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prehensive insurance" strategy manifested itself in the parallel occurrence of both processes. Records of the fates of cloned individuals allowed quantitative conclusions. Mother ramets functioned as carriers of regenerative capacity because they predominantly survived the cloning treatments. In one case the regenerative capacity was partitioned over all cloned generations to the single individuals, in the other case, the capacity was invested at the beginning of the treatment. The latter possibility was controlled at the population level. The range of regenerative capacity was estimated from maximum cloning treatments in the greenhouse and in the growth chamber as relatively constant. It is therefore conceivable, that a course of regeneration, dominated by ecological factors, is based upon a genetically dominated regenerative capacity, although available only during certain age-stages.
Survival, self seeding and partly regular and intense flowering suggested fit experimental populations. The immigration processes in the field plots confirmed the importance of appropriate safe sites for diaspores as well as for vegetatively originating units. Safe site availability was optimized by covering the plots with geotextiles which functioned as diaspore traps.

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# 8. ENGLISCHE ZUSAMMENFASSUNGEN DER IM BERICHTSJAHR 1992 ABGESCHLOSSENEN DIPLOMARBEITEN

(Summaries of Diploma Theses)

BUCHELI Erika. Differenzierungsmuster und Stromabildung bei Grasendophyten. 73 S. (Polykopie).

*Genetic differentiation and stromata formation of grass endophytes.*

Isozyme variation of 369 isolates of *Acremonium* and *Epichloë* endophytes (*Clavicipitaceae*, tribe *Balansieae*) from 22 populations of nine host grasses (*Brachypodium silvaticum* [5 populations] *Bromus benekenii* [3], *B. ramosus* [1], *B. erectus* [1], *Elymus europaeus* [3], *Festuca altissima* [2], *F. gigantea* [5], *F. ovina* [1], and *F. rubra* [1]) was examined using starch gel electrophoresis. In total, there were 25 distinct multilocus genotypes, and all of the 14 presumed isozyme loci were polymorphic. Each genotype was confined to a single host species, except one which was found in common on *Festuca rubra* and *F. ovina*. Several genotypes of *Bromus benekenii* and *Festuca gigantea* occurred only in one population suggesting geographic differentiation of genotypes. A cluster analysis based on genetic identities between populations revealed five clusters separated by genetic identities of 0.16 to 0.54. All populations from *Bromus silvaticum, Elymus europaeus* and *Festuca altissima* were grouped in separate clusters each, indicating host specific differentiation of endophytes. The endophyte populations from the remaining *Festuca* or *Bromus* host species respectively, clustered closely by genus, which would be consistent with a coevolutionary relationship of endophytes.
The incidence of infection of host species was correlated with the habitat. In host species of open grasslands (*Festuca ovina, Bromus erectus*) less than 60% of plants were infected, whereas in woodland grasses (*Bromus silvaticum, Elymus europaeus, Bromus benekenii, Festuca altissima*) 90% or more of the plants contained an *Acremonium* endophyte. This observation and the difference in the number of genotypes found among strains from

woodland or grassland host species point to a different reproductive strategy of endophytes (sexual vs. seed-borne) in these two vegetation types.
Among the isolates from *Bromus silvaticum*, a woodland grass which was always infected but rarely formed stromata, considerable genetic differences between the 36 isolates from plants with stromata and 126 isolates from plants without stromata were observed. Distribution of genotypes was significantly correlated with the original disease symptom, and more genotypes were found among sexually reproducing strains which had a higher genetic diversity.
In order to test genetic inheritance of the stroma production, endophyte free seedlings of *Bromus silvaticum* were artificially inoculated with strains from sexually or asexually reproducing plants. Significantly more plants inoculated with sexual strains became infected than plants inoculated with asexual strains. In the first flowering season after inoculation, stromata formation was observed in 19% of the plants infected with sexual strains, and in none of the plants infected with asexual strains. These results indicate that the ability of sexual reproduction may be attributed at least in part to the fungal genotype. On the other hand, in two successive years stromata bearing individuals marked in the field showed significant variation in the disease symptoms, suggesting that environmental factors may also affect stromata production.

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ESER Prisca und NÖTHIGER Markus. Die Nussbaumerseen: Inventar, Bedrohung und Möglichkeiten zur Arrondierung und Renaturierung eines Flachmoores. 94 S. + Anhang. (Polykopie).

*The lakes of Nussbaumen: Inventory, threat and feasibility of perfection and regeneration of a fen.*

The purpose of this project was an ecological inventory of the area of the lakes of Nussbaumen. The area around the three lakes is a wide, mostly cultivated and drained fen, where peat has been cut in earlier times. Today, these three lakes are listed in the federal inventory of landscapes of national significance (BLN). Close to the little remaining natural vegetation around the lakes, intensive agricultural farming is found. Acute problems are the low quality of the water (lake- and groundwater) caused by the high input of nutrients, and from the agricultural point of view the sinking and paludification of farming land. The natural vegetation of the lakeside is mostly protected by the law, although a high input of nutrients from the surrounding farming land was proved.
The project consisted of a vegetation mapping, and of an analysis of vegetation and chemical soil parameters along eight transsects from the lakeside to the agricultural land. With these results, a concept for a better protection of the natural vegetation has been formed. As an outlook the regeneration of different parts of cultivated fen leading to more oligotrophic conditions was discussed.
The vegetation mapping had to be accomplished by an adapted local key based on a new vegetation survey. The following plant-communities, alliances and associations have been found: *Phragmition, Magnocaricion, Molinion, Filipendulion, Salicion cinereae, Alnion glutinosae, Pino-Betuletum pubescentis* and *Pruno-Fraxinetum.* Deducted from the present state arrangements of maintenance have been proposed. Furthermore, the present vegetation has been compared to historical inventories and the deficiency has been named. From the submerged vegetation only an inventory of the species names has been supplied and compared to historical inventories. On the map they are shown by signatures.
The problems of nutrient influence are visualised by the presence of eutraphentous plants

in the marginal area of the protected vegetation. It can also be seen by the phenomena of the occurrence of high herbs ("macrophorbisation") of different plant-communities and in the eutrophication of the three lakes. The zonation is relatively narrow due to the new build-up of the plant-communities after the lowering of the lake level. Recreation has caused damage to vegetation and is disturbing wildlife.
The gradient analysis of the soil along the transsects contained measurements of plant-available phosphate, potassium and soil acidity. With the gradient analysis of vegetation the change of plant composition has been evaluated, and an analysis of indicator values concerning nutrients and humidity has been made. A synthesis of these results showed an inadequate buffering of the protected area against nutrients from the adjacent farm land, which could be related to the type of cultivation, the permeability of the soil, slope and water household. Therefore, buffer zones of various widths were proposed for the whole area in order to get better protection against the flow of nutrients into the natural vegetation. Further measures are the conversion of fields into permanent grassland, no more draining, and the maintenance of the Filipendulion communities along the boundaries of the protected area.
The final part of the project was to evaluate the potential of the area regarding regeneration, based on a map showing the boundaries of peat soil (Torf) and surface-near water tables.
In the light of historical inventories from the time before the great transformations and lowering of the water level of the lake, it was discussed where and which type of regeneration would make sense. Stabilizing water regime would at the same time lower the release of nutrients through decomposition of peat soil and provide the area with ecologically valuable wetlands. The legal and political bases are given.

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GASSER AHMAD Christine. Pflanzenartengarnitur und Bodenchemismus von Trespen-Halbtrockenrasen nach 14-jähriger Mahd-, Brache- und Brandbewirtschaftung bei Merishausen (SH). 69 S. (Polykopie).

*Plant species composition and soil chemistry of limestone grassland after 14 years of yearly cutting, of burning and no management near Merishausen (Canton Schaffhausen, Northern Switzerland).*

The effect of six different treatments during 14 years (cutting every year, every second or every fifth year in July; yearly cutting in October, controlled burning in early spring and no management) was analysed according to the Braun-Blanquet method and by counting the number of inflorescenses in summer of eight selected species (*Primula veris* s.l., *Chrysanthemum leucanthemum, Salvia pratensis, Bromus erectus, Brachypodium pinnatum, Prunella grandiflora, Buphthalmum salicifolium* and *Aster amellus*).
The influence of climatic factors was analysed with yearly climate diagrams (WALTER and LIETH 1960-67). Moreover, several soil parameters were investigated.

1. In comparison with the start of the management experiment in 1978 the following changes in the cover degree occurred: with yearly cutting in July, 27 species showed no change, nine increased and ten decreased; yearly cutting in October gave similar results; cutting every two years in July, 25 species with no change, six increased and twelve decreased; cutting every five years in July, the number of species are 14, three and 23, respectively, i.e. the largest overall change. With controlled burning 17 species did not change in cover degree, seven increased and 18 decreased; in no management the re-

spective numbers were 17; four and 15.

2. Compared with 1978 the number of flowers or inflorescences increased in the following cases: cutting in July *Chrysanthemum leucanthemum*, cutting in October *Prunella grandiflora*, cutting every second year *Bromus erectus* and *Buphthalmus salicifolium*, no management *Primula veris s.l.* and controlled burning *Salvia pratensis, Brachypodium pinnatum* and *Aster amellus*.
3. The points 2 and also 1 show that each treatment favours some species of interest for nature conservation and damages some others.
4. With *C. leucanthemum, S. pratensis, B. erectus, B. pinnatum* and *A. amellus* positive correlations with the mean annual temperature could be found at the beginning of experiment, i.e. from 1978 to 1981. With *S. pratensis, C. leucanthemum* and *B. pinnatum* the mean annual temperature correlated positively with the flowering only in the unfavourable treatments (see point 1).
5. The nitrogen contents in the top soil (0-4.5 cm) in the different managements were between 0.42 and 0.47 % N (highest value in "cutting in October"); in 4.5-9 cm they were between 0.37-0.40 % (highest value in "no management").
6. In the top soil the following contents of phosphate were measured: cutting in July 3.6, cutting in October 7.2, no management 5.0 and controlled burning 5.8 µg/100g soil. In the deeper horizon the contents were: cutting in July 4.5, cutting in October 2.9, no management 4.1 and controlled burning 3.0 µg/100g soil.
7. In the top soil the following contents of potassium were found: cutting in July 7.2, cutting in October 10.1, no management 12.1 and controlled burning 12.7 mg/100g soil. In the deeper horizon the contents were between 4.1-6.7 mg/100g soil.
8. From the point of view of nature conservation cutting not earlier than the 10th of July, and every 4-6 years cutting in October or no management show to be the most suitable management methods for the meadow on the "Gräte". It is recommended to cut the edge of wood or bush every 3-4 years after the 10th of July or every 2-3 years in mid-October.

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GÖDICKEMEIER Iris. Saisonale und räumliche Variabilität der Krautschicht in einigen typischen Waldgesellschaften am Üetliberg. 62 S. + Anhang. (Polykopie).

*Temporal and spatial processes in deciduous woodlands and their impact on the interpretability of relevé data.*

The goal of this thesis is to study the influence of the 1) temporal and 2) spatial variability of the herb layer in different forest communities in the neighbourhood of Zürich as well as 3) methodical aspects such as plot size, precision of cover estimates and their effects on the interpretability of phytosociological relevés.
The impact of the above mentioned factors was studied at three different levels: a) vegetation level (recognizability of different vegetation units), b) species level (completeness of species lists), c) habitat or site level (recognizability of different habitat or site conditions with help of indicator values).
Value scale

- Simple species lists are sufficient to distinguish the five vegetation types examined. Correspondence analysis including indicator values show more reliable results if the cover of the occurring species is not considered.
- Compared with the scale of BRAUN-BLANQUET, application of the value scale of LONDO allows a more detailed record of temporal changes on permanent plots. The LONDO

scale is, however, very sensitive to seasonal small-scale spatial variations.
- The value scale of BRAUN-BLANQUET is less sensitive with regard to methodical errors as well as temporal and spatial variations than the more precise scale of LONDO. Therefore, the BRAUN-BLANQUET approach can be considered as a compromise between a simple species list and a LONDO-type relevé giving very detailed cover estimates.

Plot size
- Plots of 4 $m^2$ in size are sufficient to distinguish the five vegetation types examined.
- The number of recorded species increases with increasing plot size; consequently calculations of mean of indicator values based on large plots tend to be more reliable and consistent than those based on smaller plots.
- Within a given forest type, differences in species richness between 128 $m^2$-plots from different geographical locations, on the one hand, and between 128 $m^2$-plots and 16 $m^2$-plots in the same location, on the other hand, are of the same order of magnitude.

Time of relevés - seasonal variability
- Timing of relevés is relatively insignificant if the objective is to distinguish between different forest types.
- In order to obtain a fairly complete species list the optimal point in time for a relevé differs from forest type to forest type:
- Beech forest with *Arum maculatum*: first relevé late April to late May, second relevé during summer.
- Beech forest with *Galium odoratum*: mid-May to mid-June.
- Beech forest with *Carex montana*: from mid-June; best time: early June to mid-July.
- On permanent plots vegetation should be recorded at the same phenological state if possible. A temporal shift of two weeks can only be a problem if it occurs at the time of the most intensive development. However, an unintentional systematical shift throughout the years of monitoring could affect the data rather severely and lead to wrong interpretations.

Location of relevés - spatial variability
- The exact location of the relevé is relatively insignificant with regard to the distinction of the examined forest types.
- Within a given forest type, species composition and species richness may vary significantly even at a small spatial scale.
- Permanent plots should be measured exactly to guarantee repetition of relevés exactly at the same place. An unintentional systematical shift could lead to wrong interpretations of the data, e.g. the presence of temporal gradients may be deduced.
- Within the examined vegetation units the influence of spatial small-scale variation was greater than the influence of seasonal variation.

Mean indicator values
- If mean indicator values differ by less than 0.2 units, as a rule, this does not indicate different site conditions, differences of that magnitude being within the normal range of seasonal variation.
- In plant communities which are poor in species, seasonal differences in mean indicator values of up to 0.4 units were observed.
- Species cover should not be weighted too heavily for calculating mean indicator values, otherwise seasonal variation in the cover of a single species, as e.g. *Allium ursinum*, may significantly alter the mean indicator values, especially in species poor plant communities.
- Relevés made in early spring are less suitable for calculating mean indicator values because only very few species are present in the herb layer at that time.

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GRUNDMANN Andreas. Vegetation der Wiesen auf Bahnböschungen in der Stadt Zürich. 102 S. + Anhang. (Polykopie). (Siehe Beitrag in diesem Band).
*Vegetation of meadows on railway embankments in the city of Zürich.*

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HALDEMANN Maja. Mykosoziologische Untersuchungen in Hartholz-Auenwäldern bei Brugg (Kanton Aargau). (Polykopie). (Siehe Beitrag in diesem Band).
*Mycosociological research in hardwood alluvial forests near Brugg (Canton of Aargau).*

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HOLZGANG Otto. Einfluss der Bewirtschaftung auf die Vegetation in Rebbergen von Fläsch (GR) im Hinblick auf die biologische Schädlingsbekämpfung. 51 S. + Anhang (Polykopie).
*Influence of management on vegetation in vineyards in Fläsch (Grisons) with regard to biological control.*

The present paper deals with the influence of management on vegetation in vineyards in Fläsch (Grisons). For the study 17 plots, distributed in the flat survey area "Feld" and the steep "Halde", were chosen. The management of the years 1990 to 1992 was investigated by interviewing each of the 14 wine-growers. In May and August, relevés were made separately for the rows of the grape-vines and the alleys between the rows.
For biological control, a high number of perennial forbs is of great importance.

1. In the alleys of the plots of the survey area "Feld", the cover of grasses was 56%. There were on average 34 plant species, seven species more than at "Halde". Especially for the perennial forbs, the "Feld"-plots showed more plant species. That means a great advantage for biological control. Plots of the survey area "Halde" had on average a cover of grasses of only 13%. All these differences are probably correlated to the difference in slope of the two survey areas.
2. The different types of management such as mowing, mulching, soil treatment, application of herbicides and grazing by sheep were applied in many different combinations. In order to investigate the influence of management, the plots were divided into two groups according to the intensity (frequency) of the different management types.
3. Alleys of the flat survey area "Feld":
   a) The plots of a first group were cut three to four times a year, a second group twice (both groups had a soil treatment every second year). Plots cut more intensively showed a cover of perennial forbs of 35%, the other plots only of 20%. The cover of perennial grasses was 50% for the first group, for the second 70%. The fact, that plots cut more intensively showed more perennial forbs, may also be an effect of soil treatment.
   b) The plots of a first group had a soil treatment every year, a second group every third year (both groups had two to three cuttings a year). Plots treated more intensively had a cover of annual forbs of 20%, the other plots only of 5%. The cover of geo-

phytic forbs amounted for the first group to 12%, for the second only to 2%. On the other hand, the cover of hemicryptophytic forbs was 5% for the first group and 30% for the second group. The species number was 5 and 10, respectively. The soil treatment, that was applied every year, had a positive effect on the cover of annual and geophytic forbs, but a negative on hemicryptophytic forbs. This may have negative effects on biological control.

4. Alleys of the steep survey area "Halde":
   The plots of a first group had one to two soil treatments a year, a second group every third year (both groups had three cuttings a year). Plots treated more intensively showed a cover of forbs of 99%, the other plots only of 80%. On the other hand, the cover of hemicryptophytic grasses was about 0% for the first group, and 15% for the second. The intense soil treatment resulted in a higher cover of forbs, but a lower of hemicryptophytic grasses.
5. The high variability in management correlated with different species compositions of the plots. This resulted in a relative high β-diversity of the whole survey area. But because the area considered is too large, the question remains open if there is a positive effect on biological control in the individual plots.

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KRUG Kathrin. Ökologische Bewertung von Waldrändern im Kanton Solothurn. 95 S. + Anhang. (Polykopie).

*The ecological value of forest edge habitats. Preparation of a valuation key and assessment of the present condition of the forest edges in the Canton of Solothurn.*

Problem.

It is well known that structurally rich forest edges offer favourable habitat conditions for many plant and animal species. In addition, forest edges play a vital role as corridors linking the isolated remnants of natural and semi-natural habitats in today's intensively cultivated landscape. From an ecological point of view, most of the forest edges in Switzerland are in poor condition. In particular, this is true for densely populated areas such as the Swiss Central Plateau with its intensive agriculture and forestry. However, so far very little hard data are available on the actual ecological condition of the forest edges in Switzerland, and even though several experiments have been undertaken to upgrade ecologically poor forest edges, only little is known about the relation between effort and success of such measures, since most of the experiments were not accompanied by a scientific study.

Objectives.

The objective of the paper was basically threefold. First, a key should be prepared, permitting to assess the ecological value of forest edge habitats in an objective and reproducible way. Second, a survey should be carried out in order to assess the present condition of the forest edge habitats in the Canton of Solothurn. Third, experimental plots had to be set up to monitor the effects of different upgrading treatments.

Valuation key.

The proposed key to assess the ecological value of forest edges has been tested on 82 woodland edges in the Canton of Solothurn, i.e. in the northwestern part of Switzerland. The key consists of two parts.

With the help of part 1, it is possible to assign a given forest edge to one of three quality classes, viz. fair, intermediate and poor; as shown below, really well developed forest edge communities do not occur in the study area. The assignment is based on a set of nine crite-

ria, six dealing with the structure and three with the botanical diversity of the forest edge. For practical reasons, faunistic aspects have not been taken into account. The nine criteria considered were (1) overall depth of the forest edge ecotone in metres, (2) depth of the shrub belt in metres, (3) length of the shrub belt in percent of the 100 m of forest edge considered, (4) depth of the not or only extensively utilized herb fringe in metres, (5) length of the herb fringe in percent of the 100 m of forest edge considered, (6) density (percent cover) of the forest edge at eye level, (7) number of deciduous tree species, (8) number of woody species present in the shrub belt and (9) number of spiny or thorny shrub species present in the shrub belt. Out of an original set of 17 parametres, the nine above-mentioned criteria proved to be both sufficient and reliable for classifying the 82 forest edges investigated. Analysis of sensitivity showed that the proposed valuation key is very robust.
Part 2 of the key is aimed at refining the ranking order among the ecologically more valuable forest edges, i.e. the ones assigned to the best of the three classes mentioned above. This part of the key deals, on one hand, with additional small structures as, for instance, dead wood, piles of earth or stones etc., and, on the other hand, with the ecological quality of the immediate surroundings of the forest edge.
Condition of the forest edges in the Canton of Solothurn.
The survey was carried out in five communities, representing all the major geographical regions of the Canton. Altogether 82 forest edges were examined: 13% of them proved to be in a fair condition from a nature protection point of view, 16% were found to be of intermediate ecological value and the large majority (71%) were valued as poor. It must be noted, however, that the ecological quality of even the best of the examined 82 forest edges was still far below the quality of the so-called "ideal forest edge" with well developed woodland mantle, shrub belt and herb fringe, with an overall depth of approximately 30 m. This was mainly due to lack of depth, which typically ranged from 0-5 m and exceeded 10 m only in one case. In general, forest edges with southern exposition were found to be ecologically more valuable than those with other expositions.
Upgrading of forest edges.
In order to monitor the effects of different upgrading treatments, experimental plots were set up in three locations, viz. (1) a poor, (2) a typical forest edge of the Swiss Central Plateau of intermediate value, and (3) a comparatively well developed forest edge rich in species. In each location 15 permanent plots, 10x10 m in size and 30 plots, 2x2 m each, were established. In each plot, a phytosociological relevé was made according to the method of BRAUN-BLANQUET (1964).

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MEIER Sybille und DONATI Franca. Vegetationsveränderungen in einer Riedwiese der Bolle di Magadino (Kanton Tessin). 79 S. + Anhang. (Polykopie).
*Changes of the vegetation in the a semi-natural sedge meadow in the Bolle di Magadino (Canton Ticino, Switzerland).*

The "Bolle di Magadino" are the last natural delta-landscape of the southern part of Switzerland (Ticino). They represent a protected area of national importance, and they should be maintained in all their beauty. During the last decades, the vegetation has changed, first of all due to the increasing eutrophisation. This paper should yield an optimal base for the future monitoring of the largest sedge meadow in the area.
In the course of this work a semi-natural sedge meadow of the "Bolle di Magadino" has been studied and its vegetation data statistically analysed. Furthermore, the vegetation has been mapped and compared with maps from 1964 and 1976. Moreover the permanent

plots, which were established in the sedge meadow in 1978, have been re-investigated.
Only 70 plant species have been found in the meadow; only a few among them were rare plants. Two possible reasons for this poorness in species are the increasing eutrophisation and the large floods that occur regularly. The floods are partly artificially managed through regulation of the lake level and occur at any time in the vegetation period.
The statistical analysis showed that the vegetation follows the moisture gradient of the soil. The moisture gradient correlates strongly with the factor "elevation above sea level".
The comparison of the maps and the monitoring sites show that in the last 30 years there have been changes in the vegetation. The part of the area, which is the most distant from the lake, is drying out. This fact is manifested by the spreading of the dry sedges meadows and the forbs. Also the riparian woods and the zone of willow trees along the reed are spreading. This move of the vegetation damaged the tall sedge meadows, which have experienced considerable losses. The reed bank areas have increased between 1960 and 1970. The artificial regulation of the lake and the consequent rise of the average lake level are most likely the main cause of this fact. However, also decreases of the reed bank have been identified. The cause of these changes is the growth of the willow trees along the reed bank and of reed plague in another area. These losses are compensated by an increase of the reed in the area close to the lake and by the movement of tall sedge meadows. Besides this, a tendency of pseudo-reed formation (i.e. reed outside inundated areas) was noticed.
Out of the 85 relevés from 1992, through a statistical evaluation, a number of suitable sites have been selected and proposed for the future monitoring of the area. An adequate information for the future control of the vegetation development should be guaranteed by periodical relevés of the monitoring sites and repeated mapping of the vegetation.

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VENZIN Regula. Ökologische Aufwertung von Waldrändern unter besonderer Berücksichtigung von rechtlichen, finanziellen und planerischen Aspekten. Polykopie. 84 S.

*Ecological upgrading of forest edge habitats legal, financial and planning aspects.*

Problem.
Since the end of World War II the diversity of the landscape has continually decreased in Central Europe, with regard to habitat types, plant and animal species. Moreover, the remaining fragments of the natural and semi-natural habitats are not only few but also far in between. In particular, this holds true for the Swiss Central Plateau. It is well- known that structurally rich forest edges offer favourable habitat conditions for many plant and animal species. Ecologically valuable forest edge habitats play, in addition, a vital role as corridors linking the islands of the natural and semi-natural habitats still present in today's intensively cultivated landscape. Moreover, forest edges affect considerably the visual quality of a landscape.
Objectives.
The paper deals primarily with the legal and financial aspects related to the ecological improvement and management of forest edges. In addition, the question of roads running immediately along the edge of a forest is addressed. Such roads are frequently constructed in connection with the reparceling and land reallotment schemes, and are considered to be unfavourable from a nature conservation point of view. In addition, in three locations, viz. (1) a species poor, (2) an intermediate and (3) a comparatively species rich forest edge, experi-

mental plots were set up in order to monitor the effects of different upgrading treatments.
Legal aspects.
The term "forest edge" is not mentioned explicitly in the relevant federal legislation, neither in the nominal nor in the functional forestry bills and acts. However, the corresponding legislation deals indirectly with the habitat "forest edge". Most important with regard to preserving and recreating well structured and ecologically valuable forest edges are the "Federal Act on Nature and Landscape Protection (Bundesgesetz über den Natur- und Heimatschutz)" as well as the the "Federal Act on Forest (Bundesgesetz über den Wald)". The Federal Act on Nature and Landscape Protection protects "sites serving the balance of nature or providing favourable conditions for plants and animals" and requires "ecological compensation measures" in intensively utilized areas. One of the primary purposes of the Federal Act on Forest consists in "the preservation of the forests as natural or semi-natural habitats".
Financial aspects.
The above-mentioned Federal Acts provide the legal basis to compensate land owners and managers for reduced property values and increased work loads, respectively, resulting from establishing, upgrading or maintaining ecologically valuable forest edges. At present, the approach based on voluntary contracts seems to be most promising, i.e. the cantonal government offers to pay an appropriate compensation and the forest owner or manager agrees to upgrade and manage the forest edge according to the requirements of nature protection. Compensation payments proposed for the periodical work necessary to establish and maintain an ecologically valuable forest edge habitat range at present from SFr. 1000.- to 2000.- per hectare and year. Since the forest edge and the immediately adjacent forest are of little economic value, however, the ecological upgrading of forest edges does, in general, not lead to a reduction in yield or property value and consequently no compensation is warranted in this respect.
Rural planning - forest edge roads.
In the Swiss Central Plateau, nowadays most of the forests (70%) are separated from the open land by tracks or small roads, primarily designed for and used by agricultural traffic. Up to 90% of those roads are usually constructed in connection with a land reallotment scheme. In the more hilly areas as (e.g. the Jura Mountains), the percentage of forest edges bordered by roads is with c. 20% much lower than in the Swiss Central Plateau. It should be noted, however, that in those areas practically no land reallotment schemes have been realized as yet. For planning purposes the following general rules are proposed: (1) if possible forest edge roads should be avoided, (2) if this is not possible a strip of open land, approximately 5 m in width, should be left between the road and the first row of trees, (3) the road should be small and designed as gravel track and (4) the negative impact of the road should be compensated by ecologically upgrading an appropriate section of forest edge.
Conclusions.
The establishment of ecologically valuable, well structured forest edges is a promising and politically and financially feasible way to improve the ecological value of intensively utilized areas. The relevant federal legislation encourages the ecological upgrading of landscapes and provides the basis to compensate land owners and managers for disadvantages or additional work resulting from such measures.

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