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How to monitor semi-natural key habitats in relation to grazing preferences of cattle in mountain summer farming areas An aerial photo and GPS method study

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Abstract

Summer farming was formerly an important part of Norwegian husbandry and mountain areas have been used for grazing for hundreds of years. A decline in summer farming practices, during the twentieth century, has caused a large-scale encroachment of trees and shrubs leading to extensive landscape changes and decreased biodiversity. Therefore, in order to maintain the biodiversity in summer farm mountain areas, it is now necessary to detect, map and monitor remaining species-rich fragments, i.e. key habitats. It is also important to identify still grass- and herb-rich areas that can be successfully restored for grazing because of a new interest for summer farming. Field surveys in the re-growing mountain areas are extremely time consuming, as the concomitant terrain renders movement by foot arduous. A method was thus developed for detection of key-habitats and other grass and herb-rich habitats in such areas based on interpretation of coloured infrared aerial photographs (CIR). In addition, black-and-white aerial photographs, taken nearly 40 years ago, were used to identify past open land and pastures and thus in combination with the modern ones allow the identification of areas that exhibit a continuity in grazing. Interpretation keys were developed and vegetation maps were constructed. The interpretation from the aerial photographs was compared to detailed field control and the method was found to be efficient and accurate. The method gave useful information about the landscape history and continuity of grazing. The cattle's movements were traced by GPS equipment mounted on a collar on the leading cattle, and their movements were later transferred to a map and analysed together with the vegetation map in a GIS. The results show that the cattle preferred to graze in the areas identified as most valuable and species rich. The developed method also makes it possible to identify areas for which pasture-restoration might be successfully achieved. Furthermore, the study revealed that there is a high correspondence between key habitats in the summer farming areas and grazing preferences of the cattle.
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Keywords: CIR aerial photos; Biodiversity; GPS; GIS; Key habitats; Sub alpine; Semi-natural vegetation

1. Introduction

Summer farming was formerly an important part of Norwegian husbandry making it possible to utilise the resources of outfields at long distances from the

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farms. Most summer farms were situated in the sub alpine forest region (Reinton, 1955,1957,1961) and Norwegian mountain areas have probably been used for grazing in this way since the Iron Age (Kvamme and Norderhaug, 1999). The summer farming system was most important in Norway during the nineteenth century, and covered large areas in the sub alpine forest region. 53,000 farms had summer farms in 1850 (Reinton, 1961) but the number decreased at the end of the century. Today less than 2000 summer farms remain (Kvamme and Norderhaug, 1999).

Clearing of the sub alpine birch forests around summer farms, as well as grazing and mowing over long time periods, have strongly influenced the types of vegetation present. Summer farming has created an open landscape and different semi-natural vegetation types and led to an increased biodiversity of the sub alpine areas (Olsson et al., 2000; Bryn et al., 2001). The biodiversity in these semi-natural open or semi-open vegetation types is still high. However, due to the decrease in summer farming and abandonment or cessation of management, shrubs such as *Juniperus communis* spp., *Salix* spp. and *Betula nana* are now invading the summer farming areas, succeeded by forests with *Betula pubescens* ssp. *czerepanovii* or *Picea abies* and many of the semi-natural vegetation types are gradually disappearing (Austrheim, 1998; Olsson et al., 2000; Bryn et al., 2001). This encroachment has been going on in a large scale during the last 50–60 years and has caused extensive landscape changes. It has also caused a decrease in biodiversity, as the shrub and forest habitats are less species-rich than the semi-natural vegetation types belonging to grasslands. The former widespread open grasslands remain, today, only as fragments, which still may be very species-rich. They should thus be regarded as key habitats.

We here define key habitats as those habitats characterised by remaining, mainly small patches of traditionally managed semi-natural vegetation types. They are species rich and contain formerly common but now rare species and constellations of species characteristic to extensively used pastures and hay-meadows with long continuity of use. Their existence and value depends upon further use or management. Our definition and use of the term key habitat is fairly analogous with the term woodland key habitat as it is described by Sverdrup-Thygeson (2002). The term was first introduced in Scandinavia forest management (Nitare and Norén, 1992).

To maintain the biodiversity of the remaining areas of former summer farms it is necessary to identify and secure such key habitats. Field surveys to find small fragments of semi-natural vegetation in extensive, overgrown, sub-alpine areas are, however, both difficult and extremely time-consuming. It is, therefore, important to develop a quick, reliable and efficient registration method. Remote sensing methods, based on data from air photos or satellite images have an advantage in such areas. Interpretation of coloured infrared (CIR) aerial photographs, in particular, has earlier been shown to be superior to interpretation of normal colour or black-and-white aerial photographs for vegetation and biotope mapping, a quick and efficient method with high accuracy (Ihse, 1979). Systematic tests, with assessment of the accuracy, and development of interpretation keys for medium scale vegetation mapping for planning purposes have earlier been performed on Swedish mountain vegetation (Ihse and Wastenson, 1975), as well as on vegetation in southern and central Sweden (Ihse, 1979). The CIR aerial photographs have been found to be very valuable for many vegetation types and in many applications. Specially-adapted classification systems and tests have been performed for vegetation mapping of and status description on many of the ecosystems in the Nordic countries; examples include wetlands and mires (Rafstedt and Andersson, 1981), forests (Ihse, 1992,1993,1994; Skånes and Ihse, 1988; Landenmark, 1998), grasslands as ancient meadows and pastures (Ihse, 1987; Norderhaug et al., 2000; Ihse and Lindahl, 2000) and biotopes in urban areas (Löfvenhaft and Ihse, 1998; Löfvenhaft et al., 2002). CIR aerial photos have also been used for change studies and for monitoring of cultural landscapes, including their vegetation, biotopes and landscape elements (Ihse, 1995; Cousins and Ihse, 1998; Ihse and Blom, 2000). We thus assume, that CIR aerial photos should be a valuable tool also for the sub-alpine summer farming areas in Norway. These types of photographs, however, have not previously been applied to the study of these types of vegetation as far as the authors are aware.

The encroachment of shrub and trees results in a diminishing of the amount of available pasture areas and is also a problem both for currently viable summer farming and for farmers who are interested in starting summer farming again. Technical methods and equipment for pasture restoration have been developed. Methods allowing possible identification of areas that may be successfully restored are, however, not available. Interpretation of old aerial photographs may be a useful tool for describing succession stages and identifying such areas. In addition, it will be necessary to track the walking routes of the cattle in the country to find out which vegetation types and terrain they prefer for grazing and thus guide the selection of areas for restoration. The tracking of cattle will also establish whether the cattle are especially interested in the key habitats and thereby contribute to the maintenance of these in spite of the large-scale encroachment.

With this background we used black and white aerial photos from 1964 and CIR aerial photos from 1999 to develop efficient interpretation keys to identify and map both key habitats and re-growing areas that may be successfully restored for grazing. In addition, we used a global positioning system (GPS) to track the landscape and vegetation utilisation of the cattle. The study is a part of a research project in the sub alpine forest areas of South Central Norway 1999–2002, entitled "Living Summer Farms".

2. Study sites

The investigations were performed at three sites, Liastølen, Gaurhovd and Fjellstølen (Fig. 1). They are all summer farming areas, used for cattle grazing since long time ago, at least 100 years. The land has been continuously grazed with shorter or longer breakes. In Liastølen there was a 17 years break between 1980 and 1997, in Fjellstølen a 50 years break between 1945 and 1995 and Gaurhovd has been continuously grazed. The detailed investigations were carried out on the summer farm Liastølen. The interpretation key for CIR interpretation was developed on the basis of results from the study on Liastølen and was tested in the two other summer farming areas.

Liastølen is located 930 m a.s.l. in Buskerud County. The farm lies in an open area in the sub alpine forest region in Hemsedal municipality. The investigated area is approximately 2 km^2, and it is bordered by the river Mørkedøla in the south, a mountain in the north and fences and gates to the east and west. Present land use is animal husbandry with cattle grazing. Several farms previously used this area for traditional summer farming activities with grazing of many cattles. Before 1950, about 100 cows grazed in the area (Lunnan et al., 1999). Today Liastølen is the only active summer farm, which still has cattle grazing. The outfields are grazed by about 15 dairy cattle, while the in-fields

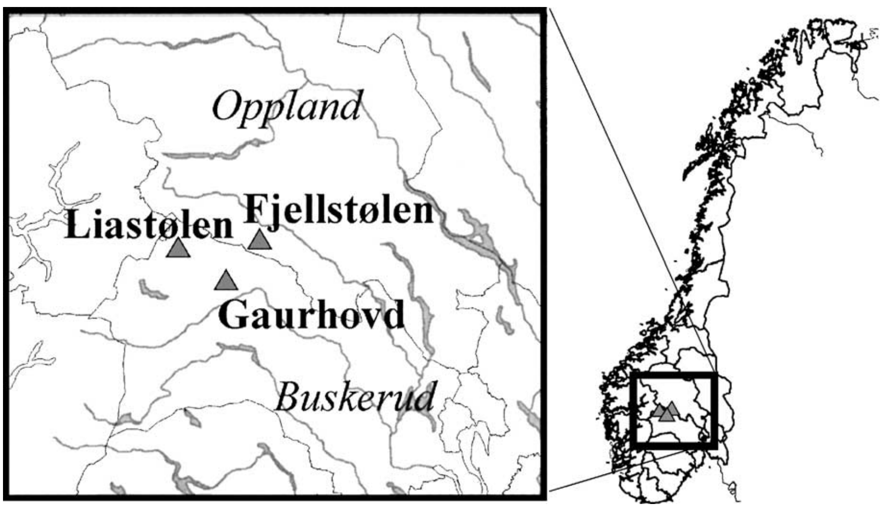

Fig. 1. The location of the investigated areas in Norway.

are used for hay production for winter fodder. The summer farm is used from the end of June until the first of September. The area contained many summer farms, but the other summer farms are today mainly used as holiday cottages. However, some of the owners have intensified the management of the in-fields for hay production.

The climate is bio-climatically characterised as a transitional section (OC) between the weak oceanic (O1) end the weak continental (C1) section (Moen, 1998). The closest weather station is in Hemsedal Municipality, located 610 m a.s.l. and about 10 km south-east of Liastølen. The average precipitation during the year amounts to 690 mm, most of it as summer rain (Aune, 1993). The yearly mean temperature by the weather station is 1.2 °C (Aune, 1993). However, Liastølen is located about 300 m higher than the weather station and the yearly mean temperature is therefore estimated, based on a decrease of approximately 0.6 °C per 100 m increase in elevation, to – 0.6 °C (Körner, 1999). The warmest month is July.

The bedrock consists mostly of diorite and gneiss. Gneiss is an acid bedrock type, with high content of silicon, and low content of other minerals. It thus exhibits a very low weathering capacity, and gives rise to nutrition poor soils. Diorite has also high amount of silicon, but exhibits a higher weathering capacity and contains also several valuable minerals for plants, e.g. calcium. The soils are more nutrition rich than those from gneiss but the nutrition values depend on type and amount of minerals.

Gaurhovd is located 1030 m a.s.l., in Ål municipality, Buskerud County. It has been continuously used as a summer farm with cattle grazing without any longer break for at least the last 100 years. They now have 14 dairy cows while they previously had both goats and about 10 cows. The neighbouring summer farms to Gaurhovd are no longer active. The outfields are, to a large extent, re-grown with *Salix* spp. and *Juniperus communis* spp. According to the farmer, this succession has occurred primarily over the last 10 years.

Fjellstølen is located 1050 m a.s.l. in Nord Aurdal municipality, Oppland County. Summer farming in Fjellstølen began again in 1995 after a break of 50 years. However, there have been both sheep and cows from neighbouring summer farms using their outfields during this period of time. Today, the farmer at Fjellstølen has 13 cows grazing in the area. The area is mostly re-grown, especially with *Salix* spp.The climate and vegetation in Gaurhovd and in Fjellstølen is comparable with that in Liastølen (Aune, 1993). The bedrock in the two last test areas is phyllit, schist-rich bedrock. This bedrock has a higher weathering capacity than gneiss, and gives thus rise to soils of intermediate or good nutritional quality for plants.

3. Methods and material

The methods used include vegetation analysis, by species inventories and vegetation survey, vegetation mapping, animal tracking and temporal analysis. The vegetation analysis was performed by field studies, the vegetation maps by aerial photo interpretation, the animals (cows) tracking by use of a geographical positioning system (GPS) and all the data was stored and analysed in an integrated way by help of a geographical information system (GIS).

3.1. Field studies

A preliminary field survey was carried out in the Liastølen area before the aerial photo interpretation. The aim of the field study was to get a general view of the most common vegetation types, some key habitats and succession stages in the area. Different vegetation types were recognised partly by using the classification system of Fremstad (1997). However, this classification system, mainly used in Norway, describes semi-natural vegetation types insufficiently. Therefore, the classification of vegetation was achieved by preparing species lists of vascular plants and describing them on behalf of species constellations, regular and dominating species (Lunnan et al., 1999). Vegetation with rare species or species-constellations related to old pastures and hay-meadows were described more accurately with species lists as complete as possible because they were seen as key habitats. The vegetation types was roughly mapped on the economic land use maps at a scale of 1:5000 to support the subsequent aerial photo interpretation, where complete mapping and accurate distinctions between different vegetation types were made. The species lists and the rough vegetation maps are published in Lunnan et al. (1999).

After the aerial photo interpretation a thorough field-check, with corrections and complements to the vegetation maps was accomplished, before the final vegetation map was constructed.

3.2. Aerial photo interpretation

Two types of aerial photographs were used, near-infrared sensitive colour film, (CIR) at a scale of 1:20,000 and black-and-white panchromatic film at a scale of 1:15,000. The CIR aerial photographs were taken specifically for this investigation at all three investigated summer farm areas, and the end of July was selected as optimal for this vegetation region and investigation (Ihse, 1993). The CIR-photos, from 1999, were available in diapositive film, which gives better resolution and interpretation possibilities than paper copies (Wastenson et al., 1972). No CIR aerial photos from older dates are available in these areas, so black-and-white panchromatic photos from 1964 were used for the succession studies.

The photographs are interpreted in three-dimensional view using a stereoscope (Wild Aviopret) with high magnification, 15.5 times and continued zoom from 2 to 15.5, giving possibilities to general overviews as well as detailed interpretation The interpretation includes delineation and classification of polygons directly from the photos. The indicators used were colour, pattern, texture, vegetation height, vegetation cover, exposition and position. These were used, alone and in combinations, to distinguish different vegetation types and succession stages. The vegetation data collected during the primary field survey supported the interpretation work.

The interpreted polygons were digitised on screen, with a scanned and rectified aerial photo as background. The geometrical rectification is needed to get accuracy in mapping and area calculations. The interpreted, digitised vegetation data is the base information in the geographical information system (GIS) in this investigation.

3.3. Geographical positioning system (GPS)

The global positioning system (GPS) unit, a Magellan GPS 315, was utilised for tracking the grazing cattle. It was mounted to the collar of the leading cow while she was still in the box during milking time in the morning and taken off in the box after she had returned for milking in the afternoon. This was done five days during the season. As the cow moved, the unit was logging the geographical position. The data collected was transferred to a PC at the end of each day. The data from all days were later integrated in the GIS and the movement of the cows could thus be analysed and presented on a map.

3.4. Geographical information system (GIS)

The GIS software package GRASS, freely-available software, was used (GRASS, 2001). Using a geographical information system (GIS) makes it possible to integrate various data sets covering the study area. By using a GIS the data can be systematically collected and stored in such a way to allow analysis and integration with other data sets. Input data sets are:

- the vegetation map from 1999, as base information;
- the vegetation map from 1964, to analyse the vegetation succession and provide proper management plans;
- the animals track to find the vegetation types and areas preferred by the grazing cattle.

4. Results

4.1. Field studies

The vegetation was dominated by shrub and bushes in most part of the study areas. *Juniperus communis* spp. and *Betula nana* had developed a dense bush-layer in the dry and mesic areas, while moist and wet areas were encroached by various *Salix* species. In this shrub-dominated area, the key habitats did appear as dry to mesic, open areas close to and around the buildings of earlier summer farms or cottages. They also appeared as dry to mesic fragmented patches of open areas in the large re-growing areas of shrubs. Some of the characteristic species found in the key habitats are *Agrostis cappilaris*, *Alchemilla alpina*, *Antennaria dioica*, *Anthoxanthum odoratum*, *Bistorta vivipara*, *Botrychium lunaria*, *Campanula rotundifolia*, *Carex bigelowii*, *Carex* *brunnescens*, *Carex vaginata*, *Cerastium cerastoides*, *Euphrasia frigida*, *Gentiana nivalis*, *Gentianella campestris*, *Hieracium lactucella*, *Leontodon autumnalis*, *Luzula multiflora* ssp. *frigida*, *Phleum alpinum*, *Potentilla crantzii*, *Sibbaldia procumbens*, *Thalictrum alpinum*, *Viola biflora* and *Viola canina* ssp. *canina*. Species rich areas contained about 30–50 different vascular plant species per square meter compared to about 15–20 in surrounding vegetation-types.

In some places the re-grown areas still contain a grass- and herb-rich field-layer, as they are not yet so dense. In other re-growing areas the shrub vegetation has been mechanical crushed by different agricultural machines to provide more open areas as pastures for the cattle. Nutrition-poor fens and heathery moors also cover large areas. A full description of the vegetation types is given in Lunnan et al. (1999).

4.2. Aerial photo interpretation

4.2.1. Classification system

It was possible to develop a classification system for the aerial photo interpretation based on four main categories: field/bottom layer, soil-humidity, bush-layer and succession degree (see Table 1). The category “field/bottom layer” was divided in eight sub categories. The other three main categories were divided in six sub categories each. Fens, crushed dwarf shrub vegetation and cultivated land were identified on the photos but not classified due to these categories. The map based on the aerial photo interpretation, i.e. the identified vegetation types and re-growing stages are presented in Fig. 2.

4.2.2. Interpretation and development of interpretation keys in CIR aerial photos

The field survey indicated that the key habitats seemed to appear on special sites with similar ecology in the Liastølen area. Almost all consisted of dry or mesic vegetation types, open or slightly re-growing with *Juniperus communis* spp. On the aerial photos these areas had a light-pink, fine-grained colour. The same colour was clearly detectable between bush-clusters of *Juniperus communis* spp. or *Juniperus communis* spp. together with *Betula nana*, in re-growing areas that still had a grass-rich field-layer and easily could be restored. The bushes of *Juniperus communis* spp. had a coarse-grained, intermediate red-brown colour that became darker together with *Betula nana*. The light-pink field-layer could be seen even in heavily re-grown areas, and are easily separated from heathery field-layer that has a dense, fine-grained red-brown colour. Fertilised grass-rich meadows appear with a medium-pink to dark-pink, coarse-grained colour and are easily separated from the key habitats in this study. The coarse-grained texture of the colour is probably caused by *Deschampsia cespitosa*-tussocks that dominate fertilised meadows in the area.

4.2.3. Field control of the CIR interpretation

A representative number of the 149 delineated and classified areas from the CIR aerial photo interpretation was visited and classified in field. Most of the habitats were easy to distinguish on the aerial photos. A thorough field control of all the 26 areas that were interpreted to be species-rich areas, i.e. key habitats in the CIR aerial photo interpretation revealed that

Table 1
Interpretation categories with subcategories developed for interpretation of the CIR aerial photos

Field/bottomlayer	CIR film interpretation categories		
	Humidity	Succ. levels (in % bushes)	Bush-layer
Grass	Dry	0–10	Crushed dwarf shrub
Grass/herbs	Dry/mesic	10–25	Juniper
Grass/lichen	Mesic	25–50	*Salix* spp.
Heather	Mesic/humid	50–75	*Juniperus*/*Salix* spp.
Heather/grass	Humid	75–90	*Juniperus*/*Betula nana*
Heather/grass/herbs	Wet	90–100	*Salix* spp./*Juniperus*/*Betula nana*
Heather/grass/herbs/lichen			
Heather/lichen			

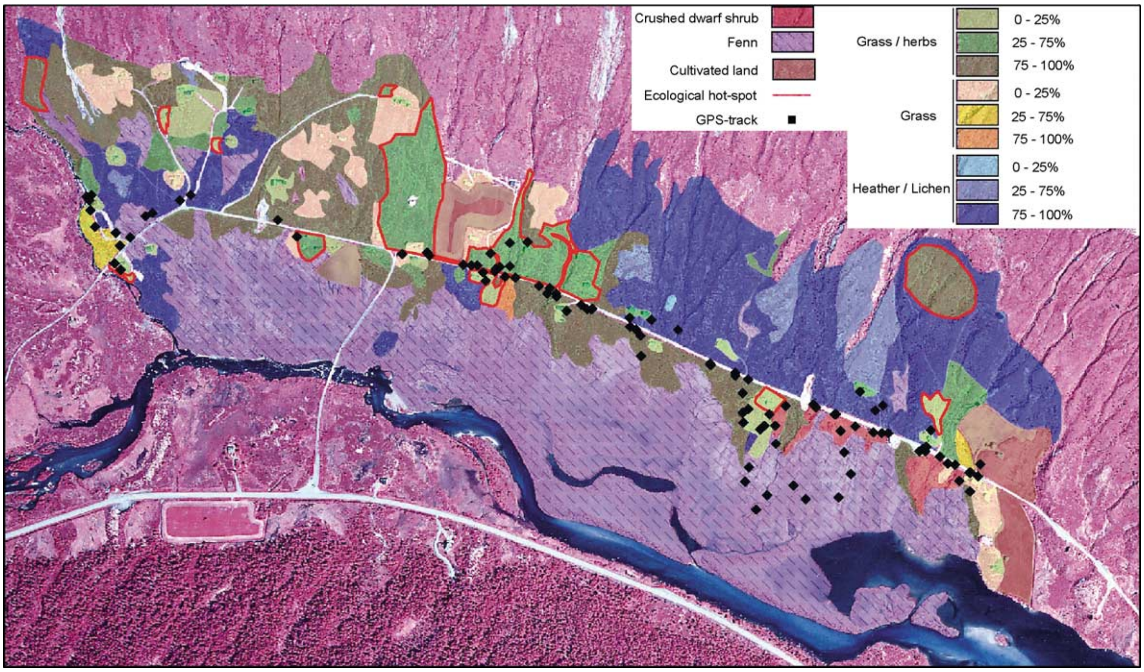

Fig. 2. Map from Liastølen with vegetation types and key habitats from the year 1999 and GPS tracks from the year 2000.

81% of them were correctly classified. However, the species-rich areas of grass and herbs could sometimes be mixed up with species poor and dry grass areas as for example *Nardus stricta* or *Festuca ovina* ssp. *ovina* dominated areas.

4.2.4. Interpretation in black-and-white panchromatic aerial photos

Using black-and-white panchromatic film it was not possible to identify as many categories as that achieved using CIR film (see Table 2). It was, amongst others, difficult to recognise different layers of the vegetation, i.e. to use the vegetation- and bush categories. Instead another classification set of recognisable vegetation types was developed (see Table 2). Various states of re-grown pastures/hay meadows could be detected if they were connected to open pastures/hay meadows. It was, however, impossible/very difficult to separate *Juniperus communis* spp./*Betula nana* bush vegetation with a grass- or herb-rich field layer from *Juniperus communis* spp./*Betula nana* bush vegetation with a heathery field layer. With regard to succession categories it was possible to use the same as on CIR film. Soil-humidity was, in contrast, difficult to interpret with a high degree of certainty and was therefore excluded as a main category using black-and-white film. It was especially difficult to separate the dry vegetation types from the intermediate dry/humid vegetation types. The vegetation map, based on the interpretation of the black-and white photos from 1964 is shown in Fig. 3.

Table 2
Interpretation categories with subcategories developed for interpretation of the black-and-white aerial photos

Vegetation category	Succ. levels (in % bushes)
Pasture	0–10
Hay meadows	10–25
Cultivated land	25–50
Dwarf schrub heath	50–75
Heathery moors	75–90
	90–100

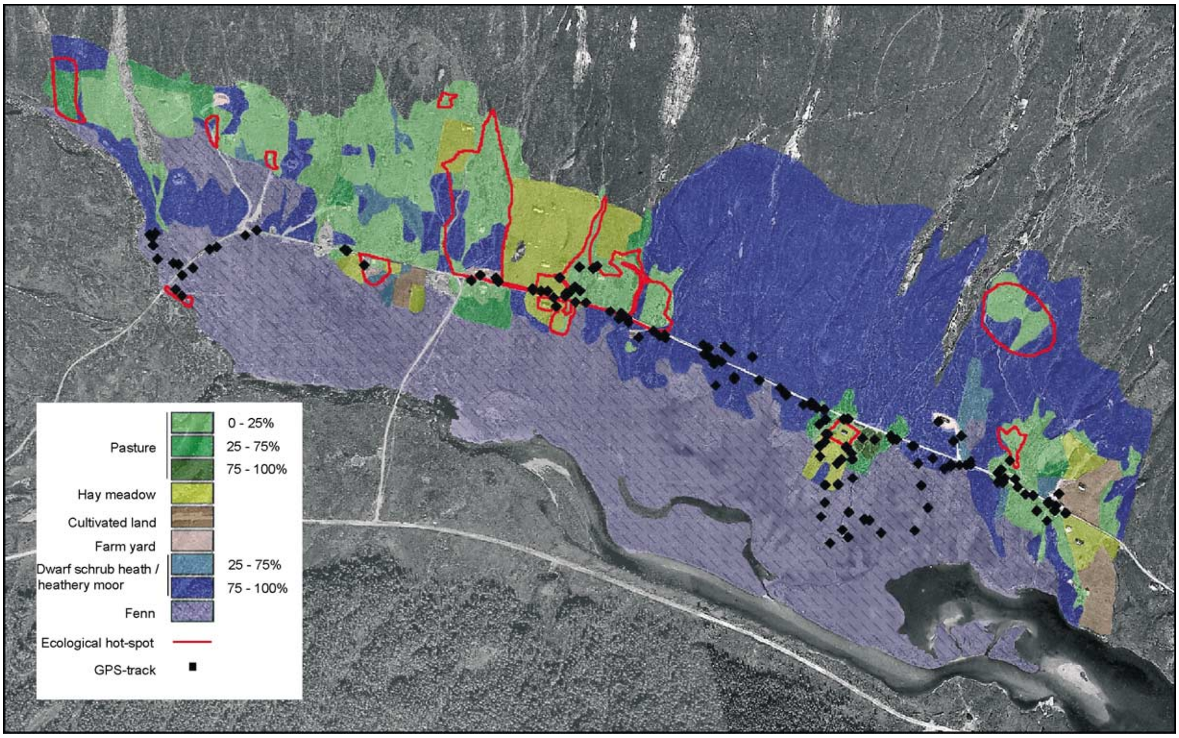

Fig. 3. Map from Liastølen with vegetation types from the year 1964, key habitats from the year 1999 and GPS tracks from the year 2000.

4.3. Testing of the interpretation keys in two other summer farming areas

Areas that had equal colour and texture as the species-rich areas on Liastølen were found on coloured CIR aerial photos from Gaurhovd and Fjellstølen. A field control of these areas revealed grass-rich and also species-rich areas, i.e. key habitats. It is, therefore, obvious that the interpretation key can be used in similar areas to detect and monitor key habitats and potentially easy-restored pastures, although further studies are needed to establish its limits.

4.4. GPS

Observations of the cows show that they mostly behaved as a herd following the leading cow (Sickel and Norderhaug, 2001). GPS tracking of the leading cow therefore was representative for the herd. The GPS study at Liastølen and subsequent integration with other data sets in the GIS (see Fig. 2) show that the cows often graze around the cottages in the area. They also graze in re-growing areas that still have a grass-rich field-layer. The GPS study also revealed that the areas preferred by cattle for grazing were often species-rich habitats, i.e. key habitats. The cows seldom graze in heathery vegetation-types or on the big fen south of the main road (see Fig. 2). Furthermore, the GPS study revealed that the cattle followed old roads and paths between the grazing areas.

5. Discussion and conclusions

Monitoring biodiversity in the steep, re-growing, Norwegian mountain landscape of former summer farms by field surveys is extremely time consuming. In this study, we therefore developed a method for interpretation, based on coloured CIR aerial photos, minimising the need for field studies. We developed an interpretation key that enabled us to efficiently map key habitats, i.e. species rich semi-natural vegetation types. The interpretation key was developed based on knowledge of historical use and ecological conditions in the area. The key habitats were interpreted with an accuracy of more than 80%. The transfer-value of the interpretation key tested in two other summer farming areas gave the same result. Further studies of coloured CIR aerial photos will probably make it possible to develop similar efficient interpretation keys to map and monitor high biodiversity areas in other Norwegian cultural landscapes as well.

The developed method integrates numerous data sources by combining information from fieldwork and stereo photo interpretation. A short initial field survey is made effective and useful for subsequent aerial photo interpretation if it is carried out in a way that provides: (a) an overview of vegetation types and the encroachment situation, (b) inventory of plant species in some representative areas, (c) a localisation and a description of the ecology of some areas with high species richness i.e. key habitats. Interpretation of older aerial photos is useful for succession studies and for providing information of earlier landscape use. This is a very important knowledge base for this kind of work, monitoring biodiversity in semi-natural vegetation types.

There is a high correspondence between earlier land use, grazing and mowing and high species diversity as earlier shown (Norderhaug et al., 2000). We introduce a new term, key habitats, for cultural landscapes. Key habitats are areas with long continuity of traditional management as grazing without fertilising, they are species rich and contain formerly common but now rare species and constellations of species characteristic to extensively-used pastures and hay-meadows, and they exists mostly as remaining, small patches of traditionally-managed semi-natural vegetation types, in a matrix of trees, shrubs and bushes or intensively used agricultural field. Their existence and value depends upon further use or management. This study has also shown that there is a correspondence between these key habitats and the grazing preferences of cattle.

In addition, the study clearly shows that the CIR aerial photos have a range of interpretation possibilities that panchromatic black-and-white air photos have not. The superiority, especially due to interpretation of the soil-humidity, is of great importance in this study, because the key habitats were only localised in the dry to mesic sites in the landscape. They were also localised in re-growing areas with a grass-rich field-layer that could easily be detected on the CIR film, but only in very limited cases on the panchromatic black-and-white film. The superiority was also due to the good possibility to distinguish the encroaching bushes and distinguish between the bush layer and the field layer. In this study, we used these advantages from the CIR aerial photos and developed a classification system, especially adopted for the purposes of this investigation. We used the possibilities provided by the CIR aerial photos to split the vegetation into four categories with several under-categories. Every polygon was interpreted due to these categories and so numerous areas with different qualities could be differentiated. This is of major importance in the process of monitoring biodiversity. It is also important for mapping different qualities of the pastures in the landscape and for selecting areas that might be successfully restored and managed.We conclude that:

1. The developed method of interpretation of stereoscopic coloured CIR aerial photos combined with fieldwork is accurate and efficient in mapping areas of high biodiversity, i.e. key habitats in the sub alpine mountain regions in Norway.
2. The coloured CIR aerial photos are superior to panchromatic black-and-white photos due to the greater possibilities of successfully classifying: (a) soil-humidity (to distinguish dry to mesic places), (b) physiognomy (to distinguish bush-layer from field-layer) and (c) a high range of different vegetation types.
3. The old panchromatic aerial photos in black-and-white give very useful information of earlier land use and continuity of grazing in semi-natural grasslands.
4. The key habitats are fragments of earlier, more widely-distributed semi-natural habitats of grass and herb dominated vegetation. They are now diminished by encroachment of bushes due to abandonment of summer farming.
5. There is a high correspondence between key habitats and grazing preferences of cattle.

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