



Prescribed Burning in Landscape Management and Nature Conservation: The First Long-Term Pilot Project in Germany in the Kaiserstuhl Viticulture Area, Baden-Württemberg, Germany

1. Introduction: Fire as a Substitutive Disturbance Process

The majority of protected areas in Central Europe is not of pristine nature. They are embedded in landscapes that have been shaped by land-use systems over centuries. These systems historically involved processes such as burning, grazing, mowing and cutting which transformed natural landscapes to unique ecosystems. These ecosystems provide habitats for many plant and animal species which are under protection today, including many endangered (red list) species. The recent socio-economic developments, however, resulted in structural changes of the rural space. Many agricultural sites are treated less intensively or are abandoned because farming is no longer profitable. As a result human-made open ecosystems are lost. Without disturbance secondary succession leads to a tree- and shrub-dominated vegetation form which is the potential natural vegetation type in most parts of Central Europe. As a result, many plant and animal species adapted to or were found in these ecosystems will face the threat of extinction.

If the maintenance of these abandoned ecosystems is desired, it is necessary to introduce substitute-disturbance processes into these areas to maintain the dynamics of processes which have shaped these landscapes historically.

To ameliorate the problem, several options can be taken into consideration. These options include traditional mowing, grazing, cutting practices, and the use of fire as a vegetation management tool. Mowing, grazing and cutting are already practised in nature conservation in Germany. But the lack of financial and personnel resources, including the loss of skill and expertise, limits the use of these practices. Thus, alternative approaches are needed. Prescribed burning could offer a potentially efficient and relatively cheap tool to achieve the land management objectives of the areas in question.

2. Fire Management on the Vineyard Slopes in the Kaiserstuhl Area

In the following an example is given how prescribed burning can be used as a substitute measure in landscape management. The aim of the research project is the investigation of the application of prescribed burning for maintaining the traditional open meadow-type vegetation structures on slope sites which are threatened by secondary succession.

The study is currently conducted in the Kaiserstuhl area, an old volcano fragment dating back to the Tertiary, located in the Rhine valley in southwest Germany. Most of the lower parts are covered by an up to 16 m-deep loess layer. The history of wine cultivation in the area dates back to the 8th century. Since then farmers grew wine on terraces built on the hilly terrain. The traditional vegetation cover on the slopes between the terraces was of a meadow-like grassland (Figure 1).



Fig.1. The typical structure of the old historical vineyards is an alternation of narrow terraces where the vines are cultivated and small steep slopes covered by a meadow-like vegetation.

Although the natural vegetation cover in the area is of a bush- and tree-dominated forest type, vineyard slopes have a distinct vegetation cover dominated by grass. These ecosystems were maintained by mowing and occasional burning until World War II. After the war the area experienced a dramatic increase in wine growing and sharp decrease of animal husbandry with its associated mowing and cutting practices. As the farmers no longer needed hay to feed their cattle, they began to burn the slopes in winter so as to suppress the growth of bush and tree species in order to maintain open vegetation structure:

In 1975, following the Federal German nature conservation law, the State of Baden Württemberg imposed a ban of the free burning (broadcast burning) of vegetation. Since then the slopes were cultivated only in some exceptions. The consequence was the ever increasing expansion of bush and trees into these areas due to secondary succession. The result was a decrease or loss of habitats for many plants and animal species that are adapted to or found in these ecosystems, and require more light and higher ground temperatures, conditions that prevail in open ecosystems:

The slopes in the old historical vineyards were only up to 8 m high. But with the consolidation and restructuring of farmland property in the 1960s and 1970s, bigger slopes of up to 40 m high and with over 100% inclination were constructed (Figure 2). Except for the initial grass layer establishment on the slopes, no human intervention has taken place in the area. Today, both the new and the historical slopes serve as a medium for secondary succession to run its course. Given the extent of the area (four square kilometres only in the central part of the Kaiserstuhl area), a major investment of time and money is required to maintain the traditional grass-dominated open structures by cutting and/or mowing. As an alternative, this project proposes the use of prescribed burning to achieve the landscape objectives set for the area:



Figure 2. With the consolidation and restructuring of farmland in the 1960s and 1970s, large terraces were constructed with slope heights stretching up to 40 m with over 100% inclination. Since their establishment they have been treated only in exceptional cases.

4.1 Objectives of a Prescribed Burning Project

The objectives of the research project were to determine whether prescribed burning of small plots in late winter could be used to maintain and promote the traditional open vegetation structure, the habitats and occurrences of typical and characteristic animal and plant species on the slopes of the vineyards of the Kaiserstuhl area. Three project studies were conducted in the late 1990s:

4.2 Vegetation study

Effects of different fire types on the composition, structure and distribution of the vegetation types of the open, meadow-like ecosystems were monitored. The reaction of some typical species which immigrate and extend since the beginning of the succession period 20 years ago were observed. In addition temperature and soil moisture measurements on burned and unburned plots were undertaken. The first results of the investigations are as follows:

Measurements of the soil temperature (at 10cm depth) and the soil moisture content (0 to 20 cm depth) on burned and unburned plots were taken (Figure 3). Depending on the location, an increase of the monthly average temperature up to 7°C on the burned plot in comparison with the unburned plots was discovered in the first vegetation period after burning. At the same time there was a partially significant decrease of the soil-moisture content on the burned plots. So the burned stands became warmer and dryer. In a longer perspective this could be of interest because it is especially the xerothermic fauna and flora which suffers under the abandonment and the secondary succession. The former use of the slopes produced relatively warm and dry conditions which gave the opportunity for continental and sub-Mediterranean species to find habitats here.

To observe the effects of different fire-types on the grassy and herbaceous dominated vegetation, permanent investigation plots were installed. Six or eight observation plots of the size of 1m² were distributed on every treatment unit. With the help of a "frequency analysis" changes of the species composition and distribution were observed over three years. To investigate the reaction of the vegetation,

evenness/number of species diagrams were used. Figure 4 gives an example how the vegetation of a relatively moist stand reacts of different fire treatments.

To carry out the frequency analysis a 1m² frame subdivided in 16 sub-units (25x25 cm) was laid over the vegetation. In each sub-unit the species and their cover (%) were recorded. This method provides a very high resolution inventory and even very small changes in species distribution can be detected (Fischer 1986). In the diagram the average evenness and the average number of species of every treatment-unit were plotted and the changes from year to year were marked with arrows. The number of species is a parameter to describe the richness of an ecosystem. The evenness (%) describes the distribution of the species. 100% means that there is no hierarchy and all species are equally distributed. The smaller the evenness number the more dominated is the ecosystem by one or a few species (Häupler 1982).

The overall results revealed that on the investigated slopes in general there was no major shift observed, neither in the number and composition of species nor in the distribution (evenness). However, an observation period of three years is rather short to obtain reliable results on long-term response of vegetation. But from other studies on comparable sites in the state Baden-Württemberg where such investigations were carried out over 20 years, it is known that the structure of fallow meadows can be maintained with the help of prescribed burning (Schreiber 1997).

Another question was how brushes and trees respond to fire. It was noted that sprouts with a diameter of less than 2 cm (at 30 cm height) are generally killed by fire, but most of the species resprout in the following spring. Under a prescribed burning regime with short fire intervals of two to three years it seems to be possible to keep young succession stages at its early stage, but it is not possible to remove them completely. It cannot yet be concluded whether the spread of shrubs and trees can be stopped with the help of fire. It seems that under a broad range of conditions the still open, grass-herb dominated vegetation structures may be maintained by fire, while it is doubtful that brushes which spread through rhizomes can be stopped in a long term.

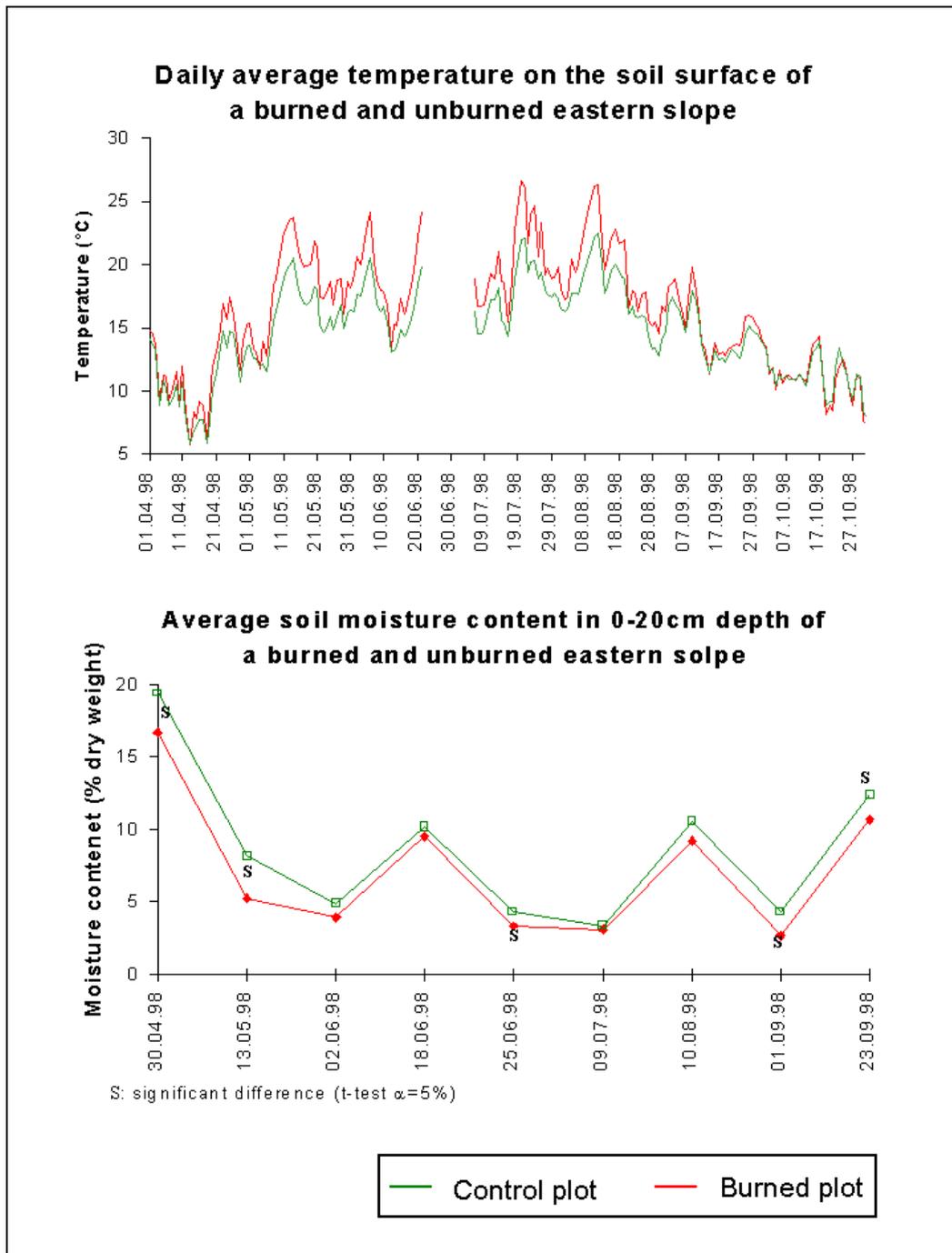


Figure 3. Soil temperature and soil moisture content in the vegetation period after the winter burning session 1997-98 on a burned and on a control plot on an eastern slope.

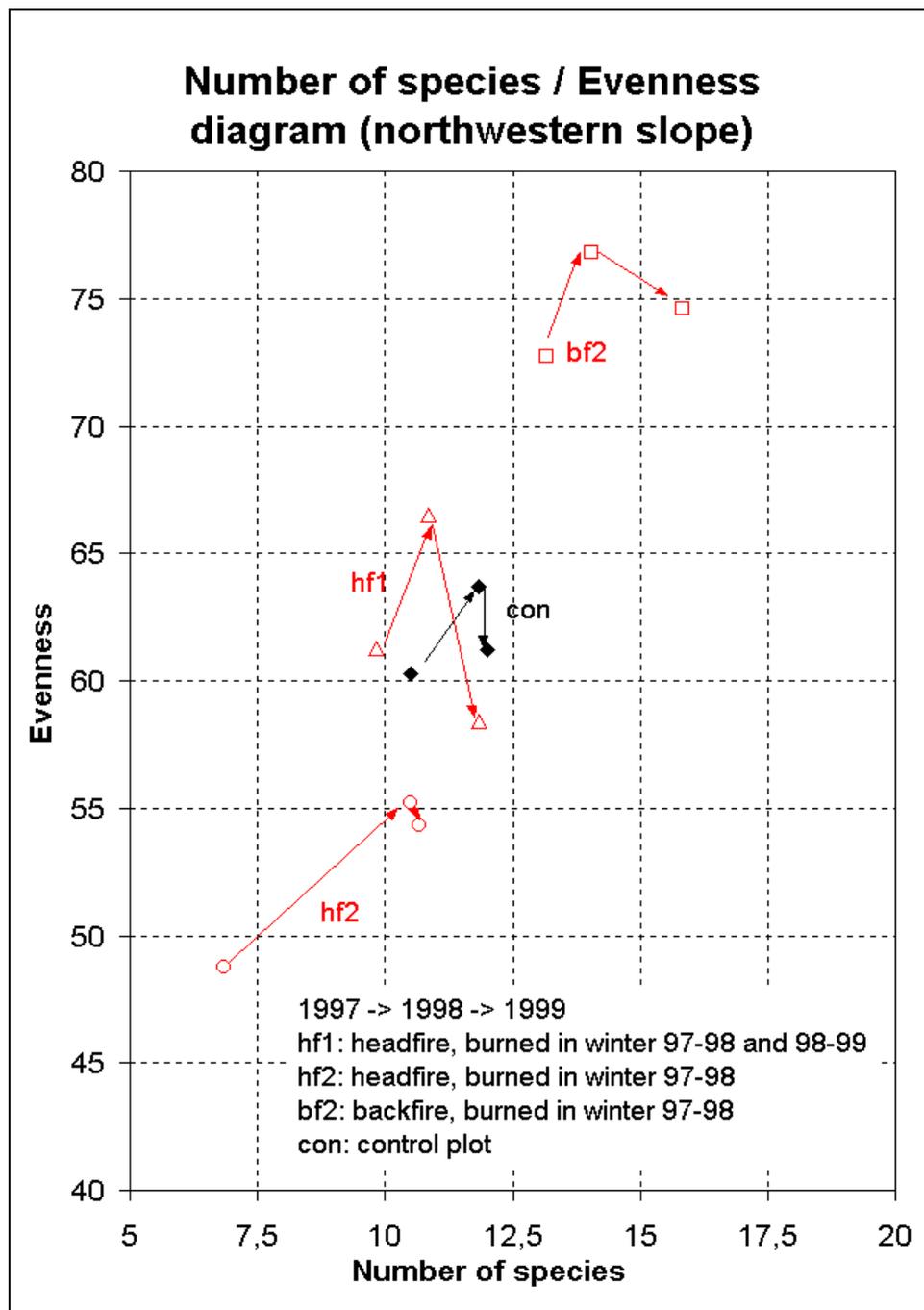


Figure 4. Number of species / Evenness diagram of a north-western slope. Neither on the burned or the unburned plots a significant shift in the distribution or average number of species can be observed in the last three years. Also the species combination is more or less the same. Note: To carry out the frequency analysis a 1m² frame subdivided in 16 sub-units (25x25 cm) was laid over the vegetation. In each sub-unit the species and their cover (%) were recorded. This method provides a very high resolution inventory and even very small changes in species distribution can be detected (Fischer 1986). In the diagram the average evenness and the average number of species of every treatment-unit were plotted and the changes from year to year were marked with arrows. The number of species is a parameter to describe the richness of an ecosystem. The evenness (%) describes the distribution of the species. 100% means that there is no hierarchy and all species are equally distributed. The smaller the evenness number the more dominated is the ecosystem by one or a few species (Häupler 1982).

4.3 Faunistic Study

Earlier investigations conducted in the 1980s on the slopes of the Kaiserstuhl area indicate that arthropods hibernating in the grass-layer are killed by prescribed fire conducted in wintertime. Individuals which hibernate in the soil usually survive. The concern about the loss of individuals affected by fire is of minor concern because the burned plots are relatively small and surrounded by unburned plots. Thus, the immigration rate after fire is very high and takes place very rapidly. Therefore there is just a temporary shift of populations, and no sustainable change in the species composition was observed so far (Lunau and Rupp 1988). In this project, the direct and indirect effects of fires on snails have been investigated. The snail populations served as indicators for the rate of spread of the post-fire re-colonisation.



Figure 5. A (upper): Burning of an experimental plot in January 1998 by an upslope headfire. The red-white sticks are used to determine the rate of fire spread. **B (lower):** The same slope immediately after burning. The typical mosaic of burned and unburned patches generated by prescribed burning is clearly recognisable. Unburned patches are important for the re-colonisation by animals.

The results of the faunistic study indicate that no shift was found in species composition of snails on burned and unburned plots. In most cases the number of the individuals were significantly reduced on the burned plots. The migration rate of big snail species is very small (average: 5 to 10m/year). The maximum distance covered was about 30m/year.

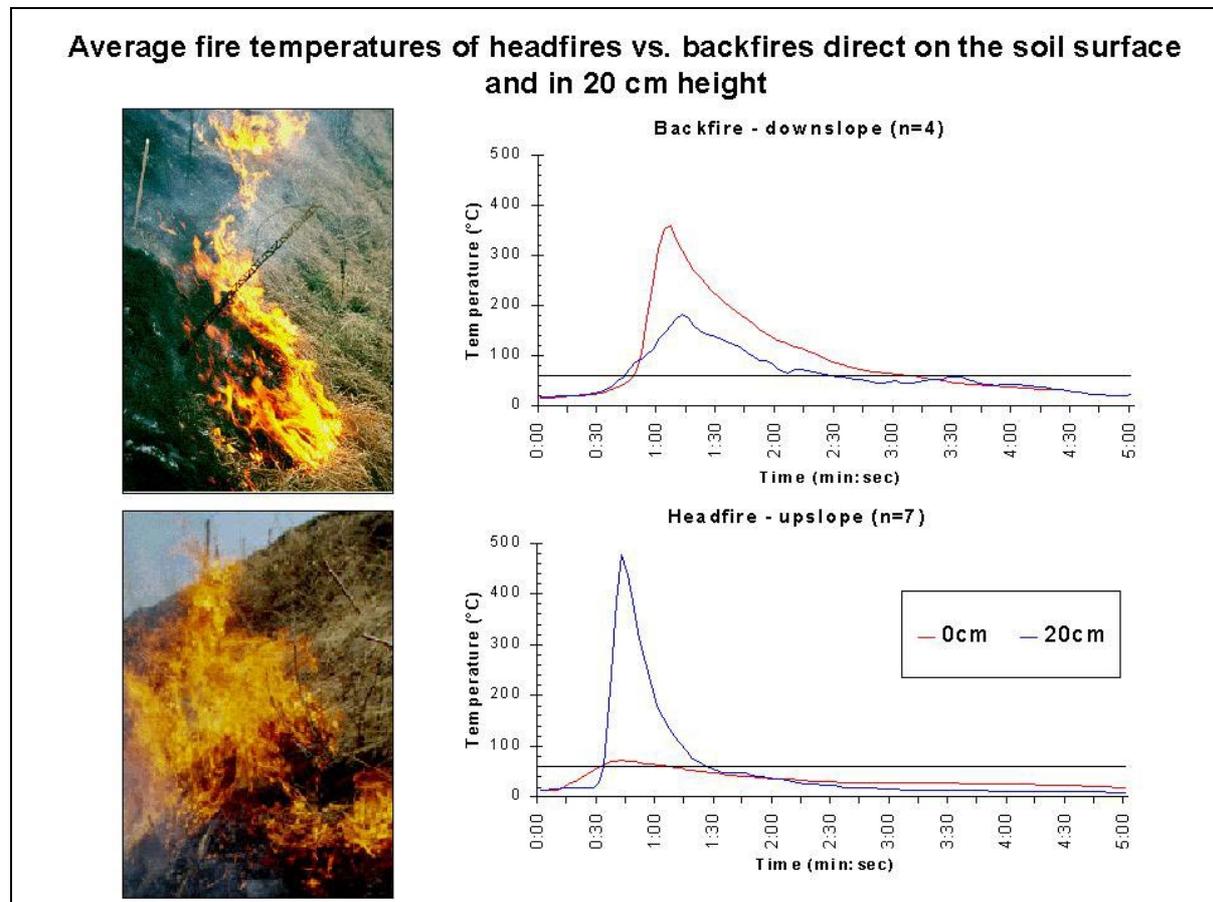


Figure 6. Average temperatures of headfire and backfire on the ground and in 20 cm height. The backfire creates very high temperatures directly on the ground. The animal and plant species which hibernate on or in the ground are much more affected by this type of fire as compared to a headfire which has its maximum temperature some decimetres above ground.

4.3 Socio-Economic Component

At the start of the project discussions with different groups of society which are involved in agriculture, viticulture and landscape management in the region (farmers, municipality, governmental and non-governmental nature conservation organisations) revealed conflicting views on the potential application of prescribed burning. While farmers and local municipalities unanimously requested for a restoration of general permission to use prescribed fire as a tool to suppress succession, the governmental nature conservation bodies and NGOs were concerned about the negative impact of burning on ecosystems concerned and on the environment in general. In order to create a common discussion platform, to overcome controversial views and to develop a mutually acceptable and harmonised management strategy a "Round Table on Slope Management in the Kaiserstuhl Area" was created.

During four round-table sessions in winter 1999-2000 an agreement was achieved which was accepted by all parties. The first result was a general strategic paper called "Model for the future development of the vineyard slopes in the Kaiserstuhl area". In this paper it is stated that the open vegetation structures which still exist in the region should be maintained and that different management tools which include prescribed

burning must be applied to obtain the desired results. This agreement and statement for the first time in Central Europe accepted prescribed burning as a tool for landscape management. In the Appendix of the strategic paper a detailed prescription is given how fire has to be (re-)introduced in landscape management in the future. The general framework states:

- Prescribed burning will be restricted to the winter season (between November and February) under specifically defined weather conditions.
- The burned parts have to be small (not more than half of a slope which belongs to one section of land (often but not necessarily identical with ownership; the absolute maximum is a 50m-wide portion of an individual slope) and it is not allowed that two burned parts border on each other. With this prescription a mosaic of burned and unburned plots is guaranteed which is a vital prerequisite for re-colonising of damaged fauna, particularly arthropods.
- The owner of the slope is responsible for the management. Everybody is eligible to obtain a permission for the use of prescribed burning under the condition that he/she has participated in an information and training programme.
- In winter 2000-2001 prescribed burning was introduced in one municipality. Based on the positive experiences the whole Kaiserstuhl area has been included in the programme starting in winter 2002-2003.

After the research phase a six-years test period (2000 until end of 2005) served to test if the management goals can be accomplished with the introduction of prescribed burning. Meanwhile more than 3000 farmers / viticulturists have participated in prescribed burning training courses.

It is currently planned to expand the use of prescribed burning in viticulture areas to the North of the Kaiserstuhl area (Northern Breisgau).

5. Conclusions

The Kaiserstuhl prescribed burning project still has a catalytic and pilot function in the landscape of prescribed burning projects in Germany. In the near future the State of Baden-Württemberg will revise its current Nature Conservation Law. It is quite possible that the current restrictions on the use of fire in natural systems may be modified towards a regulation that would allow exemptions for burning based on a burning permit system.

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