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Abstract

The maintenance of cultivated landscapes, the conservation of biodiversity and landscape aesthetics are part of a multifunctional agriculture. However, little is known about the influence of single agricultural landscape elements in different seasonal stages on landscape aesthetics. In a Swiss-wide photo survey we investigated the aesthetic preferences of Swiss residents for different agricultural landscape elements that are typical in the Swiss lowlands. Photographs of seven crops and seven ecological compensation areas (ECAs) were selected. Each element was presented in four to six different seasonal stages on single paper-based questionnaire pages and, in addition, replicated four times. A random selection of four elements was sent to each study participant who had to rank the four in decreasing order of aesthetic value (preference rating scores). Overall, ECAs received higher preference ratings than crops. Most preferred were high-stem fruit trees, hedgerows, and low-intensity pastures, i.e. ECAs with a vertical structure. Study participants characterised ECAs as varied, species-rich and beautiful. In addition, the seasonal stage of a landscape element strongly influenced preference ratings. Flowering stages of both ECAs and crops were clearly liked most. Moreover, perceived diversity and naturalness of an element had a strong positive effect on its rating. The results indicate that ECAs, besides their ecological function, are powerful elements to enhance the public's preference for agricultural landscapes. Moreover, the results might be useful for the development and adaptation of quantitative methods to capture the aesthetic value of agricultural regions and might provide a basis for political decisions concerning potential direct payments for aesthetic services of agriculture.

Keywords: Landscape preference, aesthetic value, biodiversity, ecological compensation areas, photo survey

1 Introduction

Agricultural landscapes provide beneficial functions and services to humans that go far beyond agricultural production. Modern agriculture is defined as multifunctional, comprising food production, ecological functions and recreational and aesthetic values (e.g. Jongeneel, Polman, & Slangen, 2008) and landscape aesthetics are now widely recognised as an ecosystem service (Butler & Oluoch-Kosura, 2006; Gobster, Nassauer, Daniel, & Fry 2007). Although many scholars have stressed the importance of including aesthetic aspects in landscape management, planning and policy (e.g. Dramstad, Tveit, Fjellstad, & Fry, 2006; Tress, Tress, Décamps, & d'Hauteserre, 2001), such aspects are often neglected due to a lack of quantitative indicators of visual quality (Dramstad et al., 2006).

Current agricultural policy, in Switzerland and elsewhere, can have visible effects on landscape aesthetics (e.g. Schüpbach, Zgraggen, & Szerencsits, 2008; Junge, Lindemann-Matthies, Hunziker, & Schüpbach, 2011). In the past years, the Common Agricultural Policy (CAP) of the EU was substantially reformed by decoupling area-related direct payments from production payments (Potter & Burney, 2002; Brady, Kellermann, Sahrbacher, & Jelinek, 2009). Benefits of agriculture to rural development, agro-ecology and biodiversity are now rewarded with an increasing share of agricultural subsidies (Kleijn & Sutherland, 2003; Potter, 2006). Farmers in Switzerland have since 1999 to prove that they meet a number of environmental standards in order to qualify for area-related direct payments (Aviron, Nitsch, Jeanneret, Buholzer, Luka, Pfiffner, Pozzi, Schüpbach, Walter, & Herzog, 2009; FOAG, 2012). One of these standards in the Swiss agri-environmental programme demands that each participating farmer has to manage at least 7% of his or her farmland as so-called ecological compensation areas (ECAs). For establishing these areas, farmers are financially compensated. The catalogue of ECAs

encompasses traditional landscape elements as well as new types of biotopes, which are designed for the purpose of biodiversity conservation and of enriching the agricultural landscape (FOAG, 2012; see also Jeanneret, Schüpbach, Pfiffner, Herzog, & Walter, 2003). Major types of ECAs are low-intensity grasslands, traditional orchards, hedges, and wild flower strips. Fertilisation and pesticide use is restricted in ECAs, and dates for mowing of meadows are prescribed (FOAG, 2012).

While recent research indicates that people appreciate semi-natural elements and species richness in agricultural landscapes (e.g. Soini & Aakkula, 2007; Lindemann-Matthies, Junge, & Matthies, 2010b; Hasund, Kataria, & Lagerkvist, 2011), comprehensive studies on the visual qualities of single agricultural elements such as different ECAs, crops or high-intensity grasslands are missing. Not only conservation elements like ECAs, but also the choice or combination of crops and grasslands can have effects on landscape aesthetics (Junge et al., 2011). Therefore, the aesthetic value of single agricultural landscape elements is crucial for landscape planning, and might also be of importance concerning direct payments for services of agriculture for landscape management and conservation. An adaptation and differentiation of these agricultural payments towards landscape attributes that are demanded by society may lead to a more socially efficient landscape policy (Hasund et al., 2011).

The appearance of a landscape changes with the seasons (Palang, Fry, Jauhiainen, Jones, & Sooväli, 2005). This is especially the case in agricultural landscapes with time-dependent management practices like mowing and crop harvests (Coeterier, 1996; Brassley, 1998). It has been suggested that seasonal aspects are an important component of landscape perception and aesthetic valuation (Hull & McCarthy, 1988; Brassley, 1998; Stobbelaar & Hendriks, 2007). However, seasonal landscape changes, e.g. in colours and texture, have rarely been investigated

in landscape preference research.

How people perceive the aesthetic value of a landscape depends on both physical features of the landscape and the perceptual processes that those features evoke in the viewer (Daniel, 2001). The aesthetic valuation of a landscape is thus associated with thoughts and feelings people affiliate with a landscape (Greider & Garkovich, 1994). Therefore, socio-demographic variables like age, gender or professional background (Lyons, 1983; Strumse, 1996; Dramstad et al., 2006) as well as attitudes of people towards agriculture or nature protection might influence their aesthetic valuation of a landscape (e.g. Kaltenborn & Bjerke, 2002; van den Berg & Koole, 2006; Stilma, Smit, Geerling-Eiff, Struik, Vosman, & Korevaar, 2009).

This paper investigates the aesthetic quality of agricultural landscape elements in different seasonal stages in Switzerland. Photographs of typical ECAs, crops, and intensively managed meadows and pastures in the Swiss lowlands were presented to a random sample of 4000 Swiss households. To account for seasonal variety of landscape appearance (Stobbelaar, Hendriks, & Stortelder, 2004; Stobbelaar & Hendriks, 2007), elements were shown in four to six different seasonal stages. Because an objective assessment of the aesthetic value of different landscape elements is difficult (Palmer, 2000; Dramstad et al., 2006; Tveit, Ode, & Fry, 2006), it has been suggested to use more than one photograph of the landscape element in question (Palmer & Hoffman, 2001). We therefore used two photographs per landscape element in each seasonal stage. The main questions addressed were: (1) How do Swiss people rate the aesthetic value of different ECAs, crops, and intensively managed meadows and pastures in Switzerland? (2) Are ECAs preferred over crops and high-intensity grassland? (3) How does the seasonal stage influence the aesthetic valuation of a particular landscape element? (4) Which characteristics are attributed to the elements shown, and do these characteristics influence preference ratings? (5)

Are the preference ratings influenced by socio-demographic variables such as age, gender, education, and the general attitudes of persons towards agriculture and agricultural landscapes?

2 Material and methods

2.1 Study material and photo editing

To conduct a photo survey among Swiss households, photographs of 14 different landscape elements typical for the agricultural landscape in the Swiss lowlands were taken (Table 1). Of these, seven were ECAs (wildflower strips, moist meadows, hedgerows, high-stem fruit trees, species-rich field margins, low-intensity meadows and low-intensity pastures) and seven other elements (grain, grass-clover ley, maize, rapeseed, beet, high-intensity meadows and high-intensity pastures). The selected ECAs were the most common ones in the Swiss lowlands plus a newly introduced one (species-rich field margins). The other elements were those with the highest land cover in the Swiss lowlands and those for which high subsidies are paid (beet and rapeseed). To investigate the effect of animal presence on preference ratings (Kellert, 1993; Wandersee & Schussler, 1999), the exact same picture of high intensity pastures in June was shown with and without cows.

The photographs were taken in three typical agricultural regions of the Swiss lowlands (Canton of Zurich). All photographs were taken between March and October 2006 at the same time of day in sunny weather using a Canon EOS 350D with a 35 mm focal length. The scenes were photographed from paths, as these are the most common locations for walkers to observe the landscape. A tripod was used and the pictures were taken at the eye level of the observer. With a GPS (Leica GS 50 with an accuracy of about 0.45m) and a compass the exact position and angle

of view of the photographer were recorded. Thus it was possible to photograph exactly the same scene in different seasonal stages. Photographs have been shown to serve as a good representation for the real landscape (e.g. Daniel & Boster, 1976; Shuttleworth, 1980; Hull & Stewart, 1992; Daniel, 2001). Moreover, by using photographs a large sample of different landscape images could be shown to the study participants.

The visual appearance of a landscape element can vary strongly according to site conditions or management skills of the farmer. Moreover, a single photograph represents only a specific view of a specific site. Therefore, it has been suggested to replicate physical and visual characteristics such as shape, texture and colour to increase the validity of using photographs as landscape representatives (Palmer & Hoffman, 2001). Each element was photographed at two different sites to increase objectivity and representational validity of the images used in the present study. Moreover, each image was subsequently mirrored (left content and right content were reversed), resulting in four replicates per element. Mirroring of photographs might result in a bias due to a perceptual right-left bias. However, perception studies have shown that viewers are sensitive to foreground content (which had to be valuated) and its placement in the image, and not simply to one side of the field of vision (e.g. Patsfall, Feimer, Buhyoff, & Wellman, 1984).

To account for seasonal changes in colour and shape which may affect the visual appearance of a landscape element (Brassley, 1998; Stobbelaar & Hendriks, 2007), each element was photographed in four to six stages during the growing season (March to October; see Table 1). As the growing stages of plants in temperate zones are tightly coupled to the season, we refer in the following to ‘seasonal stages’. Only stages in which the seasonal characteristics typical for an element were clearly expressed were then selected for the questionnaire study (see Table 1). Overall, 244 images (14 elements * 4–6 seasonal stages * 4 replicates) were prepared.

The pictures were edited with Adobe Photoshop CS2. As the focus of this research was on single landscape elements in the foreground, the background of the photographs was standardised: identical forest, green hills, trees and a farm building. The season of the background was adapted to the season in which the element was photographed. However, for high-stem fruit trees, hedgerows and low-intensity pastures this was not possible and the original background of the scenes thus remained.

2.2 Questionnaire and pilot test

A written questionnaire was sent to a sample of randomly selected Swiss households. Overall, 244 different single images of agricultural elements, displayed on single questionnaire pages, were prepared for the survey. A number and, at the bottom, a scale from 1 to 7 was attached to each image. Out of the 244 questionnaire pages four were randomly distributed to every study participant. The random selection was done with the statistical programme R (Version 2.6.2) and was programmed to select four different elements per participant. Thus, it was guaranteed that participants did not receive the same element in different seasons or replicate versions. As it was a Swiss-wide survey, the questionnaire was also translated from German into two other national languages, French and Italian.

Study participants were asked to rate each landscape element on a scale attached, ranging from 1: 'totally dislike it' to 7: 'totally like it'. In addition, they were asked to characterise each element with the help of ten given adjectives on five-step scales, ranging from 1: disagree to 5: agree. The adjectives referred to landscape characteristics which have been found to influence people's aesthetic valuation (Appleton, 1975; Ulrich, 1986; Kaplan & Kaplan, 1989) and have been used in other studies (e.g. Hunziker, 1995; Hunziker & Kienast, 1999). They referred to physical

characteristics (diverse, species-rich), conservation potential (worth preserving), perceived naturalness and attributes associated with thoughts and feelings (beautiful, varied, well-kept, useless, unorderly and boring) of the landscape elements. Especially the perceived naturalness of a landscape or landscape element is considered to be a strong predictor of a positive aesthetic valuation (Purcell & Lamb, 1998; Ode, Fry, Tveit, Messager, & Miller, 2009). In addition, participants were asked to indicate on a five-step scale how familiar they were with the respective element, and how often (on a five-step scale) they would like to see it.

To investigate the influence of socio-demographic variables on aesthetic preferences, all participants were asked about their age, sex, education and the postal code of their place of residence. The postal code was used to classify three residence groups: urban, peri-urban, and rural. Study participants were further asked to indicate whether they were farmers or not, whether their profession was related to ecology or landscape planning, whether they had farmers among their friends or relatives, and whether they belonged to an environmental organisation. In addition, study participants were asked to state their opinion on a number of statements concerning Swiss agriculture and the agricultural landscape on five-step rating scales, ranging from 1: disagree to 5: agree. This was done to identify participants' opinion on different functions of agriculture, ranging from mere production to multifunctional agriculture.

A first version of the questionnaire was tested with 20 agricultural and environmental experts. After critical discussions about its comprehensiveness, the validity of the questions, and the quality of the images used, a second version of the questionnaire was tested with a random sample of 500 Swiss households drawn by the Swiss Office of Statistics. The response rate was 32% and only minor layout changes on the questionnaire were necessary for the final version.

2.3 Data collection and respondents

In June 2007, the final version of the questionnaire was sent to a random sample of 4000 Swiss households. As for the pretest, the random selection of the Swiss households was provided by the Swiss Federal Office of Statistics. In the cover letter the person with the most recent birthday in the household (age 18 or older) was asked to fill in the questionnaire. Following the advice in Dillman (1978), two reminders were sent to the participants after the original mail-out. A postcard reminder was sent to everyone after one week. Three weeks after the original mail-out a replacement questionnaire was sent to non-respondents. Non-respondents were identified with the help of a code attached to the return envelopes. Overall, 1538 persons (response rate of 39%) participated in the survey and 6074 single questionnaire pages (each with one image) were filled in. About 76% of the questionnaires that had been returned were in German, 20% in French and 4% in Italian which reflects more or less the language group distribution in Switzerland.

The study participants (47% female) were between 18 and 91 years old (mean age = 52.2 years). Most of the participants lived in peri-urban agglomerations (58%), 11% in urban cities and 31% in rural areas. A high school degree (or equivalent) was held by 52%; and 16% had a profession that was related to ecology or landscape topics. About 10% were farmers, 65% had friends or relatives who were farmers and 22% were members of an environmental organisation. The participants were on average better educated than the Swiss population, and members of environmental organisations were over-represented. Such differences were also found in other studies (Soliva, Bolliger, & Hunziker, 2010; Junge et al., 2011). Farmers were also strongly over-represented and showed their strong interest in this study. At present, about 4% of the working population in Switzerland is employed in agriculture and forestry, and the number continues to fall (FOAG, 2012).

2.4 Data analysis

Principal component analyses (PCA) were used to detect patterns in the responses of participants (1) to the twelve adjectives characterising the landscape elements and (2) to the ten general attitudes towards agriculture. An orthogonal type of factor rotation (varimax) was used according to the recommendations in Frane & Hill (1976). In both PCAs two factors were extracted. In the first PCA ('characterisation') the first factor ('varied and natural') had an Eigenvalue of 5.39 and the second factor ('kempt and familiar') one of 2.21; the composition of factors is shown in Table 2. In the second PCA ('general attitudes'), the first factor ('agricultural production') had an Eigenvalue of 2.28 and the second factor ('nature protection') one of 1.50; the composition of factors is shown in Table 3. To display the landscape elements according to their association with the factors ordination plots were drawn using CANOCO (version 4.5).

Mixed effect models with element, element * stage, image, participant and element * participant as random terms were used to test for influences of the following fixed terms on preference ratings: ECA and vertical landscape element (trees, hedgerows) (nested within element), seasonal stage with the two contrasts flowering ECA and flowering crop or high-intensity grasslands (nested within element * stage), socio-demographic variables of study participants (nested within participants). The socio-demographic variables tested were age, sex, education, farming background (farmer yes / no), membership in an environmental organisation (yes / no), place of residence (urban, peri-urban, rural) and language-region of Switzerland (German, French, Italian). In addition, the two factors extracted from the characterisations of the landscape elements ('varied and natural' and 'kempt and familiar'), and the two factors extracted from the general statements concerning agriculture ('agricultural production' and 'nature protection')

were included as co-variables (fixed effects, nested within element * participant) in a second model. Interactions between ECA and socio-demographic variables and factor scores were tested against element * participant (ECA was nested within element). In the model building process, non-significant fixed terms were subsequently removed from the model and the remaining variables were then analysed by general linear models (sequential sums of squares) to investigate how much of the overall variation was due to the variables tested. As both types of analyses do not allow strong correlations between the explanatory variables (Crawley, 2005), Pearson correlations were tested first. Farming background (farmer / non-farmer) was correlated with professional background (profession related to agriculture or landscape planning or not) and with participants having farmers among their friends or relatives. Professional background and 'farmers among friends and relatives' were thus excluded from the model.

The mixed model analyses were carried out with GENSTAT (version 11, VSN International 2008). All other analyses were carried out with SPSS for Windows (version 12.1).

3. Results

3.1 Overall valuation of the landscape elements

On average, study participants rated almost all ECAs higher than crops or high-intensity grasslands. The most preferred ECAs were high-stem fruit trees, hedgerows, low-intensity pastures and low-intensity meadows (mean rating scores per element over all seasonal stages, Fig. 1). The most preferred elements other than ECAs were high-intensity pastures, rapeseed and high-intensity meadows. In case of high intensity pastures and rapeseed, the mean rating scores per element were higher than the mean rating score of the ECA moist meadow, most likely due

to the presence of cows and the bright yellow flowers of rapeseed (see Figure 1). In addition, all meadow types were rated low in March due to a greenish-brown appearance at the beginning of the growing season. The mean rating scores per seasonal stage of an element showed that flowering stages of ECAs, crops (with the exception of maize) and high-intensity meadows or pastures received the highest preference ratings (see Fig. 1; compare Table 1). ECAs also received rather high ratings in most non-flowering stages. Moreover, most ECAs were flowering in several stages. Three-dimensional elements in particular (high-stem fruit trees, hedgerows, low-intensity pastures with trees and bushes) were liked in all seasonal stages. ECAs and crops early in the year (March, 'brown' appearance after snowmelt) and cut meadows, stubble fields or stages where bare soil was visible (before germination of plants or – in case of beet - the mixture of bare soil and small young plants) received the lowest preference ratings.

3.2 Characterisation of the landscape elements

In addition to the preference ratings, study participants were asked to characterise each of the landscape elements with the help of pre-given adjectives. To identify associations between the characterisations of the elements a factor analysis was used. Two factors were extracted. The first factor combined characteristics that can be summarised as 'varied and natural' and the second factor combined characteristics that can be summarised as 'kempt and familiar' (Table 2).

In an ordination plot the landscape elements were displayed according to their association to these characteristics (Fig. 2). ECAs were mainly characterised as varied, species-rich, desired ('like to see it often'), worth preserving and beautiful. Some ECAs, depending on the seasonal stage, were described as unorderly. Crops as well as high-intensity grasslands were mainly characterised as kempt, familiar and boring.

3.3 General opinions on agriculture and landscape topics

To identify groups of general attitudes towards agriculture and the agricultural landscape among the study participants, another factor analysis was used. The number of factors was again restricted to two. The first factor combined attitudes that can be summarised as ‘agricultural production’ and the second factor combined attitudes that can be summarised as ‘nature protection’ (Table 3).

3.4 Influence of element characteristics, seasonal stage and socio-demographic variables on preference ratings

Both the type of element (ECA or not) and the seasonal stage influenced the rating of the landscape elements (Table 4). In particular, trees and bushes (vertical elements) and flowering stages positively influenced the preference ratings. Farmers rated ECAs lower than non-farmers, whereas members of environmental organisations rated ECAs higher than non-members.

The characterisation of the landscape elements (factor scores see Table 2) strongly influenced the rating. The more ‘varied and natural’ but also the more ‘kempt and familiar’ an element was perceived to be, the higher was the rating score (Table 5). The element characterisation ‘varied and natural’ was fitted before the effect of ECA. Because these two explanatory variables are highly correlated, ECA no longer had a significant effect. However, as we were interested in the interactions between ECA and socio-demographic variables and the factor scores ‘agricultural production’ and ‘nature protection’, ECA was also included in the model. The more strongly a participant scored with the factor ‘agricultural production’ (see Table 3), the higher was the

rating of a crop, high-intensity meadow or high-intensity pasture, and the lower was the rating of an ECA.

4. Discussion

Over all seasonal stages, most crops and the high-intensity meadow received mean preference ratings around the mid-point of the 7-step scale, while almost all ECAs received higher preference ratings than crops or intensively managed meadows or pastures. The aesthetically most preferred landscape elements were high-stem fruit trees, hedgerows and low-intensity pastures with trees and bushes. This shows a strong preference for vertical landscape elements. Many researchers argue that humans have an innate preference for open landscapes with scattered trees (Appleton, 1975; Orians, 1980, 1986). Especially in agricultural landscapes, three-dimensional elements such as (spaced) trees and hedgerows add character and variety to otherwise often rather homogenous sceneries, which, in turn, might result in higher aesthetic quality (Angileri & Toccolini, 1993; Seabrook, McAlpine, & Fensham, 2008; Hasund et al., 2011). In addition to three-dimensional and species-rich elements, the presence of cows was valued positively. This is not surprising as humans are generally more interested in animals than in plants (Wandersee & Schussler, 1999), and especially like large animals (Kellert, 1993).

The seasonal stage strongly influenced the valuation of a landscape element; flowering stages were clearly liked most. The yellow flowering rapeseed and the high-intensity meadow with yellow flowering dandelion were the most preferred seasonal stages of landscape elements other than ECAs. Other studies have also shown that colourful flowers are highly appreciated by people (Akbar, Hale, & Headley, 2003; Lindemann-Matthies & Bose, 2007). It has even been argued that humans have a genetically based preference for brightly coloured flowers

(Heerwagen & Orians, 1993) or certain colours in general (Smets, 1973). However, species-rich flowering low-intensity meadows were preferred to flowering rapeseed or flowering high-intensity meadows or pastures, indicating that not only flower colour but also colour variety influenced preference ratings positively. This is in line with preference scores for colourful but monotonous tulip fields, which were lower than those for more diverse field margins and crops with wildflower mixtures in a Dutch study (Stilma et al., 2009). Moreover, species-rich elements such as low-intensity meadows, species-rich field margins, and wild flower strips offer flowering species from spring to fall, in contrast to, for instance, crops such as rapeseed which flower only once a year for a short period of time. Thus, the expression of the seasons in colours and shapes in a landscape throughout the year will be far greater with extensively managed and thus more species-rich landscape elements (Stobbelaar et al., 2004; Stobbelaar & Hendriks 2007) and will increase landscape diversity over time. In addition to flower colour, there is the change in colour of deciduous trees and bushes in fall, which also received high preference ratings in our study. Although it has been recognized that seasonal changes in colour and texture of landscape elements and land-cover types influence landscape perception and evaluation (Coeterier, 1996; Brassley, 1998; Tveit et al. 2006), only few studies have examined the effects of seasonal aspects on landscape perception and preference (Stobbelaar et al., 2004; Stobbelaar & Hendriks, 2007; Kuper, 2013). The influence of the season on aesthetic preference ratings in the present study corroborates the demand to account for seasonality in landscape preference research.

ECAs were characterised to be varied, species-rich, beautiful, desirable, and worth preserving. However, some of them were also characterized as unorderly. It has been argued that the general public might not like the somewhat scrubby appearance of set-aside land and instead might prefer neat and orderly landscapes it is used to (Nassauer, 1995; Burton, 2004). In our study,

however, an unorderly appearance of ECAs was only perceived in early spring and in fall when they had a rather brownish appearance. Moreover, the season also affected the characterization of crops: cut rapeseed in August was also perceived as unorderly. In a study by Junge, Jacot, Bosshard, & Lindemann-Matthies (2009) field margins with a partly 'scrubby' appearance in an on-site survey in Switzerland were not perceived as messy but were explicitly liked because of their natural appearance and diversity. Almost all crops and the high-intensity meadow were characterised as kempt and familiar, but also as boring. In a study by Soini & Aakkula (2007), rural residents in Finland felt that monocultures reduce the aesthetic value of a landscape. Most respondents of a Dutch study by Stilma et al. (2009) gave only low or medium preference ratings to crops compared with field margins or crops mixed with wild flowers. The spatial or chromatic homogeneity of elements like crops or high-intensity grassland can make them boring and visually unattractive for humans (Wandersee & Schussler, 1999). In the present study, perceived variety and naturalness of the elements had a strong positive effect on preference ratings. Overall, the variety and natural appearance of an element more strongly influenced preference ratings than a 'kempt' appearance. This is in line with results from other studies. Beauty ratings of agrarian and nature scenes in a study from the Netherlands (van den Berg, Vlek, & Coeterier, 1998) were positively related to perceived complexity and biodiversity, and species-rich elements increased preference ratings of agrarian landscapes in Norway, the Netherlands and Switzerland (Strumse, 1994; Stilma et al., 2009; Junge et al. 2011). Two studies using an on-site approach showed that participants responded very positively to species-rich field margins, which were presented to them directly in the field (Junge et al., 2009) and that perceived species diversity increased the aesthetic appreciation of grassland vegetation by study participants (Lindemann-Matthies et al., 2010b). Moreover, a recent study measuring the willingness of

Swedish inhabitants to pay for services provided by agriculture showed that biodiversity was valued highest among attributes of agricultural elements (Hasund et al., 2011).

Our results suggest that physical characteristics of landscape elements are stronger predictors of aesthetic preference than socio-demographic variables of study participants. Variety and natural appearance of an element were the strongest predictors of the preference rating in our models, whereas socio-demographic variables and general attitudes of participants towards agriculture were of minor importance and had only small effects on preference ratings. Other studies have also shown a strong influence of landscape characteristics on preference ratings (overview in Kaplan & Kaplan, 1989; Ulrich, 1993; Kaplan, Kaplan, & Ryan, 1998) and comparatively little influence of socio-demographic variables and general attitudes of respondents (e.g. Hagerhall, 2001; Ode et al., 2009; Lindemann-Matthies et al., 2010b; Junge et al., 2011). However, members of an environmental organisation were more in favour of ECAs, possibly due to a higher affinity to 'natural' looking settings and due to more knowledge about the threats to biodiversity in agricultural landscapes (see also Hunziker, Felber, Gehring, Buchecker, Bauer, & Kienast, 2008; Lindemann-Matthies, Briegel, Schüpbach, & Junge, 2010a; Lindemann-Matthies et al., 2010b; Junge et al., 2011). Contrary, farmers were less in favour of ECAs than non-farmers. Farmers see the agricultural landscape through the lens of a production function and thus show preferences for intensively used, tidy and ordered agricultural landscapes (Stilma et al., 2009; Burton, 2011). Nevertheless, other studies have shown that farmers with an environmental interest are more in favour of conservation measures in agricultural land than farmers without such an interest (e.g. Herzon & Mikk, 2007; Junge et al., 2011). Moreover, as attitudes of the non-farming public can positively influence farmers' attitudes towards agri-environment schemes (Herzon & Mikk, 2007), the present data might help to overcome barriers

of the farming community towards on-farm nature conservation.

Due to non-response, our sample is not free from bias, reducing the representativeness of the results. However, non-response bias is difficult to avoid in postal surveys and a response rate of 39% is actually high for nature-related postal surveys in Switzerland, where rates of 25% and lower are much more common (see, e.g., Soliva et al., 2010). The over-representation of, e.g., farmers and members of environmental organizations shows their strong interest in this study. As our findings were only marginally influenced by socio-demographic variables (even being a farmer or an environmentalist explained only a small proportion of variation) non-response bias is not a serious concern.

5. Conclusions

We conclude that conservation elements like ECAs are — apart from their ecological importance — powerful elements to enhance the public's preference for agricultural landscapes. Besides their structural and species diversity, ECAs increase visual landscape quality throughout the year as being mostly permanent elements with long-lasting flowering periods. This is a pleasing result because ecologically sound landscapes are more likely to be sustained if they evoke enjoyment and approval by the public (Nassauer, 1997; Gobster et al., 2007). As the demand for recreation in agricultural landscapes is increasing (Buijs, Pedroli, & Luginbuhl, 2006), values attached to the agricultural land may be changing over time, giving biodiversity and landscape aesthetics a higher importance than the production function of agriculture. There are increasing demands for the integration of socio-cultural values into agricultural policy and, in particular, to design socially accepted payment schemes (Stilma et al., 2009; Hasund et al., 2011). One objective of the recently reformed Swiss agricultural policy is to orientate agricultural payments for public

services more strongly on social demands. However, the lack of an easily accessible methodology to assess the aesthetic values of a landscape so far often prevented the inclusion of visual aspects in the valuation of ecosystem services provided by agriculture (Dramstad et al., 2006). Our approach shows that quantitative methods can capture aesthetic values of landscape elements. It thus offers a new method that can be applied for landscape planning as well as for agricultural policy development. For example, our results could help to define landscape quality payments, which are newly introduced in Swiss agricultural policy, that meet current landscape preferences of the general public. If agricultural policy wants to foster multifunctional services of agriculture that meet the public preferences for agricultural landscapes, the strong preference for diverse landscapes and landscape elements, i.e. seasonal, structural and species diversity, should be taken in to account.

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Table Captions

Table 1: Description of the agricultural landscape elements used. Photographs of each element were taken in different seasonal stages.

Table 2. Correlation coefficients for the relationship between different characterisations of landscape elements and two factors extracted in a principal component analysis. Only correlations with $r > 0.30$ are shown.

Table 3. Correlation coefficients for the relationships between different attitudes towards agriculture and the first two factors extracted in a principal component analysis. Only correlations with $r > 0.30$ are shown.

Table 4. The influence of element characteristics, seasonal stage, and background characteristics of the study participants on the rating of the landscape elements. (a) ANOVA and (b) variance components estimated by restricted maximum likelihood. In addition, the proportion of variation explained by the tested variables taken from a GLM is shown.

Table 5. The influence of the participants' attitudes towards agriculture, their characterisation of the landscape elements, physical element features and background characteristics of the study participants on the rating of the landscape elements. (a) ANOVA and (b) variance components estimated by restricted maximum likelihood. In addition, the proportion of variation explained by the tested variables taken from a GLM is shown.

Figure captions

Fig. 1: Mean rating of landscape elements on a seven-step rating scale (1 = totally dislike it, 7 = totally like it). Mean rating per element over 4 to 6 different seasonal stages (M) and mean rating per seasonal stage (months) are shown. For the description of the seasonal stages see Table 1.

Fig. 2. Ordination of landscape elements along the gradients of their characterisation by the study participants. Blue triangles represent crops and intensively managed grasslands, red circles represent ECAs. The landscape attributes (characterisations) are displayed along the two factors extracted in a PCA (see Table 2). Shortcuts in the Figure denote in alphabetical order: ExtMeadow = low-intensity meadow, ExtPasture = low-intensity pasture, FlowerStrip = wildflower strip, Fruit = high-stem fruit trees, Grass = grass-clover ley, IntMeadow = high-intensity meadow, IntPasture = high-intensity pasture, Margin = field margin, Wetland = moist meadow; numbers denote the seasonal stage (month).

Table 1. Description of the agricultural landscape elements used. Photographs of each element were taken in different seasonal stages.

	Element	Seasonal stage (month)						
		March	April	May	June	July	August	October
Crops	**1 Grain**	Brown (very short grain plants, soil)		Green, 0.3 m		Ripe (yellow spikes), 1.2 m	Stubble field	
	2 Grass-clover ley	Brown short grass[2]	Green, short	Green, medium height (0.3 m)	Green-brownish, short (recently cut)			Green, medium height (0.3 m)
	3 Maize			Only soil[1]	Small green rows, soil	Green, 1.5 m	Green with brown spikes, 2 m	Stubble field
	4 Rapeseed		Green, 1m	Flowering, 1.5 m	Husks, 1.5 m		Stubble field	
	5 Beet			Only soil[1]	Green rows, soil	Green, 0.3 m, gaps of soil		Green, 0.5 m
	6 Intensively used pasture		Green, short	Few flowers, short	Green, short [3]			Green, short, with tussocks
	7 Intensively used meadow	Brown short grass[2]	Green, short	Flowering, 0.3 m	Cut, brownish	Green, few flowers, 0.4 m		Green, short
ECAs	**8 Wildflower strip**	Brown, 0.3-2 m			Flowering, 0.7-1.7 m	Flowering, 1-2 m		Brown, few flowers, 1-2 m
	9 Moist meadow	Brown short grass[2]	Brownish, short, some water ponds	Green, short	Flowering, 0.3-1.5 m			Green - brownish, short
	10 Hedgerow		Bare-branched	Flowering		Green		Green/reddish
	11 High-stem fruit trees		Bare-branched	Flowering		Green		Green/reddish
	12 Field margin	Brown, 0.3-1.5 m			Flowering, 0.6-1.5 m	Flowering, 0.8-1.5 m		[4]Brown, few flowers, 1-2 m
	13 Low-intensity pasture		Short grass, bushes & trees bare-branched	Some flowers/high grass, bushes & trees green	[3]Short grass, bushes, trees green			Short grass, bushes, tress reddish
	14 Low-intensity meadow	Brown short grass[2]	Green, short	Flowering, 0.3-0.5 m	Flowering, 0.3-0.7 m	Flowering, 0.3-0.8 m		Green, short

[1]One picture for beet and maize; [2]One picture for all meadow types; [3]Same picture with and without cows; [4] Picture taken in the end of September

Table 2. Correlation coefficients for the relationship between different characterisations of landscape elements and two factors extracted in a principal component analysis. Only correlations with $r > 0.30$ are shown.

Characteristic of landscape element	Factor 1	Factor 2
Varied	0.888	
Diverse	0.869	
Species rich	0.841	
Like to see it often (desired)	0.802	0.330
Beautiful	0.796	0.333
Worth preserving	0.783	0.350
Natural	0.780	
Boring	-0.694	
Unorderly		-0.795
Kempt		0.775
Useless	-0.360	-0.578
Often seen (familiar)		0.503

Table 3. Correlation coefficients for the relationships between different attitudes towards agriculture and the first two factors extracted in a principal component analysis. Only correlations with $r > 0.30$ are shown.

Statements	Factor 1	Factor 2
Agriculture leaves enough room for nature in the Swiss lowlands.	0.733	
The Swiss lowlands should be mainly used for production; there is enough room for nature conservation in the Swiss Alps.	0.678	
I prefer a landscape that contains mainly arable crops.	0.627	
Agriculture is environmentally friendly.	0.622	
The production of food is the main function of agriculture.	0.554	
I prefer a landscape that contains arable crops and grassland.		0.712
The agricultural landscape is important for recreation.		0.524
Landscape conservation belongs to the services of agriculture.		0.522
I prefer a landscape that contains mainly grassland.		-0.436
Arable crops are typical for the Swiss lowlands.	0.326	0.376

Table 4. The influence of element characteristics, seasonal stage, and background characteristics of the study participants on the rating of the landscape elements. (a) ANOVA and (b) variance components estimated by restricted maximum likelihood. In addition, the proportion of variation explained by the tested variables taken from a GLM is shown.

a) ANOVA	GLM	Mixed model			Effect
Source of variation	% SS	df	F-value	p-value	
ECA (yes / no)	8.3	1	27.68	<0.001	+
Vertical element	1.6	1	5.59	0.037	+
Flowering ECA	5.2	1	43.24	<0.001	+
Flowering crop	2.0	1	20.17	<0.001	+
Seasonal stage	2.4	4	5.44	0.001	+ in May/June – in March
Environmental organisation member	<0.1	1	1.99	0.158	
Farmer	<0.1	1	1.67	0.196	
Language region (German, French, Italian)	0.6	2	15.61	<0.001	F = –
ECA * Organisation member	1.0	1	91.63	<0.001	ECAs = + Crops = –
ECA * Farmer	0.5	1	46.13	<0.001	ECAs = – Crops = +
ECA * Language region (G, F, I)	0.2	2	7.97	<0.001	ECAs*G = + Crops*I = +

b) Estimated variance components

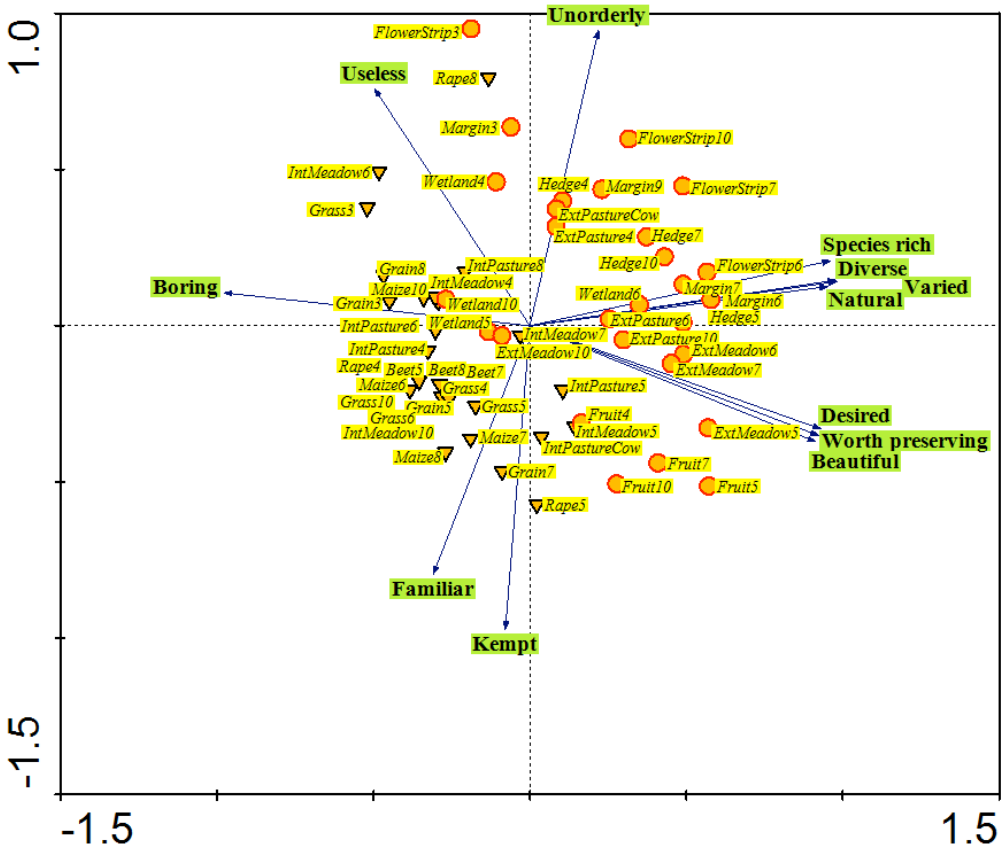
Source of variation	Component	s.e.
Element	0.0703	0.0539
Element * stage	0.1836	0.0490
Image	0.0647	0.0157
Participant	0.3287	0.0313
Element * Participant	0.8714	0.3681
Residual	0.8530	0.3666

Table 5. The influence of the participants' attitudes towards agriculture, their characterisation of the landscape elements, physical element features and background characteristics of the study participants on the rating of the landscape elements. (a) ANOVA and (b) variance components estimated by restricted maximum likelihood. In addition, the proportion of variation explained by the tested variables taken from a GLM is shown.

a) ANOVA	GLM	Mixed model			Effect
Source of variation	% SS	df	F-value	p-value	
General opinion on agriculture 'production'	0.5	1	74.21	<0.001	+
General opinion on agriculture 'scenery'	0.2	1	72.26	<0.001	+
Element characterisation 'varied and natural'	57.4	1	6153.67	<0.001	+
Element characterisation 'kempt and familiar'	11.0	1	1092.72	<0.001	+
ECA (yes / no)	<0.1	1	0.24	0.629	
Flowering ECA	0.1	1	6.30	0.015	+
Flowering crop	0.3	1	19.48	<0.001	+
Seasonal stage	0.2	4	3.33	0.019	May/June = + March = –
Environmental organisation member	<0.1	1	0.00	0.944	
Farmer	<0.1	1	0.62	0.433	
High school degree	<0.1	1	0.00	0.993	
Language region (German, French, Italian)	0.5	2	30.38	<0.001	F = –
'Production' * ECA	0.1	1	26.31	<0.001	ECAs = – Crops = +
ECA * Organisation member	0.1	1	13.28	<0.001	ECAs = + Crops = –
ECA * Farmer	0.1	1	8.66	0.003	ECAs = – Crops = +
ECA * High school degree	<0.1	1	6.45	0.011	Crops = –

b) Estimated variance components

Source of variation	Component	s.e.
Element	0.0166	0.0098
Element * stage	0.0143	0.0066
Image	0.0126	0.0060
Participant	0.1125	0.0137
Element * Participant	0.0000	bound
Residual	0.7050	0.0183



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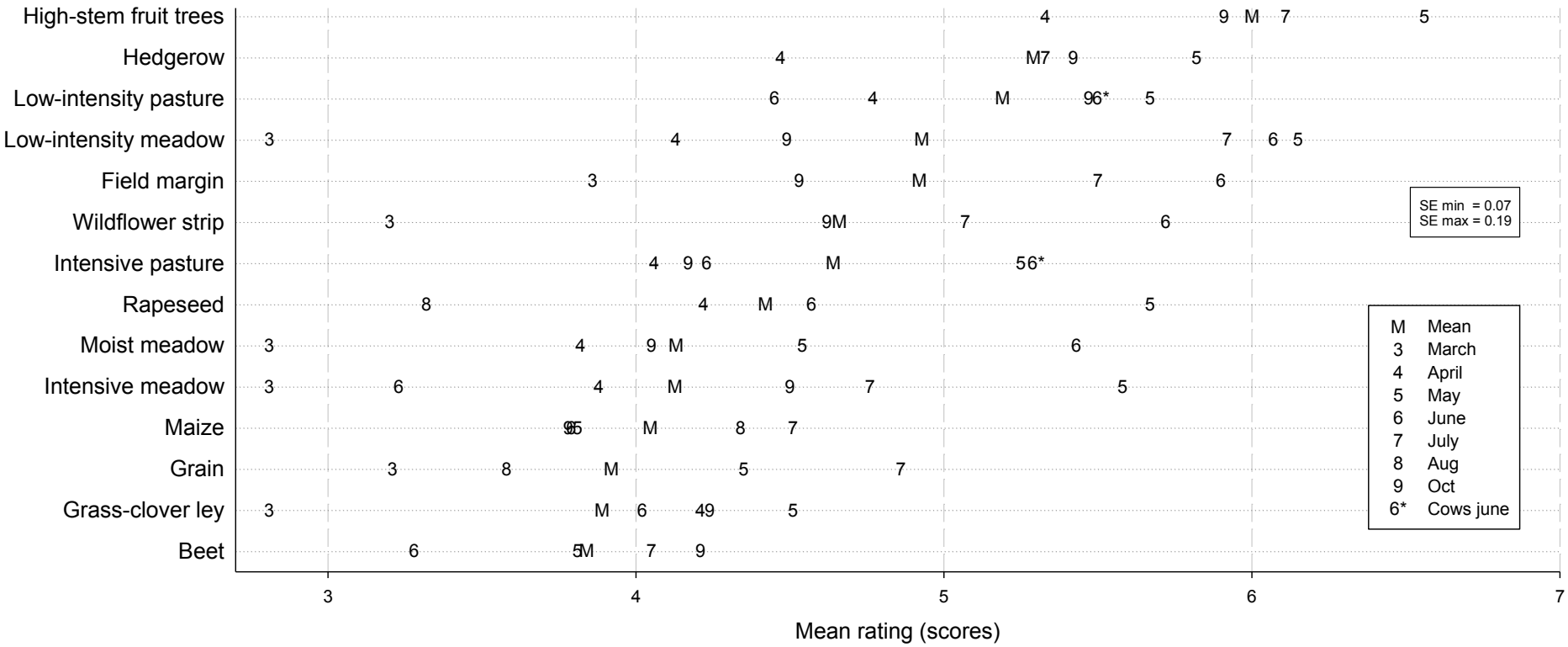

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