion that wind turbines do have an impact on foraging, migrating and residentially breeding bat species. However, less is known about bats which are on migration and important facts like timing, height, dense and routing during migration are not well analysed till now. The most central question to answer will be do any explicit mortality rate caused by wind power plants do have an effect on the specious specific populations itself. More research on this topic has to be made.

2 Assessment of the impact on wildlife and plants

An EA for wind facility should include anyway:

- A description of the environment that will be affected or might reasonably be affected
- A description of potential effects on relevant environmental components
- A determination of maintenance target
- A description of mitigation measures
- An evaluation of the advantages and disadvantages to the environment

There are four environmental issues that should be examined in every single case: birds or avian issues, flora and fauna issues, visual issues (See work package 8) and significant biotope issues.

2.1 Fauna and habitat

Important wildlife habitat areas. These may include identified habitats such as migratory bird habitat or other areas with specific wildlife. Measure of the number of such areas affected by an alternative, based on the consideration of the wildlife species using those areas and an expected impact zone as determined during the EA.

Loss of wildlife habitat. Measures the area of wildlife habitat (forested vegetation and non-forested successional areas, wetlands, meadows etc.) removed by an alternative. Includes an assessment of significance and sensitivity of wildlife habitat potentially impacted.

2.2 Vegetation

The greatest effect on vegetation is direct loss of ecosystems and the plant species they contain. This will occur due to clearing along existing and new roads, at tower sites, along the transmission lines and at the service and maintenance center.

Presence of Significant floral/faunal communities. Measures the potential effect on significant communities based on the number of documented sites either severed, encroached on, or in near proximity to the alternative. Investigations will focus on the identification and evaluation of potential impacts based on consideration of ecological factors such as habitat type and disturbance tolerance (e.g. susceptibility to edge effects, hydrological changes etc.). Unique or exceptionally diverse vegetation or habitat in the vicinity may indicate exceptional diversity and abundance of avian species or bats.

2.3 Assessment of effects on FFH areas

Regarding to areas protected by the FFH directive the impact on Natura 2000 areas regarding the direct and indirect influence on the conservation aim. This includes mapping of the specific elements of the protected area and their specific sensitivities. As a last step effects of possible impacts should be evaluated. Possible effects of wind facilities could be loss of area, fragmentation, disturbance and loss of communities.

3 Conclusions and recommendations

*3.1 Fauna **

The impact on **mammals** is still not clear, especially the situation with bats and bats during migration. Therefore a proposed research and monitor program should guarantee that this missing data can improve the knowledge of estimating the potential risk on bat strikes. The location should be analyzed for bats as a breeding ground and as migratory corridor. With bat detection systems (ultrasound and infrared cameras) migratory pathways can be predicted in a better way. For larger mammals like deer, foxes and other species a fewer impact should be expected.

After the decision is made where the location of projected wind turbines can assure be located a local investigation for the breeding and foraging population of **birds** has to be done. If no endangered and rare bird species do breed and forage in the projected area, the conflict potential should be low. During migration time a controlled monitoring of diurnal and nocturnal (moon watching method or infrared cameras) bird migrants can guarantee that the projected area of wind turbines does not cut of or miss link migratory pathways. Therefore, avoiding conflicts like constructing barriers for migratory species the orientation of wind power plants should always be planed approximately from North to South.

There is less concern about the mortality rates and migratory conflicts of **insects** compared to the high amount of insects which are deadly harmed (e.g. various eco-toxicological substances like insecticides, global public traffic).

<u>Minimize impact:</u>

- Avoid locating turbines in known local bird migration pathways or in areas where birds are highly concentrated, unless mortality risk is low.
- Avoid known daily movement flyways and areas with a high incidence of fog, mist, low cloud ceilings and low visibility.
- Avoid placing turbines near known bat hibernation, breeding, and maternity/nursery colonies, in migration corridors, or in flight paths between colonies and feeding areas.
- Configure turbine locations to avoid areas or features of the landscape known to attract raptors. Other examples include not locating turbines in a dip or pass in a ridge, or in or near prairie dog colonies.
- Do not fragment large, contiguous tracts of wildlife habitat. Where practical, place turbines on lands already altered or cultivated, and away from areas of intact and healthy native habitats. If not practical, select fragmented or degraded habitats over relatively intact areas.
- Avoid placing turbines in documented locations of any species of wildlife, fish, or plant protected under the Endangered Species Act.
- Configure turbine arrays to avoid potential avian mortality where feasible. For example, group turbines rather than spreading them widely, and orient rows of turbines parallel to known bird movements, thereby decreasing the potential for bird strikes. Implement appropriate storm water management practices that do not create attractions for birds, and maintain contiguous habitat for area-sensitive species.

3.2 Flora and vegetation

Existing information on species of greatest interest, which are known or likely to occur in the vicinity of the project impact area, have to be reviewed, mapped and incorporated into field surveys. Erosion is a concern in sensitive areas such the alpine environment. Standard engineering practices used by ski areas on the same kind of terrain are adequate to deal with any erosion issues that might be raised by construction of a wind farm and its service road.

<u>Project impacts will be minimized by:</u>

- Revegetation of disturbed areas using native species

- Minimize area to be cleared of vegetation. Keep meadow patches of affected vegetation and use them after construction for revegetation
- Using existing roads wherever possible, and minimizing construction of new roads. Upgrade existing roads for access roads
- Routing transmission lines along existing roads
- Manage construction activities to protect all vegetation
- Preparing a proper Vegetation Management Plan including monitoring
- For pastures, meadows by controlling vegetation cutting and for shrub associations by cutting

3.3 Recommendations and guidelines for authorities

Depending on size of the proposed wind farm development arises the amplitude of investigations to be undertaken. The following table is showing the subjects with a need of investigation depending on the size of the proposed project.

Subject	1	2	3
Existing directives	X	X	X
Geology Stratigraphy, structural properties, contamination	X	X	X
Groundwater and Hydrology	X	X	
Surface water and quantity	X	X	X
Hunt and fishery	X	X	
Noise	X	X	
Habitat Assessment of significance and sensitivity of wildlife habitat potentially impacted Assessment of bird migratory routes	X	X	X
Fauna Presence of protected species, migratory bird species	X	X	X
Vegetation Presence of significant communities and/or protected species	X	X	X
Monitoring for 10 years Fauna particularly bird and bats	X		
FFH protected area and species assessment	X	X	
Mitigation	X	X	

1 big wind farm - requiring an environmental impact assessment; 2 Wind farm of middle size not requiring an environmental impact assessment; 3 Small wind facilities requiring an environmental report.

3.4 Further research needs

- Effects of inclement weather in attracting birds and bats to lighted turbines particularly for passerines during spring and fall migrations
- Localized effects of turbines on wildlife: habitat fragmentation and loss; effects of noise on both aquatic and terrestrial wildlife; habituation
- Effects of wind turbine string configuration on mortality, e.g., end of row turbine effect, turbines in dips or passes or draws, setbacks from rim/cliff edges
- Effectiveness of deterrents: alternating colors on blades, lights, infrasound
- Utility of acoustic, infrared, and radar technologies to detect bird species presence, abundance, location, height and movement
- Accuracy of mortality counts: estimate of the number of carcasses (especially of passerines) lost because they have been fragmented and lost to collision momentum and the wind; size and shape of dead bird
- search areas; possibility of recording collisions acoustically or with radar or infrared monitoring

- Annual variability (temporal and spatial) in migratory pathways; what is the utility of Geographic Information System to assess migratory pathways and stopovers, particularly for passerines and bats
- Impacts of larger turbines versus smaller models
- Changes in predator-prey relationships due to placing potential perching sites in prairie habitats
- Impacts of shadow flickering on vegetation
- Impacts of flying ice on vegetation

4 Case studies

As in work package 8 case studies were performed on four test sites – one in Italy and three in Austria – to get first considerations for the suitability as a location for wind farms.

4.1 Methodology

The proposed methodology provides baseline information necessary to assess potential impacts to wildlife and plant species as a result of the construction and operation of a energy development project.

<u>4.1.1 General vegetation survey</u>

The vegetation types in the project area were inventoried from digital orthophotos, through field surveys and mapped on the base map at a scale 1:5000. Each vegetation type identified in the field was described in terms of dominant and co-plant species composition and abundance using visual estimates. Percent vegetation and shrub cover were estimated for all vegetation types.

<u>4.1.2 Avian Survey *</u>

The objective of avian use surveys is to provide information that can be used to predict potential impacts, and identify methods of avoiding and/or mitigating impacts by estimating temporal and spatial use of the general project area by birds.The ornithological studies were made from the beginning of August to the end of October 2004. During four to six investigation days particular areas have been analysed for resident and migratory birds species, their behaviour entering the investigation site and the habitat use in certain areas. Therefore this investigation analyses only the migratory parameters for autumn 2004 and the small breeding bird season 2004 which can be expected at the beginning of August.
For detecting and localising bird species gerneral ornithological equipment was used: Telescopes (Optolyth 80 x 30times Imagination), Binoculars /Leica 8 + 10times Imagination). Additionally to visual detection acoustic vocalisation of birds was recorded when possible. By foot walking through every investigation area (within a distance of at least 1500m-2000m of the planned wind power plants) all birds where recorded with following parameters: Species determination; Abundance of birds; State of Breeding or Migration; Flight parameters and characteristics e.g. flapping, gliding, soaring; Bird and Flight behaviour like soaring, foraging flights, feeding and nesting young birds, etc.
As a next step migratory species and particular greater soaring birds like birds of prey where analysed if distinct and often used migratory or flight pathways or preferred locations in the investigation area can be recorded. Finally all birds were listed in a database and analysed shortly whether the risk of collision can be predicted or not and do birds have any local protected status (eg. Red List, Environmental protection laws).

4.2 Test sites

4.2.1 Sattelberg

Fauna*

According to first results exist following hazards for birds (migration route and local breeding species): In the area exist bird migration routes. The routes proceed along the cuttings on both side of Sattelberg. Furthermore, raptors were observed on the ridge. The height above the ground can be specified with 50 – 250 meters. In case of good weather birds should be able to avoid the dangerous zones. But during bad weather conditions, including heavy wind and storms, collisions are possible (SACHSLEHNER & KOLLAR, 1997).

For the breeding bird species *Anthus spinoletta*, *Carduelis cannabina*, *Sylvia curruca Phoenicurus ochruros*, *Carduelis flammea* and possibly breeding bird *Oenanthe oenanthe have* a small collision risk. German studies show only slight decline in breeding density of the species lark, Yellowhammer and Whitethroat caused by noise of rotor blades and shadow flickering (BERGEN, 2001, LEDDY et al. 1999). For bird species like *Anthus spinoletta* and wheatear no studies are available. Species like *Corvus corax Falco tinunnculus Accipiter nisus*, *Buteo buteo* and possibly *Aquila chrysaetos* have a higher collision risk because of their flight attitude using ascending air currents close to wind turbines and flying along the (KERLINGER, 2002; BARRIOS & RODRÍGUEZ, 2004).

In the area of Sattelberg the wind turbines should be constructed parallel to the flight direction to minimize the bird collision risk. Furthermore, the breeding area should not be degraded due construction affects (e.g. leveling, destroying the vegetation cover).

Vegetation

No uncommon plant communities or otherwise sensitive plant habitats were observed during field surveys. field surveys did not reveal the presence of federally listed or state-listed plant species or their habitats in the vicinity of the projected locations of the wind farm components. According to those results the impact on the vegetation can be judged as low. Also affects on the grazing cattle and sheep can not be expected. Danish and German research showed that agriculture may continue in rural wind parks, which are often used for grazing cattle (HOHMEYER et al. 2003).

4.2.2 Aineck

Fauna*

According to first results following hazards for birds (migration route and local breeding species) exist: The observed routes of raptors in the autumn migration are not crossing the area of the wind turbines. Exceptions are Ausnahmen sind: Golden Eagle (*Aquila chrysaetos*), kestrel (Falco tinunnculus), sparrow hawk (Accipiter nisus), bearded vulture (*Gypaetus barbatus*). The distance of the migration routes to the wind farm is approximately 800 – 1500 meters. In the case of good weather the disturbance for migrating birds can be stated as marginal. The nocturnal singing bird migration can not be determined because of missing adequate observing methods. The diurnal bird migration of singing birds is moving over the total study area. East and west of the plateau song trush and lark (Turdidae und Alaudidae) were observed. In addition singing birds (mostly *Fringillidae*) were documented close to Teuerlnocks in autumn 2004. The breeding bird species *Anthus spinoletta*, *Sylvia curruca*, *Carduelis flammea, Prunella collaris, Phoenicurus ochruros* and *Oenanthe oenanthe* have a small collision risk. Those species can possible cross the area and be a victim. German studies show only slight decline in breeding density of the species lark, yellowhammer und whitethroat caused by noise of rotor blades and shadow flickering (BERGEN, 2001, LEDDY et al. 1999). For bird species like water pipit (*Anthus spinoletta*) and wheatear no studies are available. Species like common raven (*Corvus corax*), kestrel (*Falco tinunnculus)*, sparrow hawk (*Accipiter nisus*), common buzzard (*Buteo buteo*) and possibly golden eagle (*Aquila chrysaetos*) have a higher collision risk because of their flight attitude using ascending air currents close to wind turbines and flying along the (KERLINGER, 2002; BARRIOS & RODRÍGUEZ, 2004).

The biggest bird of the study area is the bearded vulture with a habitat covering the total alps. Breeding habitats have a size of approximately 170 to 300 km^2 (BLOTZHEIM, 1999). Aineck is not a potential breeding area but a food habitat. The affects and disturbance of the wind farm on the bearded vulture and can not be estimated yet and have to be investigated. The same can be said about the golden eagle.

Vegetation

No uncommon plant communities or otherwise sensitive plant habitats were observed during field surveys. The main vegetation cover is a *Nardus strica* pasture with different vegetation cover degree. Near the storage reservoir the wet vegetation community sedge reed is growing. The vegetation survey shows that no federally listed or state-listed plant species or their habitats are affected in the vicinity of the projected locations of the wind farm components.

According to those results the impact on the vegetation can be judged as low. Also affects on the grazing cattle and sheep can not be expected. Danish and German research showed that agriculture may continue in rural wind parks, which are often used for grazing cattle (HOHMEYER et al. 2003).

4.2.3 Windsfeld

Fauna*

The migratory route of small passerine birds could not be observed because of the lack of adequate methods. A daytime migration route was observed across the whole study area. This route is interfering with the location of the wind power plants. The local breeding birds Water Pitpit (*Anthus spinoletta*) and Redpoll (*Carduelis flammea*) have a low collision risk because of their flying attidtude. Comparable studies in Germany show only low drecreases in the population density of lark, yellowhammer und whitethroat. The reason for the decrease could be the disturbance due rotor noise and shadow flicker (BERGEN, 2001).

It has to be assured that the breeding areas are not degrading after the construction of the wind power plants. The ground should not be levelled and except from the foundation areas (approximately 370m^2). Common Raven (*Corvus corax*), Goshawk (*Accipiter gentillis*), Kestrel (*Falco tinunnculus)*, Sperber (*Accipiter nisus*) und Golden eagle (*Aquila chrysaetos*) have a higher collision risk because of their flying attitude (KERLINGER, 2002; BARRIOS & RODRÍGUEZ, 2004). Due adverse weather conditions like fog the birds could loose the perception for the wind power plants (SACHSLEHNER & KOLLAR, 1997). Lesser Whitethroat (*Sylvia curruca*), Common Redpoll (*Carduelis flammea*) and Alpine Accentor (*Prunella collaris*) have their breeding habitat in the dwarf pine areas and are likely not endangered or disturbed by rotor noise or shadow flicker (BERGEN, 2001).

Vegetation

The main vegetation type at Windsfeld is a mosaic of calcareous grassland and nardus stricta grassland with a stone degree up to 10 to 20% dominance. But also areas with a vegetation cover lower than 10% can be found. The vegetation survey shows that no federally listed or state-listed plant species or their habitats are affected in the vicinity of the projected locations of the wind farm components. According to those results the impact on the vegetation can be judged as low. The impacts have to be minimized by e.g. keeping meadow patches of affected vegetation and use them after construction for revegetation and using existing roads wherever possible and upgrading existing roads for access roads.

4.2.4 Paß Lueg

Fauna *

Many small birds use the particular geomorphologic structure of the Salzachtal und migrate along the valley. The flight height is 50 to 500 meters above the ground. Furthermore, the thermal lift on the south of the mountain massive near by the wind turbines is used heavily. Observed raptors (e.g. Peregrine Falcon, Common Raven, Eurasian Buzzard) have no clear migration routes during autumn. But they use also the thermal lift and as they move at a height of 30 to 100 meters above the ground they have a potential collision risk. But the flight density is low and therefore also the collision risk. The Eurasian Buzzard and the Peregrine Falcon tend to evade zones with wind turbines as recent German studies show (BERGEN, 2001). Studies in Spain or from European lowlands prove collisions of Peregrine Falcon and Sparrow Hawk (EVERAERT, 2004; BARRIOS & RODRÍGUEZ, 2004; BERGEN, 2001).

Thus the observations and results show a low collision risk at the proposed wind farm site for small birds and a higher collision risk for Peregrine Falcon, Kestrel and Sparrow Hawk. The nocturnal fall migration rate of small birds showed a density of 470 birds moving towards south east partially drifted by foehn winds. The migration corridors are marginal affected by the planned wind farm project. A monitoring programm will be necessary to assesses the effective bird collisions.

Vegetation

All three proposed wind turbine locations are situated in a dry young beech groove forest. Other vegetation types in the project include mature beech groove forest, areas with dominant hazelnut trees and the quite sensitive rocky lime steppe. The area where the vegetation has to cleared has to be minimized. Furthermore, the impacts have to be minimized by e.g. keeping meadow patches of affected vegetation and use them after construction for revegetation and using existing roads wherever possible and upgrading existing roads for access roads.

5 Identifying nocturnal bird migration via moonlight telescoping*

To identify the nocturnal bird migration a simple but never the less powerful tool was invented by Chapman 1888. The basic aim of this method is that if clear and bright night weather conditions give a free view to a full moon disk a high degree of nocturnal migratory birds can be detected by normal standard telescopes. As a result of a fast moving bird silhouette on the moon the size, direction and as a summation of birds migrate through a defined timing window, the nocturnal bird migration rate (MTR) can be estimated in a rather precisely way. Several publications by Swiss Ornithologists (e.g. LIECHTI 2001) have confidently shown that this method is a powerful tool to measure nocturnal bird migration.

Last spring in 2004 the office of ecology and vegetation „ Trifolium“ organised a bird migration-moon watching session to acquire some information about the nocturnal bird migration in South Tyrol. At 14 predefined locations moon watching was carried out. To obtain a variety of representative data we have chosen different locations in the south Tyrol area dispersed over a distance of approximately of 300 km from East to West across numerous valleys. The achieved raw data for each location was reconfigured and analysed by the Swiss Ornithological Institute “CH-6204 Sempach”. This data is divided in flight direction and bird density called MTR (Migration traffic rate). The MTR value represent the number of birds that pass a one km flight corridor within one hour.

In Salzburg a trial study on nocturnal bird migration was executed in Autumn 2004 for two times. According to the listed method used in South Tyrol similar data recordings were analysed.

The output results indicate that the used method for detecting nocturnal migratory birds by moon watching is a valid method to show existing migratory pathways in alpine regions. Migratory bird traffic was recorded several times within intense rate of approximately 100 to 3500 birds*km-1*h-1. In Jenesien, Bozen, Kiens and Gossensass a mean traffic route of more than 2000 birds*km-1*h-1 was recognised in 8 cases. This indicates that these particular areas are definitive areas of a normal to strong used traffic route by nocturnal migratory birds. After analysing the main direction trend for nocturnal migration in spring approximately 30 to 40% of all locations have shown a clear NNE (North North East) migratory route. This is the expected route via the alps in these particular regions.

As shown in figure 1.0 the highest MTR (Migration traffic rate) was reached on 5 April in Jenesien and Gossensass. This would precisely show, that birds uses the direct route through the Sarntal over the Penser Joch pass and the Brennerpass to cross the South Tyrol area. Not in general but repeatedly a high degree in nocturnal activity was performed in day 3 and 4 of April 2004 in most of the locations. More investigations have to be done to get more detailed information about the migratory traffic through South Tyrol in Spring and in Autumn.

The data which was analysed for the area in Salzburg (Austria) give an evident view on the nocturnal bird migration in front of the alpine border which has to be crossed. A clear Autumn migration route in the direction SSW (South South West) with MTR rates of approximately from 400 to 2100 birds*km^{-1}*h^{-1} was recorded twice. This data (Salzburg and South Tyrol) suggest that the avian migration is conservative linked to valleys and predefined migratory routes. The number of bird which passes these particular areas is sometimes imprecise to estimate. As a negative impact on these date set the number of birds which passes at higher altitudes get lost. Furthermore detailed information at which altitude level species specific flight strategies are expected in alpine regions only are detectable via radar or infrared methods.

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