4.2

Impact of Highland Cattle on the Vegetation of the Natural Reserve "La Grande Cariçaie"

This report was elaborated during the practical term at
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the propose of the studies of environmental biology
at
the University of Applied Science, Bremen, Germany
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1 Introduction and Acknowledgement

The Grande Cariçaie is the largest littoral mire landscape of Switzerland. Since 1982 it is managed for the conservation of species and nature. Its legal protection is yet definitively acquired, the Grande Cariçaie is accepted as "biogenetic reserve of the Council of Europe", as "Ramsar site" (international convention for the protection of wetlands) and in several inventories as landscape of national and international importance for the conservation of one of the last wetlands of Switzerland (URL: http://www.grande-caricaie.ch {August 27.02}).

The 1982 created working group GEG (Groupe d'étude et de Gestion) is the executive organ of the project. Its tasks are the maintenance of the mire landscape, the scientific monitoring of the work, the public work and the administrative and financial management. For this purpose 8 persons (five biologists) are employed, who share 6.5 places of work. Also they have several trainees and volunteers each year (URL: http://www.grande-caricaie.ch {August 27.02}).

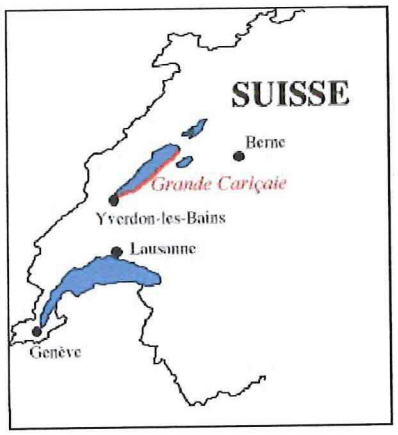


Fig 1.1: General map[1]

The wetland of the Grande Cariçaie (Fig 1.1) extends along the 42 km long south shore of the Lake of Neuchâtel. It is situated on the south fringe of the Jura Mountains in the Sub- Jurassic glacier depression and is part of the Rhine watershed area. The mean altitude of the wetland lies around 430 m (GRÜNSING 1994).

The marshland was artificially made by man about one hundred years ago. For gaining a larger gardening area the sea level of the three connected Jura lakes (Lake of Neuchâtel, Lake of Murten, Lake of Biel) was lowered.

Since the first Jura water correction, approx. 200 m of the shore of the southern lakeside has been eroded (GRÜNSING 1994).

The nature reserve with the lakes, reeds, meadows, marshes and riparian forests covers around 2300 ha. The Grande Cariçaie acts as a refuge for many stenotopic species bound to these environments. The high habitat diversity of the natural reserve makes it to one of the richest of the country, regarding the species number (3500 animal species were found in 1997) (CATTIN et al 2002).

To conserve this large diversity the natural reserve has to be maintained by mowing the wet meadows every 2 to 4 years on an rotating basis, digging out of ponds that have been filled in, cutting of shrubs and protecting the shore against erosion. (GRÜNSING 1994)

Since 2000 an attempt is made to find a possibility to support the mechanical maintenance of the reserve with the help of highland cattle. In 2002 the impact of the cattle on the vegetation was studied. For these studies a modification of the method used by Dominik Käuferle from the ETH (Eidgenössische Technische Hochschule) was employed for the first time at La Grande Cariçaie.

[1] www.grande-caricaie.ch {August 27.02}

Scottish Highlands (*Bos taurus primigenius scotticus*) have been chosen because of their special qualities. The highland cattle is a robust race from the Scottish Highlands. They are unassuming and weatherproofed animals. Due to their adaptability Highlands can survive on poor pasture and rough land. They are well known for their browsing ability. Because of their low weight they make little damage to the soil (http:// www.naturschutzstation-malchow.de {August 27.02}).

So far there have already been some trials with the Scottish Highlands in nature reserves to maintain the nature, e.g. in France have been trials in marshlands. In the nature reserve "Falkenberger Rieselfelder" in Germany the cattle are also used to keep the vegetation short (WALTHER 1994).

In this report three heifers, one male and two female, have been studied, which have been released on the study area between May 16. 2002 and September 07. 2002.

The present work should scientifically monitor the influence of the Scottish Highlands on the vegetation through an eventual modification of the soil.

There for several questions have to be answered:

- Is the pressure of the cattle on the area homogenous?
- Which type of vegetation is preferred for feeding by the cattle?
- How does the spatial distribution of the cow dung occurs?
- How important is the cow dung for the transformation in organic matter and for the balance of nutrients of the lot?

With this work an attempt was made to monitor completely the impact of the pasturing on the biocoenosis and on abiotic factors.

Acknowledgement
I want to give thank to the staff of La Grande Cariçaie that has given me the opportunity to do the practical term at La Grande Cariçaie and who have helped me in many ways. Also I want to give thank to the two "stagiaires" Laure and Paloma who have had the courage to spend with me one whole night observing the cows. Many thanks also to Sabine Güsewell from the ETH were the “lab-work” was done, who answered me a lot of questions and helped me with a room in Zürich. Last but not least I want to thank the Hochschule Bremen for the newly established study course of ISTAB (International Studies of Technical and Applied Biology) where the practical term in a foreign country is obligatory.

2 Area of examination

Fig 2.1: Map Gletterens, modified[2]

The study field (Fig 2.1 - flesh) is situated nearby the village Gletterens in the canton Fribourg in Switzerland. It is part of the natural reserve called "La Reserve de la Baie d'Ostende" which is part of La Grande Cariçaie. The exactly co-ordinates of the pasture are 46.54°N and 6.56°E. The mean annual precipitation, measured at the weather station at Payern, in approx. 10 km distance from there, is about 845 mm, the middle temperature lies around 8.4 degree Celsius.

The field has a size of 2.7 ha. An electric fence surrounds the whole area. A solar module with a voltage of approx. 10 kV powers the fence.

At the north corner the area is in touch with the lake. On the northwest side in-between the lake and the area of examination a *meadow of reed* has been established. On the other three sides the field is shadowed by forest and resp. a mixed grass and tree population.

When the field side was studied earlier mainly eight different types of vegetation have been found on the area:

1. Meadow of *Carex acutiformis*
2. Meadow of *Phalaris arundinacea*
3. *Phalaris arundinacea* with *Thypha latifolia*
4. Meadow of *Carex riparia*
5. Meadow of *Carex elata*
6. *Phragmitetum australis*
7. Meadow of *Cladium mariscus*
8. Meadow of *Carex hostiana*

Also small parts of the following vegetations are represented:

- Meadow of *Schoenus (nigricans)*
- Bush: *Salix cinerea*
- Tree: *Alnus glutinosa*
- Tree: *Salix alba*
- Bare land

A view of the vegetation unit distribution on the field can be found in Fig. 8.5 and 8.1

The vegetation units have been named after the indexes of phytosoziology of the Grande Cariçaie and are only translated into English and Latin.

The study site is used since 2000 for pasturing with highland cattle. In 2000 three young cows -0.6 CU (cattle unit)- have been on the feedlot, in 2001 two young cows and one cow (0.8 CU). Before that the site has been mowed every third year.

[2] http://www.swissgeo.ch/{Sept. 10.02})

3 Materials and Methods

3.1 Soil samples

Soil samples have been taken on July 11th with a soil corer in which a plastic tube with a diameter of 5 cm has been placed. The soil has been taken out within a depth of approximately 20 cm. The sample included the Litter- layer, the A-layer and a part of the B-layer. From all main vegetation units five soil samples have been taken, distributed about the whole area (Fig. 8.2).

After drilling the samples out of the soil the plastic tube has been taken out of the soil corer and a note with the sample number and the date has been placed inside. Then the plastic tube has been closed with a cap and sent to the Eidgenösische Technische Hochschule (ETH) of Zürich where the samples have been analysed.

The soil samples as well as the vegetation and cow dung samples have been mainly analysed for Phosphorus. Phosphorus is one of the limiting plant nutrients. The convenience of Phosphorus is that it is strongly bound to the soil and not easily washed out. In addition most of the Phosphorus is contained in the cow dung and not in the urine. (BLUME 1990). At Zürich the samples have also been analysed for the density, the water content, the total amount of nutrients and the organic material. Each sample has been divided into two layers of five centimetres except those that have had only roots as first layer. In this case the whole root bulk has been taken as upper layer.

upper soil + lower soil.

3.2 Vegetation samples

Between May and September vegetation samples have been taken three times (22nd/23rd of May, 22nd/23rd of July, 09th of September). From every vegetation unit three samples – each of the size of one square meter – have been taken out. To randomise the sampling a self-made wooden frame of $1m^2$ has been thrown into the vegetation (Sampling points Fig. 8.3 and 8.4).

cut = d

In May the vegetation had been mainly cut at the estimated grazing height of the cows. The first two vegetation units have been cut at five centimetres from the ground three times and one more time at the estimated grazing height. In July and September the vegetation has always been cut at five cm.

Sampling method:

1. First a photo of the vegetation has been taken and the height of the vegetation had been measured.
2. Then the different plants with their quantities (scale Braun Blanquet) had been recorded. Also the presence of water and dung has been written down.
3. The plants had been cut with a sickle or a secateur mostly at 5 cm.
4. The weight of the vegetation of the whole square meter had been taken (with a Lysesex balance, Swiss made).
5. The plants had been cut in smaller pieces by a pair of scissors and were well mixed.
6. With the help of a letter balance (Digi 2000 from Wedo) a composite sample of 200 gr. had been taken out of the centare sample.
7. The composite sample had been dried at 80°C in a hot-air cabinet for a duration of two up to three days.
8. Than the weight of dry matter, taken with the help of the same letter balance, had been noted.

9. The sample had been put in airtight plastic bags with a paper composing the sample number and the sampling date and were sent to the ETH.
10. There the sample had been chopped with a "Retschmühle" No.: Sk1 25624 from Haan Germany up to a particle size of approx. 0.5 mm. (Fig.8.7)
11. The grounded sample had been dried again for half an hour by 80°C.
12. 150 mg of the sample had been taken and terminated with the Total Kjeldahl Method for Phosphorus.

3.3 Cow dung samples

Five cow dung samples have been taken three times (29th of May, 23rd of July, 09th of September) from the whole area. (Sampling points Fig. 8.3 and 8.4) For that approx. half of a cow dropping has been taken into a plastic cup and the fresh weight has been taken. Then the dung has been put in the oven at 80°C for a duration of three up to four days. After that the preparing of the sample has been continued as described under "Vegetation samples" point 8 to 12.

3.4 Counting cow dung on the area

Twice (10th of July and 02nd of September) a transect has been laid on the whole area of examination. For that two tape measures of 50 m have been put together and have been spanned from each baton with the same number from one side of the field to the other side. From each side of the field a person walking on the tape measure has been counting every cow dung that has been between a distance of 1 m away from each side of the tape measure. To find this correct distance of one meter the person was holding a stick of two meters in the middle of the body with his hands (Fig. 8.8). Every five meters the number of counted cow dung has been written down. In July it has been differentiated in old and new (from the year of investigation) dung. This differentiation was not made in September. According to the script (Tab. 8.6) the transect started with zero to five meters on the landside and continued to the direction of the lake in an ascending order. For this work only the results of September have been chosen.

3.5 Observation of the cows

The cows have been observed to get information about their habit and the places they feed and rest. The observation method is related to the observation method used by D. Käuferle from the ETH.

After some trials of a few hours the cows have been observed during the grazing season approximately once a week from dusk till dawn. Twice trials to observe them during the night have been made. Each observation has last half an hour, after that occurred a break of half an hour.

The cattle activity has been divided into the following categories:
1. Feeding
2. Ruminating
3. Resting
4. Moving
5. Other activities

Other activities included scratching themselves with their claws or their horns or with the help of e.g. a tree. Scratching each other, drinking water, playing and other kind of social contact between them has also been considered as other activities.

Every minute the main activity (that lasted for more than half a minute) of each cow has been noted. It has also been noted when and where a cow sprayed dung. For every observation the weather conditions like clouds, precipitation and temperature have been recorded. The hand written notes have been entered in an Access data base for evaluation.

The cow activity has been followed if possible from the observation stand (see area of examination and Fig. 8.10) also with the help of a binocular. If the cows have been out of sight or too far to determine their correct position they have been followed outside the enclosure. The observer (Fig 8.15) has been tried not to influence the cow activity through her presence.

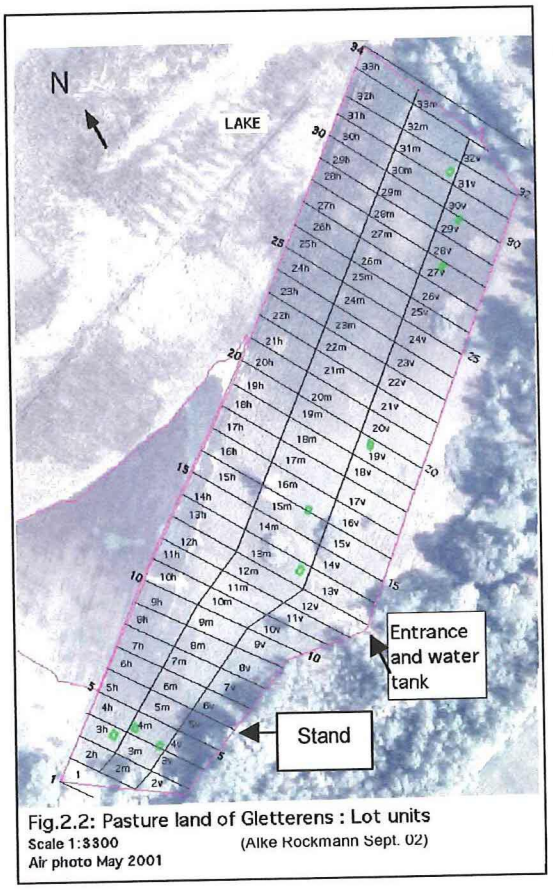


Fig.2.2: Pasture land of Gletterens : Lot units
Scale 1:3300 (Alke Rockmann Sept. 02)
Air photo May 2001

For the observation, on the long sides every 10 m a stick has been planted starting on the left corner of the lakeside. The first one got the number one. On the right side of this stick the other numbers have been in an ascending order. From the third stick a rectangle has been drawn so that the first stick on the other side has been at an angle of 90 degree to that one on the lakeside. All the other sticks have been projected similarly. All sticks with odd numbers have been wrapped with yellow coloured adhesive tape on the top, the others have been wrapped with red and white coloured tape. To recognise the number of the stick easier the numbers 5, 10, 15, 20, 25, 30 have also been coloured in the middle of the stick. The area on the right side of stick no. 1 up to stick no. 2 was become the no. 1. The lot on the right side of stick no. two up to stick no three received the no. 3 and so on. On the short sides the area has been divided in three parts. The side to the lake got the letter H, the middle area the letter M and the side at the entrance the letter V.

At approx. position 5V an observation stand (Fig. 8.5) had been built. A water tank was placed nearby the entrance at 12 V.

For the calculation of the utilisation coefficient (Tab 4.7) the following formula is applied based on the determinated terms in Tab 4.6: The percentage of time (of feeding or corresponding of total activity) or of dung pats they have spend/made in one vegetation unit is divided by the percentage of the area of this vegetation unit. This count is multiplied by the total amount of time (of feeding or corresponding of total activity) or dung pats which is divided by the total area in percent. The count at the end is multiplied by hundred.

e.g.: (Feeding in % / Area in %) * (Total Area in % / Total feeding time in %) * 100

$$\frac{F}{A} \cdot \frac{TA}{TF}$$

4 Results

4.1 Soil

By the time of the completion of this work there had been only results for the density and the water content of the soil samples from Zürich. (Sampling points: Fig.8.2)

The following table is showing the density and the water content of the soil under the eight main vegetation units. The density of the soil was taken from the dried soil. The percentage of water content is in relation with the dry matter. 200% water content means that the sample was compost out of 50 g dry matter and 100 g water. Like described in the material and methods each sample has been divided into two layers of five centimetres except those that have had only roots as first layer. In this case the whole root bulk has been taken as upper layer. Some of the five collected samples of the soil under the vegetation units four and five have had a thick root mat some had not. For this reason these numbers have a mean value for the upper soil and for the root mat.

Tab. 4.1: Mean of density and water content of the soil under the eight main vegetation units of the area

Vegetation type	Lower soil (6-11 cm)		Upper soil (1-6 cm) Mean of		Root mat	
	Density (g*cm^3)		Density (g*cm^3)		Thickness	Density (g*cm^3)
1. Meadow of *Carex acutiformis*	0,55 ±0.03	LS[1]	0,5 ±0.04	LS		
2. Meadow of *Phalaris arundinacea*	0,8 ±0.08	L[1]	0,66 ±0.08	LS		
3. *Phalaris arundinacea* with *Thypha latifolia*	0,47 ±0.06	L	0,38 ±0.05	LS		
4. Meadow of *Carex riparia*	0,32 ±0.04	L	0,29 ±0.07	LS	10,3 ±1.3	0,13 ±0.06
5. Meadow of *Carex elata*	0,41 ±0.02	LS	0,34 ±0.04	SL	5,7 ±0.9	0,14 ±0.1
6. *Phragmitetum australis*	0,53 ±0.03	S[1]			11,3 ±0.7	0,14 ±0.3
7. Meadow of *Cladium mariscus*	0,52 ±0.03	LS	0,33 ±0.03	SL		
8. Meadow of *Carex hostiana*	0,53 ±0.09	LS	0,41 ±0.06	LS		
	Water content (%)		Water content (%)		Water content (%)	
1. Meadow of *Carex acutiformis*	97,7 ±3	LS	101,3 ±0.5	LS		
2. Meadow of *Phalaris arundinacea*	64,5 ±2.4	L	70,7 ±10.8	LS		
3. *Phalaris arundinacea* with *Thypha latifolia*	135,1 ±21	L	147,2 ±19.4	LS		
4. Meadow of *Carex riparia*	174,2 ±15.1	L	211,7 ±29.8	LS	339,2 ±53.8	
5. Meadow of *Carex elata*	124,9 ±3.2	LS	185,3 ±24.3	SL	355,5 ±64	
6. *Phragmitetum australis*	96,4 ±4.7	S			382,1 ±66	
7. Meadow of *Cladium mariscus*	92,2 ±6.4	LS	135,1 ±12.5	SL		
8. Meadow of *Carex hostiana*	106,4 ±13.3	LS	138,3 ±14	LS		

[1] L = Loam, S = Sand, LS or SL = Intermediates

The soil under the eight vegetation units is composed out of loam, sand and its intermediates. Under the *Phragmitetum* only pure sand has been found. A thick root mat is under the most samples of the vegetation units 4 and 5 and under all samples of vegetation no. 6. The water content in the root mat samples is high. The table shows that the soil under the meadow of *Phalaris* has the highest density and the lowest water content.

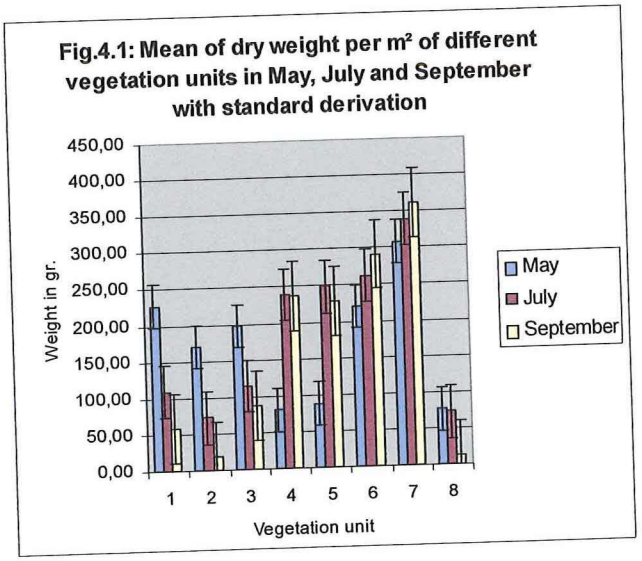
4.2 Vegetation

The whole vegetation relevé with the plant species and their quantities is shown in the Annex Tab. 8.1, 8.2 and 8.3, the weight of the samples and the calculation of the dry weight in percent in Tab. 8.4.

The following table 4.2. is showing the mean dry weight of the three taken samples of each vegetation unit. The weight is calculated using the fresh weight per square meter and the percent of dry weight of every composite sample.

Tab.4.2: Mean of dry weight per m² of different vegetation units

Mean of dry weight (m^2)	Vegetation unit							
	1	2	3	4	5	6	7	8
May	226,61	169,91	196,72	79,87	87,66	219,90	307,92	76,06
July	108,77	72,28	113,88	238,33	248,00	261,84	338,78	71,68
Sept.	57,45	19,63	87,25	236,89	227,63	291,28	361,45	12,20



The figure shows that the dry weight of the meadows of *Carex acutiformis* and of *Phalaris arundinacea* as well as *Phalaris arundinacea* with *Typha latifolia* and the meadow of *Carex hostiana* have decreased between May and July. The letter has decreased the most in-between July and September and not a lot in-between May and September.

The biomass of the meadows of *Carex riparia* and of *Carex elata* has risen up in-between May and July and slightly decreased in-between May and September. The dry matter of the meadow of *Cladium mariscus* as well as *the Pragmitetum australis* has constant slightly increased in-between May and September.

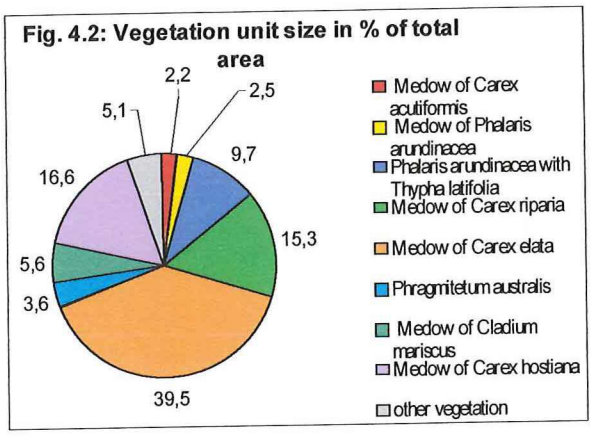
Table 4.3. shows the size of every vegetation unit determined with the computer program Canvas. The mean of the dry weight of every vegetation unit was used to calculate the mean of the biomass of every vegetation unit on the area. For a better comparison of the part that the biomass has related to the other sampled vegetation units on the area it was set in percent.

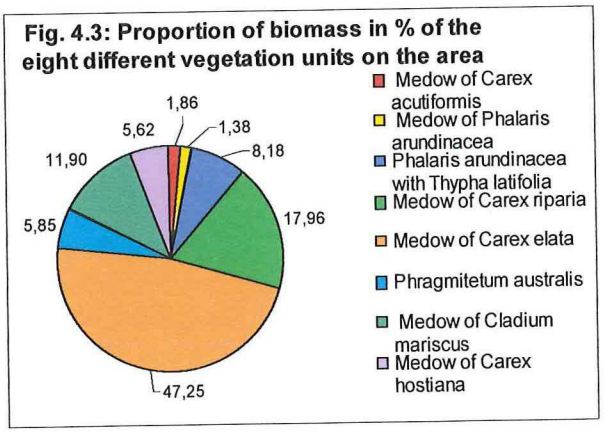
Tab.4.3: Surface and dry weight related to vegetation unit

		Surface		Mean of	On area dry weight	
Veg No.	Vegetation unit	(m^2)	(% of area)	dry weight (g/m^2)	(kg)	(%)
0	bare land	236	0,9	no data	no data	no data
1	Medow of *Carex acutiformis*	617	2,2	130,95	80,79	1,9
2	Medow of *Phalaris arundinacea*	687	2,5	87,27	59,96	1,4
3	*Phalaris arundinacea* with *Thypha latifolia*	2684	9,7	132,62	355,94	8,2
4	Medow of *Carex riparia*	4226	15,3	185,03	781,93	18,0
5	Medow of *Carex elata*	10956	39,5	187,76	2057,11	47,3
6	*Phragmitetum australis*	989	3,6	257,67	254,84	5,9
7	Medow of *Cladium mariscus*	1542	5,6	336,05	518,19	11,9
8	Medow of *Carex hostiana*	4587	16,6	53,31	244,55	5,6
9	Bush: *Salix cinerea*	512	1,8	no data	no data	no data
10	Tree *Alnus glutinosa*	135	0,5	no data	no data	no data
11	Tree: *Salix alba*	78	0,3	no data	no data	no data
12	Medow of *schoenus*	457	1,6	no data	no data	no data
Sum		27706	100,0		4353,32	100,0

The smallest surface from the examinated units has the meadow of *Carex acutiformis* followed by the meadow of *Phalaris arundinacea*. The biggest surface has the meadow of *Carex elata* which has also the highest amount -around the half- of biomass. The highest dry weight per square meter has the meadow of *Cladium mariscus*. This causes a relative high percentage of dry weight on the area compared to its surface. The dry matter per square meter is very low on the meadows of *Phalaris arundinacea* and of *Carex hostiana*. Specially for the latter case it means that the vegetation unit maintained only a small part of the whole biomass compared to its occupied surface.

Fig. 4.2 and 4.3: A pictorial performance of the part of the surface and the biomass of the different vegetation units on the area





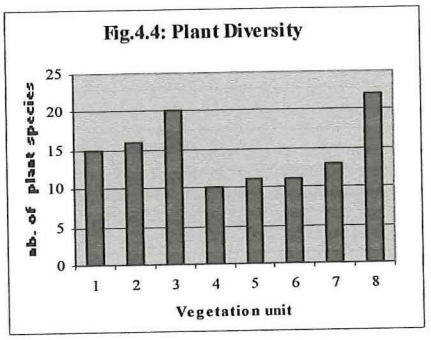
Unfortunately by the time of the completion of this work there have been no results of the plant and cow dung samples from Zürich. (Sampling points Fig. 8.3. and 8.4.)

The next figure is showing the mean number of plant species of the eight different vegetation units. This presentation might be interesting for the work of further years so it should be also mentioned within this report. Also it must been mentioned that the sample of one square meter is not big enough to make a safe statement of the plant diversity.

Tab. 4.4: Number of plant species of every vegetation unit

Vegetation unit	1	2	3	4	5	6	7	8
Nb. of plant species	15	16	20	10	11	11	13	22

The table and the figure are showing that the vegetation units 3 and 8 have about 20 plant species whereas the vegetation units 4, 5 and 6 have only the half.



4.3 Cow dung

Altogether 459 dung droppings have been counted with the transect in September. The transect covers only a fifth part of the area. An extrapolation gives about 2300 dung droppings on the whole area. (Number of dung recorded every five meters with the help of the transect Tab. 8.6.)

Table 4.5. is showing the mean fresh weight of the five half dung pats sampled in May, July and September. It also displays the mean of the dry weight in percent, calculated out of the fresh and the dry weight, for every month. (Tab. 8.5)

Tab.4.5: Mean of dry weight in percent and of total fresh weight of dung pats

Month	Mean dry weight (%)	Mean total fresh weight (g)
May	16,1	373,6
July	17,3	392,2
Sept.	17,3	736,6

The dry weight in percent of the dung pats has rested nearby the same. The fresh weight of the chosen cow dung has doubled between September and July.

Also in this case the analyses have not yet been completed.

4.4 Cow observation

The next table is exhibiting the activities among the vegetation types in percent of total observed activity time compared to the amount of dung pats in percent and to the area in percent of the vegetation unit. The distribution of activities among the vegetation types is calculated out of the observed activity in minutes in every lot and the proportion that the vegetation unit had in every lot set in percent to the total amount of the observed activity. (List with the activity and the proportion of every vegetation unit of every lot Tab. 8.7.)

Tab. 4.6: Size of the vegetation types, activities of the cows and dung pats in the vegetation units

Vegetation unit	Area	Activities of cattle in the vegetation types (% of total time)					Dung pats
	(%)	Feeding	Resting	Ruminating	Moving	Other	(%) [1]
1. Meadow of *Carex acutiformis*	2,2	1,97	0,00	0,44	0,02	0,57	5,2
2. Meadow of *Phalaris arundinacea*	2,5	3,55	0,72	1,15	0,15	0,29	6,1
3. *Phalaris arundinacea* with *Thypha latifolia*	9,7	11,71	0,31	0,60	0,11	0,50	20,0
4. Meadow of *Carex riparia*	15,3	5,27	0,26	0,00	0,13	0,34	7,6
5. Meadow of *Carex elata*	39,5	10,28	1,16	0,10	0,06	0,63	10,7
6. *Phragmitetum australis*	3,6	3,41	0,00	0,00	0,00	0,02	0,2
7. Meadow of *Cladium mariscus*	5,6	1,68	0,94	1,33	0,04	0,65	6,1
8. Meadow of *Carex hostiana*	16,6	9,05	1,04	2,34	0,12	3,11	28,8
Other Vegetation	5,1	2,39	13,24	17,55	0,11	3,71	15,3
Total (%)	100,0	49,3	17,7	23,5	0,8	9,8	100,0
Total (ha, minutes, pats)	2,7	9276	3325	4420	142	1849,0	2295

[1] off all with the transect counted dung pats in September

Of all observed activities the cows have spent half of their time with grazing. The time they have used for resting was nearby one fifth and the time they have been ruminating was about one forth of total observed time. Other activities and moving did not much preponderate.

The majority of their time the cows have been feeding in the meadows of *Phalaris arundinacea* and *Carex elata*. The cows haven't spent a lot of their time grazing in vegetation unit no. 1 and 2 and also not in the other vegetation types. No resting was observed in the Meadow of *Carex acutiformis* and in the *Pragmitetum*. In the latter case there was also no ruminating or moving observed. Resting, rumination and other activities have been taken place almost in the not specified vegetation.

Nearby one third of the dung pats have been found in the meadow of *Carex hostiana* and one fifth of them in *Phalaris arundinacea*.

The utilisation coefficient in Table 4.7. displays the activity of the cows and the amount of cow dung in relation to the size of the area (Calculation 3.5). The columns presenting the feeding and total activity have to be treated separately. The counts of feeding are related to the total feeding activity (which is compared to the total of the total activity about fifty percent) and the counts of feeding activity are related to the total of all activities. E.g.the ultilisation coefficent for feeding in the meadow of *Carex acutiformis* of around 180 % means that the vegetation type is used in relation to the proportion to its area nearly two times more for feeding. This vegetation type has been grazed around two times more than the Other Vegetation. The number of 180 does not mean that the meadow of *Carex acutiformis* has been used more for feeding than for the sum of all activities.

Tab. 4.7: Utilisation coefficient

Vegetation unit	Area (%)	Utilisation coefficient (%)* Feeding	Total activity	Dung
1. Meadow of *Carex acutiformis*	2,2	179,6	133,6	234,8
2. Meadow of *Phalaris arundinacea*	2,5	290,6	234,0	246,0
3. *Phalaris arundinacea* with *Thypha latifolia*	9,7	245,0	135,0	206,9
4. Meadow of *Carex riparia*	15,3	70,0	39,0	50,0
5. Meadow of *Carex elata*	39,5	52,7	30,6	27,0
6. *Phragmitetum australis*	3,6	193,7	95,3	6,1
7. Meadow of *Cladium mariscus*	5,6	61,4	82,6	109,6
8. Meadow of *Carex hostiana*	16,6	110,8	93,6	173,7
Other Vegetation	5,1	95,0	717,5	299,0

* 100% means that a vegetation type is used exactly in proportion to its area

In relation to the area, the distribution of activities and the amount of cow dung pats are showing another kind of view:

- Very high grazing rate in meadow of *Phalaris arundinaceae*
- High grazing rate in meadow of *Carex acutiformis*, in *Phalaris arundinaceae* with *Thypha latifolia* and in the *Pramitetum*
- The feeding is relatively low in the vegetation units 4, 5, 7 and in the not monitored vegetation
- The amount of dung is very high in the meadow of *Carex acutiformis* and *Phalaris arundinacea*, in *P. arundinacea* with *Thypha latifolia* as well as in the not specified vegetation areas which are often used for other than feeding activities
- Related to the almost very low pasturing the meadow of *Cladium mariscus* displays a high amount of dung
- Compared with the feeding coefficient the *Phragmitetum* shoes a very slight amount of dung
- The utilisation coefficient of the feeding compared with the utilisation coefficient of the dung shows that there has been more dung in the meadow of Carex acutiformis, the meadow of Cladium mariscus, the meadow of Carex hostiana and in the other not further examined area than these vegetation units have been used for feeding

In July and August there was often no water in the tank. During this time the cows have spent a long time feeding in the *Pragmitetum.* The feeding in the meadow of *Cladium mariscus* has been mostly observed in the end of the grazing period where the main parts of the other vegetation units have been already grazed.

Figure 8.6 in the annex shows that around the lots with high grazing rate also the amount of dung pats is high. Most of these lots are close to the during daytime most frequently used resting area (lot one and around the water tank).

The results are showing that the cows have preferred to graze on the meadows of *P. arundinacea* and *P. arundinacea* with *Thypha latifolia.*

5 Discussion

5.1 Discussion of the results

The areas of high grazing pressure have been almost between their preferred resting place and the water tank. That area have been most of the time in the shadow. These seem to be the principal reasons that this area was preferred by the cattle.

The meadow of *Cladium mariscus* was not preferred as fodder by the cattle. This is shown by the fact that they have been feeding it only in the end of the grazing period when large parts of the other vegetation units have been already grazed. Another indicator that the cattle have not preferred this vegetation unit as nutriment is that the dry weight is slowly increasing. Still the utilisation coefficient for feeding of this vegetation unit is not that small. This might be due to the small spots of this vegetation unit distributed in the area, which easily increases the faults of mapping of the area and of the observation. However the observation has been showing that the cows have liked to rest and ruminate in the meadow of *Cladium mariscus* especially at night.

The observation of the high pasturing of the vegetation units 1, 2, 3 and 8 is also underlined by the matter of fact that the dry weight per m^2 is declining during the grazing season.

In the areas with low feeding pressure and many dung pats the amount of nutrients is increasing, in areas with high feeding rate and few dung pats it is decreasing (If a dung pat shows only a slightly lower amount of nutrients, than the for one dung pat required amount of fodder)

The high density the soil shows under the meadow of *P. arundinacea* might be explained through the high use of the area. Unfortunately there are no data of former years which are indicating the state of the soil before the cattle use.

The main cause of the high grazing rate in the wet area of the vegetation unit *Pragmitetum* could be the lack of water in the tank in July and August.

At least the pasturing pressure seems to be heavily depending on the location and reachability of the vegetation unit. With the small amount of information gained through the work done in the year 2002 it cannot be explicated specified which vegetation unit is preferred because of their plant composure. Only the meadows of *Carex riparia*, *Carex elata* and especially *Cladium mariscus* are definitive not a delicacy for the Scottish Highlands. As a consequence it could be studied in the next year what will happen if the water tank would be shift to the far end of the field (32v).

5.2 Discussion of the method

The employed methods for the determination of the impact of the Scottish Highlands on the vegetation lead to many significant and usable results.

In a few cases it would have been advantageous to have a comparison area. Some of the vegetation units are also represented outside the enclosure. To get more results this area should also be examined.

To find out the role of the water impact measurements of the water level should be done. It is important to know were the water is going after leaving the area and what happens with the nutrients of the overflooded areas. The rising of the lake level also might have caused the loss of some dung pats in the wet areas.

An important aspect is how much weight the cows have been gaining during their pasturing on the area of examination. The weight of the cows could be taken in future before and after the pasturing. Therefor it could be also possible to estimate the amount of nutrients they have been taken from the area.

It would have been advantageous to cut all the vegetation units at the same height for a better comparison of the results. So the results of the vegetation units 3 to 7 from May should be handled with care to make predications.

Not all the sticks on the field are showing the exact distance of 10 meters. When they have been planted into the soil there was no true map of the area given so that the angles of the field have been imprecisely determined. A correction of this fault was tried later on the maps of the area. An other opportunity is to make the measurements with a GPS and the appropriate computer programs.

When the both transects (July and September) of cow dung are compared (8.6) there are partially big differences. The differences might be also a fact of time- to some extend they might have been trodden down from the cattle or washed away by the flood. The main reasons are more founded on the fact that in July the vegetation was much higher than in September so that it was hard and not always possible to lay the tape measure straight on the field- especially there, where have been big distances in-between two sticks. Due to the higher vegetation some cow dung might have been overlooked. Another factor is that different people have made the transect. Also it is not that easy to determinate which size a cow dropping has, how many little droppings should be counted as one and so on. Another problem is to determinate the difference between old and recent dung. This must be more clarified before making a transect. Also the transect should be verified.

The parcelling of the area was made without taking care of the vegetation units. This can lead in some cases to wrong results To set an example the cows have been feeding in 32h mainly in the *Pragmitetum* and not in the meadow of *Carex riparia*. This has been tried to balance by calculating the part of the vegetation unit six bigger. But this is not that easy possible for the spots of the meadow of *Cladium mariscus*. These have been mainly used for other than feeding activities but not for feeding. The happy medium would be to classify vegetation units with a small size as lot for itself and only parcelling the bigger vegetation units.

The activities of the cows during daytime are not the same as during in nighttime. So an extrapolation of the observed activity is not possible. But it seems that the cows are mainly ruminating and resting during the night what is at least not important for the transfer of phosphorus on the area.

The activity moving was nearly not shown from the cows. This column could be included in the column of other activities.

To gain more information the attempt must be documented for more than one year. A long dated observation under steady circumstances will show the whole impact that the Scottish Highlands have on this special area.

6 Summary

Since 2000 a first attempt for pasturing was made to find out the impact of Scottish Highlands on a maintained area of the Grande Cariçaie. In this submitted report of the year 2002 the productivity of the different vegetation units, the different pattern of activity and of space use as well as the distribution of cow dung on the area have been recorded. To find out the role of the cow dung in the turnover of the organic matter and in the nutrient balance of the area the soil and vegetation samples as well as the cow dung have been analysed especially for the phosphorus content. This first attempt is showing the heterogeneity of pasturing and of the space using as well as of the distribution of cow dung. Also the importance of extern factors, that have a great impact on the heterogeneity, e.g. the place of the water tank is worked out.

Im Jahre 2000 wurde ein erster Beweidungsversuch mit Schottischen Hochlandrindern auf einer der Unterhaltsflächen der Grande Cariçaie unternommen um die Auswirkung, die diese Tier auf die Vegetation haben zu untersuchen. Bei der vorliegenden Arbeit aus dem Jahre 2002 wurde die Produktivität der unterschiedlichen Vegetationstypen, die verschiedenen Verhaltensmuster der Tiere und ihre Nutzung der Fläche sowie die Verteilung der Kuhfladen festgehalten. Um herauszufinden welche Rolle die Kuhfladen im Umsatz des organischen Materials und in der Nährstoffbilanz der Parzelle spielen wurden die Boden- und Vegetationsproben sowie die Kuhfladen insbesondere auf ihren Phosphorgehalt hin analysiert. Es zeigt sich eine Heterogenität der Beweidung und des Raumnutzungsverhaltens sowie der Kuhfladenverteilung. Auch die Wichtigkeit externer Faktoren (wie z.B. der Standort des Wassertankes) die einen grossen Einfluß auf die Heterogenität haben, wird herausgehoben.

Depuis l'année 2000 une première expérience de pacage avec des vaches écossaises est entreprise sur une parcelle d'entretien de la Grande Cariçaie. Dans ce travaille en 2002 la productivité des différents types de végétation, les fréquences des différents comportements du bétail, leur distribution spatiale sur la parcelle et la distribution des bouses ont été relevées dans ce travail. Pour mesurer l'importance des bouses dans le turn over de la matière organique et dans le bilan des éléments nutritifs sur la parcelle, des échantillons de sol ont été prélevés et les différentes végétation ainsi que les bouses ont été analysés en fonction de leur teneur en phosphore. Cette première analyse met en évidence l'hétérogénéité qualitative du broutage et de l'utilisation des différentes zones de la parcelle. L'hétérogénéité de la distribution des bouses est aussi mise en évidence tout comme l'importance de facteurs „externes" comme l'emplacement du réservoir d'eau et de l'ombrage.

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8 Annex

Annex

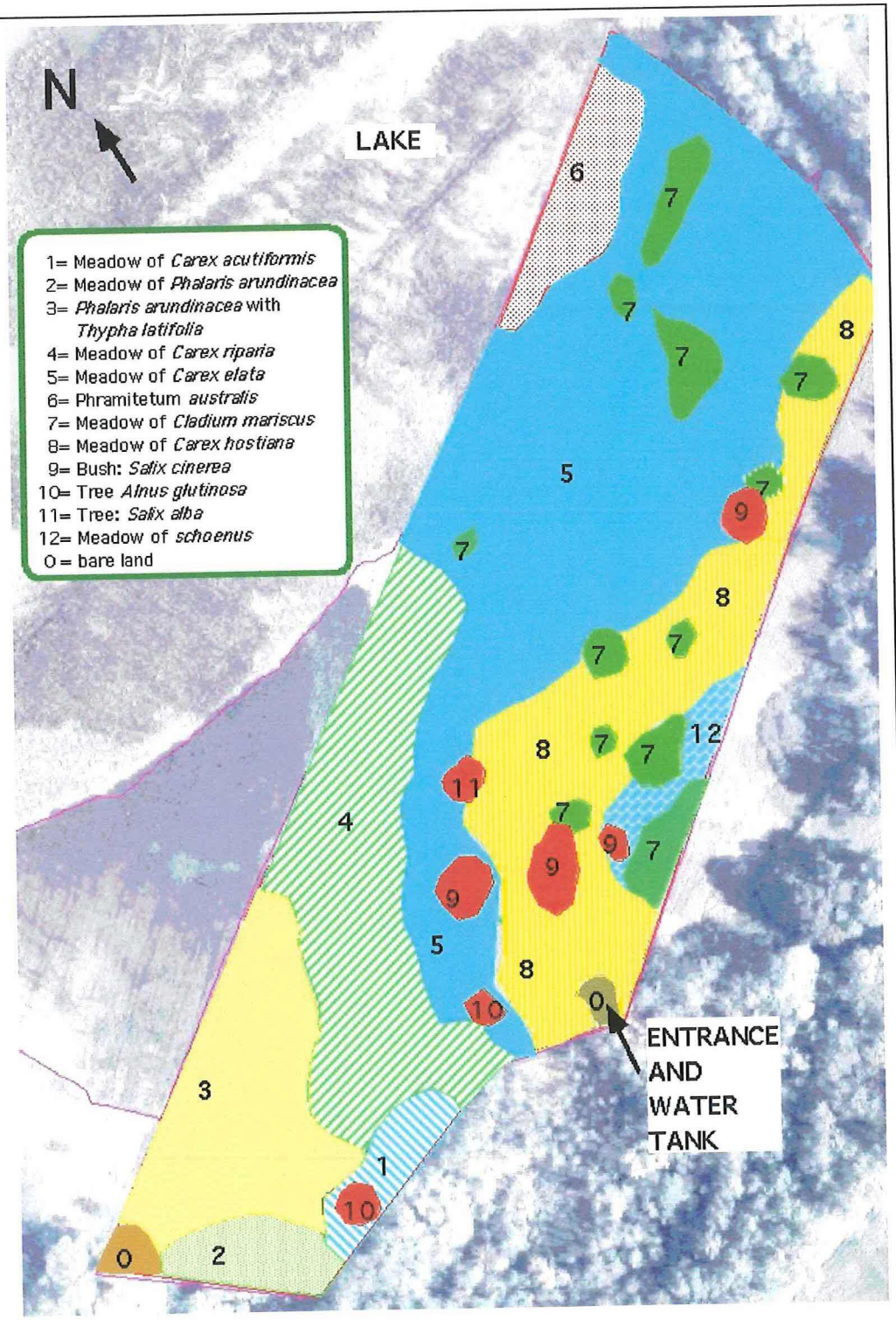

Fig 8.1: Pasture land of Gletterens: Map of vegetation types

Scale 1:1600
Air photo May 2001

(Alke Rockmann 2002)

Annex

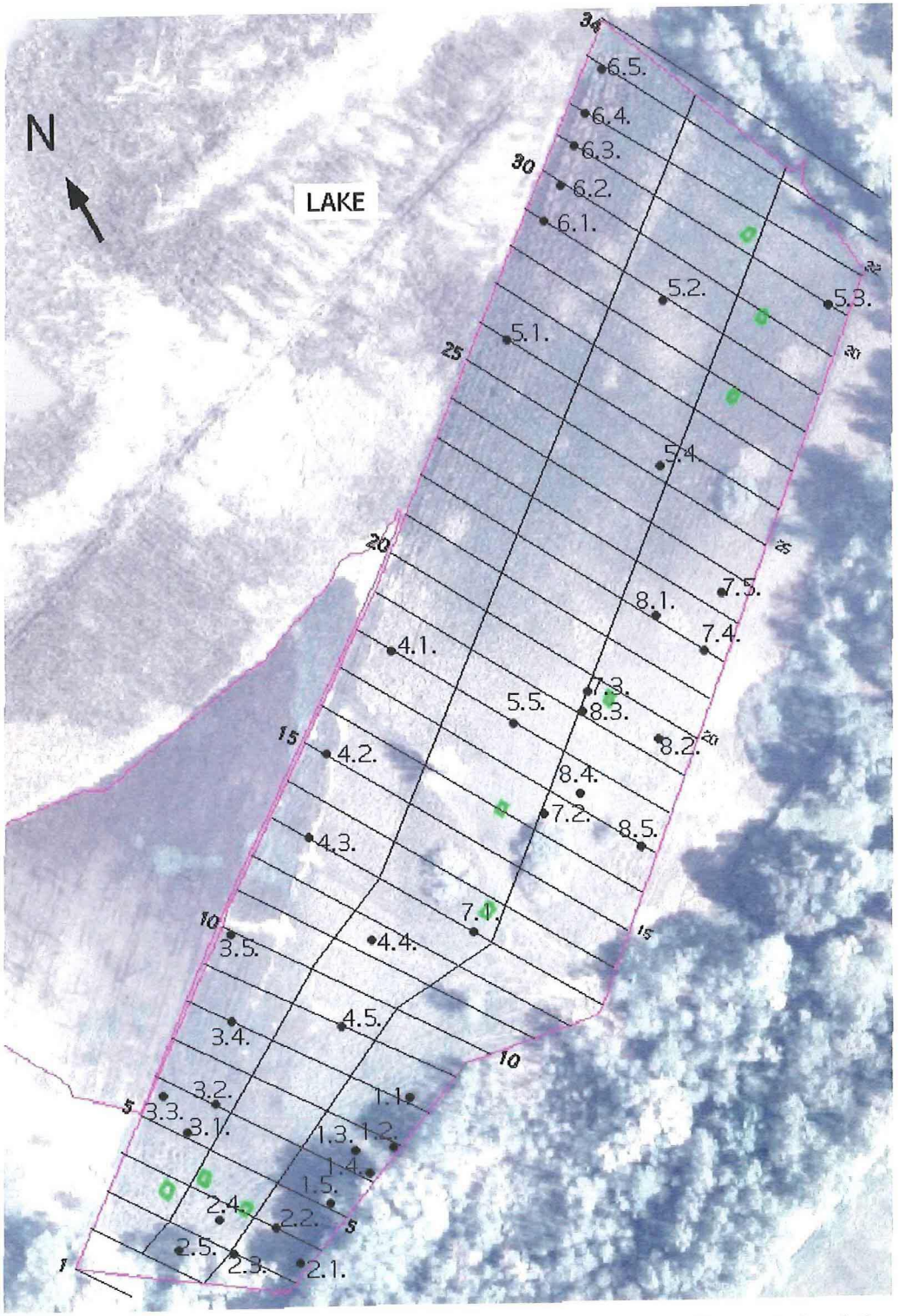

Fig.8.2: Pasture land of Gletterens : Soil sampling July 11

(_._) = (Vegetationunit no. . Soil sample no)

Scale 1:1600

Air photo May 2001

(Alke Rockmann 2002)

Annex

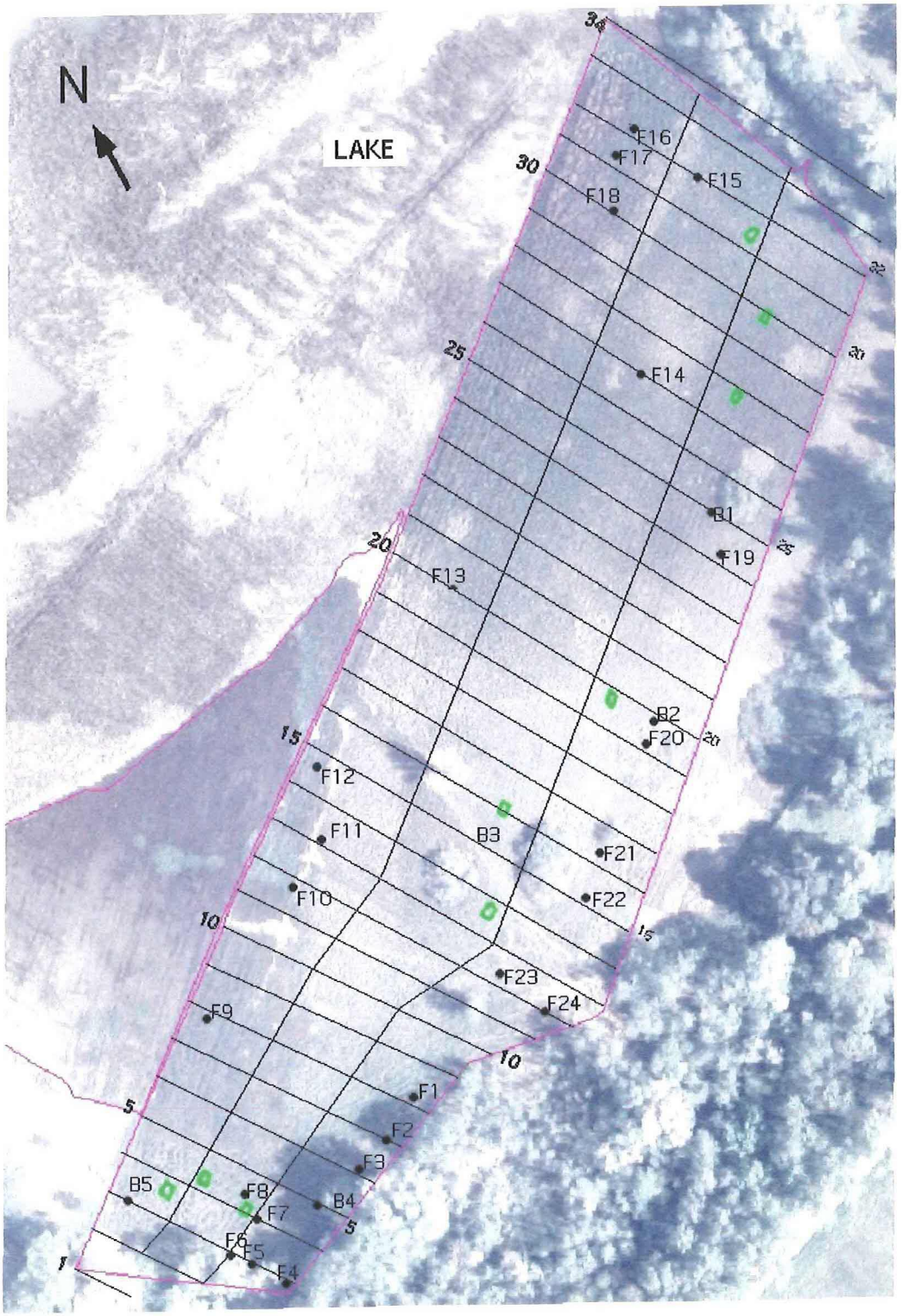

Fig.8.3: Pasture land of Gletterens : Sampling vegetation (F) and dung (B) July 22/23

Scale 1:1 600

Air photo May 2001

(Alke Rockmann 2002)

Annex

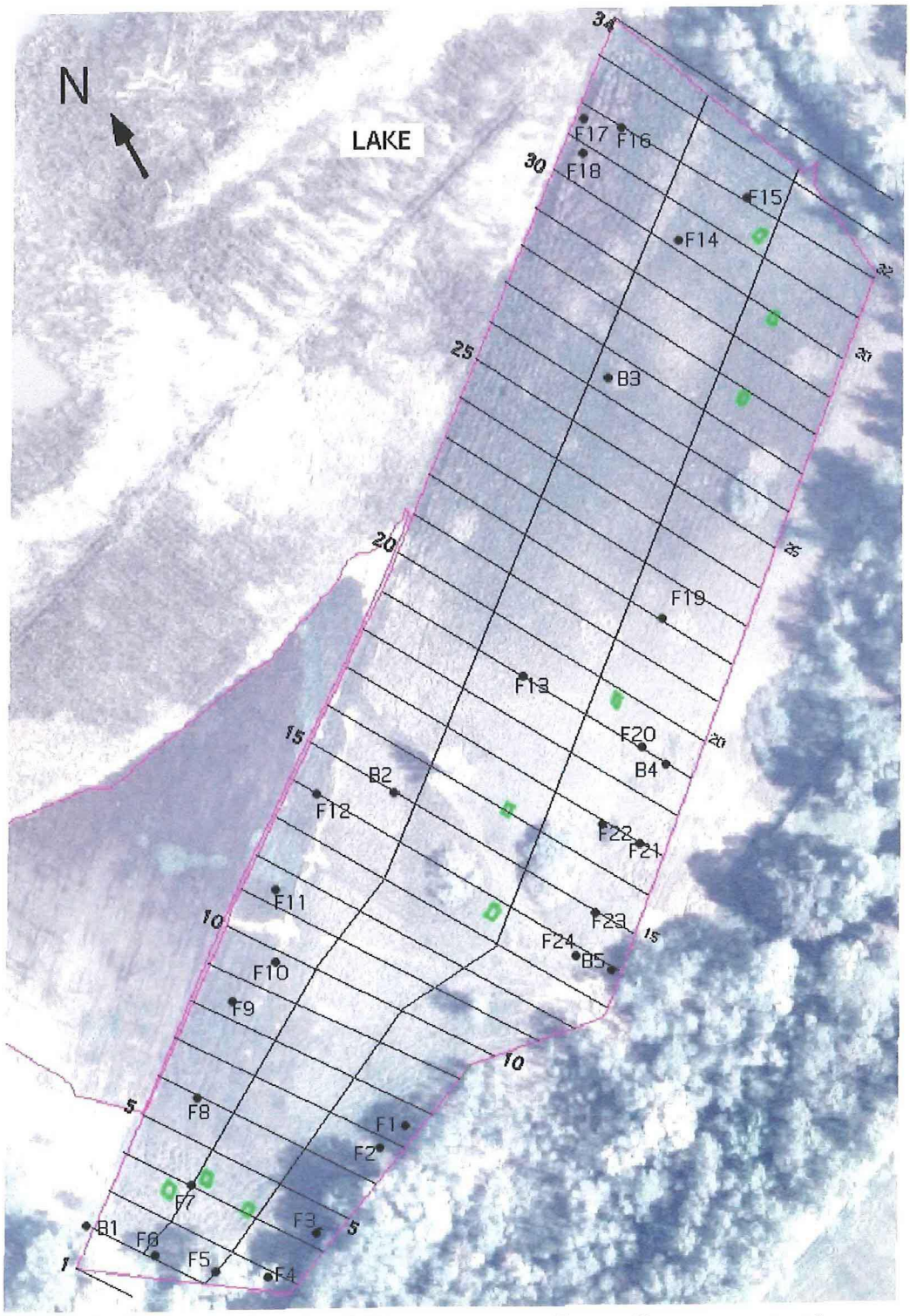

Fig.8.4: Pasture land of Gletterens : Sampling vegetation (F) and dung (B) September 22/23

Scale 1:1600 (Alke Rockmann 2002)

Air photo May 2001

Annex

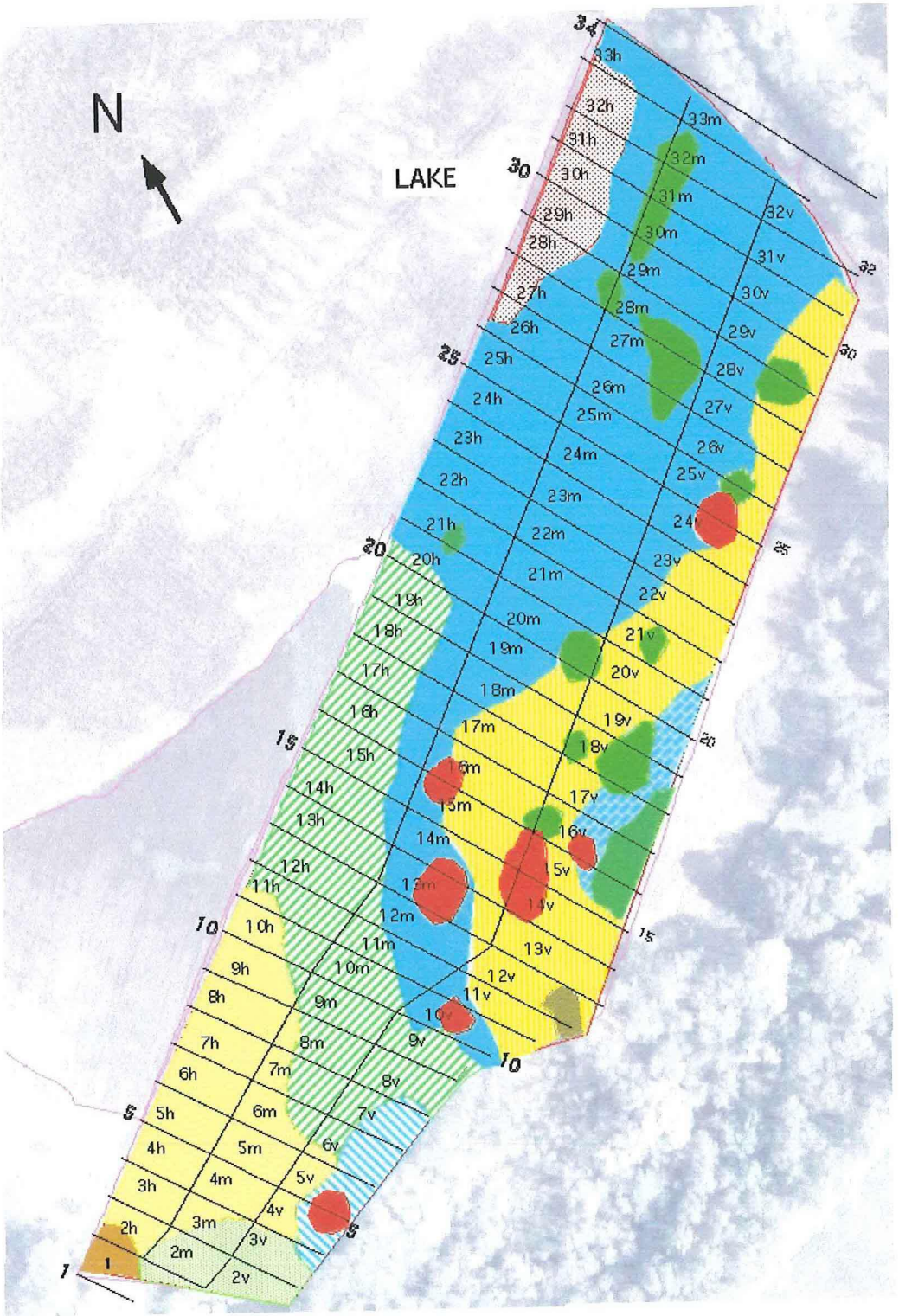

Fig. 8.5: Pasture land of Gletterens: Lots and different types of vegetation (Vegetation Index Fig. 8.1.)
Scale 1:1600
Air photo May 2001
(Alke Rockmann 2002)

Annex

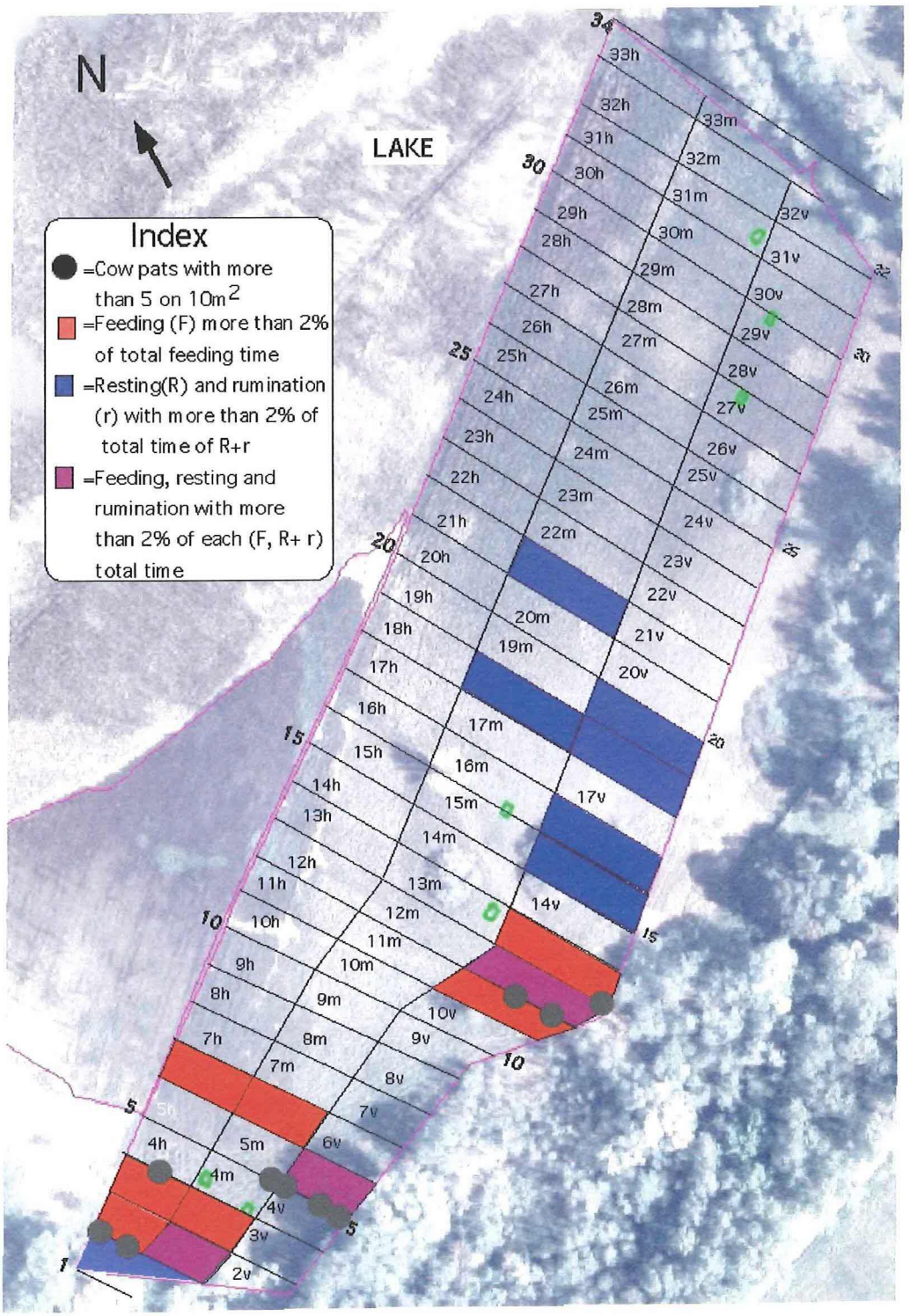

Fig.8.6: Pasture land of Gletterens : Lots with high spots of feeding, resting and rumination and cow dung

Scale 1:1600

Air photo May 2001

(Alke Rockmann 2002)

Tab 8.1: Vegetation relevé 22.5./23.5.02

Vegetation unit	1			2			3			4			5			6			7			8			1	2
code square	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22	F23	F24	F25	F26
hight upper stratum (cm)	70	70	70	100	90	80	120	120	130	100	60	60	60	60	120	200	200	200	50	60	70	30	30	60	60	80
cover Hgt. strate (Br-Bq)	4	4	4	4	4	4	3	4	4	4	3	3	3	3	1	4	4	4	2	5	5	3	4	2	4	5
hight lower stratum (cm)			30	20	15	20	20	80	100		30	20	10	20	90	10	20			10			5	5		10
cover lower stratum (Br-Bq)			2	1	4	3	2	1	+		+	2	+	2	3	+				1			1	1		2
cover Lit. Debout %	+		+	+		+	+	1	+	3	2	2	+	+	2	1	1	+	2			+	+	1	+	
cover Lit. soil %	2		1	1		+	1	3	2		2	+	2	+	1	+	+		5			1	+	+	2	1
piétinement %																										
hight. Water (Br-Bq)				0	0		0	0	0		2	0	1	3	6	20	20	20	0				0	0	0	0
cover water (Br-Bq)									+		+		+		4	1	5	5								
presence of dung																										
Carex acutiformis	4	3	3																						4	3
Phalaris arundinacea			+	3	2	4	+	+																	+	3
Phragmites australis	2	3	3	3	3	2	3	4	4			1	+	+	3	4	4	4				1	1	2	2	2
Carex riparia										3	3	3														
Carex elata													3	3	3							+		+		
Cladium mariscus																			2	5	5					
Carex hostiana																							+	1		
Carex panicea																						3	3	3		
Ranunculus ficaria				2	2	2	1	+																		2
Cardamine amara							+			+	+						+	+								
Carex sp.																	+			+						
Circea lutetiana				1	+	1	+	+																		+
Eleocharis uniglumis																						+	2			
Epilobium parviflorum						+		+																		
Epilobium sp																							+			
Galium elongatum							+													+						
Galium palustre	+		+				1	+	+	+	+	2	+	1								+				
Galium sp.																							r			
Hydrocotyle vulgaris	1																			2		+		1		
Juncus articulatus																						+	+			
Lysimachia vulgaris																						+	1	+		
Mentha aquatica										+		1											+			
Molinia sp.			2																							
Nasturtium officinale																+		5								
Peucedanum palustre													+													
Rorippa amphibia									+																	
Rorippa palustris					+		1				+	+														
Scutellaria galericulata			+											1						r						
Symphytum officinale								+																		
Taraxacum officinale																										r
Urtica dioica					+	1																				+
Veronica becca bunga						3			+																	
cut at cm	5	5	5	5	5	5	40	40	40	30	30	30	30	30	30	30	30	30	30	30	30	5	5	5	35	45

Annex

Tab 8.2: Vegetation relevé 22.7./23.7.02

Vegetation unit		1			2			3			4			5			6			7			8	
code square	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22	F23	F24
hight upper stratum (cm)	40	40	40	20	80	60	100	100	90	110	100	130	90	90	210	300	250	220	130	150	100	30	40	35
cover Hgt. strate (Br-Bq)	5	4	4	2	2	2	2	2	2	5	4	4	5	4	+	2	2	1	5	4	3	+	5	4
hight lower stratum (cm)				5	10	20	30	20	10	40	50	70	0	60	150		130	130		15	30	5		
cover lower stratum (Br-Bq)				3	4	4	4	2	3	+	2	1	1	1	5	+	1	2		2	1	4	+	
cover Lit. Debout %	+	1	1	0	0	+	1	1	+	+	1	1	0	+	+	+	+	+	+	+	+	0	+	+
cover Lit. soil %	2	3	2	3	1	+	2	1	2	2	4	3	1	1	1				1	3	1	+	5	+
piétinement %	3	4	2	3	1	2	2	4		0									1	2	4	2	1	3
hight. Water (Br-Bq)	0	0	0	0	0	0	0	0	15	5	10	12	10	17	25	40	45	40	8	0	0	0	5	0
cover water (Br-Bq)									5															
presence of dung	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
Carex acutiformis	5	3	4	2	+		+								5									
Phalaris arundinacea				2	1	4	+	+										1						
Phragmites australis	+	2	1	+	+	1	4	2	2		+	1	+	+	+	2	2		+		+	+	+	+
Carex riparia			+					+		5	4	4	+				1							
Carex elata													5	4		+		2					2	
Cladium mariscus																			5	4	3			
Carex hostiana																						2	1	+
Carex panicea																							1	3
Poa sp.				1	4	2	+																	
alnus glutinosa			+					+																
Calamagrostis epigeios																							1	2
Cardamine amara								+		+														
Circea lutetiana				1	1	+	+	1																
Cirsium arvense																					+			+
Eleocharis palustris																							1	
Epilobium parviflorum				1	+																1			
Epilobium sp																								+
Galium aparine																								+
Galium elongatum		+	+				2														+			
Galium palustre								+	3	+	+	+	1	+	+								+	+
Hydrocotyle vulgaris																				2				
Juncus articulatus	+																						2	+
Juncus effusus					1																			
Lysimachia vulgaris										+										+		+	+	+
Mentha aquatica									1	+	1	+											+	1
Molinia sp.																						2	+	
Myosotis scorpioides									1															
Myriophyllum verticillatum																3	2							
Nastridium sp.								+																
Quercus robur																				+				
Rorippa palustris										+														
Rorippa sp.							+																	
Scrophularia umbrosa								+																
Scutellaria galericulata	+	+					+			+	+		+	1	+							+	+	1
Solidago virgoaurea			+					+																
Thalictrum flavum													+											
Urtica dioica							+	+																
Veronica anagallis-aquatica																								
cut at cm	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

Tab 8.3:Vegetation relevé 09.09.02

Vegetation unit		1			2			3			4			5			6			7			8	
code square	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22	F23	F24
hight upper stratum (cm)	20	35	30	10	30	25	80	80	100	80	70	60	50	100	110	250	300	270	50	70	70	10	10	15
cover Hgt. strate (Br-Bq)	2	4	3	5	4	5	1	2	2	5	5	4	3	4	95	2	2	2	5	4	4	3	3	3
hight lower stratum (cm)							10	10	20	5	30	30	15	10		40			10	10	5			
cover lower stratum (Br-Bq)							1	4	4	+	2	+	1	1		+	+		2	1	+			
cover Lit. Debout %	1	4	+	0	0	0	+	1	1	+	0	1	2	1	+	1	1	1					+	+
cover Lit. soil %	2	4	2	1	2	1	4	2	2	4	2	3	2	2	5	1	2	2	3	2	2	1	+	1
piétinement %	3	2	4	1	2	1	5	3	3	0	1	2	3						2		2	3	4	3
hight. Water (Br-Bq)	0	0	0		0	0	0	0	0		0	0	0	0	3	20	25	25	0	0	0	0		
cover water (Br-Bq)	1							1	1					1		5	5	5						
presence of dung	0	0	0		0	0	0	0	0	0	0	0		0	0	0	0	0	0	1	0		0	0
Carex acutiformis	2	3	3	1																				
Phalaris arundinacea	+	+	+		1		4	2																
Phragmites australis	+	+	+		3	+		1	2		+	+	+	+	+	2	2	2				+	+	+
Carex riparia		1								5	5	4												
Carex elata								+	+				3	3	5	+	+							
Cladium mariscus																			4	4	3			
Carex hostiana																						2	3	3
Galium palustre				+	+		+	2	2	+	1	1	+	+			+		+		+			+
alnus glutinosa							+																	
Cardamine palustre											1													
Cardamine amara								+	+															
Cardamine sp.												+				+								
Circea lutetiana		+			+	+																		
Cirsium sp.																							+	
Elocharis palustris																						+	1	+
Epilobium parviflorum	+	+	+				1	+																
Epilobium sp					+																	+	1	+
Galium elongatum			+																					
Geum rivale						1																		
Hydrocotyle vulgaris																			1	1	+	1	+	+
Juncus articulatus					+	+																	+	
Juncus effusus	+				+																			
Lysimachia vulgaris													+						+			+		+
Mentha aquatica									+				1									+		+
Molinia caerulea																						2	1	1
Myosotis scorpioides							+		3															
Myriophyllum verticillatum																+		+						
Poaceae				5																				
Poa sp.			+		2	4	+																	
Rorippa sp.								+																
Schoenus nigricans																					1		+	
Scutellaria galericulata												+		+										
Utricularia minor														+		+								
Urtica dioica				+	+		+																	
cut at cm	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

Annex

Tab 8.4.: Weight of Vegetation samples

Weight vegetetation sampels 22.5./23.5.02

code square	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
Weight sqarem (g)	889	906	858	830	690	550	515	839	1088	263	203	251
Weight fresh (g)	200	200	200	200	200	200	200	200	200	200	200	200
Weight dry (g)	51	49	53	46	50	52	50	45	50	66	68,5	66
Weight dry % of w. fresh	25,50	24,50	26,50	23,00	25,00	26,00	25,00	22,50	25,00	33,00	34,25	33,00

Weight vegetetation sampels 22.7./23.7.02

code square	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
Weight sqarem (g)	321	277	294	165	276	86	341	305	261	800	495	655
weight fresh (g)	200	200	200	160	200	86	200	200	200	200	200	200
Weight dry (g)	74	76	69,5	66	76	38	75	77	74	74	73	73
Weight dry % of w. fresh	37,00	38,00	34,75	41,25	38,00	44,19	37,50	38,50	37,00	37,00	36,50	36,50

Weight vegetetation sampels 09.09.2002

code square	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
Weight sqarem (g)	84	285	192	61	138	74	175	233	290	541	592	470
Weight fresh (g)	84	200	192	61	138	74	175	200	200	200	200	200
Weight dry (g)	29	58,00	55,00	13,00	31,00	15,50	56,00	73,00	88,00	91,00	82,00	93,00
Weight dry % of w. fresh	34,52	29,00	28,65	21,31	22,46	20,95	32,00	36,50	44,00	45,50	41,00	46,50

Weight vegetetation sampels 22.5./23.5.02

code square	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22	F23	F24	F25	F26
Weight sqarem (g)	231	226	348	936	1070	762	455	923	839	338	161	281	218	704
Weight fresh (g)	200	200	200	200	200	200	200	200	200	200	168	200	200	200
Weight dry (g)	65	71	60	49,5	45	48,5	81	88	81	61	50	55	52	49
Weight dry % of w. fresh	32,50	35,50	30,00	24,75	22,50	24,25	40,50	44,00	40,50	30,50	29,76	27,50	26,00	24,50

Weight vegetetation sampels 22.7./23.7.02

code square	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22	F23	F24
Weight sqarem (g)	610	472	1004	544	568	860	854	1246	389	100	244	217
weight fresh (g)	200	200	200	200	200	200	200	200	200	100	200	200
Weight dry (g)	78	76	60	95	75	69	90	81	74	40	72	78
Weight dry % of w. fresh	39,00	38,00	30,00	47,50	37,50	34,50	45,00	40,50	37,00	40,00	36,00	39,00

Weight vegetetation sampels 09.09.2002

code square	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22	F23	F24
Weight sqarem (g)	258	325	825	774	420	390	858	928	726	35	16	28
Weight fresh (g)	200	200	200	200	200	200	200	200	200	35	16	21
Weight dry (g)	103	96	92	112	111	108	82	85	92	15	7	11
Weight dry % of w. fresh	51,50	48,00	46,00	56,00	55,50	54,00	41,00	42,50	46,00	42,86	43,75	52,38

Tab. 8.5: Cow Dung on the Area of Examination

	Weight of cow dung 29.5.02				
code square	B1	B2	B3	B4	B5
Weight fresh (g)	325	350	379	508	306
Weight dry (g)	50	50	72	72,5	54,5
Weight dry %	15,38	14,29	19,00	14,27	17,81

	Weight of cow dung 23.7.02				
code square	B1	B2	B3	B4	B5
Weight fresh (g)	318	264	718	361	300
Weight dry (g)	61	33	124	80	46
Weight dry %	19,18	12,50	17,27	22,16	15,33

	Weight of cow dung 09.09.02				
code square	B1	B2	B3	B4	B5
Weight fresh (g)	454	407	414	1359	1050
Weight dry (g)	73	75	71	241	182
Weight dry %	16,08	18,43	17,15	17,73	17,33

Sum dung on area:	4200
Mean weight of all dung (g):	16,9
Dry weight of one dung (g):	33,9
Weight dry dung all area (g):	142195,15
Weight dry dung all area (kg):	142,20

Annex

condt. Tab. 8.7

Lot	Vegetation unit								Activity in Minutes				
no.	1	2	3	4	5	6	7	8	Feeding	Resting	Ruminating	Moving	Others
27h					0.7	0.3			46				
27m					0.4		0.6		71				
27v					0.5			0.5	2				
28h					0.1	0.9			50				
28m					0.6		0.4		40				
28v					0.5		0.3	0.2	20				
29h					0.1	0.9			121			1	5
29m					0.9		0.1		49				
29v					0.5		0.1	0.4	4				
2h			1						233	2	20	9	25
2m		0.9	0.1						309	133	186	27	40
2v		1							122	16	30		11
30h					0.1	0.9			93				
30m					0.8		0.2		10				
30v					0.6			0.4	6				
31h					0.1	0.9			156				
31m					0.8		0.2		43				
31v					0.8			0.2	16				
32h					0.1	0.9			228				
32m					0.8		0.2		17				
32v					1				39				
33h					0.8	0.2			172				
33m					1				22				
3h			1						190			2	
3m	0	0.5	0.5						238		16	3	
3v	0.1	0.9							166		12	3	8
4h			1						140				1
4m			1						168	12	25		4
4v	0.6		0.4						169		17		16
5h			1						182				
5m			1						221		3	3	7
5v	0.7		0.3						206		103		115
6h			1						199				1
6m			0.7	0.3					186				3
6v	0.6		0.1	0.3					105				4
7h			1						148	8			
7m			0.3	0.7					114			3	2
7v	0.6			0.4					66			6	23
8h			1						136				1
8m			0.2	0.8					96			2	33
8v	0.1			0.9					63			3	
9h			0.8	0.2					74				
9m				1					42				
9v				0.9	0.1				47	27			7
sum	3.7	5.3	16.1	19.2	37.7	11.2	11.9	22.6	9276	3325	4220	143	1848

Annex

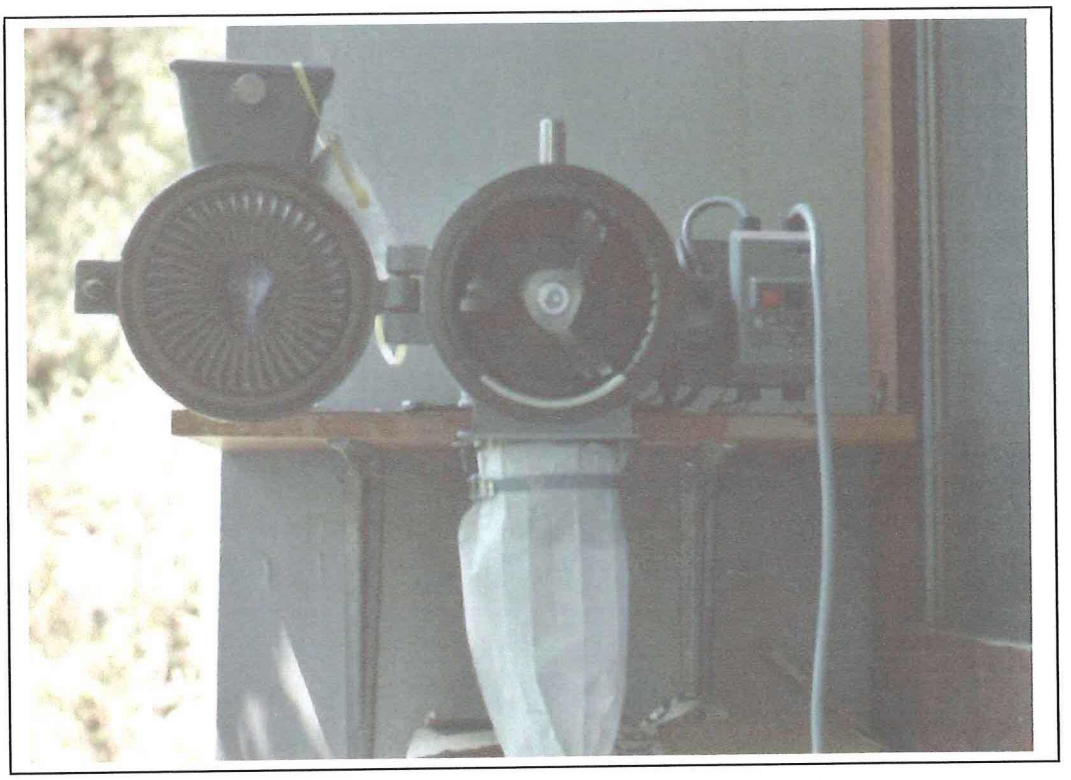

Fig. 8.7: Retschmühle (A. Rockmann 2002)

Fig. 8.8: Transect: Counting dung pats (A. Rockmann 2002)

Annex

Fig.8.9: In the back corner resting place (lot 1) (A. Rockmann 2002)

Fig. 8.10: Observation stand (A. Rockmann 2002)

Annex

Fig. 8.11: Meadow of *Phalaris arundinacea* (July 2002) (A. Rockmann 2002)

Fig.8.12: Meadow of *Carex riparia* (July 2002) (A. Rockmann 2002)

Annex

Fig. 8.13: *Phragmitetum australis* (July 2002) (A. Rockmann 2002)

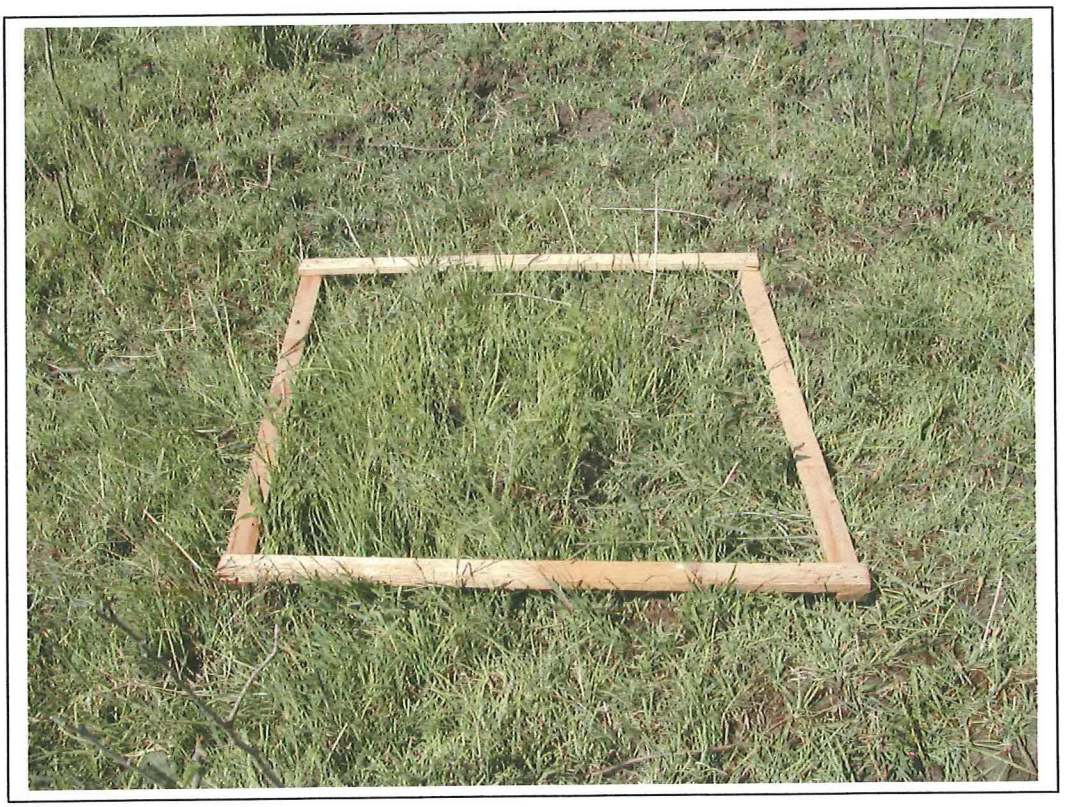

Fig. 8.14: Meadow of *Carex hostiana* (July 2002) (A. Rockmann 2002)

Annex

Fig. 8.15: Goodbye at the end of the work (I. Dunand 2002)