Amden – Management for species conservation in a special forest reserve

C30

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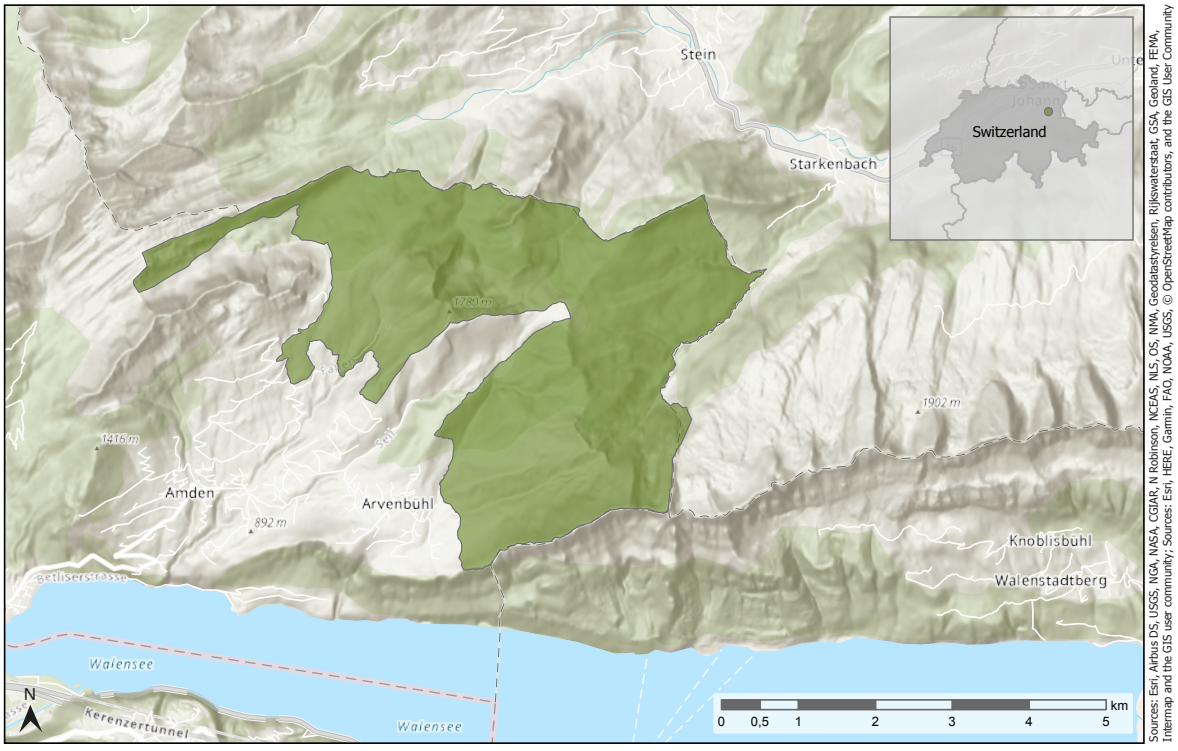
Background

The municipality of Amden (area – 4300 ha; population –1800 inhabitants; altitude 420–2101 m) lies on the edge of the Alps in northeastern Switzerland between the Lake Walen and the Toggenburg Valley. Around 2000 ha or 46 % of the municipal territory is covered by forest whereof 75 % is owned by the local community of Amden, a public corporation without fiscal sovereignty. Private forest covers 13 % of the forest area and is divided into small parcels. The local community of Amden also owns



< Fig. C30.1. Target species – a male capercaillie – in the forest Amden (Photo: René Güttinger, RGBlick).

Statement

"The forest reserve is on the right track, should be further developed according to the defined objectives and evaluated regularly."

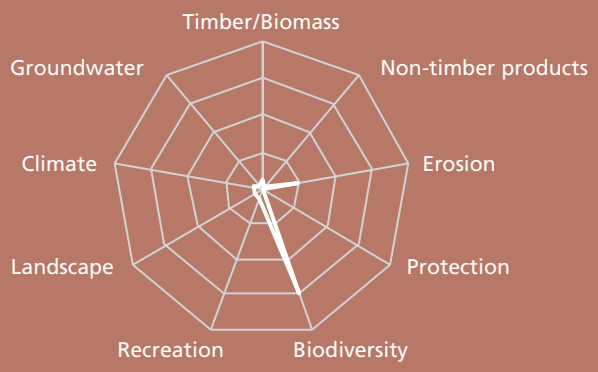


Table C30.1. Forest characteristics in the special forest reserve Amden.

Forest communities	43 % high-montane fir-spruce forest and 39 % high-montane fir-beech forest, 18 % diverse
Forest area	1045 ha
Management system	'Plentering' (single-tree or group selection system)
Standing volume	328 m^3/ha
Annual increment	ca. 7.0 m^3/ha
Annual timber harvest	2.0 m^3/ha
Deadwood (standing and laying)	Standing 4 snags/ha, laying 5 m^3/ha

1159 ha of Alpine pastures, which they lease to 50 local farmers.

The area has an annual precipitation of 2000 mm and is characterised by a remarkable snow layer in winter (e.g. up to 5 m in winter 1998/99). Therefore, protection against natural hazards – including avalanches, floods, landslides – protective forest maintenance and technical constructions are important objectives of the forest management. The geological bedrock consists of flysch, limestone, molasse, and moraine. From these materials, very different soils have formed; the soils vary from very wet to extremely dry, and from very acidic to alkaline. Raised bogs and mires of national importance, protected dry grasslands and rare forest sites are indirectly indicators of this.

There are two forest reserves in the municipality: Amden and Seerenwald. The special forest reserve of Amden is dedicated to conservation of capercaillie *(Tetrao urogallus).* The special forest reserve of Seerenwald at Lake Walenstadt (about 80 ha) is dedicated to conservation of the lime trees *(Tilia cordata, T. platyphyllos)* as well as floristic and faunistic biodiversity.

Forest history and forestry

In the nineteenth century, the Amden municipality was dominated by agriculture and there was a great demand for timber. As a consequence, the forests were overexploited and the supply of wood had to be restricted by regulations (Ehrbar 2006). From the middle of the twentieth century onwards, the protective function of forests against natural hazards became a priority. In 2006, the different forest functions were specified in a planning process. Since then, 38 % of the forest area has been managed as a protection forest against natural hazards, and 57 % has been managed as a forest reserve, whereby a large part of the reserve area is also a protection forest against natural hazards. Commercial production of timber is a primary objective on only 5 % of the area.

The overall forestry objectives in Amden is to preserve the natural characteristics of the mixed-mountain forest of the region while providing multiple-services to the community. Special emphasis is given to the protection from natural disturbances and biodiversity conservation. The forestry system is integrative with single or multiple

Fig. C30.2. View on the eastern part of the Amden forest reserve. It is dominated by spruce-fir forests. (Photo: Rolf Ehrbar).

tree harvesting and mainly natural regeneration as principle. Because of the often poor productivity of soils and the very difficult topographical conditions with deep valleys/gorges and streams and steep slopes, the development of a forest road and path network is very difficult. The density of access is low with less than 4 m of forest road per hectare. There is no other forest district in the region with such a low value. Timber harvesting with skidders is only possible on 20 % of the forest area. On the remaining area, cable cranes and helicopters are used. About one-fifth of the timber remains in the forest. The cost of forest management is covered by financial support from the Confederation and the canton of St. Gallen as sales of timber does not cover the cost of management. Therefore, poor quality assortments are left in the stand for economic and ecological reasons. The amount of wood to be left in the forest is already specified in the planning. However, if the revenue covers the costs for the wood transport, the logs are transported to the next forest road and sold. The majority of the timber produced is supplied to the market, also because the community has a large wood energy plant installation.

Timber harvesting costs in the narrow sense could be reduced with a better forest road network. It would also support the management of the protective function of the forest. However, the cost–benefit ratio of such a forest road investment would be negative and economically hardly justifiable. Further, such an infrastructure would not be compatible with the primary objectives of habitat and species conservation.

A single district forester is responsible for the forest management. The local community of Amden employs its own forestry group. It is responsible for implementation of all forest management in the reserve, and for all protection forest activities. In addition, orders of the political municipality such as technical protection constructions and work for third parties are also important.

The special forest reserve of Amden

The forest reserve of Amden is located in the northeast of the municipality on either side of the watershed of the River Linth and the River Thur. The coordinates of the centre of the reserve are 9°13’E,

Fig. C30.3. Schematic representation of a typical bilberry-fir-spruce forest in the reserve. The ground vegetation is mainly composed by bilberry and ferns (Illustration: Andrea Klaiber, www.doppel-kopf.ch).

47°10'N. The forest reserve covers a total area of 1772 ha, of which 1045 ha are forest (fig. C30.2). The reserve extends from 1040 to 2101 m above sea level and lies in the vegetation-specific zones from upper-montane to alpine. Table C30.1 presents an overview of the characteristics of the special forest reserve which is owned by the local community of Amden.

Exact figures on tree species composition are not available. The interpretation of the stand map shows mixture proportions of about 68 % spruce *(Picea abies),* 9 % silver fir *(Abies alba),* and 22 % deciduous broadleaved trees with beech *(Fagus sylvatica)* as dominant species. The reserve perimeter is characterised by a considerable amount of bilberry fir-spruce forest (fig. C30.3) and contains 290 ha of mires. Forest and mires are intensively intertwined, which is responsible for the large forest edge ecotone (fig. C30.4).

Objectives and strategy in the special forest reserve of Amden

The main objectives of the special forest reserve of Amden are to conserve and promote the local, nationally important capercaillie population and to increase habitat connectivity with neighbouring populations. The aim is to double the area of habitat used by capercaillie with positive effects on the resident population. With this aim in mind, the local community of Amden together with the canton of St. Gallen have established a special forest reserve in 2006 as conservation tool for optimally implementation the habitat improvement measures. In contrast to a strict forest reserve, measures for a specific objective can be applied in a special forest reserve. Therefore, they are particularly useful for the conservation of threatened forest species that depend on well structured, semi-open forests such as the capercaillie (Bollmann *et al.* 2008). The minimum population size of the capercaillie in

Fig. C30.4. Forest and mires are closely intertwined. This spatial habitat mixture causes a long forest edge ecotone which is preferably used by species that depend on stocked and open habitats, including the capercaillie (Photo: Rolf Ehrbar).

2003 was estimated at 16 individuals using genetic methods (Debrunner *et al.* 2005). A description of the species' biological characteristics, its habitat needs and the significance of the forests reserve for local and regional capercaillie conservation is given in Bollmann (2006) and Bollmann *et al.* (2013). Habitat deterioration by increasing timber growing stock and high canopy closure were identified as the main threats to the resident capercaillie population. Therefore, large-scale habitat improvement by logging measures were defined as the main conservation strategy in the long term. The contract between the canton of St. Gallen and the local community of Amden specifies an operating period of 50 years for the forest reserve. The canton has committed to provide sufficient funds to cover the costs for habitat management, and the local community signed up to implement the measures as planned according to the objectives of the reserve.

Planning and management in the special forest reserve

A management system was established for the planning and management of the forest reserve. It comprises the provision of the basic principles, the planning and implementation of management measures based on various thematic materials that were developed before or at the start period of the reserve.

Habitat suitability map as basis

Habitat modelling revealed that the entire forest reserve is potentially suitable as habitat for the capercaillie (Robin *et al.* 2004). However, the actual habitat quality must be determined for each stand based on structural features and plant composition. For this reason, a habitat suitability map was developed, which shows where the capercaillie's requirements are met and where they are not (fig. C30.5). This was done according to the method of Schroth (1994). This method evaluates essential habitat requirements for the capercaillie with regard to forest structure (canopy closure 40–60 %), cover of ground vegetation (ground vegetation with moderate to high dwarf shrub ratio and shelter elements), and food availability (abundance of *Vaccinium* sp. and ant hills). The method classifies the habitat quality into five categories, from 'unsuitable' (dense homogeneous stands with little ground vegetation) to 'optimally suitable' (semi-

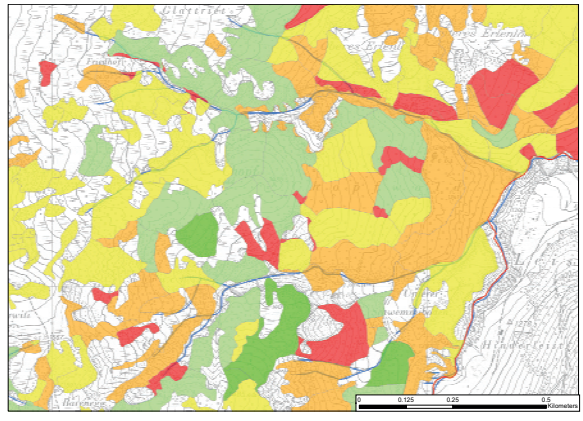


Fig. C30.5. Extract from the habitat suitability map 2017 with suitability classes from unsuitable (red) to optimally suitable (dark green).

Fig. C30.6. Example of unsuitable capercaillie habitat with homogeneous, dense stands characterised by high canopy closure and sparse ground vegetation (Photo: Kurt Bollmann).

open, heterogeneous stands with well developed ground vegetation and Vaccinium abundance). These criteria can accurately predict the probability of capercaillie being present in a particular habitat. At the start of the project, about one-third of the forest area was classified as unsuitable habitat (fig. C30.6), one-third as poorly suitable habitat, and one-third as suitable/good habitat (fig. C30.7).

Identification of the need for habitat improvement measures and prioritisation of measures

When determining the need for habitat measures, three questions arise: Where? When? and How? Therefore, the way in which the interventions are carried out is a matter of spatial and temporal prioritisation. Priority was given to stands with unsuitable habitat quality, since, there is a close relationship between habitat characteristics and the presence of capercaillie. In order to be able to derive the type of intervention, an assessment form was developed and applied for each stand. The comparison of the habitat requirement profile (with its target figures) with the current state of the forest stand reveals the actual habitat deficit. This enabled determination of the required forestry measures to improve the habitat quality. Methodologically, this procedure corresponds to the 'NaiS' planning and controlling system, which was developed for the management of protection forests against natural hazards (Nachhaltigkeit im Schutzwald [Sustainability in Protection Forests]; Frehner *et al.* 2005).

The 'Capercaillie habitat assessment form' was developed as a working tool (fig. C30.8). It is structured in such a way that the actual, stand-specific habitat quality assessed in the forest can be compared with the target state according to the ecological requirement profile of the species (e.g. Bollmann *et al.* 2005) (fig. C30.9). The need for action can be derived from the difference between the target and actual state which relates to the useful and effective measures. The form has been used in the test areas ('Weiserflächen', see below) and for

Fig. C30.7. Example of suitable capercaillie habitat characterised by coniferous trees with moderate canopy cover, a well developed ground vegetation cover, a high proportion of bilberry shrubs and possibilities for hiding below basal-branched trees and behind root plates (Photo: Rolf Ehrbar).

all logging operations in the special forest reserve. This means that all forestry activities are recorded and effects on the capercaillie population can be related to the reference situation and the logging operations later on.

Test areas, project planning and controlling

As an example, the need for logging operations and habitat improvement measures was determined on test areas, so-called 'Weiserflächen'. The test areas are used for both project planning and later for the impact control of forestry measures. In order to fulfil this purpose, the test areas must be representative of the forest area as a whole, the habitat suitability classes, and the forest stands. The diversity of sites and forest stands in the Amden forest reserve required 12 test areas. They were established in 2004 and cover between 1 and 10 ha. They were used to: (i) determine the need for habitat improvement measures; (ii) determine the suitable measures; and (iii) define the milestones which have to be monitored for future impact analyses. Then, the trees for logging were marked in each stand, and the amount of harvest and the remaining standing stock was recorded. From this, the intensity of intervention, an important comparative figure in silviculture, can be calculated. Since the 12 test areas represent the range of conditions in the forest reserve, the amount and intensity of intervention could be extrapolated to the entire forest area.

As mentioned above, the operation impact analysis is also carried out on the test areas. For this purpose, the habitat assessment form was extended and adopted. The current condition of the forest stand is also assessed in the impact analysis according to the criteria of the ecological requirement profile. Herewith, it can be determined whether the logging and habitat measures improved the conditions and have led to the achievement of the desired milestones. Or, what were the reasons for any deviations from the milestones? This makes it possible to define the conservation and silvicultural strategy for the next period and to identify appropriate adaptations. Thanks to

Test area habitat assessment form | **Derivation of need for habitat measures** | Version: 22.02.2019

Community:	Location:	Test area No.:	Date:	Name:
1. Site type(s):		Forest type:	Natural hazard to be considered:	
2. Stand No.:			**Suitability class:**	

3. State, development trend and measures

Stand and tree traits	Minimal profile* see comment!	Actual situation	Actual condition Trend in 10, in 50 years	Effective measures with control values	Reasonability	**6. Milestones with control values** Will be evaluated in years.
WINTER-Habitat • **Tree mixture** (Type and degree)	Dominance of **conifer trees**; If site condition allow: Fir, Pine > 10-20% else Spruce, Larch; Deciduous trees < 30%, Preserve Beech, no pure spruce stands					
• **Basal-branched single trees (i.e. spruce) or "Rotten" (tree collectives)**	Several basal-branched trees or "Rotten" (tree collectives)					
• **Horizontal structure** - Cover, ecotones, eventual gaps, Stem number	Degree of **canopy cover** 30-**40-50-60**-70% Ecotone length > 100m/ha; Several basal-branched tree collectives, single trees; Low stem number					
• **Mature trees** - Crown development - Slenderness ratio - Target diameter	Sitting-/Sleeping-/Lekking-trees with strong, horizontal branches and sight protection from predators through the crown; Minimum 1 flight aisle, downhill, 4 m wide					
SUMMER-Habitat • **Nutrition** - Blueberry	**Berry herb cover** 70-100%; the more berries, the better (in particular blueberry). Substitution of blueberry if possible by other Ericaceae, raspberry, *Eriophorum* sp., and herbs					
• **Cover** - Vegetation in 30-50 cm height	**Extensive**, but **irregular** occurrence of **ground vegetation**, also in pole wood; As much berry herb cover as better					
• **Regeneration** - Seedlings to pole timber	Tree regeneration covers <50% of stand area, ideally as patches ("Rotten"); Closed thickets >10 m diameter have gaps, as of pole timber of 3-4 m					
• **Requisites** (laying dead wood, root plate, sand bath; gastroliths, fens; ant hills)	**Insects**, in particular caterpillars and ants (as hatchling food); Warm, sunny sites with a rich availability of insects and hiding structures; Vegetation-free sites for sandbath and gastroliths					

very bad minimal ideal

in 50 years
in 10 years
actual

4. Action required ☐ yes ☐ no

5. Urgency ☐ small ☐ medium ☐ high

bold = compulsory ressource classes

Timber harvest:
Remove timber (ratio or m^3, timber assortments):
Phytosanitary treatments (z.B. debarking: assortments, m^3):
Special measures:
Timber transport (means and distances):

6. Rotation period:
7. Harvesting type and volume of next treatment:

**** The minimum habitat profile has been derived from capercaillie core areas. It has to be adapted to local conditions in each individual case by experts!***

Fig. C30.8. Capercaillie habitat assessment form for test areas (Weiserflächen).

this feedback process, the management of the special forests reserve can be continuously improved.

Both, the development of the requirement profile and the derivation of the need for action on the test areas were carried out on an interdisciplinary basis with the participation of researchers and practitioners. This integral approach proved to be extremely valuable.

Measures taken

A detailed action plan is drawn up for four to five years at a time. As already mentioned, the measures are prioritised according to the habitat suitability map. In the first 12 years of the forest reserve, 23 000 m^3 of timber were cut on 281 ha. The average utilisation intensity was 80 m^3/ha and the average intervention area was 3 ha. In addition, disturbances (storm damage and beetles) resulted in a removal of around 1400 m^3 of timber. On average, about a quarter of the standing stock on the logged stands was used according to plan, which is a target-oriented intensity of intervention according to our experience. Too intensive logging causes problems with snow pressure for the regeneration and vegetation competition, and too little intervention is ineffective and inefficient. The type of logging is comparable to group 'plentering', a silvicultural system in which trees are removed in groups to create gaps of sufficient size for regeneration of light-demanding species. While the chosen intensity of intervention is appropriate, it would be desirable to significantly increase the number of forest stands treated annually. Actually, this is supported by the responsible cantonal department. For the next five years, significantly more resources will be available for habitat improvement measures for the capercaillie. The outcome of such a logging intervention is shown in Figure C30.10.

In the period mentioned, in addition to the timber revenue of approximately CHF 1.2 million, over CHF 2 million in the form of subsidies and foundation support were invested in the management of the forest reserve. A total of 127 ha of forest stands were classified as not suitable as capercaillie habitat and have been designated as unmanaged. They are, in fact, natural process areas with no priority importance for capercaillie conservation. However, these areas support deadwood related conservation goals in the reserve. Deadwood as a biodiversity resource is considered as a secondary ecological objective in the forest reserve. The aim is to reach at least the habitat threshold value of standing deadwood for the three-toed woodpecker *(Picoides tridactylus).* For this purpose, trees infested and dying from bark beetle infestations are left standing whenever possible (fig. C30.11).

Changes in habitat suitability

In 2017, the habitat suitability map was updated with the aim of determining the impact of the previous logging operations on habitat quality. The suitability value has improved between 2003 and 2017 on 18 % of the forest area (Schmid 2018). On average, habitat suitability increased by 0.6 points (on a scale of 1 [unsuitable] to 5 [optimally suitable]) as a consequence of the logging operations. The proportion of suitable to optimally suitable areas increased by almost 10 % to 46 %. This habitat improvement is the direct consequence of logging operations. It was shown that all three assessment criteria of the habitat suitability map could be influenced by forestry measures, but cover of ground vegetation and forest structure were influenced more than food availability. Habitat quality was affected positively in the fir-spruce forests, and also the fir-beech forests. This positive development in this mixed broadleaved-coniferous forest type was not predicted at the beginning of the project. However, the relatively short observation period with respect to forest succession must be taken into account in the interpretation of the results.

Developments in the test areas

The impact analysis of the forestry measures was carried out on the test areas in 2017. They revealed that the management objectives were broadly achieved. In no cases was the intervention too strong, but in some stands it was too weak and had to be adjusted. There was a tendency to leave too little deadwood. The habitat assessment form proved to be very useful for the impact analysis. The impact analysis was carried out by an interdisciplinary team of foresters and ornithologists.

Fig. C30.9. The habitat assessment form is also used to assess the bilberry vegetation, the abundance of basal-branched tress and the occurrence of anthills (Photo: Rolf Ehrbar).

Fig. C30.10. Harvesting measures improve the light conditions in previously dense stocks and thus initiate natural regeneration and the development of ground vegetation and ant nests (Photo: Kurt Bollmann).

Development of the capercaillie population and the use of summer habitat

The impact monitoring on the test areas showed that the summer habitat is the limiting factor for the capercaillie. Summer habitat is characterised by mature stands with moderate canopy cover and a high proportion of bilberry ground vegetation cover. Since the use of summer habitat by the capercaillie had not been recorded at the beginning of the project, plausible assumptions had to be made (Ehrbar 2019). In summer 2017, the distribution of the capercaillie was determined by means of moulting feathers, faeces, and direct observation of capercaillies (Schmid 2018). This investigation led to the results that the forestry measures have caused an increase of summer habitat and that capercaillie move into and use logged and improved stands soon after they have been restored. Therefore, we concluded that the habitat measures were effective and the silvicultural objectives pursued were appropriate. This is in accordance with the previous statement concerning the overall improvement and the development in the test areas. The capercaillie population has responded to the logging operations and moves into the improved habitats. It prefers fir-spruce forest stands, which is likely related to the high abundance of bilberry plants *(Vaccinium myrtillus)* and the suitable forest structure. Fir-spruce stands is also the preferred winter habitat as long as the canopy cover does not exceed 60–70 %.

The number of capercaillie was determined on the basis of DNA analyses from faeces samples collected on snow in spring 2008 and 2017 (Mollet 2018). No increase in the number of capercaillie was detected between 2008 and 2017. The observations made in the summer of 2017, and the winters of 2008 and 2017, confirmed that capercaillie used suitable habitats more intensively than unsuitable habitats.

Fig. C30.11. Standing deadwood in the Amden forest reserve. Forest management also aims at increasing the deadwood volume in the reserve (Photo: Rolf Ehrbar).

Conclusions

The special forest reserve Amden is a good practice example for an integrative management of a mountain forest that is primarily aimed at improving and conserving the habitat of an emblematic target species of nature conservation and at the same time taking into account the other important services of a mountain forest (e.g. protection, recreation, production of timber and non-timber products). The general management of the special forest reserve has been successful so far. The large area of the reserve, the high percentage of mires, the long resulting forest edge ecotone and the poor accessibility to the area are important quality features of this reserve for capercaillie conservation. From the conservation perspective, the status as special forest reserve is very important as it gives the possibility of active habitat management by forestry measures that would not be possible in a

strict forest reserve. The forestry measures have been effective and have resulted in a higher area ratio of suitable capercaillie habitat. The habitat suitability map accurately reflects the species' requirements for both summer and winter habitat. The test areas enable the evaluation of the logging operations carried out using the habitat assessment form based on the ecological requirement profile of capercaillie. The planning and control system enables the targeted development of the forest reserve, and the interdisciplinary planning process with forest experts and ornithologists ensures a high professional standard, also during success control activities. The impacts of the management measures are recorded, and this ensures that the management and future habitat improvement measures can be adapted. Causality analyses are also possible. However, the forest reserve was only established in 2006 and has not existed for long enough to make definitive conclusions. The second important management indicator for example, the number of capercaillie, has not yet reacted positively to the measures implemented. We cannot exclude that other factors such as human disturbances or climate change are counteracting the habitat improvement measures. Therefore, policy makers are called upon to sustainably protect the forest reserve from negative impacts in the future.

An important prerequisite for the success of this project is that the community of Amden and policy representatives of the canton of St. Gallen support the project and its objectives. Hence, communication and information are important accompanying measures in the project management. The forest reserve has strengthened the identification of the community with its forest and with the resident capercaillie population. The reserve has become a frequently used excursion destination for students and naturalists and thus contributes effectively to environmental education and sensitisation. The awarding of the renowned Binding Forest Prize to the local community of Amden in the year of the forest reserve's foundation was a great opportunity to publicise and explain the aims of the project. The community generally accepts the forest reserve, and the municipality of Amden is grateful for the employment generated by the forest reserve. These jobs are very important to this community. In summary, the forest reserve is on the right track, and should be further developed according to the defined targets.

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Fig. C30.12. Overview of the special forest reserve Amden (Photo: Kurt Bollmann).