Colophon

North Western dune and lowland heaths – natural processes and management.
Abstracts and excursion guide. 13th European Heathland Workshop, Denmark, 23rd to 28th of June 2013. Department of Geosciences and Natural Resource Management (IGN), Denmark.

Front cover pictures:
Inger Kappel Schmidt
Aslak Kappel Hansen

Cover design:
Johannes Ransijn
Karin Kristensen

DTP:
Karen Thirslund

Department of Geosciences and Natural Resource Management (IGN)
Rolighedsvej 23, 1958 Frederiksberg C
E-mail: sl@life.ku.dk
Website: www.sl.life.ku.dk
Tlf: 353 31500
Fax: 353 31508

13th European Heathland Workshop

23rd to 28th of June 2013

Denmark

North Western dune and lowland heaths – natural processes and management

Abstracts and excursion guide

Table of contents

Welcome

We welcome you all to the 13th European Heathland Network Workshop, which takes place in Denmark, 23rd-28th June 2013.

The European Heathland Network has been established to enable people involved or interested in heathland ecological research, conservation of wildlife, and in policy formulation and implementation in relation to European heathlands to meet, discuss, and exchange knowledge and ideas on research and conservation of heathland ecosystems. We are looking forward to show you some of our great coastal and inland heaths and discuss patterns, processes and management with you.

The present workshop will focus on the Danish coastal dune heaths. Our first venue is located next to this magnificent and dynamic landscape of dry sand dunes, moist hollows and shallow lakes where dune formation can be studied. The coastal heaths are more stable than inland lowland heaths but as former exploitation of the dune heaths have ceased, they are threatened by encroachment of shrubs and conifer trees.

The Organizer Committee would like to thank our local excursion guides for making the excursions at the workshop possible. Furthermore we would like to thank the participants contributing with abstracts for talks and posters enabling interesting morning sessions. Last and not least we would like to thank AAGE V. JENSENS FOND for economical support.

The Organizer Committee

Rita Buttenschøn, Inger Kappel Schmidt, Johannes Ransijn, Ib Johnsen, Marie Dam, Torben Riis-Nielsen and Karen Thirslund

Photo: Inger Kappel Schmidt

The coastal dune and inland heaths of Denmark

The Danish heaths cover about 84.000 ha or close to 2 % of the area of Denmark. They are an important part of the NATURA 2000 network. Heathlands > 2.500 m^2 are protected by law. Further, many of the larger heathlands are state owned, designated as conservation areas as NATURA 2000 nature.

There is a gradual transition from the coastal dune heath to the inland dry Calluna-Empetrum heath (habitat code 4030), which is the main type of inland heaths. Inland heathlands include about 25,000 ha of dry *Calluna vulgaris* heath (habitat code 4030), often to be found in a mosaic with Northern Atlantic wet heaths with *Erica tetralix* (habitat code 4010). Part of the inland heaths consist of inland dune heath including dry sand heaths with *Calluna* and *Genista* (habitat code 2310), with *Calluna* and *Empetrum nigrum* (habitat code 2320) and Inland dunes with open Corynephorus and *Agrostis* grasslands (habitat code 2330).

The coastal heaths cover about 25,000 ha – about half of the total dune area along the North Sea. They consist mainly of two types: fixed grey dunes (habitat code 2130*) and decalcified fixed dunes with *Empetrum nigrum* (habitat code 2140*). The dune heaths develop on coastal dune sand when the acid and nutrient-poor grey dunes are invaded by dwarf shrubs, especially *Empetrum nigrum*. In 1800, large part of Denmark was still covered by heath. In 1850 the heaths covered about ⅓ of the total area of Jutland or ¼ of Denmark (Fig. 1).

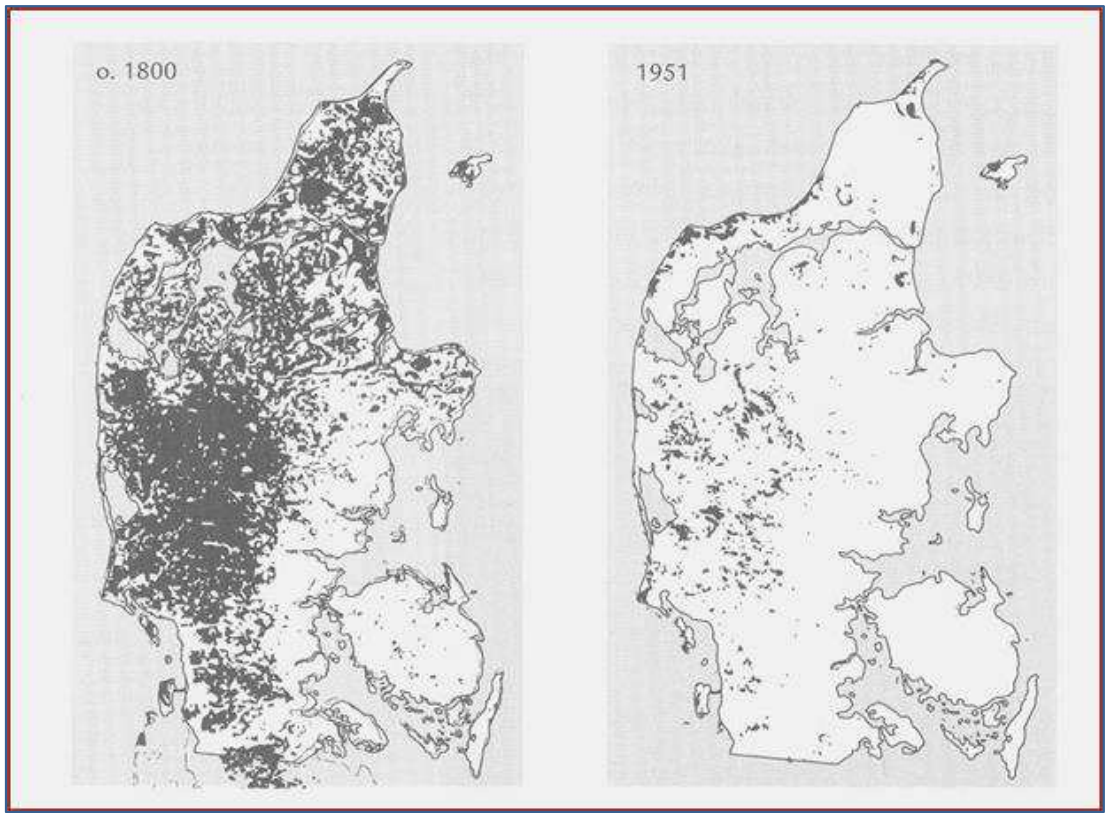


Figure 1. Heathlands in Jutland and Fyn around 1800 and 1951. The main heathland area in 1800 was located in the western part of Denmark, which was not covered by ice during the last glaciation. From Joensen (1967).

Over-exploitation by man during centuries created the cultural landscape dominated by *Calluna vulgaris*. The farmers used the in-field and out-field system. The out-fields were used extensively for grazing, hay cutting and sod-cutting continuously removing nutrients, which was brought to the farm and mixed with manure from the animals and added to the in-fields. The farming system has

contributed to differences in soil characteristics and heathlands types. The former land-use is still visible as more grass and herb rich flora at the former cultivated in-fields compared to the *Calluna-Empetrum* heath at the former outfields. The heaths of Nørholm, Randbøl and Kongenshus are good examples.

From 1800-1950 most of the 1 million ha was turned into agriculture or plantations with imported conifer trees. Since 1950, we have lost another 40.000 ha leaving us with about 84.000 ha or 2 % of the area of Denmark. The remaining area is highly fragmented and threatened by drainage, atmospheric nitrogen deposition and lack of management (Table 1).

Table 1. The distribution of Danish heaths based on their size. From Buttenschøn (2001).

Area (ha)	number	% of total
Under 1	4190	43
1-5	3661	38
5-10	778	8
10-50	825	8
50-100	125	1
100-500	136	1
500-1000	11	Under 1
Over 1000	8	Under 1
Area in total	9734	100

The dune heaths were used for grazing, cutting of heather and peat and the utilization created gaps in the vegetation where wind could break up the dune. Drifting sand was therefore a major problem, plantations with imported conifer species were established and *Leymus arenarius* and *Ammophila arenaria* were used to stabilize the dunes. The remaining heaths are now threatened by invasion of non-native species such as *Pinus mugo* and *Pinus contorta* from the plantations preventing the natural dynamics. Besides the trees, we imported the shrub *Rosa rugosa* from Asia in 1875, which has spread along the coast and is a major threat to the coastal dune heaths.

We have long considered the coastal dune heaths to be relatively stable. However, the stabilization of the dunes has stopped the natural dynamics and changed soil and microclimate with major impact on the dune flora and fauna. Other threats are elevated atmospheric nitrogen deposition, increasing the cover of the grass *Deschampsia flexuosa*, drainage and eutrophication. A number of management trials have been initiated to restore natural dynamics including removal of trees, grazing or small-scale burning.

Programme

Sunday, 23 June

Arrival at hotel Slettestrand

16:00	**Coffee and cake**
19:45	**Dinner at the hotel**
21:00	Midsummer bonfire at the beach

Monday, 24 June

07:30	**Breakfast**
09:00	Opening of 13th European Heathland Workshop - Geert de Blust, Rita Buttenschøn, Inger Kappel Schmidt
09:15	Presentations
10:15	**Coffee**
10:45	Presentations
11:25	Poster session
12:30	**Lunch**
13:30	Presentations
15:00	Introduction to the afternoon excursion
15:30	Excursion to Fosdalen with coffee and cake
19:00	**Dinner at hotel Slettestrand**
20:30	Heathlands – natural and cultural ecosystems - Bent Odgaard
21:15	Introduction to next day's excursion – Ib Johnsen

Tuesday, 25 June

07:30	**Breakfast**
08:30	Presentations
09:50	**Coffee**
10:20	Presentations
12:00	Discussion part I - The role of the network and its relation to European biodiversity policy
12:40	**Lunch**
13:40	Poster session
14:30	Excursion to Hulsig dune heath, Råbjerg Mile and Skagen
20:00	**Dinner at Grenen (the tip of Jutland) restaurant De 2 Have (the 2 seas),** www.restaurantde2have.dk
22:30	Arrival at the hotel

Wednesday, 26 June

07:30	**Breakfast**
08:30	Presentations
10:10	**Coffee**
10:40	Presentations
11:45	Introduction to Thy National Park
11:50	Discussion Part II and final remarks
12:40	**Lunch**
14:00	Excursion to Thy National Park
19:15	Drinks and Introduction to the 2-days excursion
19:45	**Dinner at Hotel Slettestrand**

Photo: IKS

Thursday, 27 June

Departure or 2-days excursion

07:30	**Breakfast**
08:15	Departure in private cars
10:15	Kongenshus Heath www.kulturarv.dk/1001fortaellinger/en_GB/kongenshus-memorial-park
11:15	**Lunch**
14:00	Mols Bjerge National Park Walk to climate change experiment and to grazing experiment at Buelund through the central part of Mols Bjerge National Park to Trehøje www.increase-infrastructure.eu www.naturhistoriskmuseum.dk/molslaboratoriet/Findvej.htm Coffee and cake
19:30	**Dinner at Fuglsøcentret, Knebel www.fuglsoecentret.dk/english**

Friday, 28 June

07:00	**Breakfast**
07:30	Departure
09:30	Randbøl Heath, visit the LIFE+ project www.naturstyrelsen.dk/Naturbeskyttelse/Naturprojekter/Projekter/Vestjylland/LIFE-Hede/English/ Coffee and cake
12:30	**Nørholm Heath and lunch**
15:45	Departure to Billund airport (arrival 17:00) Vejle Station (arrival 17:15)

Schedule for the sessions

	Time	#	Name	Title
Sessions June 24th	09:15	T1	Knud Erik Nielsen	Is current management part of the solution or part of the problem for nutrient-poor ecosystems?
	09:35	T2	Mons Kvamme	Action plan for conserving coastal heathlands in Norway
	09:55	T3	Leonor Calvo	Challenges in the use of ecosystem services as a tool to manage heathlands of the Cantabrian Mountains
	10:15			**Break**
	10:45	T4	Simona Bacchereti	LIFE Nature for heathland management and conservation: examples and best practices
	11:05	T5	Geert de Blust	Disturbance by grazing sheep as a management risk for ground-breeding heathland birds
	11:25			**Poster session**
	12:30			**Lunch**
	13:30	T6	Leif Christian Torsøe	Sheep on the Moors in southern Norway
	13:50	T7	Martin Woestenburg	That is why we eat sheep
	14:10	T8	Berit Kiilerich	Practical experiences from heathland management by sheep grazing in West Jutland
	14:30	T9	Jaime Fagúndez	Biodiversity and conservation of wet heathlands in Galicia (NW Spain)
	15:00			**Introduction excursion**
	15:30			**Excursion**
Sessions June 25th	08:30	T10	Morten Strandberg	Challenges in managing Danish inland Erica tetralix wet heathland
	08:50	T11	Frederik Naedts	LIFE Visbeek: Developing a heathland landscape
	09:10	T12	Kristina Krenz	Maintaining the favourable conservation status of European Dry Heaths on an active military training area - a case study from the SAC Colbitz-Letzlinger Heide
	09:30	T13	Henk Siepel	The economy and ecology of heathlands
	09:50			**Break**
	10:20	T14	Sarah O'Loughlin-Irwin	An integrated approach to conserving specific Annex I heathland habitats in the Burren, Western Ireland
	10:40	T15	Isabel Alonso	Meeting species requirements with heathland management prescriptions: generalists vs. specialist
	11:00	T16	Chris Dictus	Protection of butterflies on heathland sites in Flanders and the management case study of the Alcon blue (Maculinea alcon)

	11:20	T17	Natascha Segers	Species actions plans for butterflies in Flanders (Belgium)
	11:40	T18	David Nash	Maculinea butterflies and Myrmica ants – coevolution in time and space
	12:00		Geert de Blust	Discussion part 1 - The role of the network and its relation to European biodiversity policy initiatives and knowledge demands
	12:40			**Lunch**
	13:40			**Poster session**
	14:30			**Excursion**
Sessions June 26th	08:30	T19	Johannes Ransijn	Divergent succession at Nørholm Hede: An indicator for alternative stable states?
	08:50	T20	Piotr Sewerniak	Slope exposure as a factor determining heathlands occurrence on dunes in the Toruń Basin (Northern Poland)
	09:10	T21	Christian Frølund Damgaard	Erica tetralix and wet heathland
	09:30	T22	Jap Smits	Opportunities for a N2000 heathland after Wildfire
	09:50	T23	Frank Meyer	Status and management of subcontinental Calluna heathland in German Natura 2000 sites - with special emphasis on prescribed burning
	10:10			**Break**
	10:40	T24	Hans Jørgen Degn	Danish heathlands are becoming more wet
	11:00	T25	Klaus Steenberg Larsen	Effects of elevated CO_2, warming and summer drought on the carbon balance in a Danish heathland after seven treatment years – results from the CLIMAITE project
	11:20	T26	Werner Haerdtle	Heathlands under global change - the importance of interactive effects
	11:45		Rita Buttenschøn	Thy National Park
	11:50		Geert de Blust	Discussion part II and final remarks
	12:30			**Lunch**

Participants

Adamska, Edyta	Nicolaus Copernicus University, Poland	adamska@umk.pl
Aksdal, Siv	Møre og Romsdal Fylkeskommune, Norway	siv.aksdal@mrfylke.no
Alonso, Isabel	Natural England, UK	isabel.alonso@naturalengland.org.uk
Bacchereti, Simona	Association Europeenne pour l'information sur le Développement	sba@aeidl.eu
Bargmann, Tessa	University of Bergen, Norway	tessa.bargmann@bio.uib.no
Buttenschøn, Jon	Ministry of Food, Agriculture and Fisheri, Denmark	jon@ e-venture.dk
Buttenschøn, Rita Merete	Geosciences and Natural Resource Management, KU, Denmark	rmb@life.ku.dk
Calvo, Leonor	University of Leon, Spain	Leonor.calvo@unileon.es
Clement, Bernarh	France	bemiclement@gmail.com
Clement, Mrs.	France	bemiclement@gmail.com
Dam, Marie	Terrestrail Ecology Section, Copenhagen University, Denmark	madam@bio.ku.dk
Damgaard, Christian	Aarhus University, Denmark	cfd@dmu.dk
De Blust, Geert	INBO Reseach Institute for Nature and Forest, Belgium	geert.deblust@inbo.be
De Smidt, Jaques	Member of the EHW standig comittee The Netherlands	jt.de.smidt@hetnet.nl
Degn, Hans Jørgen	Consultant, Denmark	hjdegn@dkgmail.dk
Dictus, Chris	Natuurpunt, Belgium	chris.dictus@natuurpunt.be
Diemont, Herbert	Alterra, The Netherlands	herbert.diemont@wur.nl
Ekelund, Kristine	Ekelund Consulting, Norway	kristine.ekelund@gmail.com
Fagundez, Jaime	Spain	jaime.fagundez@gmail.com
Hansson, Jeanette	Länsstyrelsen Halland, Sweden	jeanette.hansson@lansstyrelsen.se
Henning, Katrin	Leuphana University of Lüneburg, Germany	k.henning@loel.hs-anhalt.de
Henning, Matthias	Hochschule Anhalt, Germany	m.henning@loel.hs-anhalt.de
Hjorth, Emilie	Masterstudent KU, Denmark	emilie_hjorth@hotmail.com
Hoareau, Guillaume	Masterstudent KU, Denmark	hoa.guillaume@gmail.com
Hollesen, Christian	Naturstyrelsen, Denmark	csh@nst.dk
Holmenlund, Annette	Denmark	annette@hyrdetimer.dk
Hradska, Ivana	The West Bohemian Museum in Pilsen, Czech Republic	ihradska@zcm.cz
Härtle, Werner	Leuphana University of Lüneburg, Germany	werner.haerdtle@uni.leuphana.de
Jacobs, Maarten	Natuurpunt, Belgium	maarten.jacobs@natuurpunt.be
Jankowski, Michal	Soil Science and Landscape Manag., N. Copernicus Uni. Poland	mijank@umk.pl
Jensen, Hans	Naturstyrelsen, Denmark	hjn@nst.dk

Johnsen, Anne Marie	University of Copenhagen, Denmark	ibj@bio.ku.dk
Johnsen, Ib	University of Copenhagen, Denmark	ibj@bio.ku.dk
Kaland, Peter Emil	University of Bergen, Norway	peter.kaland@bio.uib.no
Karnfält, Lisa	Länsstyrelsen, Västra Götalands län, Sweden	lisa.karnfalt@lansstyreslen.se
Killerich, Berit	Lystbaekgaard.dk, Denmark	lystbaekgaard@mail.tele.dk
Klein, Stefan	RANA - Büro für Ökologie und Naturschutz, Germany	stefan.klein@rana-halle.de
Knudsen, Ole	Naturstyrelsen, Denmark	okn@nst.dk
Krenz, Kristina	Hochschule Anhalt, Germany	k.krenz@loel.hs-anhalt.de
Kvamme, Moms	Lyngheisenteret, Norway	mons@ballast.no
Kvingedal, Torhild	Lyngheisenteret, Norway	torhild@lyngheisenteret.no
Larsen, Inken Breum	Naturstyrelsen, Denmark	inb@nst.dk
Larsen, Klaus Stemberg	Technical University of Denmark, Denmark	klas@kt.dtu.dk
Larsson, Bengt	Västkyststiftelsen, Sweden	Bengt.larsson@vastkyststiftelsen.se
Laurijssens, Guy	INBO Reseach Institute for Nature and Forest, Belgium	guy.laurijssens@inbo.be
Lindholm, Matthias	Västkyststiftelsen, Sweden	mattias.lindholm@vastkyststiftelsen.se
Marcos, Elena	Univesity of Leon, Spain	elena.marcos@unileon.es
Meyer, Frank	RANA - Büro für Ökologie und Naturschutz, Germany	frank.meyer@rana-halle.de
Mieczslaw, Kunz	Nicolaus Copernicus University, Poland	met@umk.pl
Moe, Kirstie	Møre og Romsdal Fylkeskommune, Norway	kirsti.moe.oterhals@mrfylke.no
Naedts, Frederik	Natuurpunt, Belgium	frederik.naedts@natuurpunt.be
Nash, David	Biologisk Institut, Ecology and Evolution, KU, Denmark	Drnash@bio.ku.dk
Nielsen, Knud Erik	Aarhus University, Bioscence, Denmark	ken@dmu.dk
Nienartowicz, Andrezej	Nicolaus Copernicus University, Poland	anienart@umk.pl
Nilsen, Liv	Norwegian Nature Inspectorate, Norway	liv.nilsen@dirnat.no
Noe, Ole	Danmarks Jægerforbund, Kalø, Denmark	ono@jaegerne.dk
Odgård, Bent	Institute for Geoscience, University of Aarhus, Denmark	bvo@geo.au.dk
O'Loughlin Irwin, Sarah Anne	National University of Ireland GalwayIrland	sarahann.o@gmail.com
Pechackova, Sylvie	The West Bohemian Museum in Pilsen, Czech Republic	spechackova@zcm.cz
Peksa, Ondrej	The West Bohemian Museum in Pilsen, Czech Republic	opeksa@zcm.cz
Ransijn, Johannes	Geosciences and Natural Resource Management, KU, Denmark	jran@life.ku.dk

Rasmussen, Søren	Naturstyrelsen, Denmark	sra@nst.dk
Riis-Nielsen, Torben	Geosciences and Natural Resource Management, KU, Denmark	tri@life.ku.dk
Sahlèn, Fanny	Länsstyrelsen, Västra Götalands län, Sweden	fanny.sahlen@lansstyrelsen.se
Schmidt, Inger Kappel	Geosciences and Natural Resource Management, KU, Denmark	iks@life.ku.dk
Segers, Natascha	INBO Reseach Institute for Nature and Forest, Belgium	natascha.segers@inbo.be
Sewerniak, Piort	Nicolaus Copernicus University, Poland	sewern@umk.pl
Siepel, Henk	Wageningen University, The Netherlands	Henk.Siepel@wur.nl
Simonsen, Claus	Naturstyrelsen, Denmark	csi@nst.dk
Smits, Jap	Staatsbosbeheer, The Netherlands	bee@japsmits.nl
Stenild, Jesper	Naturstyrelsen Kronjylland, Denmark	ild@nst.dk
Strandberg, Morten	Bioscience, Aarhus University, Denmark	mts@dmu.dk
Sünksen, Anna Johanne	Danish Defence Estates & Infrastructure Organization, Denmark	FBE-KCDK07@mil.dk
Taylor, Toby	RSPB, UK	toby.taylor@rspb.org.uk
Tefal, Ivo	The West Bohemian Museum in Pilsen, Czech Republic	itetal@zcm.cz
Thirslund, Karen	Geosciences and Natural Resource Management, KU, Denmark	karenbt@life.ku.dk
Torsøe, Leif Christian	Agder Villsau Da, Norway	lechri@frisurf.no
Tveraabak, Lin Unn	Nesna University College, Norway	unnt@hinesna.no
Underhill-Day, John	RSPB, UK	john@footprint-ecology.co.uk
Webb, Nigel	Member of EHW Standing Committee	Nigel.r.webb@btopenworld.com
Willers, Bart	De Wassum, Venlo, The Netherlands	bartwillers@gmail.com
Woerstenburg, Martin	Daarom eten wir schaap, The Netherlands	martin@woestenburg.nl

Abstracts for oral presentations

Heathlands – natural and cultural ecosystems

Bent Odgaard
Department of Geoscience, University of Aarhus, Denmark.

Managers of modern heathlands struggle with maintaining dwarf shrub ecosystems and may tend to see the systems as heavily dependent on cultural management. Yet, heathlands have a strongly oceanic distribution reflecting a clear interplay with climate. Furthermore, palaeoecological data from the oceanic fringe of Europe suggest the existence of communities with much Calluna long before the introduction of any farming disturbance. Identifying the ecological functioning of such pre-farming communities is of considerable relevance for defining target conditions and intervention strategies in modern management. This talk will give a broad overview of long-term heathland history and, especially, zoom in upon the pre-farming ecosystems with much Calluna discussing their interactions with climate, soil, internal competition and disturbances such as herbivory and wild-fire.

Thy Photo; Rita Buttenschøn

Nørholm. Photo Inger Kappel Schmidt

T01- Is current management part of the solution or part of the problem for nutrient-poor ecosystems?

Knud Erik Nielsen and Morten Strandberg
Institute of Bioscience, Aarhus University, Denmark.

Heathland ecosystems are heavily managed by fire, cutting and removal of the upper organic top layer. Modern management methods try to simulate the old management practice with the main purpose of controlling succession towards tree dominance due to a wide use of the dominating dwarf scrub *Calluna vulgaris* – as fodder, insulation, building materials or energy for heating or cooking. Recently major increase in atmospheric deposition of nitrogen has introduced additional purposes related to a general speed up of succession, productivity and change in competition and species composition.

The result of modern management methods has been a much more uniform heathland landscape with a high cover of common heather *Calluna vulgaris* – in other areas heathland management has been less successful resulting in a constant war against competitive grasses like *Deschampsia flexuosa* and *Molinia caerulea* (Fig. 1). On the basis of data from monitoring, old and new investigations in inland dry and wet heathlands there are clear signs of acidification, dieback of dominating species and loss of biodiversity. We hypothesize that science-based management should include long-term effects on abiotic processes to prevent collapse of buffer systems. Management is probably an important factor in the acidification process.

Figure 1. *Deschampsia flexuosa* are now dominating large areas in coastal dune ecosystems. Photo Knud Erik Nielsen.

Current management successfully removes excess nitrogen, which is important for the ecosystem (Fig. 2). However, with the removal of live and dead biomass as well as the part of the upper morlayer, base cations, important micro nutrients and various weathering products are also removed from the ecosystem. In many heathlands these management measures are repeated with 10 – 20 year intervals or shorter. In the long term such repeated management may be problematic, and in ecosystems with a low ability to buffer acidifying deposition such as heathlands, sulphur deposition and biomass removal may in the long result in massive acidification of the upper soil layers, with dramatic impact on the dwarf scrubs and accompanying biodiversity.

Figure 2. To the left Vejrup Søhede 1999, to the right the same place in 2010. The area has been cleared and the area contained hardly any living *Erica tetralix*. Photo Hans Jørgen Degn.

Abiotic processes should be accounted for in management, and on this basis we suggest and discuss alternatives to current heathland management methods based on natural soil and vegetation development. These hypotheses points to a need for research in the dynamics of soil buffer systems in non-forested semi-natural ecosystems, balances of other nutrients than nitrogen in the same systems. Furthermore there is a need for improved understanding of the interaction between contemporary management methods and long term stability of ecosystems. Liming is obviously a choice to counteract acidification, but could have undesired effects. Specifically we suggest testing of a more long term management allowing regrowth of trees, because tree growth is known to increase pH and bring back nutrients to the top soil through degradation of the podzol profile.

T02 – Action plan for preserving coastal heathlands in Norway

Mons Kvamme[1] and Peter Emil Kaland[2]
1; The Heathland Centre, Bergen, Norway.
2; Institute of Biology, Bergen University, Norway.

Until the 1970's, the coastal heathlands of Norway received little attention from scientists or nature conservation authorities. They were regarded to be of marginal value both for the biodiversity and for agricultural purposes. Several research projects during the last 40 years have however shown that the coastal heathlands are of anthropogenic origin, they have been of great importance to coastal settlement and subsistence, they constitute key habitats for coastal biodiversity and today they disappear rapidly due to great changes in agricultural practise since World War II. In 1997 it was roughly estimated that about 90% of the historical heathlands in Norway had disappeared. As Norway never has ratified the NATURA 2000 act of EU, Norwegian heathlands so far have had no legislative protection as is the case in the rest of Europe.

Heathlands are important parts of the cultural landscapes along the coasts of Norway, and due to their dependence of low intensity farming, they have been difficult to protect in accordance with the former Norwegian legislation of nature conservation. Many protected areas at the coast contained valuable heathlands, but as they were established as bird protections, traditional heathland farming was prohibited and therefore the heathlands in these areas have disappeared. As a consequence, only a few areas of heathlands (about 5 including The Heathland Centre) so far have attained specific protection.

With the implementation of the new nature conservation law, The Nature Diversity Act from 2009, the environmental authorities are obliged to take action when biodiversity is threatened also outside protected areas. This is not only the case for threatened species, but also for threatened nature types. The Norwegian Directorate for Nature Management therefore initiated the work of making an action plan for coastal heathlands in Norway. The main object of this plan is to make sure that the total variation of coastal heathlands in Norway is preserved for the future, including the gradients from southeast to north and from outermost islands to low heights some km inland from the coast, as well as the variation on different types of substrate. Another important goal of the work is to secure remaining knowledge of sustainable management and of food production based on local resources and traditional breeds of livestock in the different heathland regions of Norway.

During 20 year of local registrations, 585 areas of heathlands of national or regional value have been described in the database of the Directorate. Our job has been to select a small number of localities (reference sites (Fig. 1)) in cooperation with regional environmental authorities, which together will represent the total variation of heathlands in Norway. However, in the areas we selected, it should also be realistic possible that traditional management will be continued by local farmers in the future. This last point appeared to be the most difficult one. In the 23 areas we have selected, there are local interest to maintain traditional heathland management in agreement with environmental and agricultural authorities, with some economic support. When the action plan (hopefully) has passed the Government this spring, it will be possible for owners of the 585 areas to apply for this kind of economic support. The goal of the Directorate is that about 100 areas of coastal heathlands will be actively managed based on this kind of voluntary agreements within 2018.

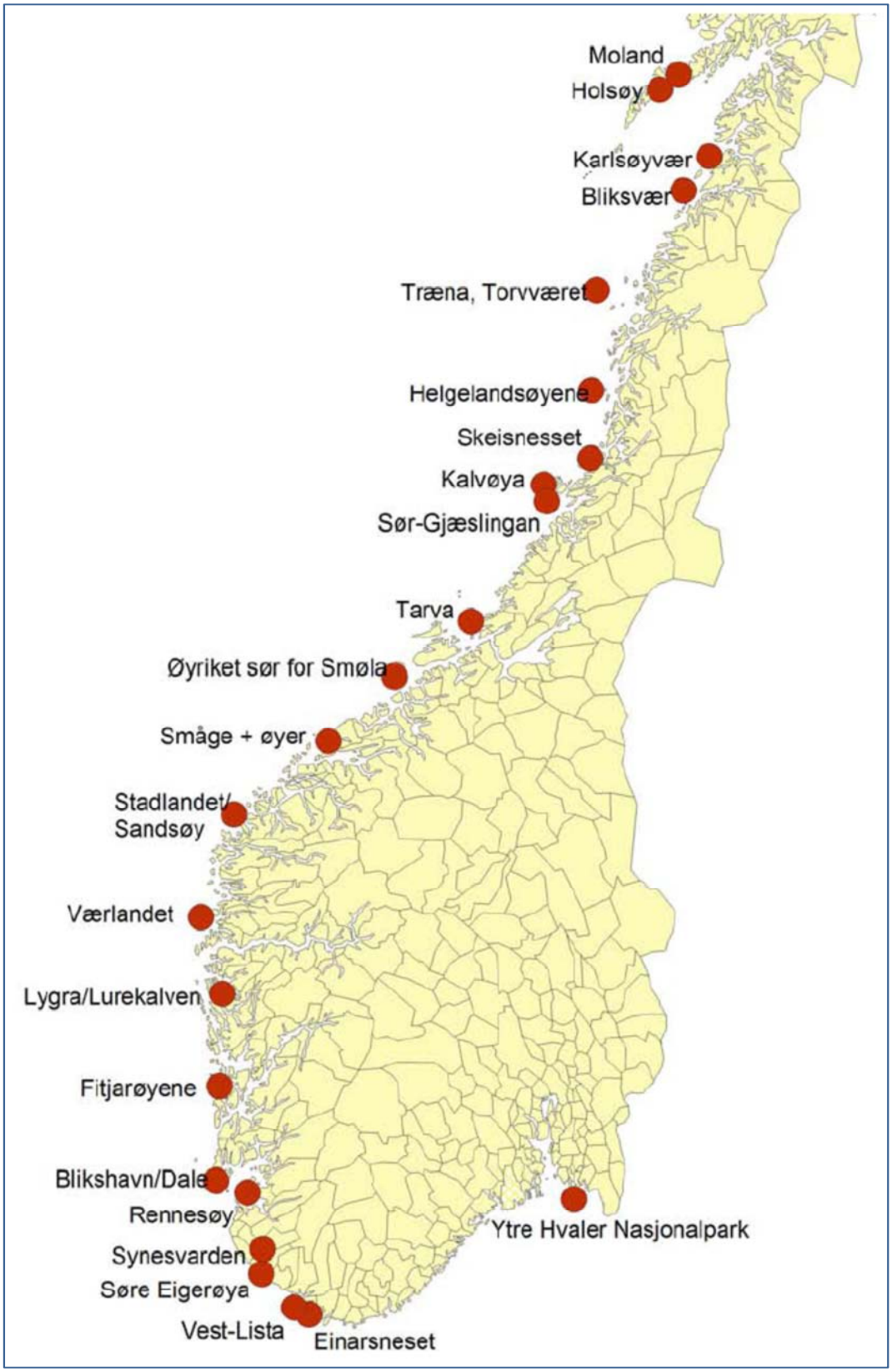


Figure 1. Reference sites of coastal heathlands for the action plan.

T03 - Challenges in the use of ecosystem services as a tool to manage heathlands of the Cantabrian Mountains

L. Calvo, A. Morán-Ordóñez, S. Suárez-Seoane, E. Luis, R. Tárrega, E. Marcos, L. Valbuena and A. Taboada
Department of Biodiversity and Environmental Management, University of León, Spain.

Heathlands situated in the southern part of the Cantabrian Mountains represent one of the ecosystems that allow considering this area as a biodiversity hotspot. The conservation of these heathlands constitutes a challenge to local forestry managers in the current framework of global change and evolving socio-economic situation. In facing this challenge, the ecosystem services provided by these heathlands are expected to be the ecological key to define the best management tools for their preservation. The approach of ecosystem service provision will help to raise awareness of the cultural, socio-economic, conservation and aesthetic values of these heathlands among the public, stakeholders and managers at different institutional scales (local, regional, national and international).

The Cantabrian Mountains have a long history of traditional management and, here, heathland cultural landscapes occurred closely linked to extensive silvopastoral systems associated to sheep transhumance. However, since the early 20th century, the low profitability of these transhumance systems has led to their gradual abandonment. As a consequence, the benefits that the Cantabrian Mountains' inhabitants obtained from heathlands have changed over time, as well as the value of heathlands to societies. As social preferences and needs evolved, so did the stakeholder's perception of heathlands and the goods and services provided by these ecosystems. Particularly, in the last decades, the demand of provisioning services (e.g., meat, fuel) from heathland landscapes in the Cantabrian Mountains has strongly declined in favour of cultural services, mainly related to their natural heritage and recreational values (e.g., ecotourism, hunting). Such transformation has to be taken into account for developing effective management strategies aimed at the economically sustainable preservation of these heathlands. Indeed, the maintenance of the natural heritage and high biodiversity values of these heathlands that support profitable cultural services requires solid ecological knowledge on the heathland ecosystem responses to management actions, such as prescribed burning and cutting. In this sense, it is particularly relevant to evaluate the impact of management on a broad range of organisms (e.g., plants, invertebrates) and especially on many endemic and endangered species inhabiting these heathlands, in order to reliably inform heathland managers and policy makers.

T04 - LIFE Nature for heathland management and conservation: examples and best practices

Simona Bacchereti
LIFE Programme Communications Team, Brussels, Belgium.

The LIFE Programme has been the European Union's funding instrument for the environment since its approval in 1992. It is composed of three strands (LIFE Nature and Biodiversity, LIFE Environment Policy and Governance, and LIFE Information and Communication).

Since its establishment 21 years ago, the LIFE Nature and Biodiversity component (formerly LIFE Nature), has co-financed a total of 1 348 projects, providing some € 1.2 billion, and mobilising a further € 1.2 billion in other public and private contributions. This continuous source of targeted financing has radically changed the capacity of many countries and regions to care for and manage Natura 2000 sites.

LIFE project actions are varied and can encompass the development of management plans and other policy documents, support for the enlargement of the Natura 2000 network, improving knowledge of species and habitats, direct conservation actions, capacity building and awareness raising. The results of the first assessment of the conservation status of species and habitats (Article 17 report), which was published in 2010, highlight the importance of LIFE as the sole source of funding for the conservation, restoration and management of certain species and habitats at EU level. Most LIFE projects targeting habitat restoration have resulted in the sites concerned achieving favourable conservation status.

Restoration of endemic Macaronesian heaths (*Erica azorica*) in Azores,
LIFE Laurissilva sustentavel (LIFE07 NAT/P/000630)

Since the establishment of the LIFE Programme in 1992, approximately 250 projects have directly or indirectly targeted heathland habitats. Around 65% of European heathlands are deemed to be in an unfavourable conservation status, mainly as a result of inadequate management and direct habitat destruction (uncontrolled fires).

The main threats to these habitats include poor grazing practices and replacement by commercial forests and other land uses (recreation, urbanisation, etc.). Invasive species (especially alien scrub and trees) and nutrient deposition (mainly atmospheric nitrogen and waste) are also a problem for heathlands.

Lack of good management (balanced grazing and controlled fire) has led to habitats becoming dominated by trees and therefore the most common restoration activity is the removal of trees. Some other examples of project actions on heathland ecosystems include: elimination of alien plants and species, grazing with beef cattle and ponies and, for wet heaths, water level modification. LIFE projects have also aimed to increase public awareness of the value of heathlands, which are often treated as dumping grounds. They carried out school education programmes and involved community groups in monitoring activities. In some cases they introduced fire-prevention measures such as the construction of firebreaks and fences to protect particularly sensitive areas and the employment of wardens throughout the summer period. Land purchase has also been a common action for conserving this type of habitat: areas of heathland have been bought by LIFE projects and added to the Natura 2000 network sites thus ensuring their continued management. While European heathland habitats still have an unfavourable conservation status, many of the actions taken by LIFE projects have had a significant impact on the conservation status of heathlands on a local and regional level.

This communication will present some examples and best practices from successful LIFE Nature projects targeting heathland management and conservation with the aim of contributing to the active dissemination of the results.

T05 - Disturbance by grazing sheep as a management risk for ground-breeding heathland birds

Glenn Vermeersch[1], Luc De Bruyn[1,2], Diederik Strubbe[2], Guy Laurijssens[1], Filiep T'Jollyn[1] and Geert De Blust[1]
1; Research Institute for Nature and Forest, Brussels, Belgium.
2; University of Antwerp, Antwerp, Belgium.

Sheep grazing is a widespread nature management practice in Western European heathlands. The possible impact of the grazing herds on ground-breeding birds has not received much attention in literature. However, substantial financing is needed when grazing is implemented in a special protection area (SPA). Recently, population objectives have been set for Annex I species in all Belgian SPA's. In a large heathland in northern Belgium, we conducted a landscape scale experiment to investigate whether sheep grazing is generally beneficial for a ground-breeding insectivorous bird species of Annex I, the Woodlark (*Lullula arborea*).

In 2010-2012 we searched for Woodlark nests in 6 plots with two treatments (4 grazed, 2 non-grazed). All nests (N=362) were visited every 4 days to monitor egg and nestling fate. We calculated nest success, hatching success and offspring survival for all nests. We used temperature loggers (i-buttons) to measure nest temperature. Doing so, we could register the timing of predation events. Bushnell trophy cams were used to identify nest predator species.

Nest success was lower in the presence of grazers, not related to nature management, higher in the first laying period in 2010 and higher for larger clutches. Logger data revealed a shift from night-time predation to daytime predation after the introduction of sheep in the grazed plots (during the first decade of May). The probability for daytime predation was significantly higher when sheep were present but was not related to management practices. The first results of a nest experiment with plasticine eggs suggest that predation by bird species increases when sheep are present whereas in control plots both mammal and bird predation occurs in equal numbers.

We conclude that sheep grazing is a management risk for ground-breeding heathland birds. We suggest that grazing sheep cause direct disturbance to incubating females or feeding adults. Bird predator species like Carrion Crows (*Corvus corone*) may respond to changes in behaviour of adult Woodlarks.

T06 - Sheep on the Moors in southern Norway

Leif Christian Torsøe
Agder Feral sheep and Agder Coastal pastures team, Norway.

General conduct and use of the coastal heathlands in the southern part of Norway

We have for some years been grazing with sheep in the coastal Heath hill-side. And over the years it has become a major renovation works with felling of planted *Picea sitchensis* and other undergrowth that threaten the Moors after the use has ceased. As a result, we get back the original heathlands and its ecology and the meat of those animals that we use in the Heathlands.

T07 - That is why we eat sheep

Martin Woestenburg[1] and Bart Boers[2]
1; Freelance landscape writer, Woestenburg tekst en uitleg, The Netherlands.
2; Retired nature manager, De Hoge Veluwe, The Netherlands.

In this essay we want to tell the tale that lies behind the Dutch practitioner's network *That is why we eat sheep*, which is the tale of a profound disconnection in modern society. People namely do no longer connect the food on their plate with agriculture, nature or landscape – or culture, for that matter. They tend to have a romantic view of sheep and sheep farming, as a cultural historical relict from old times. The connection which is made in the practice of sheep farmers and shepherds between nature management and meat production is overlooked. People do not understand that a shepherd is a professional farmer and nature manager as well, and that the sheep that graze the heath produce high quality lamb and mutton. They do not eat sheep – they eat prefabricated lamb chops from the supermarket. The practice of sheep farmers and the meat on the plate are disconnected. We have to reconnect this, because extensive grazing companies can provide substantially in meat production, while managing millions of hectares of natural and cultural landscape, reviving regional culture and economy, and serving a growing market for sustainable and regional products and services.

T08 - Practical experiences from heathland management by sheep grazing in West Jutland

Berit Kiilerich
Lystbækgaard, Ulfborg, Denmark.

Livestock grazing of heathlands in West Jutland has been strongly reduced due to the large changes in agricultural practise during the last 100 years. Large areas of heathlands have disappeared, and of the remaining areas too many are in a poor condition, with old, self-dying stands of *Calluna*, high content of *Empetrum nigrum* and encroachment of species like *Jumiperus communis*, *Pinus spp*,, *Picea abies* and *Cytisus scoparius*. Due to nitrogen deposition large areas are dominated by tall growing grasses like *Molinia caerulea.*

Large areas are managed by the public authorities, but of economical reasons they are reluctant to use grazing animals. Instead, very much heathland management is implemented with different kinds of mechanical treatment. The three most common types of mechanical treatment are cutting machines to harvest the heather, plowing machines to remove the N-rich topsoil and harrow machines to mix up plants and soil to stimulate new succession of heathland. These methods are effective, but important aspects of heathland qualities like biodiversity, plant community structure and cultural heritage are often poorly preserved. The reduction of invasive species is neither always particular successful. In order to catch up with decades of neglected management, large areas are intentionally put on fire (100 ha or more). This may be beneficial to the heather, but it results in a monotonous landscape, and when not grazed, it is readily open to re-invasion from pine and other species.

Experience from more than 20 years of nature management based on sheep grazing, have shown that this represent an alternative kind of heathland management. By the use of robust breeds (like Heidescnucken or other short tailed Nordic breeds) and in particular when led by a wandering shepherd, invasive species on the heathland can be effectively combatted. When combined with regular small scale controlled burning (plots of 1-3 ha), the productivity and a healthy structure of the heather plants are maintained. This creates variations between areas of different heather age and species composition. Such mosaic patterns of the heathland are optimal for the biodiversity. Controlled burning at regular intervals (10-20 years) also keeps species like *Juniper* and *Empetrum* under control, and with the correct grazing pressure at the right time of the year after burning, the problems of *Molinia* can be strongly reduced.

Nature management by sheep grazing is difficult in Denmark because the marked of sheep products is very limited. Sheep mutton has not the same popularity here as e.g. in Germany and Norway, and the prices for the wool are very low. The economy has therefore to be secured by support from different sources (regional and EU), based on grazing appointments with private land owners and public authorities. The possibility to achieve well managed heathlands based on sheep grazing in the future is totally dependent on the knowledge and experience of the policy makers. Although similar results have been shown from Norway, there is a need for further scientific documentation from Western Jutland of these practical experiences.

T09 - Biodiversity and conservation of wet heathlands in Galicia (NW Spain)

Jaime Fagúndez
University of A Coruña, Galicia, Spain.

Heathlands are one of the most valuable plant communities of Western Europe, and a few types are protected under the Habitats Directive. In Galicia, the northwest corner of the Iberian Peninsula, heathlands are well-represented and constitute a key formation of the traditional landscape. Wide areas of wet heathlands, considered as priority habitats, can be found across the region, wherever traditional farming practices are still in use.

A key aspect of heathland ecosystem is the presence of large herbivores, mainly wild horses, together with its predator, the wolf, shaping a trophic chain strongly associated to heathland ecosystem. Recent changes on Galician government´s policies on the control of wild horses may indirectly affect heathland conservation. In this project, the importance of grazing by wild horses for conservation of a particular wet heath of northern Galicia is being studied.

The studied community is the endemic wet heathland dominated by *Erica mackayana* and *Ulex gallii* which occurs in large areas of the north of Galicia. Several areas, which were considered to cover the whole distribution and diversity of the community in terms of location, altitude, geology or orientation, have been selected for the study. Within each area, a representative field was selected for sampling. Fields are delimited either by changes in land use or fencing.

Two main aspects are being measured: plant richness and diversity, and vegetation structure, and compared to the different levels of grazing by horses, cattle, or both. In each field, five plots were set randomly, where every vascular plant present is recorded, and a cover value was given using a modified Braun-Blanquet cover classes system. Three random 10-meters transects perpendicular to the main steep were set in each field. Every 25 cm, presence-absence of each structural species (grasses and shrubs) using a perpendicular bar was recorded. Height of first hit to the nearest cm for each species was also recorded. Grazing pressure by the two main herbivores, cattle and horses, is measured by counting dungs along three random transects, and is contrast with census of animals in the field and data from questionnaires to land owners.

From the first results obtained, no significative relationship can be drawn between species richness and herbivore pressure. However, for a set of target species there seems to be a positive interaction with horse but not with cattle. Higher occurrences of the target species are found in plots grazed by horses and are absent or rare from those fields ungrazed or heavily grazed by cattle. Facilitation may take place due to the particular vegetation pattern developed by horse grazing, in which mounds of gorse and heather alternate with narrow paths with low herbaceous cover. Horses may be playing a key role in heathland maintenance and conservation. I suggest that wrong policies on horse domestication will negatively affect wet heathlands ecosystem in the long term, together with the ecosystem services they provide and the biodiversity they hold.

T10 - Challenges in managing Danish inland Erica tetralix wet heathland

Morten Strandberg[1], Christian Damgaard[1], Jesper Bak[1], Knud Erik Nielsen[1] and Hans Jørgen Degn[2]
1; Institute of Bioscience, Aarhus University, Denmark.
2; Degn's NaturConsult, Ringkøbing, Denmark.

Nutrient poor dwarf shrub dominated ecosystems such as heathlands and ombrotrophic bogs are considered sensitive to nitrogen deposition due to the ability of nitrogen to increase the growth of competitive species such as the grasses Wavy hairgrass and Purple moor grass. Both species have been reported to outcompete Common heather in dry heathlands and the latter to outcompete *Erica tetralix* in wet heathland. Here we report investigations of observed disappearance of *Erica tetralix* from inland wet heathland in Denmark that cannot solely be explained by eutrophication driven effects of competition (a).

The main investigations include:
1. Analysis of data from the monitoring programme of Danish terrestrial nature (b)
2. Vegetation analysis and soil chemistry along two line-transects on the location "Borris Hede"
3. Comparison of wet heathland vegetation development from 1995 – 2010 on Lønborg Heath

In addition to this we revisited two inland wet heathlands with a known record of high abundance of *Erica tetralix*.

The main results were:
1. High abundance of dead *Erica tetralix* in many sites
2. The cover of deergrass (*Trichophorum germanicum,)* purple moor grass and Common heather were substantial in the former *Erica tetralix* dominated areas
3. The C/N ratio in the morlayer showed a ratio of 21 – 26 in the mor-layer under the *Erica tetralix*-stands
4. The pHH2O generally was between 3.0 and 3.5 in the 0-5 cm organic horizon

Based upon data and available literature, causes of the dieback of *Erica tetralix* are discussed, a hypothesis is suggested and challenges in managing wet heathland subject to several threats at the same time are discussed.

In conclusion the identified possible causes of the die back of *Erica tetralix* include acidification, eutrophication, unbalanced soil nutrients, hydrological changes and mismatching management. These causes are not necessarily independent and current management may mitigate one cause and at the same time increase another.

References:

a. Strandberg, M. T., Damgaard, C., Degn, H. J., Bak, J. L. & Nielsen, K. E. 2012 I Evidence for acidification-driven ecosystem collapse of Danish wet heathland**.** : Ambio. 41, 4, s. 393-401.

b. Nielsen, K.E., J.L. Bak, M. Bruus, C. Damgaard, R. Ejrnæs, J.R. Fredshavn, B. Nygaard, F. Skov, B. Strandberg & M. Strandberg. (2012). NATURDATA.DK – Danish monitoring program of vegetation and chemical plant and soil data from non-forested terrestrial habitat types. Biodiversity & Ecology 4: 375–375.

T11 - LIFE Visbeek: Developing a heathland landscape

Frederik Naedts
Natuurpunt, Mechelen, Belgium.

The valley of the Visbeek is located in northern Belgium. The nature area consists of pine plantations, grasslands, arable fields and a brook valley with Alder forests.

Until 1850 the area was a part of a central Flemisch heathland region characterized by *Erica tetralix* and *Calluna vulgaris*. Changes in land use caused a fast decrease in surface and quality. In 2010 only 3 hectares heathland were left! Still, threatened species like *Vipera berus*, *Satyrium ilicis* and *Thelypteris palustris* were present in the area. Even more, records from the last decades of *Cirsium dissectum*, *Littorella uniflora* and *Lanius collurio* indicate that the heathlands of the Visbeek valley were very diverse. Combined with the relatively small scale of exploitation of the former heaths, the opportunities for heathland restoration are high.

Natuurpunt therefore applied for a LIFE-project for 5 years that started in 2010. Starting from the heathland relicts a management plan was made to improve, enlarge and connect the relicts into:

- 37 ha wet (4010) and dry heaths (4030) and inland dunes (2330)
- 14 ha *Molinia* meadows (6410)
- 4 ha mesotrophic standing waters (3130)

Instead of giving an overview of the typical restoration actions, the most remarkable actions will be discussed in more detail:

Partnerships

- One of the two local communities is the largest landowner within the project area with almost 180 ha pine plantations. Under the supervision of a ranger of the Flemish Agency for nature and forest, municipality workers spend every winter a couple of months in the plantations restoring heathland. The costs for extra efforts by external contractors are co financed through LIFE.
- Several local farmers own or use grasslands and arable fields in the area. The farmers cooperate with Natuurpunt during and after the project by mowing or grazing the restored grasslands. Even more, the cultivation of grass-clover will be practiced to attenuate the former nutrient-rich farmlands. This win-win ensures a qualitative harvest and an increase quality of heathland habitats in restoration. The costs to start the cultivation of grass-clover are co-financed by LIFE.
- Several preparatory actions of the LIFE-project with firewood harvest can be done by locals. Doing this public support for nature restoration will increase.

Research

- An important action of the project is the restoration of *Molinia* meadows. This habitat needs very specific groundwater and soil conditions. Therefore an external consulting firm has selected the best locations to restore this habitat and gave restoration advices. The restorations actions were planned with input of the results from the report.
- The phosphate levels of the former farmlands are mostly to high for the restoration of heathland habitats. Therefore topsoil removal or grass-clover can be efficient restoration actions. To prepare these actions it's necessary to examine the phosphate levels on several soil depths.

Archeology

- Due to the frequent variety in dry and wet areas, the project area was very attractive for people in the Stone age. Parts of the area have interesting archeological features in the soil, who cannot be removed. So, sod cutting of a pine plantation of 8 ha after deforestation is not possible to restore the heathland. After deforestation this area will be grazed with a high concentration of livestock during a certain period instead of sod cutting.

More info: www.life-visbeek.be

T12 - Maintaining the favourable conservation status of European Dry Heaths on an active military training area - a case study from the SAC Colbitz-Letzlinger Heide

Kristina Krenz, Matthias Henning, Birgit Felinks and Ellen Kausch
Anhalt University of Applied Sciences, Bernburg, Germany.

The SAC Colbitz-Letzlinger Heide, an active military training area, is characterized by 4.500 ha of the habitat type 4030 and is hence of nationwide importance in the transition zone from atlantic to continental climate. Though, changes in military techniques and training operations modify the landscape. As a consequence the favourable habitat status of European dry heaths is affected by ongoing grass- and scrub encroachment and reduction of vitality of *Calluna vulgaris* which causes a high percentage of the degenerate phase.

The aim of the present study is to evaluate the effects of different strategies to preserve European Dry Heaths and how these management strategies can be combined with the needs of the military user. To test distinctions a block design with different management strategies (Fig. 1) was set up in five vegetation structures: heath in optimal condition, heath with grass encroachment, heath with increasing cover of *Betula pendula* and with *Prunus serotina*, and transition plots with heath, grasses and herbs. Additionally, controlled burning, mowing and mulching was implemented on a lysimeter station with soil samples taken from the military training area.

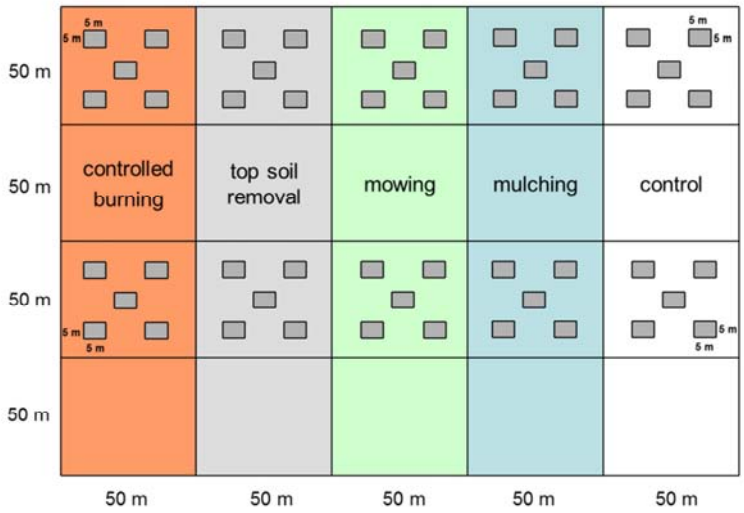


Figure 1: Block design with different management strategies and vegetation relevées (5 x 5 m)

Vegetation relevées, soil and biomass samples were taken before and after the management was carried out. The influence of the different management strategies is additionally analysed for locusts within the block design and for birds in larger areas of the respective vegetation structures and management strategies.

Results of the soil analyses reveal that the study area is characterized by homogeneous soil conditions, with acidic pH-value; rich in humus, low levels of nitrogen and phosphorus, and a close carbon to nitrogen ratio. The initial state of vegetation reveals a general deficit of bare soil and typical species. Partially grasses, such as *Molinia caerulea*, *Deschampsia flexuosa* and *Calamagrostis epigejos* show a high cover. *Calluna vulgaris* stands mainly comprise all different life cycles. During the first vegetation period after management has been carried out, effects of the strategies varied with respect to the vegetation structures (table 1).

Table 1: Effects of different management strategies one year after management. Top soil removal was carried out in summer 2012, thus results are yet not available.

		heath in optimal condition	heath with grass encroachment	heath with scrub encroachment	transition plots with heath, grass and herbs
controlled burning	bare soil	⇨	⇨	⇨	⇨
	cover of grasses	⇨	⇧	⇧	⇧
	cover of scrubs	⇨	⇩	⇨	⇩
	juvenile phase	⇧	⇨	⇨	⇨
mowing	bare soil	⇨	⇨	⇨	⇧
	cover of grasses	⇧	⇨	⇨	⇧
	cover of scrubs	⇨	⇨	⇨	⇨
	juvenile phase	⇨	⇨	⇧	⇩
mulching	bare soil	⇨	⇨	⇨	⇨
	cover of grasses	⇧	⇧	⇧	⇧
	cover of scrubs	⇨	⇨	⇨	⇨
	juvenile phase	⇨	⇨	⇨	⇨
control	bare soil	⇨	⇨	⇨	⇧
	cover of grasses	⇨	⇧	⇨	⇩
	cover of scrubs	⇧	⇨	⇨	⇨
	juvenile phase	⇨	⇩	⇨	⇨

The differences in the constituents of soil are not yet measureable. Nevertheless, results of the lysimeter station show that the N_{min} output rate is higher in the samples with the burned heath than with mulching or mowing. The number of locust species was not reduced by controlled burning, but a shift in species composition was observed. Similarly, typical birds of open sand heaths like *Anthus campestris* were predominately mapped within burned areas and *Upupa epops* in mosaics of bare soil, heath and sparsely vegetated forests.

The preliminary results show, that different management strategies might be necessary in order to preserve the typical species composition and vegetation structures on different spatial scales. Though actually it seems to be difficult to integrate a variety of measurements in every day military training practice.

T13 - The economy and ecology of European Heathlands

Henk Siepel[1] and Herbert Diemont[2]
1; Radboud University Nijmegen, The Netherlands.
2; Alterra, Wageningen UR, The Netherlands.

Surfaces of heathlands have declined in the last century, but are increasing in many places again in particular if heathlands are defined within a wider setting of extensive used land or outfields. We will provide an overview of changes in heathlands across Europe in the past, discuss the law of comparative advantages as a tool as to explain both economic and ecological changes in heathlands. The information presented makes reference to a book on economy and ecology of heathlands published soon.

T14 - An integrated approach to conserving specific Annex I heathland habitats in the Burren, Western Ireland

Sarah O'Loughlin Irwin[1], Micheline Sheehy Skeffington[1], Sharon Parr[2] and Brendan Dunford[2]
1; Botany and Plant Science, School of Natural Sciences, NUI Galway, Ireland.
2; Burren Farming for Conservation Programme (BFCP), Old Schoolhouse, Carron, Ireland.

The Burren is internationally renowned for its biodiversity and supports many habitats of European importance (Annex I-listed under the EU Habitats Directive) that depend on farming, in particular low-input grazing systems. The Burren Farming for Conservation Programme (BFCP), which followed on from the highly successful BurrenLIFE project, is a locally-targeted, research-based, programme which relies on a partnership between the farming community, agricultural advisors and ecological scientists to develop best practice guidelines for farmers to sustainably manage habitats of conservation importance. Given the complexity of Burren habitats and their management requirements, further targeted research is required to underpin policy and guidelines for farming practice. Some of the rarer Annex I habitats in the Burren, such as Alpine Heath, are under threat from changes in land-use and their conservation status is considered poor. In certain areas, vigorous species such as *Calluna vulgaris* are increasing at the expense of other less frequent species. It is essential to devise management prescriptions in order to best conserve these habitats.

This research focuses on vegetation dominated by *Arctostaphylos uva-ursi* and/or *Empetrum nigrum*. Both are very localised in distribution both in Ireland and the Burren. The plant communities in the Burren containing these key species will be mapped and classified in relation to soils and microhabitat characteristics and areas will be noted where *Calluna* or *Molinia* are encroaching. Farmer questionnaires will document past and recent land-use of target sites and, through

experiments, the effects on the Alpine heath plant communities of seasonal *Calluna/Molinia* cutting regimes will be analysed. In addition, the presence and abundance of certain groups of invertebrate pollinators will be examined, namely bumblebees and butterflies, as a further aspect of the characterisation of this Alpine heath community in the Burren. The further development of methodologies for the management of such habitats in the Burren will inform future measures under the BFCP and can be modified and applied to other low-intensity farming regions of high nature value.

T15 - Meeting species requirements with heathland management prescriptions: generalists vs. specialists

Isabel Alonso
Natural England, Sheffield, England.

Until recently heathland management and conservation seemed to focus primarily in restoring or creating dwarf-shrub heath, and promoting heather in particular (e.g. Gilbert and Anderson, 1998). However, a review of the requirements of priority species associated with this habitat (Webb et al 2010) revealed that the needs of those species are complex and sometimes differ at different stages of their life cycle. Therefore, in order to favour as many species as possible, the main conservation and restoration objective should be to provide as a structurally diverse habitat as possible. This diverse structure should incorporate, besides dwarf shrubs, areas of bare ground, a heath and grassland matrix, transitions to other habitats with scrub and trees and areas that provide shelter. Within this broad objective, there is still ample margin to maintain the different regional characteristics of heathlands. For example, the English Breckland heaths are very grassy in character, whereas other southern heaths are characterized by higher cover of heathers and gorses. The requirements of species in different geographical locations can help to determine local and national priorities (Dolman et al 2012).

Webb et al (2010) reviewed the list of species of conservation concern in England associated with lowland heathland. There were 133 species, whose needs were classified as shown in Figure 1.

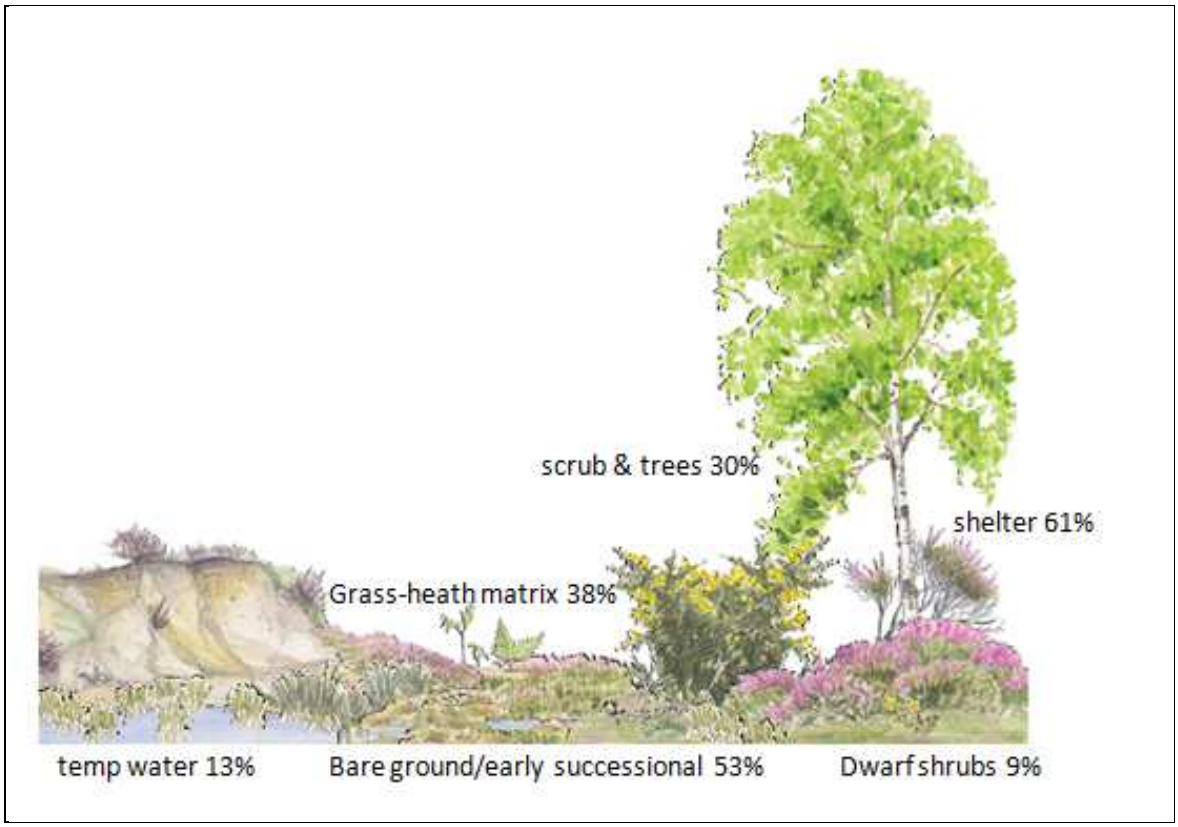


Figure 1 Niche requirements of species associated with lowland heathlands in England. (Adapted from Webb et al 2010)

Favourable condition for heathlands in the UK is defined by a series of targets for each of the following attributes: extent, bare ground, vegetation structure, vegetation composition and indicators of local distinctiveness (JNCC 2009). General heathland management to achieve those

targets is expected to provide the niche requirements that most heathland species need. But in some cases specific interventions will be necessary to ensure the needs of rare or geographically restricted species are met.

We reviewed the most common heathland management interventions (cutting, burning, grazing, turfing) to determine how they succeed or fail to provide the necessary attributes. We provide recommendations for site managers to cater for as many specialist species as possible in heathlands of diverse character. We highlight examples of species for which regular heathland management will not suffice and micro-management or other extraordinary measures may be required to ensure their survival.

References:

DOLMAN, P.M., PANTER, C.J., MOSSMAN, H.L. 2012. The biodiversity audit approach challenges regional priorities and identifies a mismatch in conservation. J.Appl.Ecol., 49(5): 986-997.

GILBERT, O.L. & ANDERSON, P. 1998. Chapter 6 - Heath and moor. In: Habitat Creation and Repair. Pg 130-159. Oxford University Press, Oxford.

JNCC (Joint Nature Conservation Committee). 2009. Common Standards Monitoring Guidance for Lowland Heathland. http://jncc.defra.gov.uk/pdf/0902_CSM_lowland_heathlandv2.pdf

WEBB, J.R., DREWITT, A.L., & MEASURES, G.H., 2010. Managing for species: Integrating the needs of England's priority species into habitat management. Part 1 Report. Natural England Research Reports, Number 024. http://publications.naturalengland.org.uk/file/61078

T16 - Protection of butterflies on heathland sites in Flanders and the management case study of the Alcon blue (Maculinea alcon)

Chris Dictus
Natuurpunt, Mechelen, Belgium.

Typical ***heathland butterflies*** in ***Flanders*** are vulnerable because they're dependant of the special conditions relating to their habitats that are traditionally under pressure, especially in a densely populated area.

The presentation will first focus on a few typical species for Flanders like Grayling (*Hipparchia semele*), Silver studded blue (*Plebejus argus*) and Green hairstreak (*Callophrys rubi*). A short overview of typical habitat requirements and some examples of how simple management measures can facilitate these species will be given. The most vulnerable heathland butterfly however is ***Alcon blue*** (*Maculinea alcon*) due to the very special conditions it requires. Its ecology will be highlighted and the species will be situated in a European context.

Afterwards the main focus will be on the Flemish situation where its status is 'critically endangered'. At the request of the Flemish government a management plan has been written by the University of Antwerp and is evaluated on a regular basis in workshops with researchers and managers. The outlay of the plan will be explained.

A few examples of measures and different approaches in management in several reserves with positive but also sometimes negative results will be reviewed.

Natuurpunt is a volunteer based NGO with professional staff and the largest private nature preservation and management organisation in Belgium. We manage about 19.000 hectares of nature, amongst which a lot of heathland, and we have about 90.000 families as subscribed members. About 5000 active volunteers are supported by a workforce of some 400 professionals. Our organisation is a key player in the Flemish Natura2000 network and in that capacity we have had 22 Life Projects until now, of which 7 are still ongoing.

Figure 1: A Flemish Gentiana pneumonanthe with eggs *Maculinea alcon* (Photo: Chris Dictus)

Figure 2*: Maculinea alcon* wet heathland of habitat in military use (Photo: Chris Dictus)

T17 - Species actions plans for butterflies in Flanders (Belgium)

Natascha Segers, Dirk Maes, Wouter Vanreusel, Hans Van Dyck and Ilf Jacobs
Institute for Nature and Forest, Belgium.

66% of the butterfly species in Flanders are now considered extinct or threatened. This decrease on a regional scale can be explained by a change in land use causing fragmentation and habitat loss and by exceeding of the critical load for nitrogen deposition causing encroachment. In order to halt this decline and restore current butterfly populations, 3 species action plans are compiled for *Hipparchia semele*, *Satyrium ilicis* and *Lasiommata megera*. Their choice is based on a recent evaluation of their Red List status in Flanders according to IUCN criteria and their European threat status.

In a preliminary research, the mobility and habitat use of the endangered Grayling (*Hipparchia semele*) were investigated by a capture-mark-recapture study in 'Hoge Kempen' National Park. These results were linked to a comparison of microclimate and vegetationtype changes in sites where they recently disappeared, and where they are still present. A comparison was made with previous studies from 2001 and 2002 for mobility and 2003 for vegetation cover. In 2002, mean distances between consecutive capture points (264 ± 10m) were longer than in 2011 (207 ± 45.8m) and there was more potential for the population to colonize new sites. Decrease in mobility is probably linked to an overall conversion into unsuitable habitat by grass and tree encroachment. Temperatures for egg-laying, development and growth of the butterflies were suitable (mean max 35 ± 1.1°C, mean min 13.4 ± 0.4 and 14.6 ± 0.5) and could not explain their absence in certain sites.

With the results of the mobility analysis, Functional Conservation Units can be delineated and severity of fragmentation can be assessed at a regional scale. Furthermore, it allows us to delineate areas that are of prior concern in reconnecting populations using the resource based conservation approach. The importance of a practical conservation approach by halting vegetation conversion using a calculated vegetation proportion is advocated. When extrapolating this resource based approach at a regional level, specific suggestions for species based management can be done and elucidate the possible future impact of climate change.

T18 - *Maculinea* butterflies and *Myrmica* ants – coevolution in time and space

David R. Nash
Centre for Social Evolution, Department of Biology, Copenhagen University, Denmark.

The large blue butterflies (genus *Maculinea*) have an unusual life cycle in which they develop on specific host plants for the first three larval instars, but spend the fourth larval instar and the pupal stage inside the nests of *Myrmica* ants (Fig. 1). The fourth instar caterpillars are taken in to the ant nest by foraging workers because they mimic the surface hydrocarbons found on *Myrmica* larvae. Once inside the nest, they eat the ant brood and in some cases are fed directly by the ant workers in preference to their own larvae. Hence they are virulent social parasites of the *Myrmica* colonies, which are expected to exert a strong selection pressure on their host ants to see through their disguise. This provides the background for an on-going antagonistic arms race between hosts and parasites.

Here I will present a summary of our work on the Alcon blue butterfly, *Maculinea alcon*, over the last 15 years. The Alcon blue is found patchily across Europe on wet heathlands where its initial foodplant, the marsh gentian (*Gentiana pneumonanthe*) co-occurs with its *Myrmica* host ants. However, the particular species of Myrmica that it exploits varies on both large and small geographical scales, reflecting some degree of local adaptation. In Denmark and Sweden, both *Myrmica rubra* and *Myrmica ruginodis* are used as hosts, and different populations are specialized on different hosts depending on host availability and the time course of the coevolutionary cycle. The butterflies and their host ants provide one of the clearest examples of a coevolutionary mosaic.

The requirement for the simultaneous presence of marsh gentians and the correct species of *Myrmica* ant for each population means that the Alcon blue butterfly is naturally rare and sensitive to habitat destruction and fragmentation. We are now starting to be able to use the knowledge we have obtained about the coevolution *Maculinea* butterflies and their host *Myrmica* ants to aid in their conservation.

Figure 1. The life cycle of *Maculinea alcon.*

T19 - Divergent succession at Nørholm Hede: An indicator for alternative stable states?

Johannes Ransijn[1], Sebastian Rojas[1], Kris Verheyen[2], Torben Riis-Nielsen[1] and Inger Kappel Schmidt[1]
1; Department of Geosciences, Natural Resource Management, University of Copenhagen, Denmark.
2; Department of Forest and Water Management, Ghent University, Belgium.

Colonisation by trees and invasion by grasses threaten the existence of remaining heathlands and many heathlands have seen a shift from dwarf shrub dominance to grass dominance in the last decades. As a semi-natural and cultural landscape, most heathlands need management to remain dominated by dwarf shrubs. There are however indications that dwarf shrub dominated heathlands can be relatively stable without management under certain conditions.

Nørholm hede is a Danish heathland that has been without management for more than 100 years. Although trees and grasses have expanded at the expense of dwarf shrubs, large areas are still dominated by dwarf shrubs. We analysed the vegetation dynamics at 20 flora plots where 12 vegetation inventories have been conducted between 1921 and 2012 in order to assess heathland ecosystem stability and describe successional patterns on heathland in the absence of management.

Cluster analysis showed a similar floristic composition with dominance of *Calluna vulgaris* all but three plots in the 1920s. These dry heathland plots split into two distinct clusters during succession between 1921 and 2012. About half of them are now dominated by grasses, whereas the other half saw no grass expansion at all. Dwarf shrubs (*Calluna* vulgaris and *Empetrum nigrum*) remain dominant in these plots and grasses are currently less rather than more abundant than before (Fig 1). The three exceptions were located in wet areas and are not so relevant for dry heathland successional patterns.

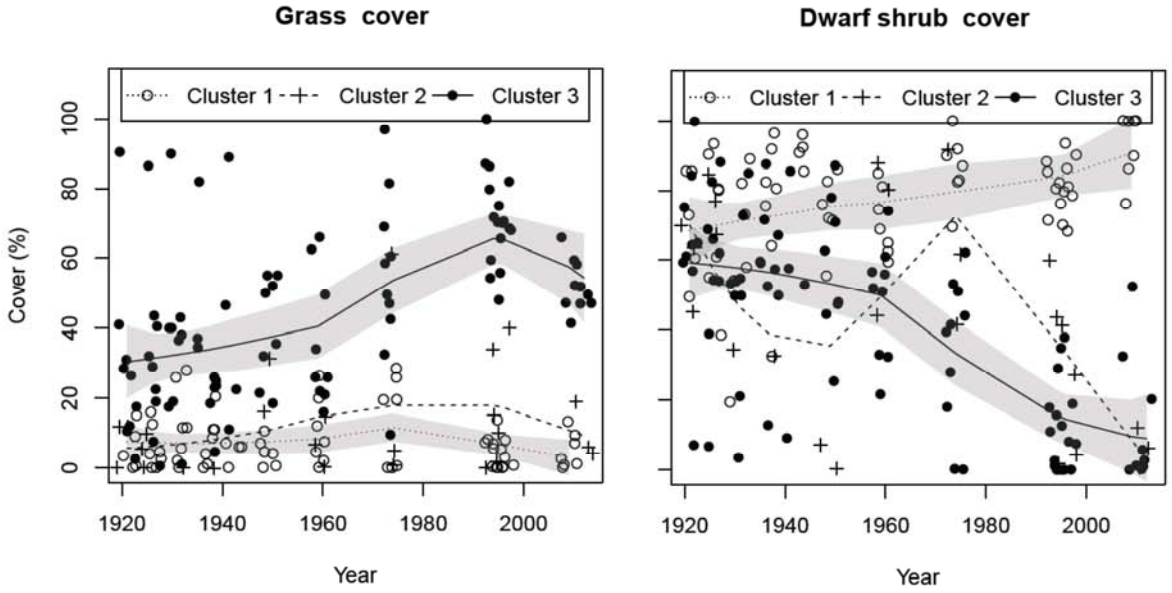


Figure 1: Trends of grass and dwarf shrub cover at the 20 plots (grouped per cluster). Cluster 1 is dominated by dwarf shrubs in the latest survey, cluster 2 by bog vegetation (only three plots) and cluster 3 by grasses. A loess smoothed trend line is plotted and its 95% confidence interval is shown for clusters 1 and 3. Multi-storey canopies were present and cover values >100% were set to 100%.

Investigation with Non-metric Multidimensional Scaling (NMDS) of Bray-Curtis dissimilarity matrices of the vegetation inventory data of all plots across all years reveals a 'stability-landscape' with two

stability domains (Fig 2). This hints towards the existence of two alternate attractors (grass dominated and dwarf shrub dominated). Additional analyses of soil paramaters are needed to investigate whether this divergent successional pattern is driven by external environmental conditions it is the result of internal vegetation dynamics (biotic interactions). The different stable states are only "alternative" in the latter case.

Such alternative stable states can be either the result of a founder control mechanism where the species exceeding certain threshold abundance will attain dominance. Another mechanism leading to alternative stable states is "ecosystem engineering" by species that have profound effects on the abiotic environment around them. The plant-litter-soil-plant feedback loop is an example and *Calluna vulgaris* and many other ericaceous species are known to enhance soil acidity and nutrient availability, which could alter competitive interactions to their advantage.

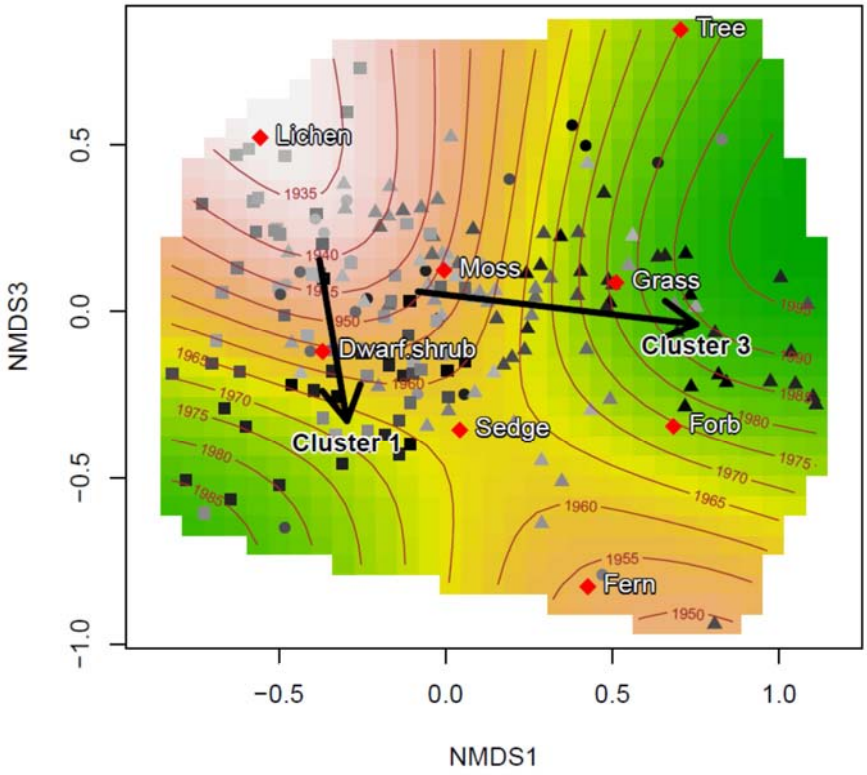


Figure 2: NMDS ordination scores for axis 1 and 3 of all vegetation plots between 1921 and 2012. Darker dots represent later surveys. Plots of clusters 1, 2 and 3 are displayed by squares, circles and triangles, respectively. Positions of maximal correlation for different growth forms are indicated by red diamonds. The successional tendency over time is shown by smoothed surface fitting of time with green representing later years. Black arrows show cluster-specific succession between 1921 and 2012 for clusters 1 (dwarf shrub dominated) and 3 (grass dominated).

T20 - Slope exposure as a factor determining heathlands occurrence on dunes in the Toruń Basin (Northern Poland)

Piort Sewerniak and Michal Jankowski
Department of Soil Science and Landscape Management, Nicolaus Copernicus University in Toruń, Poland.

The study was conducted in the active military (artillery) area located south of Toruń (52º55'N, 18º36'E). The area is situated in one of the biggest inland dune fields of Central Europe. The dominant soil type for the dunes are Podzols with pine forest *Peucedano-Pinetum* as climax vegetation. Since the 19th century the area was gradually deforested for military purposes and since then natural succession and fires caused by military activity were main factors determining vegetation occurrence. During preliminary field works we observed a clear, regular relation between dune slope exposure and plant communities distribution. Northern slopes are covered by heathlands (*Calluna vulgaris*) while southern by grasslands (*Festuca* sp., *Corynephorus canescens* and *Calamagrostis epigejos*) mainly. The aim of the research was to examine main site factors determining such vegetation pattern. We investigated soil morphology and properties as well as microclimate parameters in northern and southern slope of a representative dune in the area of natural succession and in the respectively exposed slopes of a control dune located outside the military training ground in a pine, timber old growth forest (Fig. 1). In measurements of investigated microclimate parameters (temperature and relative humidity of atmospheric air 15 cm above ground level) automatic HOBO U23-001 recorders were used. For soil parameters determination standard methods used in soil science were applied.

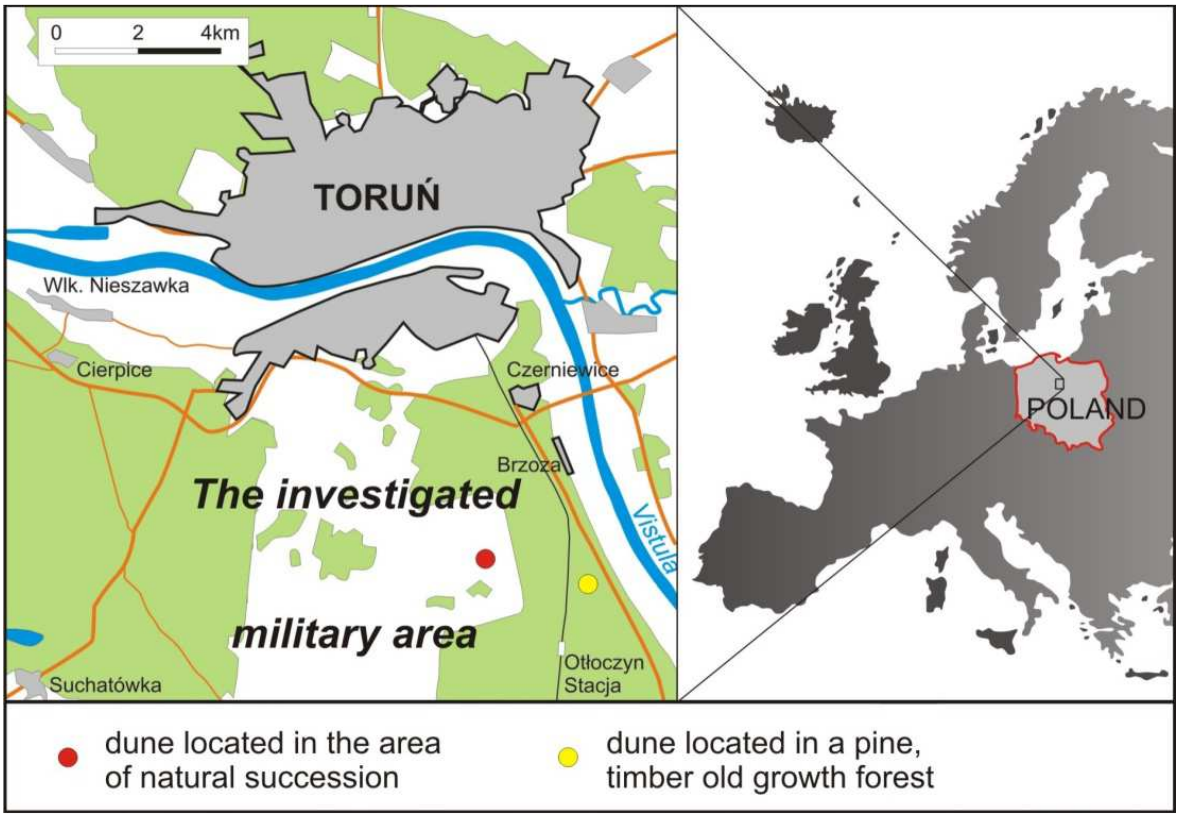


Figure 1. Location of the study site

The obtained results showed both, clear differences in microclimate occurring in the investigated slopes (distinct higher relative humidity and lower temperature of atmospheric air on northern than on southern hillside) and explicit differences in morphology and properties of soils located in slopes of different exposure in the investigated deforested dune. In spite of the same parent material (quartz, loose sand) soil of northern slope in comparison to southern exposure was characterized by higher stocks of organic matter and nutrients (N, Mg, K, Ca) and lower temperature. Moreover, the north-facing soil was of higher moisture (Tab. 1) that prevented deflation after deforestation per se, besides formed quite favorable conditions for recovering the ground surface by vegetation. Thus, in northern slope of the deforested area Podzols occur that in morphology and properties are similar to these that appear in control dune overgrown by old growth pine stand.

Table 1. Some properties of the soils located in the area of the natural succession

Horizon	Depth [cm]	OC [%]	Nt [%]	Actual moisture [weight %] and temperature [°C] for two example measurements			
				7.08.2010		8.10.2010	
				moisture	temp.	moisture	temp.
Soil located in a northern slope							
Ol	4-3	41,8	1,639	n.d.	n.d.	n.d.	n.d.
Of	3-0	23,9	1,116	n.d.	n.d.	n.d.	n.d.
AEs	0-10	1,43	0,112	11,5	21,2	11,1	10,4
Bhs	10-20	0,66	0,050	19,4	21,3	9,5	10,6
Bs	20-32	0,36	0,049	7,3	20,7	8,4	10,6
BsC	32-100	n.d.	n.d.	7,1	19,7	7,2	11,4
C	>100	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Soil located in a southern slope							
(A)	0-6	0,67	0,083	4,7	26,3	2,8	15,2
Bs(A)	6-12	0,46	0,054	6,6	25,3	4,4	14,4
Bs	12-30	0,28	0,040	7,8	24,9	6,7	13,7
C	>30	n.d.	n.d.	6,8	24,5	7,1	13,5

n.d. – not determined

Higher insolation causing high temperature and low soil moisture entails distinct other soil and vegetation evolution in a southern slope after deforestation. Dry soil is much more susceptible for wind erosion that results in deflation of surface horizons of Podzols what can reach in depth even soil parent material. Eroded, dry slope surface, with time is fixed by xerothermic grass species and in bared parent material of Podzol, initial, sandy soil (Arenosol) develops. In spite of high insolation, such unfavorable dry and initial soil condition of Arenosols are not suitable for *Calluna vulgaris* that finds good site conditions on Podzols occurring on northern slopes only.

The research was financed by the Polish Ministry of Science and Higher Education (project N N305 304840).

T21 - Why does the abundance of *Erica tetralix* decrease on wet heathlands?

Christian Damgaard
Institute of Bioscience, Aarhus University, Denmark.

The role of atmospheric N deposition and soil acidification for explaining the decreasing trend in the cover of *Erica tetralix* (from 28% in 2004 to 18% in 2009) was investigated using 1130 wet heathland plots at 89 Danish sites. The hierarchical data were analysed using structural equation modeling (SEM), where the pin-point cover data of *Erica tetralix* was modeled using a generalised binomial distribution (or Pólya-Eggenberger distribution). The most important causal effect revealed by the SEM was a significant negative effect of N deposition on the cover of *E. tetralix*, whereas soil acidity tended to have a negative effect of relatively less importance. Surprisingly, there was no significant effect of N deposition on soil pH, which indicates that there are no major indirect effects of N deposition on the cover of *E. tetralix* mediated by soil acidification.

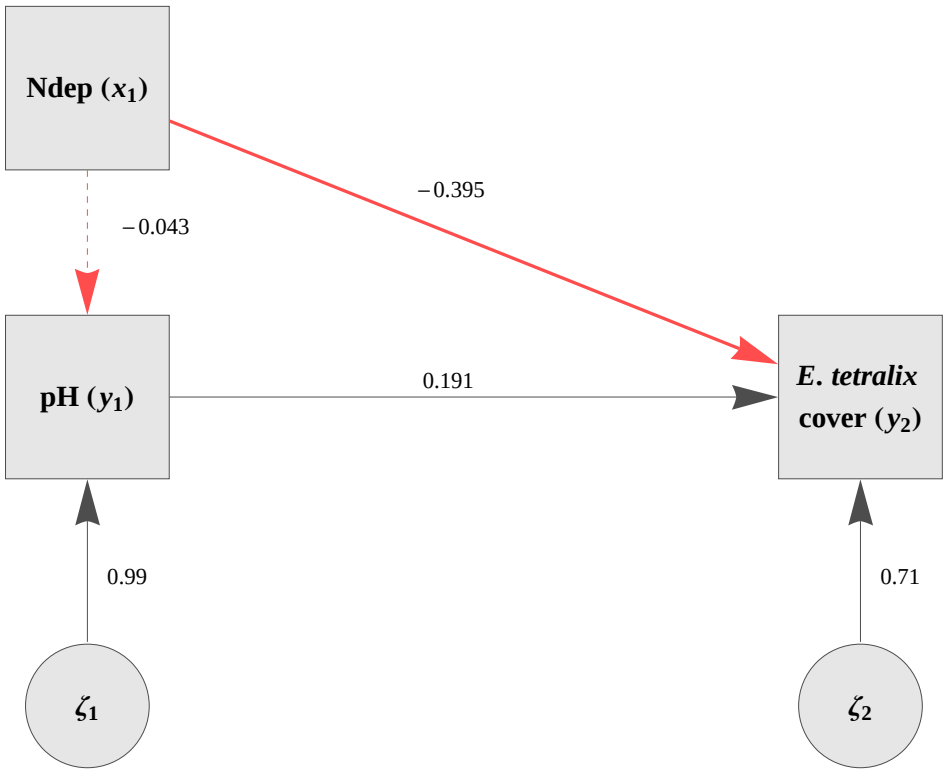


Figure 1: Structural equation model of the effect of atmospheric N deposition and soil acidification on the cover of *Erica tetralix* on wet heathlands.

Photo: Inger Kappel Schmidt

T22 - Opportunities for a N2000 heathland after Wildfire: Effects, recovery and monitoring

Marijn Nijssen[1], Jap Smits[2] and Joost Vogels[1]
1; Bargerveen foundation, The Netherlands.
2; Staatsbosbeheer, The Netherlands.

On July 2nd 2010 (38 ºC and strong SE wind) a small fire-incident turns into a huge wildfire. It takes 5 days to control the fire, and 70 hectares of woodland and 80 hectares of heathland were destroyed. Temperatures during the fire exceeded 1200 ºC and the organic soil of the forest as well as the heathland almost completely disappeared.

Effects

The effect of the wildfire on flora and fauna was huge. Many songbirds were struck by the wildfire, like Yellowhammer (*Emberiza citrinella*), and Meadow pipit (*Anthus pratensis*) as well as approximately 10 European Nightjars (*Caprimulgus europaeus*). Probably all Common lizards (Zootoca *vivipera*) and Moor Frogs (*Rana arvalis*) in the burned area died, even as most invertebrates, and a few Juniper (*Juniperus communis*) shrubs. Many Natterjack toads (*Bufo calamita*) and purseweb spiders (*Atypus affinis*) survived because their diurnal hiding places were located deep in the ground.

Recovery

After several weeks, grasses began to recover and especially Purple Moorgrass (*Molinia caerulea*) gained approximately 10 centimetres in height each week. Sheep grazing was introduced directly after the fire to counteract this expected greenflush. In September and October, dozens of fire-dependent fungi species were discovered. While the old *Calluna vulgaris* shrubs did not regenerate after the fire, a massive germination of seedlings occurred, suggesting that *Calluna vulgaris* in the Netherlands also has fire induced germination mechanisms, which has first been described in Norwegian *Calluna vulgaris* plants. Seedlings grew very vigourously quick and were able to flower in autumn at the same year. These plants reached the “building phase” stage in one year’s growth. Plant nutrient status of these seedlings was very high, with average tissue N:P ratios of 10-12. Before the fire took place, N:P ratios of Calluna vulgaris at the same site was approximately 20-30, suggesting that the wildfire resulted in the release of large amounts of phosphorus that were unavailable for plants in the pre-burn phase. As a result, the plant nutrient quality following fire is very high compared to the pre burn situation, which resulted in a strong response by several fauna species. Ground breeding bird species such as the European Nightjar (*Caprimulgus europaeus*) were quick to reoccupy territories in the burned area. After the second year typical heathland invertebrates such as the Heath tiger beetle *(Cicindela sylvatica)*, Blue-winged grasshopper (*Oedipoda caerulescens*), and Small copper (*Lycaena phlaeas*) live in great numbers in the burnt area.

New developments

Most of the burned forest is removed in the first two years, the rest collapsed due to damage by invertebrates. The largest part of the burned forest and heathland will be developed into dry heathland with sparse patches of pine and birch forest. Every year since the wildfire sheep grazing is used to suppress vegetation growth. In the light of Natura 2000, measures are taken to restore 15 to 20 hectares of inland drift sand and more dry Calluna heathland. Measures include removal of all woody material and organic soil. All these natural materials (27500 m2) are used within the area to build artificial sand dunes between the border of the nature area and the adjacent highway.

Research and monitoring

The wildfire struck half of the research plots of a project in which the effect of leaching of minerals and micronutrients on the heathland ecosystem are studied for a 3 year period. This made it possible to study the effects of wildfire on soil chemistry and invertebrate fauna. For monitoring the development of vegetation and fauna of the new inland drift sand the State Forestry Service assigned a project to specify the situation just after the measures and write a monitoring plan for the following ten years. Both projects are carried out by the Bargerveen Foundation.

Figure 1 *Rumex acetosa* in fire truck tracks one year after wildfire

Figure 2 Wildfire Strabrechtse Heide July 2nd 2010

T23 - Status and management of subcontinental Calluna heathland in German Natura 2000 sites - with special emphasis on prescribed burning

Frank Meyer and Stefan Klein
RANA – Büro für Ökologie und Naturschutz, Halle, Germany.

The dry heathlands in the continental eastern part of Germany differ from the Atlantic influenced Western Europe as they are relatively young ecosystems. These do not have a long traditional land use but have mostly been employed within a military context that often lasted only for some decades. The majorities of these areas are active or abandoned military training areas as well as parts of the former German-German border, often referred to as the “Green Belt”. Besides being abandoned after the cold war, the ongoing reduction of the armed forces has further increased the number of sites.

Such military-associated heathlands are of vital and national importance for nature conservation and a constitutional part of the European Natura 2000 network, in particular as Sites of Community Importance (SCI) and Special Protection Areas (SPA). More than 60% of the area, which are designated as the habitat types 4030 and 2310 in Germany, are found in the four north-eastern German states Brandenburg, Mecklenburg, Sachsen-Anhalt and Sachsen. This calls for a high responsibility to maintain a favorable conservation status, but the implementation is complicated by the special measures required since this differs from other so-called “civil” areas.

One of the main factors is the heavy contamination with ammunition and other military waste, which prevents the establishment of conventional forms of land use and landscape management. In the meantime, many of these heathland sites are highly endangered through succession. This process is further aggravated by the shorter life cycle of *Calluna* under subcontinental climatic conditions, which could be shown in annual growth ring analysis.

This has led to substantial habitat losses, thereby questioning the fulfillment of the Natura 2000 conservation obligation. Furthermore, there are often internal conflicts concerning heathland management versus wilderness concepts.

Using selected examples from different nature reserves, the possible approaches to solving the problems in the planning stage and actual implementation will be illustrated. A key procedure is the use of prescribed burning as an effective measure to revitalize degenerated *Calluna* heathlands. To cope with the ammunition contamination, special burning techniques were developed.

The traditional man-made fire can also be initiated by remote ignition.

A specially tailored tank for employment in the prescribed burning of heathlands contaminated with ammunition.

T24 - Danish heathlands are becoming more wet

Hans Jørgen Degn
Degn's Naturconsult, Ringkøbing, Denmark.

The discussion about climate change has mostly focused on models and predictions. But changes have started, also in dry terrestrial habitats as heathlands.

Temporary ponds in 7 heathlands covering 33 km^2 have been examined on a large number of aerial photos from the period 1944-2012. It is easy to determine when they are in the state of a pond or when they are dried-up. During this period the frequency of water cover has more than doubled (Fig. 1).

It is obvious to compare this increase with changes in precipitation. A detailed local study for the period 1863-2008 reveals a mean increase of 2.67 mm per year. For the period with aerial photos this corresponds to an increase in annual precipitation on 180 mm.

Not only the temporary ponds have become filled with water more frequently, but the surrounding heathlands have also become more wet, as a free water surface is an indicator of a high level of the ground water.

Predictions describe a continued increase of precipitation, so in the future the temporary ponds will be water-filled more often and/or for longer periods, and new ponds will emerge. It is discussed how the quality of nature can be increased. Consequences for the surrounding landscape are far more difficult to predict, but may be serious.

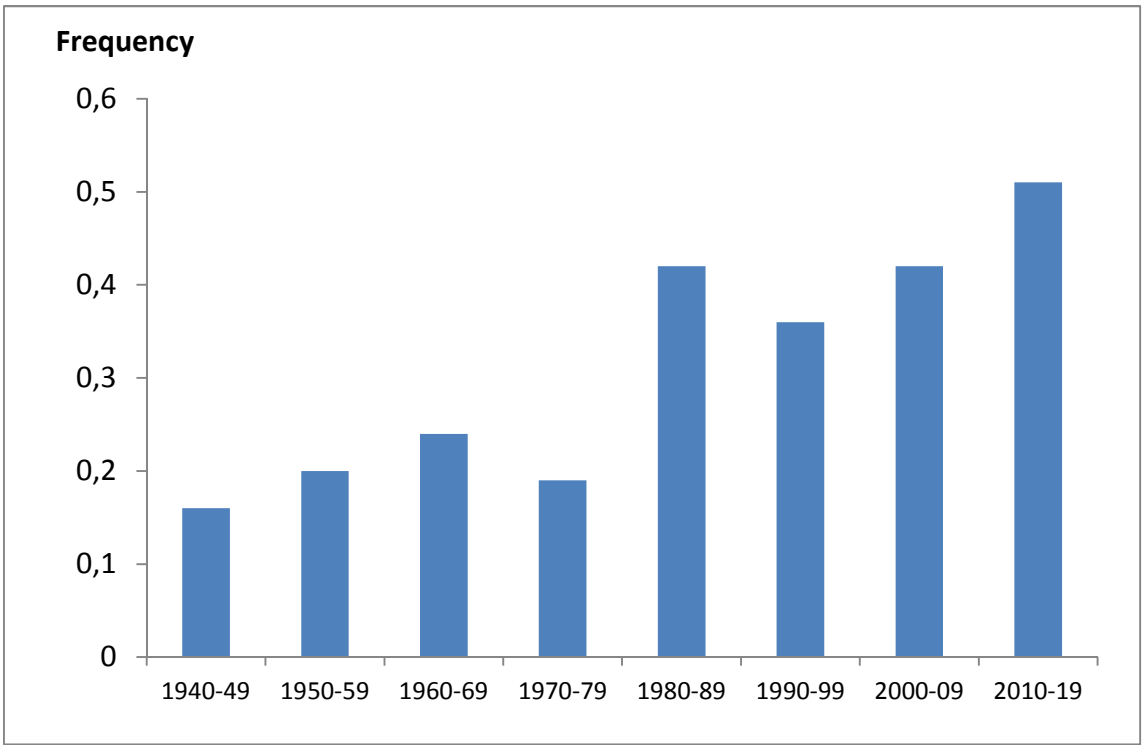


Figure 1: Frequency of water-cover in temporary ponds in 7 heathlands 1944-2012.

T25 - Effects of elevated CO_2, warming and summer drought on the carbon balance in a Danish heathland after seven treatment years – results from the CLIMAITE project

Klaus Steenberg Larsen[1], Per Ambus[1], Claus Beier[1], Kristine Boesgaard[1], Kristian Albert[1], Andreas Ibrom[1], Johannes Ransijn[2], Inger Kappel Schmidt[2] and Jian Wu[1]
1; Department of Chemical and Biochemical Engineering, Technical University of Denmark (DTU), Kgs. Lyngby, Denmark.
2; Department of Geosciences and Natural Resource Management, University of Copenhagen, Copenhagen, Denmark.

In a Danish heathland co-dominated by heather (*Calluna vulgaris*) and grasses (*Deschampsia flexuosa*) we simulated realistic future climate scenarios in a full-factorial design of elevated atmospheric CO_2 (510 ppm), increased temperatures (0.5-1.5 °Celsius) and intensified summer drought events (4-6 weeks per year). Treatments were initiated in 2005. Using manual chamber techniques, we measured soil respiration (SR), ecosystem respiration (ER) and net ecosystem exchange of CO_2 (NEE) and determined gross ecosystem photosynthesis (GEP) as NEE – ER. We also monitored carbon losses in the form of dissolved organic carbon (DOC) in leached soil water.

The results show that across all combinations of treatments with elevated CO_2, SR rates increased by 20-30%. GEP rates also increased under elevated CO_2 but this effect was reduced when elevated CO_2 was combined with drought and/or warming. Elevated CO_2 did not significantly affect above-ground ecosystem respiration rates or below-ground DOC leaching. While the warming effect induced changes in the phenology (higher uptake rates during spring but lower during summer and fall), the warming treatment had only small effects on annual rates of GEP and respiration rates, i.e. slightly decreased uptake rates by photosynthesis and slightly increased loss rates by respiration. In contrast, the drought treatment led to reduced rates of both photosynthesis and respiration. The results highlight that not all ecosystems may be expected to increase their net carbon uptake in a future CO_2 enriched atmosphere especially because other climate drivers may significantly affect the final ecosystem response.

T26 - Heathlands under global change - the importance of interactive effects

Werner Haerdtle[1], Leonor Calvo[2], Elena Marcos[2], Maren Meyer-Gruenefeldt[1] and Goddert von Oheimb[1]
1; Institute of Ecology, University of Lueneburg, Germany.
2; Fac. Ciencias Biológicas y Ambientales, University of León, Spain.

Heathland ecosystems host a huge proportion of the biodiversity typical of open acidic landscapes in NW Europe. Further, they provide important ecosystem services such as carbon sequestration and clean water, are source of livelihoods and important for recreational purposes. As a result of changes in land use practices, the area of heathlands has declined dramatically since the second half of the 19th century. In recent decades, heaths are subject to global changes such as shifts in climate conditions and atmospheric pollution (particularly nitrogen). Altered precipitation patterns (e.g. summer drought) might affect heathland ecosystems in particular, since their European range is related to a humid climate with moderate summer temperatures and drought events.

Despite recent research on the effects of global change drivers on diversity patterns and the functioning of heathland ecosystems, our knowledge on interactive effects of co-occurring global change drivers is still limited. In principle, ecosystem responses to simultaneous effects of global change drivers (e.g. climate change and N deposition) might be additive (i.e. the summation of single effects) or non-additive (i.e. antagonistic or synergistic interaction). In the latter case, ecosystem responses are often perceived as "ecological surprises", because they are difficult to predict, and our ability to anticipate and understand them often requires multi-factorial studies with full-factorial combinations of the respective treatments.

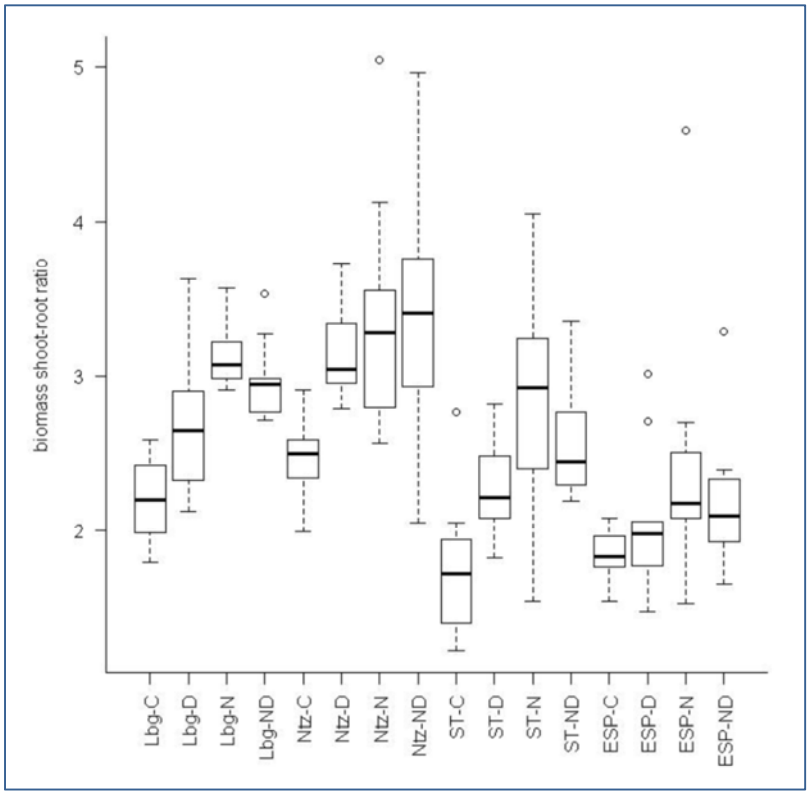


Figure 1 Treatment effects on shoot-root ratios of *Calluna*-plants. Abbreviations: Lbg-Lueneburg heath, Ntz-Nemitz heath (central populations), ST=Saxony Anhalt, ESP=Cantabrian Mountains/N Spain (rear-edge populations); treatments: C=control, D=drought, N=N fertilisation, ND=N fertilisation and drought).

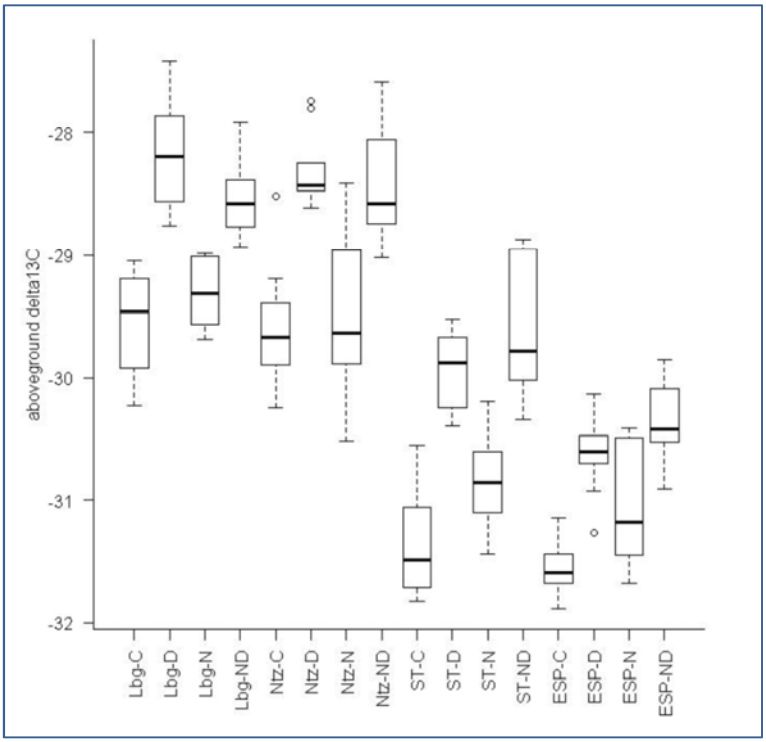


Figure 2 Treatment effects on (aboveground) tissue $\delta^{13}C$ signatures of *Calluna*-plants. Abbreviations: Lbg-Lueneburg heath, Ntz-Nemitz heath (central populations), ST=Saxony Anhalt, ESP=Cantabrian Mountains/N Spain (rear-edge populations); treatments: C=control, D=drought, N=N fertilisation, ND=N fertilisation and drought).

This talk will summarise the most recent findings (of both field and greenhouse experiments) on interactive effects of co-occurring global change drivers on the functioning of heathland ecosystems, with a focus on interactive effects of N fertilisation and drought events on plant growth and competition. N fertilisation strongly increased the aboveground biomass allocation of *Calluna*-plants, resulting in a distinct increase of biomass shoot-root ratios (Fig. 1). In addition, we found strong antagonistic interaction effects of N fertilisation and drought for both aboveground and belowground biomass production. $\delta^{13}C$ values indicated that N fertilisation increased the evaporative demands of *Calluna* plants, likely due to increased biomass shoot-root ratios, which in turn resulted in higher drought susceptibility. Young plants proved to be particularly susceptible to combined effects of N fertilisation and drought, whereas older plants were characterised by low shoot-root ratios (<1) and thus responded less pronounced to drought events following N fertilisation. “Central populations” of *Calluna vulgaris* (NW Germany) proved to be more susceptible to drought events compared to plants originating from “rear-edge populations” (N Spain, E Germany; cf. tissue $\delta^{13}C$ signatures in Fig. 2).

Our findings indicate that multi-factor analyses may help to better understand and anticipate plant growth responses to co-occurring global change drivers, which in turn might support the guidance of management and conservation efforts aiming at the long-term preservation of European heathland ecosystems.

List of posters

	#	Name	Title
Poster session 1: Monday June 24th	P01	Rita Buttenschøn	Cattle grazing of Erica tetralix on wet heathlands at Læsø
	P02	Marie Dam	Increased activity in heathland soil at future CO_2 levels
	P03	Johannes Ransijn	Climate change needs disturbance to affect shrubland plant communities
	P04	Michal Jankowaski	Heathlands as the stage of ecological succession and soil development on inland dunes in the Toruń Basin (Northern Poland)
	P05	Elena Marcos	Nitrogen distribution in heathland ecosystems of the Cantabrian Mountains using ^{15}N tracer
	P06	Tessa Bargmann	Life after fire: germination responses of herbs and graminoids to ash and smoke treatments in northern heathlands
	P07	Andrzej Nienartowicz	Variability of the structure and directions in the development of heaths in the Torun Basin
Poster session 2: Tuesday June 25th	P08	Kunz Mieczysław	The use of Unmanned Aerial Vehicle (UAV) in heath studies – first results of investigation
	P09	Rita Buttenschøn	Experiments on control of Rosa rugosa on dune heathlands in Thy
	P10	Liv Sigrid Nielsen	From overgrown to well managed heathland; the turnover process at Skeisneset in Leka municipality, Nord-Trøndelag
	P11	Peksa Ondřej	Heathlands – the endangered habitat of the Czech Republic (interdisciplinary study of biological diversity)
	P12	Ivana Hradská	Invertebrates of heathlands in western part of the Czech Republic
	P13	Edyta Adamska	Lichens of Heathlands in the City of Toruń and Wielka Nieszawka Commune
	P14	Hans Jørgen Degn	A new method to reduce Purple Moor-Grass *Molinia caerulea*
	P15	Katrin Henning	Effects of seed production and germination ability of overmature Calluna vulgaris-stands in a continental bioclimatic region

Abstracts for poster presentations

P01 - Cattle grazing of *Erica tetralix* on wet heathlands at Læsø

Rita Merete Buttenschøn[1] and Jon Buttenschøn[2]
1; Geosciences and Natural Resource Management, Copenhagen University, Denmark.
2; Danish Veterinary and Food Administration, Denmark.

Erica tetralix is present in the heathlands on Læsø at June sub-soil water levels from 1.2 to 0.1m below surface. Over 22 years the stands of *E. tetralix* were susceptible to drought in summers with low precipitation in the 0.8 to 1.2m sub-soil water level. Massive fall in cover was seen after dry summers in the named sub-soil water range.

We studied the effect of Galloway cattle grazing as compared to no husbandry grazing in the period 1987 to 2008. Here we report the response of *E. tetralix* to grazing. Grazing was carried out at two sites, Holtemmen and Kærene.

Table 1

Site and type	Grazing pressure and period	Sub-soil water level, metres	Start and end cover-%	Start and end frequency (plots)	Number of plots
Holtemmen					
Wet heath, mire[2]	Low, summer	0.1 – 0.5	6/8	15/16	16
Wet heath, mire	None	0.1 – 0.5	6/6	9/13	16
Wet dune-land[2]	Medium, summer	0.2 – 0.4	0/1	0/2	32
Mire clearings[2, 3]	Medium summer	0.1 – 0.2	0/0.5	0/2	32
Kærene					
Wet heathland[1]	High winter	0.2 – 0.8	14/1	28/7	32
Wet heathland	None	0.2 – 0.8	25/12	14/12	32
Dry heathland[2]	Low, summer	0.6 – 1.2	18/14	14/14	16
Wet heath, mire[2]	Medium, summer	0.2 – 0.5	0.5/2	3/9	16

[1]Fencing (12.5 ha) in connection to winter quarters for the whole herd.
[2]Colours indicate part of same fencing
[3]Cleared of dense willow-birch shrub in 1987

Under low to medium grazing in summer *E. tetralix* increases in cover as well as areal distribution in the period after initiation of grazing. It is reintroduced to areas where it was out-shadowed under periods without grazing or by natural afforestion. Heavy grazing, however, as in connection to the winter quarters, results in a collapse of the *Erica*-stand. In the un-grazed areas the *Erica*-stands are out-shadowed with progressing natural afforestation. The increased distribution in the un-grazed mire at Holtemmen we connect to increasing light connected with a progressing degeneration-process in the initially super-dominant *Molinia coerulea*-sward in the 0.1 – 0.2m below surface water level zone.

Our conclusion is that *E. tetralix* is promoted and stabilised by low to medium pressure cattle grazing within its optimal water level distribution range, whereas it may by subject to periodic collapse in stands growing under dryer conditions. Heavy grazing causes collapse in *Erica*-stands.

Figure 1: *Erica tetralix* at cattle grazed wet heathland at Læsø.

P02 - Increased activity in heathland soil at future CO_2 levels

Marie Dam and Søren Christensen
Terrestrial Ecology Section, University of Copenhagen, Denmark.

Natural terrestrial ecosystems such as heathlands could be at risk of disappearing due to changes in dynamics, structure and functioning caused by climate change. To optimize the prediction of climate change consequences for terrestrial ecosystems and the terrestrial C-balance, the combined effects of climate change factors should be considered, as well as the single factor effects. And to understand the extent and nature of the responses and possible feedback mechanisms in terrestrial ecosystems, it is necessary to examine the effects on plant-soil interactions.

This study focused on the interactions between *Descampsia flexuosa* and the microfauna in the rhizosphere soil in a Danish heathland system subjected to experimental climate factors based on prognoses for year 2075. Root biomass, root C/N ratio and nematodes in the associated rhizosphere soil was measured after 6 years in a full factorial FACE-experiment with the treatments: increased CO_2, increased nighttime temperatures, summer droughts, and all of their combinations. After 6 years of CO_2 enrichment root biomass, root C/N, and the abundance of nematodes increased, suggesting increased activity in the soil.

These results indicate a change in the system towards increased microbial activity and decomposition rates at future CO_2 levels and a build-up of a greater pool of more easily degradable carbon. For heathlands this change could imply increased mineralization, possibly priming and a thinner layer of mor that might push the system towards increased grass dominance.

Photo: Rasmus Dalhoff Andersen

P03 - Climate change needs disturbance to affect shrubland plant communities

Johannes Ransijn[1], György Kröel-Dulay[2], Inger Kappel Schmidt[1], Alwyn Sowerby[3], Albert Tietema[4], Marc Estiarte[5], Giovanbattista de Dato[6], Torben Riis-Nielsen[1], Jane Kongstad[1], Bridget Emmett[3], Paolo de Angelis[6], Klaus Steenberg Larsen[7], Romà Ogaya[5], Andrew Smith[8], Claus Beier[7] and Josep Peñuelas[5]

1; University of Copenhagen, Denmark.
2; Centre for Ecological Research Hungarian Academy of Sciences, Hungary.
3; Natural Environment Research Council, United Kingdom.
4; University of Amsterdam, The Netherlands.
5; CREAF-CEAB-CSIC, Spain.
6; University of Tuscia, Italy.
7; Technical University of Denmark, Denmark.
8; Bangor University, United Kingdom.

We studied the effects of experimental night-time warming and drought on total plant cover, species diversity and vegetation composition in seven shrubland or shrubland-grassland sites located in different European climatic regions since 1998 (Wales-UK, Netherlands-NL, Denmark-Mols, Spain-SP), 2001 (Sardinia-IT, Hungary-HU), or 2005 (Denmark-BB). The sites differ both in climatic (annual precipitation temperature) and ecological characteristics (total cover and species richness) but all are dominated by shrub or shrub-grass vegetation and the four northern sites (UK, NL, DK-Mols and DK-BB) are dry heathland ecosystems.

We used the same experimental setup at all sites: reflective curtains covered warming plots during the night to increase temperature and transparent curtains covered drought plots during rain events. Night-time warming was conducted all year round, whereas drought length and timing was site-specific. We monitored the cover of vascular plants in permanent vegetation plots and looked for treatment effects on individual species, total plant cover, species diversity and plant community composition. We tested for treatment effects on vegetation composition by calculating the Bray-Curtis dissimilarity of the plant community of each plot in a specific year relative to the plant community at the start of the experiment and compared trends in treated and control plots.

Vegetation composition, total cover and species diversity were rather resistant in the face of experimental climate change and treatment effects did not follow the pattern of the European climate gradient. Responses were highly site specific with little across site generality. Climatic change seems to have their largest effects on vegetation composition when combined with (accidental) disturbances like heather beetle attacks. The site with the most dramatic changes in vegetation composition was the Mols heathland site where the original plant community dominated by *Calluna vulgaris* recovered after heather beetle attack and consequent cutting in the control plots but not in the drought plots (Fig. 1). Across site analysis shows that the climatic treatment effect on vegetation composition is correlated with the successional state of the ecosystem. Ecosystems under succession (recovering from disturbance) seem to be more vulnerable to climatic changes than steady state or retrogressive ecosystems (Fig. 2)

These results show that the interaction between otherwise normal disturbance events and climate change affects ecosystems more than climate change on its own. This calls for an intentional rather than an accidental inclusion of such disturbances in experiments and emphasizes the importance of long-term studies for evaluation of global change effects on ecosystems. Our results also highlight that responses at the site level often differ from expectations drawn from broad-scale gradients.

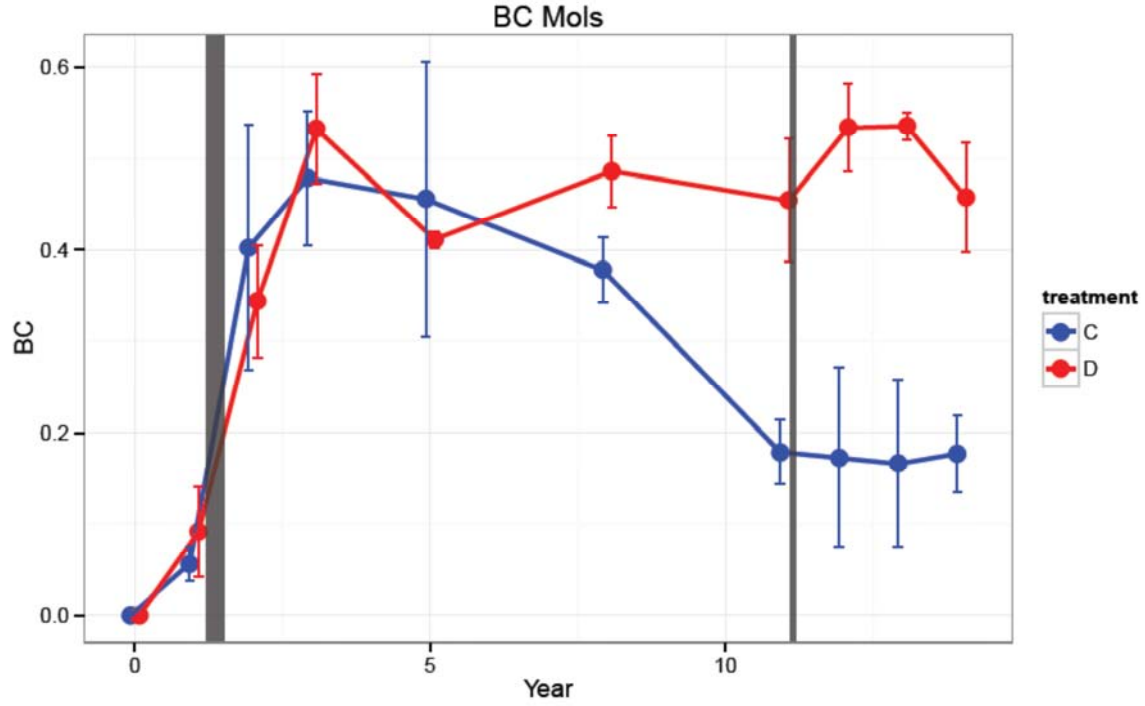


Figure 1: Bray-Curtis dissimilarity of the vascular plant community relative to start (1998) for Drought (D) and Control (C) plots at the Mols site (Denmark). Grey bars indicate heather beetle attacks.

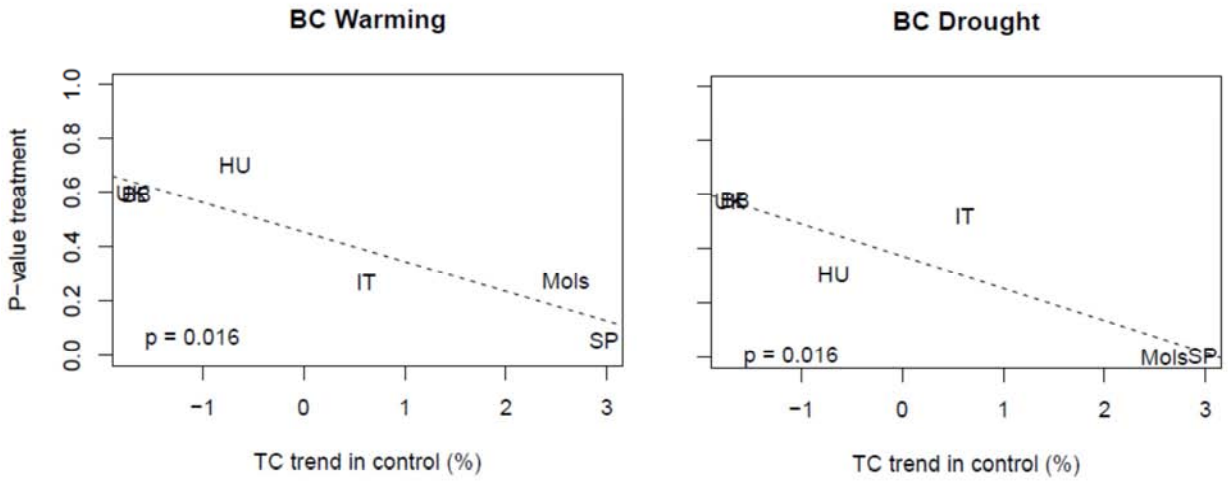


Figure 2: Significance of differences in Bray-Curtis dissimilarity (relative to start) between treated and control plots after >6 of climate treatments. The x-axis gives the overall trend in in total vascular plant cover (TC) and the p-value for an effect of TC trend on the significance of treatment differences. The Dutch site is excluded since it only has one species. UK and BB overlap in both graphs.

P04 - Heathlands as the stage of ecological succession and soil development on inland dunes in the Toruń Basin (Northern Poland)

Michał Jankowski and *Piotr Sewerniak*
Department of Soil Science and Landscape Management, Nicolaus Copernicus University in Toruń, Poland.

The aim of this work was to recognize the position of heathlands in soil development proceeding parallel to plant succession in inland-dune area of the Toruń Basin (Northern Poland). The area is occupied by extremely poor, sandy soils mostly, which are very susceptible to degradation in case of primary vegetation destruction. In such places plant succession starts from initial stages, as well as a new generation of soils begin to develop.

Two study sites located in the intensively used artillery training field were examined. They represent different landscape situations typical for the area:

1. an anthropogenic desert developed on windblown glaciofluvial terrace, nowadays overgrown by vegetation of initial plant communities representing consecutive stages of succession of a primary character (*psammosera*). This process takes place on initial soils (Arenosols) developing in bare sands exposed on the land surface due to former destruction of primary soils by aeolian activity. On this site heather occurs as a transitional type of vegetation, displacing plants of initial psammophitic community (*Spergulo-Corynephoretum*) and later giving place to clusters of *Pinus sylvestris* and finally to the pine forest.

2. dunes stabilized by non-forest vegetation forming regular mosaics determined by slope exposure. Heathlands occur on northern slopes, overgrowing quite well preserved Podzolic soils developed in the past under forest vegetation. Southern slopes are occupied by grasslands (*Festuca* sp., *Corynephorus canescens* and *Calamagrostis epigejos*). In this case heathlands represent a plant succession line and soil development pattern of a secondary character, because these processes have started in remains of not completely destructed former ecosystem.

In spite of important differences between these two situations, they show several similarities of site factors, which can be essential for heathlands existence: exposition to the sunlight, low pH and nitrogen content in the upper mineral soil horizons: initial humic horizons of Arenosols (A) and eluvial horizons of Podzols Eh.

On both sites heathlands represent an intermediate stage of plant succession, however, in a case of the pattern of a secondary character they seem to be more resistant to overgrowing by pines, due to more stable conditions provided by well-developed soils (Podzols) preserved on northern slopes of dunes.

The research was financially supported by the Polish Ministry of Science and Higher Education (project N N305 304840).

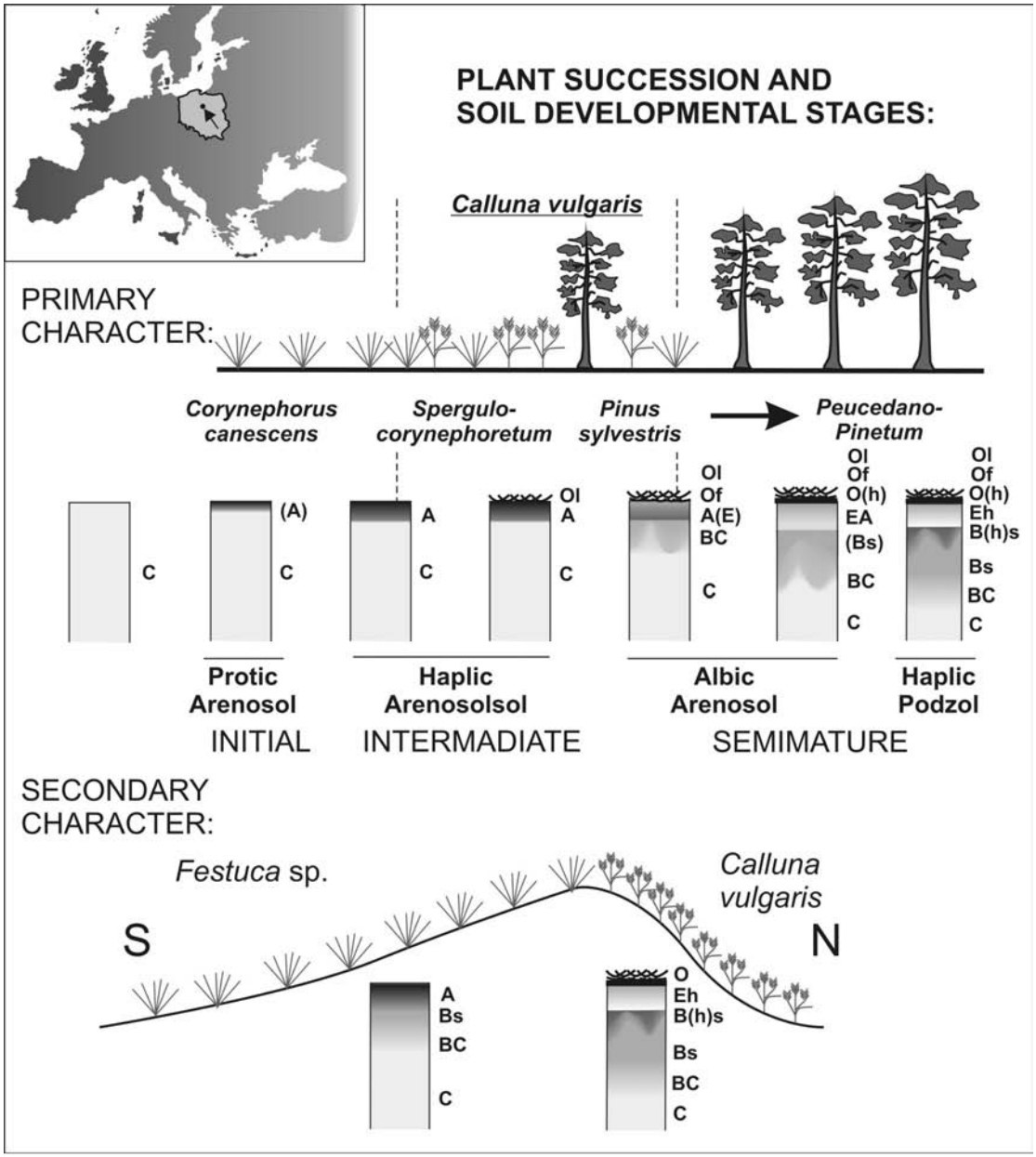


Figure 1. Location of the study area and the place of heathlands in the scheme of soil development and plant succession

Table 1. Basic characteristics of heather occurrence situations on the study sites

Study site	Plant succession and soil development character	Soil type	pH in H_2O in (A)/EA horizon	OC content [mg·kg^{-1}] in (A)/Eh horizon	Nt content [mg·kg^{-1}] in (A)/Eh horizon
overgrown desert	primary	Haplic Arenosol	4.8-4.5	6.0-7.6	0.43-0.55
dunes with slope exposure-determined mosaics	secondary	Haplic Podzol	4.4	14.3	1.1

P05 - Nitrogen distribution in heathland ecosystems of the Cantabrian Mountains using ^{15}N tracer

J. Calvo, E. Marcos, E. Luis, R. Tárrega, L. Valbuena, A. Taboada and L. Calvo
Department of Biodiversity and Environmental Management, University of León, Spain.

This study is part of a research project aimed at determining nitrogen (N) pools and allocation patterns in the different ecosystem compartments of *Calluna vulgaris*-heathlands in the Cantabrian Mountains (north-west Spain).

In June 2010, we established four replicate heathland plots (7 x 3m) and two subplots (2 x 1m) per plot at the southern slope of the Cantabrian Mountains. We randomly assigned each subplot to the following treatments: one was used for the determination of ^{15}N natural abundance (control plot) and the other received ^{15}N tracer (labelled plot). ^{15}N tracer was added once in June 2011, and each subplot received 106 mg $^{15}NH_4$ $^{15}NO_3$ m^{-2} (98at.%) dissolved in 0.5 ml water. In each subplot we determined N content and ^{15}N tracer recovery to assess ^{15}N allocation patterns in: old and new shoots of *Calluna*, soil microbial biomass, and O, A and B soil horizons. Our analyses were complemented by establishing four replicate plots (5 x 3m) at the same locations in June 2010, to evaluate N loss by leaching by means of two lysimeters per plot that were assigned to the following treatments: control and ^{15}N tracer addition (labelled lysimeter). These plots received the same quantity of ^{15}N tracer than labelled plots. In total, we obtained 10 samplings per experiment during the vegetative periods in 2011 and 2012. In this study, we only report the results of N allocation in the soil horizons and in the vegetation.

^{15}N natural abundances ranged between -3.65‰ of the old shoots of *Calluna* and 9.09‰ of the B-horizon. ^{15}N natural abundances in the soil compartments increased with depth from O- to B-horizons. One week after the ^{15}N tracer addition, the values of $\delta^{15}N$ increased for all the ecosystem compartments, although only slightly in the case of soil A- and B-horizons. The greatest increase in $\delta^{15}N$ was observed for the O-horizon, with the highest value of $\delta^{15}N$ = 221.38 ‰ achieved four months after the ^{15}N tracer addition. Indeed, during the first year, the greatest amount of $\delta^{15}N$ was found in the O-horizon, compared to the other ecosystem compartments (soil and *Calluna* shoots). However, during the second year, the values of $\delta^{15}N$ of the O-horizon decreased, approaching those of the A- and B-horizons. We found no significant differences between the values of $\delta^{15}N$ of the old and new shoots of *Calluna*. But the amount of $\delta^{15}N$ of the *Calluna* shoots found in the control subplots greatly differed from the ^{15}N-addition subplots during the whole study period. Also, the values of $\delta^{15}N$ of the *Calluna* shoots were similar in the first and second years of the study.

P06 - Life after fire: germination responses of herbs and graminoids to ash and smoke treatments in northern heathlands

Tessa Bargmann[1], Inger E. Måren[2] and Vigdis Vandvik[1]
1; Department of Biology, University of Bergen, Norway.
2; Department of Geography, University of Bergen, Norway.

Fire is an important disturbance factor in many terrestrial ecosystems, one of which is heathlands. Heathlands are periodically exposed to natural or anthropogenic fires, the latter of which are used as a management strategy to maintain heaths. As a result, heathland species are likely to either tolerate, or be facilitated by fire or its by-products.

Previous studies have documented the efficacy of smoke, charcoal, ash and heat in promoting germination in a wide range of species, but little has been done in this regard in northern European heathlands. Particularly, the effects of fire related cues on herbaceous plants and graminoids has been lacking, and the effect of time since the last fire event is mostly ignored. These effects were studied experimentally using a heathland in Western Norway as a study location, by investigating the effects of aqueous smoke solution, ash and a combination of the two treatments on the germination of graminoids, herbs and ericaceous species (*Calluna vulgaris* and *Erica tetralix*). In addition, it distinguishes between the effect these treatments have on seed banks of newly burnt heath in comparison to seed banks that have not been exposed to fire for 28 years. Main findings are that both ericaceous plants and graminoids respond strongly (both positively and negatively) to fire cues, whereas herbs generally do not. Further, older seed banks of graminoids and ericaceous species responded positively to ash and smoke treatments, and negatively to the combined treatment, when compared with newer seed banks.

P07 - Variability of the structure and directions in the development of heaths in the Torun Basin

Andrzej Nienartowicz[1], Wieslaw Cyzman[1], Milosz Deptula[1], Joanna Chojnacka[1], Dariusz Kaminski[1] and Mieczyslaw Kunz[2]
1; Faculty of Biology and Environmental Protection, Nicolaus Copernicus University, Poland.
2; Faculty of Earth Sciences, Torun, Poland.

Phytosociological analysis of non-forest communities was carried out on one of the oldest and the biggest military training grounds in Europe, located near the city of Toruń, in central Poland (Fig. 1). Heaths and psammophilous grasslands developed here as a result of deforestation of inland dunes in the valley of the Vistula River, as well as a result of destruction of soils and vegetation brought on by manoeuvres and artillery firings.

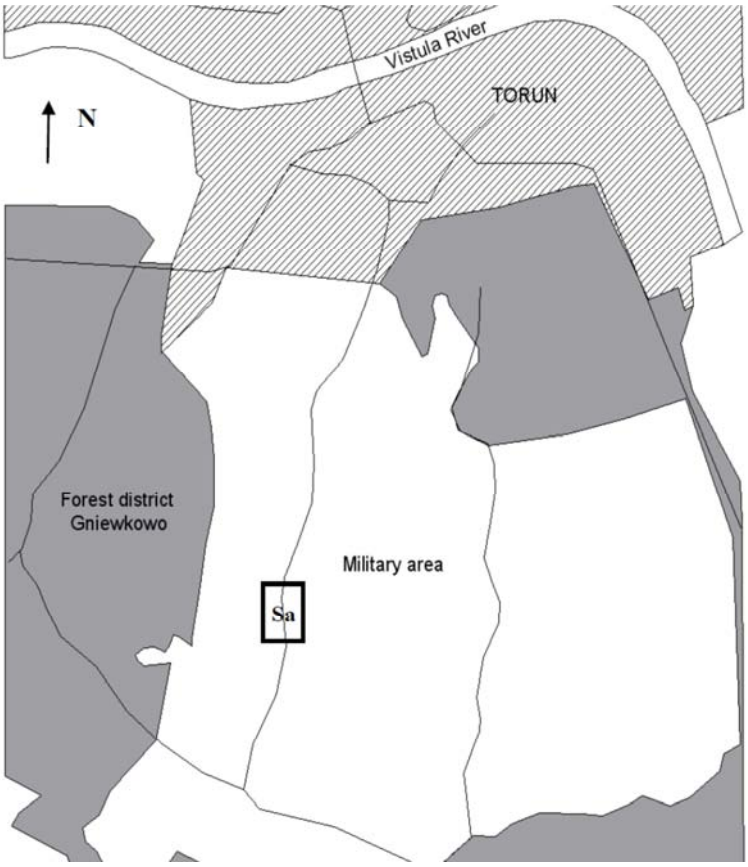


Figure 1. Location of the study area (Sa)

They form a landscape mosaic with young self-seeding pines, mature pine forests and birch forests. Using the Braun-Blanquet method, over 100 relevés were made in the areas dominated by dwarf shrubs. Applying the classic phytosociological method, the following plant associations were distinguished in the set of relevés: *Spergulo vernalis – Corynephoretum*, *Arctostaphylo-Callunetum, Pohlio-Callunetum* and *Calamagrostietum epigeji*, as well as the community with *Cytisus scoparius.* In this work, the heterogeneity within associations and community was presented together with descriptions of individual syntaxa (Fig. 2), as well as dynamic and developmental rela-tionships between the aforementioned units were identified.

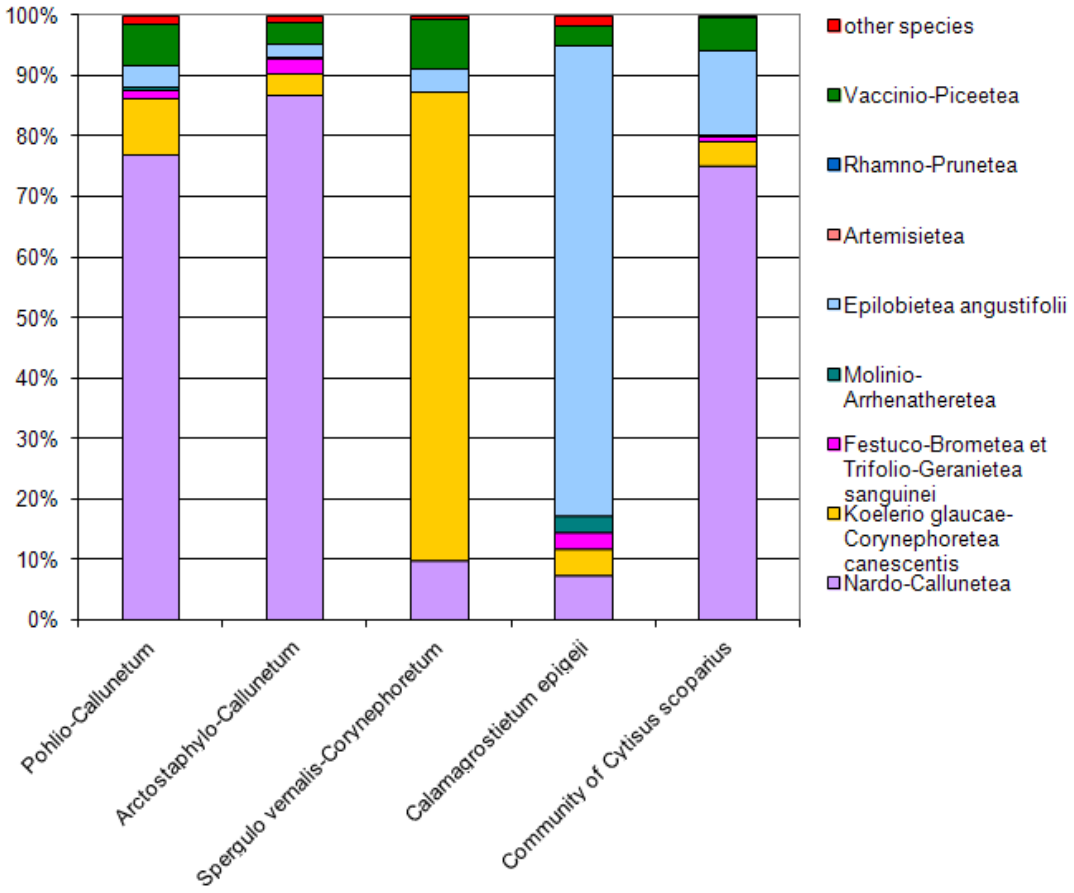


Figure 2. A relative cover degree of particular vegetation classes (syngenetic groups of species) in non-forest communities of the artillery range near the city of Torun

The relevés from the military training grounds were compared with the set of those relevés made in phytocoenoses representing various developmental phases in similar habitats, but existing in other parts of the Torun Basin (Fig. 3). The comparisons have been done performed with the classical phytosociological method according to Braun-Blanquet, as well as with numerical taxonomy methods using from the software Canoco and MVSP.

Figure 3. *Arctostaphyllos uva-ursi* patch in 2009 (A) and 2013 (B) – changes in time and space; two stages

P08 - The use of *Unmanned* Aerial Vehicle (UAV) in heath studies – first results of investigation

Mieczysław Kunz[1] *and Andrzej Nienartowicz*[2]
1; Faculty of Earth Sciences, Nicolaus Copernicus University, Toruń, Poland.
2; Faculty of Biology and Environmental Protection, Toruń, Poland.

Nowadays *Unmanned Aerial Vehicles* (UAVs) have become a modern interdisciplinary area of science and research, and at the same time they are tools for many practical uses, especially in applications considering natural environment and its chosen components. Because of their various constructions (from airframes to multicopters), UAVs make it possible to create aerial-photo campaigns from the low height and to gain image data for small areas repeatedly and quickly. In the world, it is intensively developing alternative for the traditional way of data acquisition about geographical and natural environment. It complements the range of heights captured by remote methods (Fig. 1).

Considering these facts, UAVs can collect data from the heights which are not available for other systems remotely. Satellites register information from several hundreds of kilometers, aero planes from several hundred of meters, from UAVs from more than ten to several hundred meters regardless of daytime, season and weather conditions (except strong wind). This modern method of spatial data acquisition can be applied for interdisciplinary scientific studies and for geographical information for local and regional spatial data infrastructures. It enables to acquire fast spatial information of local, complementary, contemporary character which is the basis for conducting recurrent, complex studies, and monitoring small areas, e.g. heathlands.

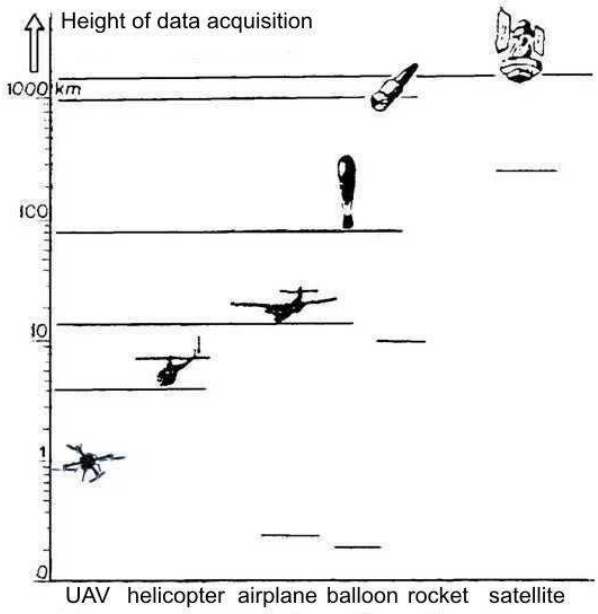


Figure 1. Contemporary methods of acquiring remote sensing data.

From practical point of view, apart from load capacity and the time of the separate flight, there is installed equipment on the carrying platform. It is the most important element of UAV deciding of its target abilities. This tool acquires data and its technical parameters such as spatial resolution and registered spectral bands are key elements for the application.

Faculty of Earth Sciences Nicolaus Copernicus University in Toruń have uses UAV with a unique registering devices such as digital photo-camera Sony NEX-7 (24,3 Mpx), Sony film-camera, multispectral camera Mini-MCA6 TETRACAM (1,3 Mpx) registering in six spectral bands (470, 550, 660, 760, 800 and 950 nm), and also thermal FLIR-TAU camera (640x480 matrix). Table 1 presents a spatial resolution of UAV equipment.

Table 1. Terrain pixel size (spatial resolution) depending on flight height and the type of a registering camera.

			Flight height [m]								
			50			**100**			**150**		
Camera	Number of pixels		GSD [m]	Photograph range		GSD [m]	Photograph range		GSD [m]	Photograph range	
	X [px]	Y [px]		X [m]	Y [m]		X [m]	Y [m]		X [m]	Y [m]
Sony NEX-7 (24 mm lens)	6000	4000	**0.008**	48.75	32.50	**0.016**	97.50	65.00	**0.024**	146.25	97.50
Multispectral camera TETRACAM	1280	1024	**0.027**	34.67	27.73	**0.054**	69.33	55.47	**0.081**	104.00	83.20
Thermal camera FLIR (13 mm lens)	640	512	**0.065**	41.85	33.48	**0.131**	83.69	66.95	**0.196**	125.54	100.43

Registered multispectral data make it possible to calculate chosen indices such as NDVI, Green NDVI, SAVI, ARVI, NIR/G and Canopy Segmentation. Currently at the Faculty of Earth Sciences Nicolaus Copernicus University in Toruń there are tests, implementation in practice, and pilot studies leading to interdisciplinary application of the UAV for monitoring heathlands. Figure 2 presents hand-made photographs of heaths made by multispectral, thermal, and visible (optical range) cameras. These studies are to be used for the analysis of a structure, condition and a spatial variability of heathlands.

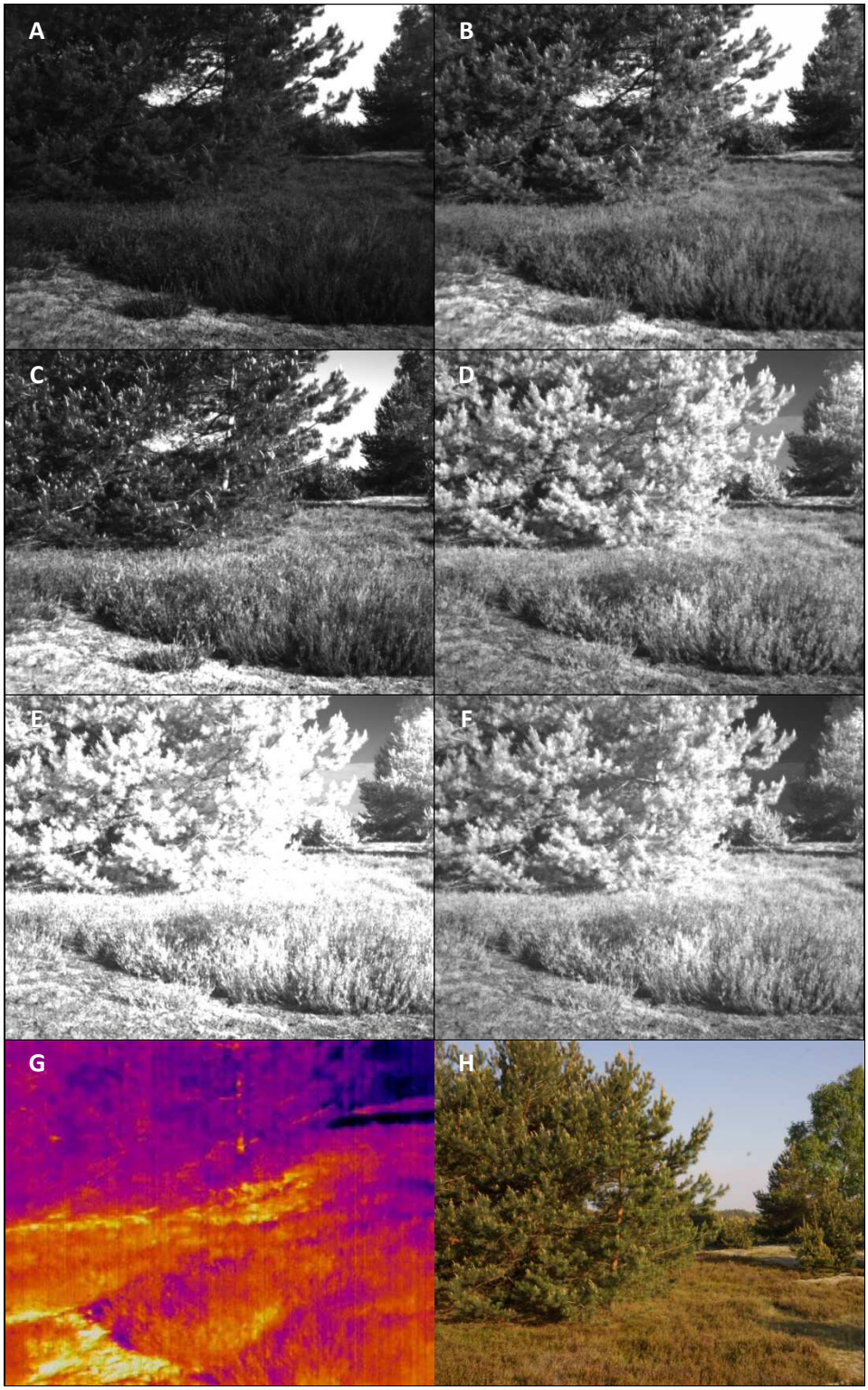


Figure 2: Heaths registered on 19 May 2013 in chosen spectral ranges: 470 nm (A), 550 nm (B), 660 nm (C), 760 nm (D), 800 nm (E) and 950 nm (F), in a thermal range (G) and visible range (H).

P09 - Experiments on control of *Rosa rugosa* on dune heathlands in Thy

Rita Merete Buttenschøn
Department of Geosciences and Natural Resource Management, Copenhagen University, Denmark.

Rosa rugosa is one of the most common invasive plant species in Denmark. It has its natural distribution in North-East Asia and is not native to Denmark. The species is salt, wind and drought tolerant and thrives even under annual sand deposition of up to 30cm. It is mainly invasive in salt environment on dune-land heaths and salt grasslands and meadows, but is also seen spreading from inlands stand, e.g. roadside and wildlife plantings and gardens. It is widespread in most saline environments in Denmark, but most aggressive in the dune-land heaths along the West coast of Jutland.

In 2010 experiments on different control measures and large scale practical management was started on a 450 ha large area of dune-land heath. The rose stands cover 8.0ha distributed in 2157 clones. The experiments include a four replicate, seven-treatment set up looking at chemical control (one or two annual applications) and cutting (May or September) combinations and an experiment looking at the effect of seasonal (May to October) sheep, goat and cattle grazing. The chemical-cutting treatments are applied under a practical management approach parallel to the mentioned experiments during 2010 to 2013. This is aimed at harvesting data for a cost-benefit analysis on practical management.

None of the methods used has fully exhausted the rose clones, but there is a significant reduction of the rose stands with most treatments seen in relation to frequency and cover, suggesting an efficiency ranking of chemical over cutting and twice a year treatment over one. The grazing is efficient after two years with a significant reduction in frequency from the first to the second grazing season, with a ranked efficiency sheep = goats > cattle. It appears that grazing has the advantage of continuous removal of productive foliage throughout the growing season. Control of *Rosa rugosa*, however, takes years.

The project is part of a LIFE+ project “LIFE08 NAT/DK/000464 Dry Grassland in Denmark – Restoration and Conservation “

Foto: Sheep eat all the green parts of Rosa rugosa

P10 - From overgrown to well managed heathland; the turnover process at Skeisneset in Leka municipality, Nord-Trøndelag

Liv S. Nilsen
Norwegian Nature Inspectorate, Trondheim, Norway.

Skeisneset is approx. 3.5 km^2 and represent a coastal landscape without modern technical disturbances or infrastructures, like roads, cultivations, cabins and windmills. There is a variety of topography and bedrock types and this causes a diversity of vegetation types (both rich and poor types). Here you find more than 250 ha of heathland (wet, dry and rich types). Other vegetation types are bogs, fens, grasslands, saltmarshes, tall herb birch forest and rocky shore vegetation.

Stone Age settlements and more than 40 cairns from the Bronze- and Iron Age are testifying that the area has been used by man for a long time, including grazing and mowing, until the middle of the 20th century. Heather burning and heather mowing were common until about 100 years ago. Because of land use changes, the utilisation of the heathlands was reduced already before World War II. The heather plants then grew old and became weakened, and shrubs and trees invaded the heaths. From the late 1980ties the area has been grazed again, but with a smaller grazing pressure.

The values at Skeisneset have been scientific investigated since the 1990ties, resulting in a detailed management plan. This plan is now under implementation. The area has later been included in a reference list of valuable heathlands for the action plan of coastal heathlands, and Skei is also one out of 23 national selected cultural landscapes. The western part is in addition protected as a bird conservation area.

Different economic subsidies have been given to Skeisneset the last few years. A reference group consisting of landowners, the management authorities and the Norwegian Nature Inspectorate are doing the overall priorities. This has given results; the heathlands are cleared again, heather burning is resumed and the grazing pressure is increasing (both sheep and cattle). The practical work has been done by the landowners and by the Norwegian Nature Inspectorate.

P11 - Heathlands – the endangered habitat of the Czech Republic (interdisciplinary study of biological diversity)

Peksa Ondřej and Pecháčková Sylvie
The West Bohemian Museum in Pilsen, Department of Botany, Pilsen, Czech Republic.

The heathlands are important elements in the landscape, both from the biological and historical point of view, as they are evidence of specific land-use in the past. In the Central Europe they were mostly created by human activity (deforestation, pasture, turf cutting, mowing or burning). Land-use changes during the 20th century (especially controlled forestation or spontaneous succession combined with the lack of pasture) have led here to gradual disappearance of heathlands.

In the western part of the Czech Republic (Pilsen region) only few fragments of the lowland heathlands remain, being of various stages of degradation. They often occupy very small area (about several hundred square metres), in some places several last *Calluna* shrubs waste away. They mainly survive in nutrient-poorest places such as tops of rocky hills or sandy or stony soils at the pine forest edges, moreover often intensively trampled. The only larger area of heathlands occures in the strips under the electric lines where frequently repeated cutting of the young wood maintains the strips open (deforested).

To reveal the biological value of these heathland rests and their connection to former large „fully-fledged“ heathlands, we have decided to investigate the diversity of several target groups of organisms: vascular plants, bryophytes, lichens, spiders, ground beetles and other groups of invertebrates. The vascular plants, bryophytes and lichens were studied using standard phytocenological relevés (5 × 5m), invertebrates were collected by pitfall traps (see poster Hradská & Těťál: Invertebrates of heathlands in western part of the Czech Republic)

Preliminary results show great variability of the species composition in all studied groups of organisms as well as among particular localities. Nevertheless, in general we found two basic types of heathlands: „non-forest heathlands“ occupying mainly rocky or sandy hills or former pastures and „shifting forest heathlands“ occuring in plantations with predominance of Scots pine (the „shifting“ means a migration of a heathland „from clearcut to clearcut“ within certain suitable forest area). Actually, the stands in the strips under the electric lines belong to the second group.

As heathland is mostly a secondary biotope dependent on specific management and it is mostly occupied by a pioneer community, it is very difficult to bring a proof of „biotope continuity“ based on vegetation analysis. Neverthelless, besides *Calluna vulgaris*, we found some species called as diagnostic for heathlands in both distinguished heathland types (vascular plants: *Hieracium pilosella*, *Jasione montana*, *Rumex acetosella*; bryophytes: *Polytrichum piliferum*; lichens: *Cetraria aculeata, Cladonia foliacea*, *C. furcata*, *C. uncialis*).

The species composition of studied invertebrates groups showed the predominance of species typical for open biotopes, including some heathland specialist. Thus, although recent heathlands in Pilsen region are very small, they represent a refuge for several rare and also endangered species of plants, lichens and invertebrates demanding specific conditions. The heathlands under electric lines, as the only larger and relatively stable stands, are therefore very important for the conservation of this biotope in western Bohemia (maybe in whole Czech Republic or central Europe).

Two examples of studied sites: a) heathland in the strip under the electric lines; b) vanishing heathland (being swallowed by *Calamagrostis epigeios*).

P12 - Invertebrates of heathlands in western part of the Czech Republic

Ivana Hradská and Ivo Těťál
The West Bohemian Museum in Pilsen, Department of Zoology, Pilsen, Czech Republic.

In the frame of the research of heathlands in the western part of the Czech Republic (see poster by Peksa & Pecháčková: Heathlands – the endangered habitat of the Czech Republic), we have performed the survey of invertebrates. The research was carried out in the years 2011 and 2012. Altogether 20 localities were chosen in the altitude of 360–720 m. The invertebrates were collected by using pitfall traps. In each heathland, there were three traps placed in the study plot of 5×5 m. Overall, there were 60 traps installed which were culled every month from May to November. Several groups of invertebrates were studied, here we present the first results regarding spiders (Araneae) and ground beetles (Coleoptera, Carabidae).

The spiders are usually used as bioindicators of the preservation of a specific area. For this purpose, in the Cataloque of Spiders of the Czech Republic (Buchar & Růžička 2002), they were categorized based on all faunistic data available into species living it these habitats: climax – habitats minimally infuenced by man´s activities, inhabited predominantly by K-strategic species; semi-natural – secondary habitats inhabited by species with broader ecological valency; disturbed – habitats with a high, permanent degree of disturbance, usually inhabited by r-strategic, pioneer species.

In total, 4175 specimens were determined (mostly epigeic) in adult and subadult stages. Roughly 80% of the species are spiders of secondary habitats, 12% of disturbance habitats and only 8% of climax habitats – the last group includes species typical for open habitats such as forest-steppes or peatbogs. The most interesting findings are following: *Evansia merens* (Linyphiidae) living in the nests of ants *Formica fusca* and *Formica sanguinea*, *Walckenaeria monoceros* (Linyphiidae), *Episinus truncatus* (Theridiidae), *Arctosa lutetiana* (Lycosidae), *Evarcha laetabunda* (Salticidae), *Micaria dives* (Gnaphosidae), *Pardosa bifasciata* (Lycosidae). On the contrary, the most frequent species was *Xerolycosa nemoralis* (Lycosidae).

Carabids are also used as a model group for bioindication changes in the environment. For this purpose, Hůrka et al. (1996; Klapalekiana 32: 15–26) classified all species and subspecies reported from the Czech Republic to three basic groups according to their ecological demands and attachment to habitat: group R (relict species) – the species with small ecological valency, often relicts; group A (adaptable species) – the species colonizing habitats close to natural; group E (eurytopic species) – species with no specific requirement to the environment.

In total, 2148 specimens of ground beetles were recorded, belonging to 93 species, from which 53% belong to the group A, 42% to the group E and 5% to the group R. The most interesting species are following: *Amara pulpani*, *Bradycellus ruficollis*, *Cymindis axillaris*, *Cymindis vaporariorum*, *Masoreus wetterhalli*, *Notiophilus germinyi* and *Olisthopus rotundatus*. These species (mostly of the group R) are typical for open xerothermic habitats, heathlands or edges of peatbogs. The most frequent species *Poecilus cupreus cupreus* and *Pterostichus niger niger* were detected in all localities. The species *Carabus arvensis arvensis* was relatively abundant in study area in comparison with the rest of the Czech Republic (it was detected in 50% of study localities).

Alopecosa schmidti – interesting finding of rare thermophilous species. Photo R. Macek

Pellenes tripunctatus occurs rarely in heathlands in western Bohemia. Photo R. Macek.

P13 - Lichens of Heathlands in the City of Toruń and Wielka Nieszawka Commune

Edyta Adamska
Faculty of Biology and Environment Protection, Department of Plant Taxonomy and Geography
Nicolaus Copernicus University, Toruń, Poland.

Lichens growing on heathlands are an important and integral element of these communities. Those are mostly terricolous species, but also species growing on other substrates, e.g. on thalli of other lichens. Lichens of heathlands located in urban areas are of particular interest as they are exposed to major anthropopressure associated with air pollution and spatial development – building of housing estates, roads etc. Also contamination of the soil surface by illegal waste disposal and illegal landfill sites constitutes a serious problem in these areas. Heath lichens are a group of organisms with specific habitat requirements – heliophilous species and species growing on dry and trophic-poor habitats. Due to elevated trophic conditions and the ongoing eutrophication process in urban areas, the biota of terrestrial lichens has been impoverished. Lichens are sensitive indicators of changes in habitat conditions, which is widely used in lichenoindication methods applied in urban and industrial areas worldwide. Lichens of heathlands may also be considered as indicators of these changes. For example, *Diploschistes muscorum* abundant in the studied area and known for its capability to accumulate large amounts of heavy metals, is regarded as an indicator of this type of contamination.

Toruń is a particularly interesting city because of the availability of such habitats as heaths, and consequently the biota of the city and its biodiversity were enriched with species rarely associated with urban lichens. One of the most interesting Toruń sites with lichens associated with heathlands is located under an electric traction running along the Łódzka street and is represented by bearberry heaths (classified as *Arctostaphylo-Callunetum*) (Fig. 1).

The city of Toruń is situated in Poland between 52°58’ and 53°04’ of north latitude and between 18° 32’ and 18°43’ of east longitude. Within the current administrative limits, the city covers an area of over 115 km^2 and has 191 227 inhabitants. The city is situated on the river terraces and dunes.

The present project aims at describing the biota of mainly terricolous lichens on the heathlands located in Toruń and the adjacent Wielka Nieszawka Commune. The research on lichens was conducted mainly in the city of Toruń from 2006 to 2010. The data on lichens come from my own research and literature. Due to the availability of habitats and substrates, terricolous species dominate here, mainly from the genera *Cladonia* and *Cetraria* (Fig. 2).

Peltigera canina, Polyblastia agraria, Rinodina conradii and *Stereocaulon condensatum* are one of the most interesting species occurring in the study area as they are rare, endangered and protected in Poland.

Figure 1. Heathlands along the Łódzka street. Photo Adam Adamski - www.Adamscy.pl

Figure 2. *Cladonia macilenta*. Photo Adam Adamski - www.Adamscy.pl

P14 - A new method to reduce Purple Moor-Grass *Molinia caerulea*

Hans Jørgen Degn
Degn's NaturConsult, Ringkøbing, Denmark.

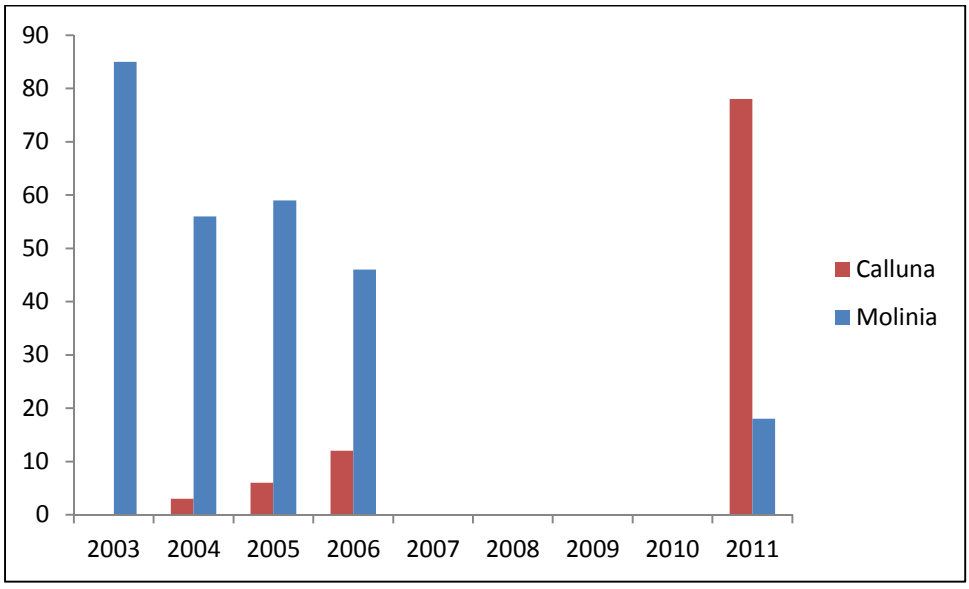
The idea: Is it possible to change competition in favour of *Calluna vulgaris* by removal of aboveground biomass of massive Purple Moor-Grass *Molinia caerulea*?

The factual background: Aerts (1989) has shown that aboveground biomass of *Molinia* as well as content of phosphorus (P) and nitrogen (N) in the leaves decrease from around the start of September.

The starting point:
85 % Purple Moor-Grass *Molinia caerulea*
13 % Wavy Hair-grass *Deschampsia flexuosa*
0 % Heather *Calluna vulgaris*

The action: For 3 successive years 2003-2005 the green biomass was cut and removed in the first part of August.

The results:



P15 - Effects of seed production and germination ability of overmature *Calluna vulgaris*-stands in a continental bioclimatic region

Katrin Henning[1,2], Sabine Tischew[1] and Goddert von Oheimb[2]
1; Anhalt University of Applied Sciences, Bernburg, Germany.
2; Leuphana University of Lüneburg, Lüneburg, Germany.

Calluna vulgaris-dominated heaths and their associated plant communities such as dry basophilic grasslands are widely recognized to be of high conservation value. Currently they are affected by a sharp decline due to the abandonment of traditional and often cost-intensive management. This results often in an overaging of heath and the disappearance of earlier age stages of *Calluna vulgaris*. For that reason, the effects of seed production and germination ability of overmature *Calluna vulgaris* were studied in a continental, summer dry region in Saxony-Anhalt – the "Oranienbaumer Heide".

As a hypothesis, it is assumed that the limited generative regeneration is due to the low seed production and / or the low germination rate of the mostly overmature heath in the "Oranienbaumer Heide".

Therefore seed production per square meter was estimated in overmature *Calluna*-stands by collecting all flowering shoots in 96 quadrants (0.25 m^{-2}) at the time of the highest seed maturity.

Germination experiments were carried out in the laboratory over 3 month. Seeds were collected from different age stages of *Calluna vulgaris* (building-, optimal-, degenerate phase) in the "Oranienbaumer Heide". Half of the seeds were exposed to an 8-week cold period; the other half was stored at 15 °C. Seeds were sowed on moist filter paper inside plastic boxes with plastic covers, which were placed in a growth chamber with a day temperature of 20 °C / a night temperature of 10 °C and a photoperiod of 12 h light / 12 h darkness.

The seed production of overmature *Calluna*-stands was extremely variable, ranging from 139 639 to 760 451 seeds m^{-2} (average: 340 770 seeds m^{-2}). Thus, the calculated values of the overmature *Calluna*-stands can be compared with those from the literature (e.g. 80 000-800 000, Miller 1979; 400 000, Miller & Cummins 1981).

The germination experiments showed no significant correlation between age stages of *Calluna vulgaris* and germination ability of seeds (Table 1). In addition, the cold period did not affect germination. Overall, the germination rates correspond with the data in the literature (e.g. more than 70 %, Gimingham 1972).

Table 1. Germination rates of *Calluna vulgaris* depending on the age stages and cold treatment (n=96). Standard deviation is given in parentheses.

Age stage	Germination rate (%)	
	without cold period	with cold period
Building phase	66.3 *(9.1)*	78.2 *(12.9)*
Optimal phase	73.3 *(5.5)*	72.3 *(8.9)*
Degenerate phase	69.3 *(8.4)*	62.7 *(7.8)*

Therefore, the limited generative regeneration did not result from the mostly overmature stands in the study area. Other reasons, such as climate change, especially lower spring and summer precipitation, or a lack of bare ground caused by small-scale disturbance-events must be considered and will be studied in the future.

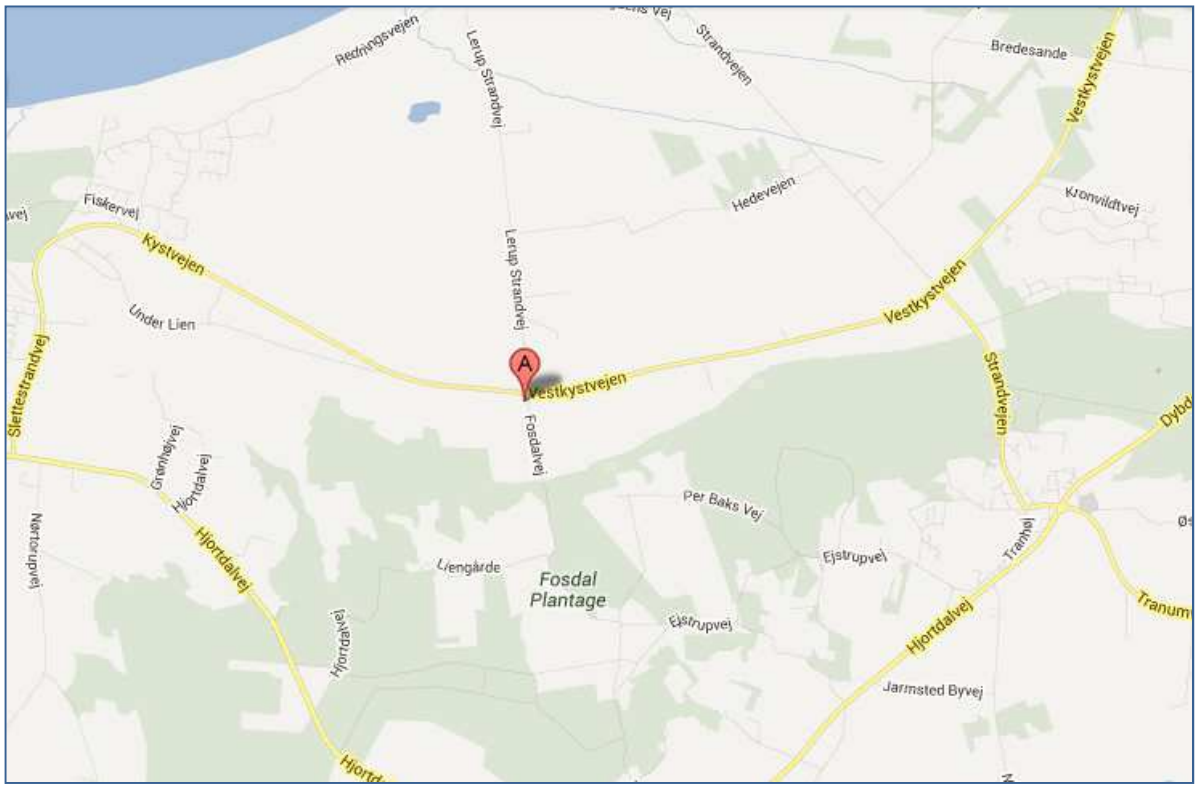
Excursions

Fosdalen

Meeting point;
Naturcenter Fosdalen - Fosdalvej 69, 9460 Brovst.

Guides;
Marianne Fisker (mkf@jammerbugt.dk) Jammerbugt Municipality
Svend Møller Nielsen (smn@jammerbugt.dk) Fosdalen Naturskole, Jammerbugt Municipality

Keywords;
Lien, grazed heathland, wet heath meadow, conservation, chalk-loving plants, inland cliff and dunes.



From; maps.google.dk

The workshop venue is located in the northwestern part of Jutland close to the sea. The plain along the coast is elevated seabed. Inland, the old coastal line is dominated by 'Lien' – Denmark's largest inland cliff (60 m).

5000 years ago, the Littorina Sea reached the foot of the cliff. Today, the old coastal cliff is situated several kilometer inland. The excursion will go to the mouth of the gully "**Fosdalen**". Originally, the whole of Fosdalen was intensively grazed heathland, and it was decided to preserve the valley in this condition in 1902 by a conservation action. Consequently, grazing ceased and most of the valley developed into closed deciduous forest. The grazing will be sought re-introduced, and at the same

time tree encroachment on the nearby heaths will be removed, thereby creating better conditions for the rare chalk-loving plants.

The lower section of Fosdalen is still open, and many beautiful stretches of heathland remain with inland dunes characterized by species such as *Calluna vulgaris*, *Juniperus*, *Arctostaphylos uva-ursi, Vaccinium myrtillus* and *V. vitis-idaea*. On the fells *Cornus suecica* is common, and the Rødland heath has a large population of *Arnica montana*. Drevelsvig heath slopes down towards a wet heath meadow with *Salix*, *Myrica*, *Erica tetralix*, and *Narthecium ossifragum*.

Arnica montana

Hulsig dune heath, Råbjerg Mile and Skagen

Guides;
Bjarke Huus Jensen (bjhje@nst.dk) Danish Nature Agency, Vendsyssel
Ib Johnsen (ibj@bio.ku.dk) University of Copenhagen

Keywords;
Dune heath, natural processes, management, flora and fauna, Marsh Fritillary

The first stop is at Lodskovvad (Fig. 1.1) - a Marsh Fritillary (*Euphydryas aurinia)* habitat which was restored as one of the habitats included in a LIFE project, ASPEAE. At the next stop we visit a dune heath under restoration from plantation to open heath and heathland managed by burning (Fig. 1.2). **Hulsig Hede** consists of vast and continuous dune and heathland with scattered wetlands under the strong influence of west winds (Fig. 1.4). **Råbjerg Mile** makes up the southern part of the area (Fig. 1.3). It is the largest migrating dune in Northern Europe and on the windward side of the dune an even plain has emerged with a distinctive environment with numerous ponds and dune slacks, where you find the Natterjack toad. On Hulsig Hede the dunes are subject to free migration dynamics and natural water levels and thus a rich and diverse flora and fauna. Many valuable dune habitats are found here, e.g. grey dunes (2130), humid dune slacks (2190) and active migrating dunes (2120). Also, alkaline fens (7230), oligotrophic waters (Littorelletalia uniflorae, 3110) and the rocky blowout area of Råbjerg Mile with rare lichens are important habitat types of the area. Rare grasses are abundant (*Koeleria glauca* and *Deschampsia setacea*), and red-listed plant species such as *Botrychium matricariifolium*, *Pilularia globulifera*, and *Euphrasia arctica ssp. Minor* are found here, too. Wood sandpiper, Common Crane and Red-backed Shrike are among the breeding birds. Extensive tree removal, starting in the mid-1990s, has stopped the threat posed by the immigration of pine from the nearby Skagen dune plantation. The natural dune and heath vegetation is back in the cleared areas, and so is the fauna associated with the open heath and dune areas. CNN just released a list of worlds 100 best beaches and no. 66 is Skagen strand and sourroundings due to the coast line, an artist colony from 1900, a landscape and milk white dunes, fairy tale forests and wind exposed beaches. Skagen is where the two seas Skagerrak and Kattegat meet (Fig. 1.5). The very tip is a sandy, shifting promontory known as 'Grenen'. It is fascinating to stand on the tip of Jutland and

the European mainland with a foot in each sea and watch the waves from the seas beat together and break the Skaw Reef.

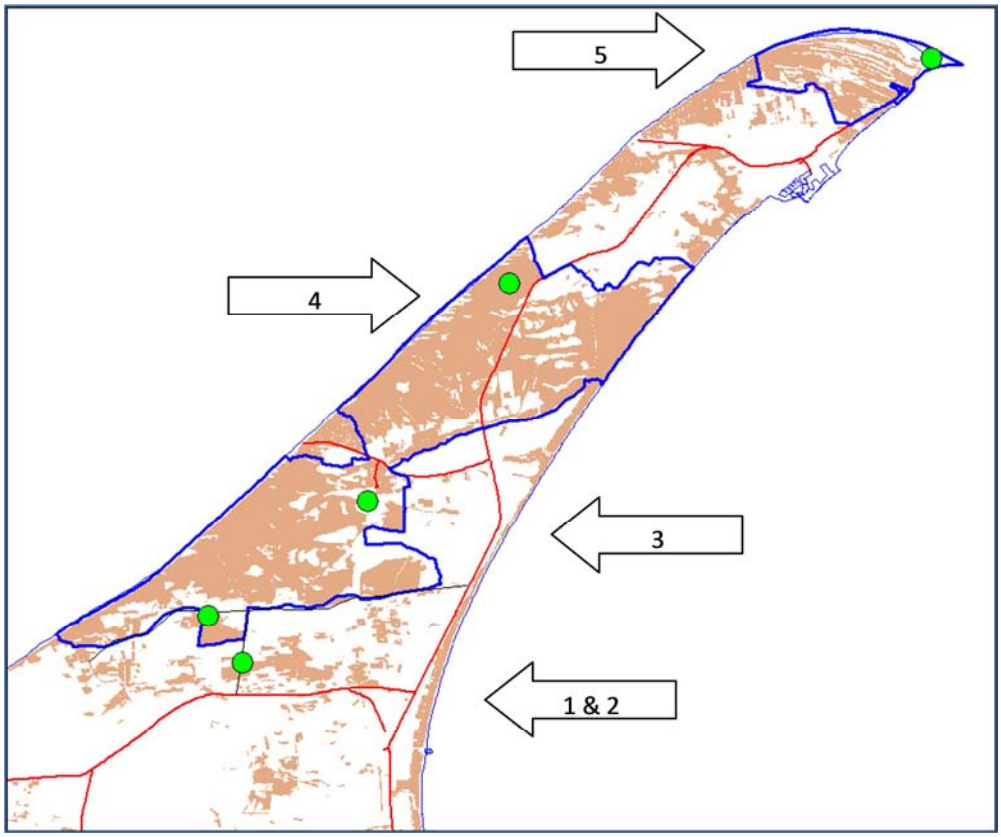


Figure 1. Map of the Northern part of Jutland

The migration dune Råbjerg Mile. The sand migrates in a parable shaped dune and leave a shallow lakes or wetlands behind.

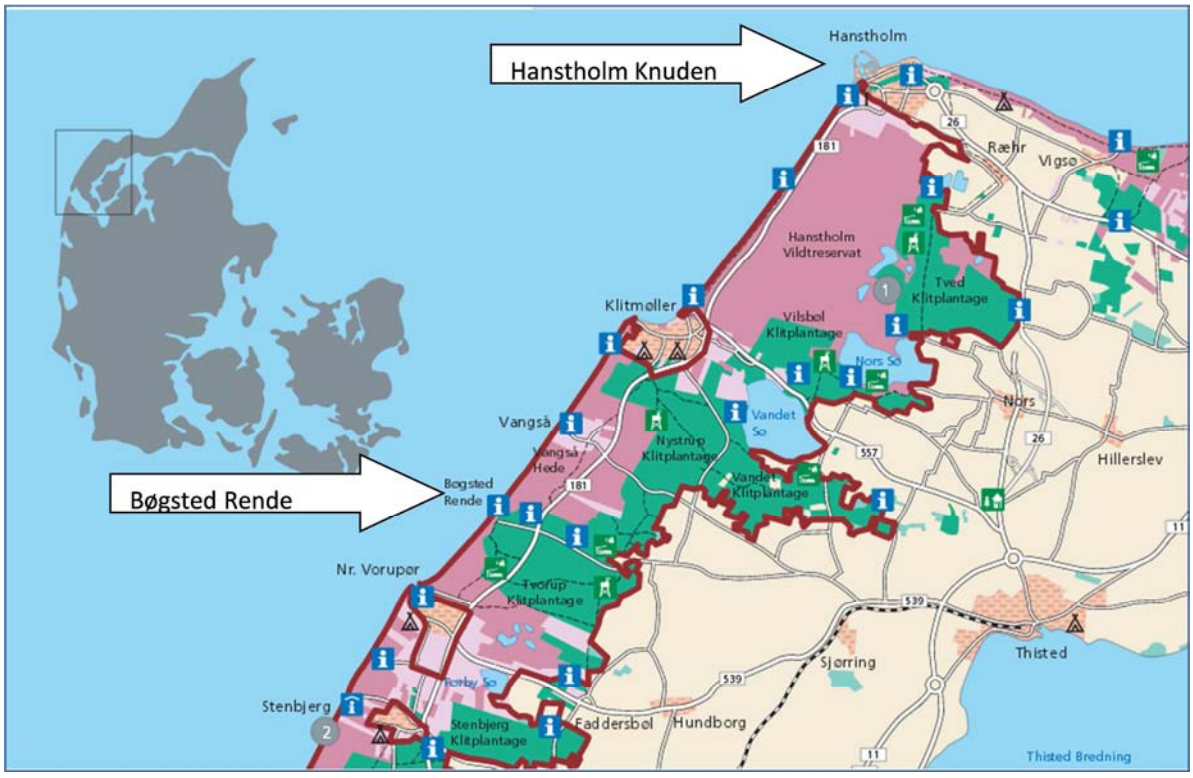
Thy National Park

Meeting point;
Hanstholm Knuden and Bøgsted Rende

Guides;
Else Østergaard Andersen (eloes@danmarksnationalparker.dk) Thy National Park
Signe Kappel Jørgensen (sikjo@danmarksnationalparker.dk) Thy National Park
Henrik Schjødt Kristensen (hsk@nst.dk) The Danish Nature Agency, Thy

Keywords;
National Park, Dune heaths restoration, coastal Limestone cliffs, dune plantation, *Rosa rugosa*, recreational use and protection.

On June 26th, we will go to **Thy National Park**. The west of Thy has been designated as the first Danish national park. It is a large and relatively unspoiled natural area totaling 244 km^2. The harsh wind and the drift of the sand on land are visible by the abandoned farmlands which today are dune heaths or plantations. All of this is a testimony of a time not too long ago, when life on the west coast was tough on the locals. In this exposed part of Denmark the weather and nature are constantly shifting, ranging from lashing wind by the coast, to stillness in the established forest habitat. The national park consists of coastline, dunes, dune heaths, dune plantations as well as great lakes and is tied together with minor extensive farm areas. The dunes and dune heaths are of great national and international importance.



The Northern part of Thy National Park.
http://www.danmarksnationalparker.dk/NR/rdonlyres/E2D664B1-16F3-46B2-A87E-C4DF5217DB4D/123080/10248Infolder_UK_010412.pdf

Thy National Park stretches for an up to 12-kilometer-wide belt along the west coast of Jutland from Hanstholm, past Nors lake, to the dune plantations of South Thy and Agger Point. Hanstholm is the headland at the furthest North West point of Jutland where the North Sea meets the Skagerrak. Over thousands of years, the former island became a mosaic of geological forms. In the stone age, Thy was a kingdom of islands. Subsequent land uplift over the last 5,000 years brought Hanstholm into close proximity with the rest of Thy. The Febbersted gorge east of Hanstholm is a famous haunt of botanists. The western slope is composed of chalky rubble and stone, and the vegetation is incredibly diverse. It includes some of Denmark's rarest species such as *Draba incana* which has survived here since the time when ice withdrew from the area. If you are lucky, you might find the *Euphrasia dunensis*, unique in the entire world to the Febbersted gorge and Bulbjerg. The slopes are grazed to achieve the best conditions for the growth of wild flowers.

Further south, the landscape is a mosaic of large plains - known as "blow out plains" - and massive dune formations. On the plains there are a large number of shallow lakes which often dry out in the summer. Eastwards, just below the coastal cliffs, is a ring of lakes whose waters can be up to 6 meters deep, as with Blegsø. Like the much larger Nors Lake, these bodies of water are karst lakes, with chalk bottoms. Most of the water flowing into these lakes comes from fissures in the carbonate rock. The drier dune heaths are dominated by *Calluna vulgaris*, *Empetrum nigrum*, *Carex arenaria*, *Ammophila arenaria* and lichens. Rare species such as *Calystegia soldanella* and *Ligusticum scoticum* appear on coastal dunes and damper depressions support *Vaccinium uliginosum*, *Myrica gale*, *Molinia caerulea*, *Erica tetralix*, *Gentiana pneumonanthe*, *Vaccinium oxycoccos* and several species of *Drosera*. Many of the shallow lakes harbour species of *Littorelletalia uniflorae*, whilst the deep, pure water of Nors Lake features rich flora including many species of *Characeae* and the very rare *Najas flexilis*.

The east side of Agger Point, the sheltering effect of the point has allowed new land to form with marshes and canebrakes. The shallow lagoons, reeds areas and tidal flats are valuable breeding and foraging areas for many species of waterbirds.

In 2013, Thy National Park has also been the place of the first sensational observations of wolf in Denmark in 200 years!

Foto: Henrik S. Kristensen

Kongenshus Heath

Meeting point;
Kongenshus Hotel, Vestre Skivevej 142, Daugbjerg, 8800 Viborg

Guides;
Torben Riis Nielsen (trni@life.ku.dk), University of Copenhagen
Inger Kappel Schmidt (iks@life.ku.dk), University of Copenhagen

Keywords;
Dry lowland heath, sheep grazing, glacial landscape formation

From; maps.google.dk

On the first day of our two-day excursion, we will go to Kongenshus heath and Mols Bjerge. First stop is Kongenshus heath. Kongenshus Hede is a 1,2 km^2 heath situated at an outwash plain from last glaciation formed in front of the ice front 12-15,000 years ago, where sand and gravel was deposited by the water. The "terraces" seen at Kongenshus Heath was formed as the great glacial streams changed their outflow. It is traversed by glacial gorges. The heath at Kongenshus was part of the large "Alhede", which was a royal game preserves once covering about 50 km^2. In 1723/1751 King Frederik V promised tax exemption and exemption from military services for farmers who cultivated the heath at Kongenshus. After many years under miserable conditions more modern techniques Most of the formerly widespread heath is converted into modern agriculture or coniferous plantation. In 1953, a conservation action protected the last 1200 ha. It was turned into a memorial park with engraved stones with 1200 names of the first moorland farmers who struggled to make a living out of the poor soil.

The heath gives a glimpse of the widespread heath plains and the prehistoric glacial landscape. We will walk to Stabelbakkerne and overlook the valley of Karup river and eat lunch.

The heath is fenced and grazed by sheep. Management also includes mosaic burning and cutting of the heather. The present heathland was once a mixed deciduous forest with oak, which was cleared for timber and firewood. Today's vegetation is dominated by *Calluna vulgaris* with the typical distribution of *Arctostaphylos uva-ursi* on dry south facing slopes, *Vaccinium myrtillus* on north facing slopes and *Empetrum nigrum* and *Vaccinium vitis-idaea* on more moist locations can be found. Close to Kongenshus Hotel are old fields, which were cultivated in 1754 and farmed for about 50 years. A special flora with *Arnica Montana* and *Antennaria dioica* and several species of orchids can be found in the old fields.

Mols Bjerge

Meeting place;
Molslaboratoriet, Strandkærvej 6, Femmøller

Keywords: National Park, grazing and climate change

Nigel Webb and Henning Petersen (former head of Molslaboratoriet) will meet us here.

Molslaboratoriet is a field station under the National History Museum in Aarhus. The farm was given to the Museum to be used for research in the heathland farming. It has been a center for research in terrestrial ecology since 1941. Research in conservation management of heath and permanent grassland was initiated in 1971. Herds of Galloway cattle and of Icelandic sheep were purchased for grazing experiments. The Galloway is still in the management of the area and in long term studies of grazing impact.

By Danish standards, Mols Bjerge has a dry sunny climate, and light- and warmth-demanding species that are normally found further south are typical of Mols. *Putsatilla*, *Viscaria Vulgaris* and *Helichrysum arenarium* grow on the sandy, dry and sunny hills and slopes.

A large part of the plantations have been cleared to restore an open landscape with heath and permanent grasslands partly financed by a LIFE project: Restoration of dry grasslands in Denmark.

INCREASE/VULCAN long term climate experiment

14:30 A short walk to a climate change experiment, and to grazing experiment at Buelund

Guides;
Inger Kappel Schmidt (iks@life.ku.dk) Geosciences and Natural Resource Management, Denmark
Johannes Ransijn (jran@life.ku.dk) Geosciences and Natural Resource Management, Denmark
Rita M. Buttenschøn (rmb@life.ku.dk) Geosciences and Natural Resource Management, Denmark
Jon Buttenschøn (jon@fvst.dk) Ministry of Food, Agriculture and Fisheri, Denmark

In Mols Bjerge, the climate has been manipulated in experimental plots since 1999. We create night-time warming and extended summer drought by automated curtains. The heat is kept in the ecosystem at night with reflective curtains increasing the minimum temperature. The rain input is reduced during the summer with transparent curtains. The curtains are automatically controlled by light and rain sensors. We compare the results from the heat and drought plots with control plots without curtain cover to compare with ambient conditions.

Similar experiments are installed in Spain, Italy, Hungary, The Netherlands and Wales. The experiments are part of the European research network INCREASE coordinated by Inger Kappel Schmidt, University of Copenhagen. Within this network of climate change experiments, we measure ecosystem processes and functioning in a future climate including growth and adaptation of plants and animals, decomposition of dead plant material in the soil, emission of green-house gasses and leaching of elements to the ground water.

Main results from the plant surveys show that the strongest effects of climatic change are related to interactions with extreme events and biotic interactions. Drought, and to a minor extent warming had minor direct effect on *Calluna vulgaris*, where it affected both susceptibility to and recovery from heather beetle outbreaks. This decreases the resilience of the system. The results indicate that the future climate scenarios for Denmark with prolonged summer drought will change the distribution range of *Calluna vulgaris*.

The research facilities are open and shorter stays at the sites are supported for external scientists to conduct climate change research (see homepage for application form www.increase-infrastructure.eu).

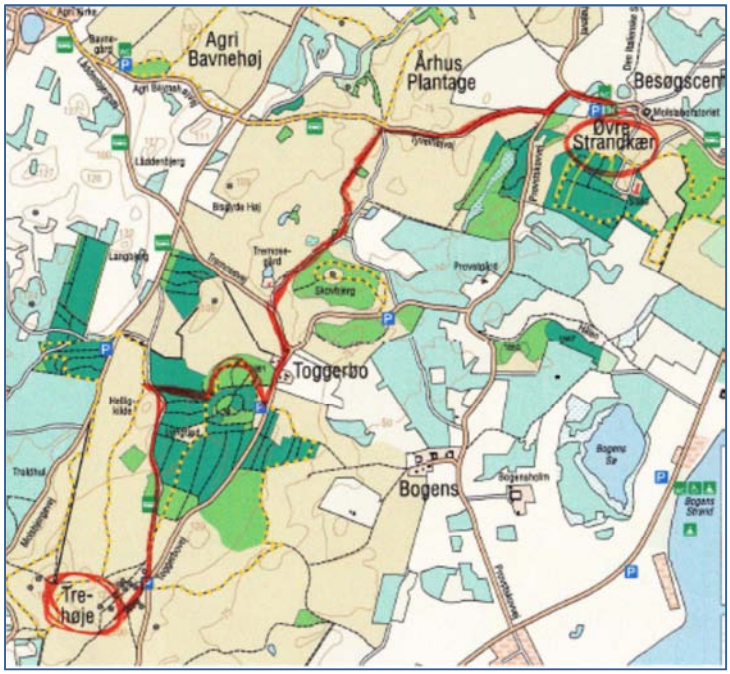
Buelund – grazing experiment

Buelund is a mixed heathland/grassland. It has a prehistory within the heathland farming system of the region, where the land was arable for two or three seasons followed by up to three decades of grazing between arable periods. Buelund remained arable until 1959 and was completely abandoned from 1959 to the start of the studies in In Mols Bjerge, where part of it was grazed by Galloway and part of the area continued as abandoned land.

Buelund; Rita Merete Buttenschøn

15:30 Introduction to Mols Bjerge National Park in the National Park information Center (Øvre Strandkærgård) and a walk (about 3,5 km) through the central part of the national park to Trehøje

Guides;
Kim Egefjord (kfe@nst.dk) Danish Nature Agency, Kronjylland
Søren Rasmussen (sra@nst.dk) Danish Nature Agency, Kronjylland



Mols Bjerge National Park
Mols Bjerge was designated as the second Danish national park in 2009. Mols Bjerge is a hilly moraine landscape covered by heaths and permanent grasslands, plantations and oak woodlands, bogs, and marshes. The area is about 30 km^2 and of great national importance due to unique landscape and geology. The landscape varies with its large ranges of hills that rise up to 137 meters above sea level, the highest points being Agri Bavnehøj and Trehøje. All topped by Bronze Age burial mounds. There are also several kettle holes.

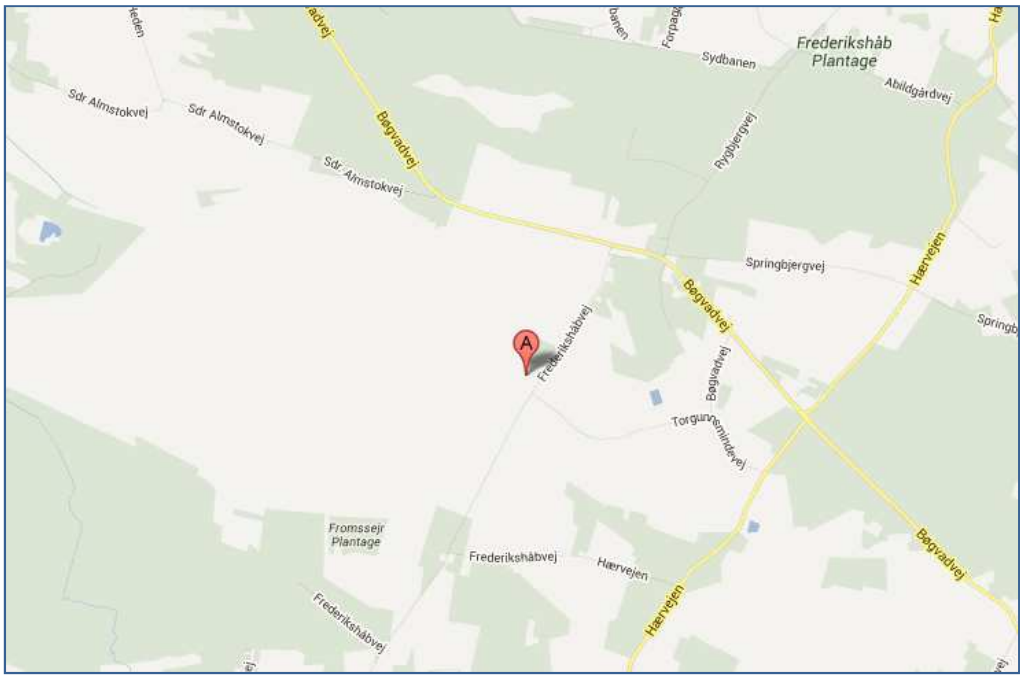
Trehøje; Rita Merete Buttenschøn

Randbøl Hede (Heath)

Meeting point;
Kristinelyst, Frederikshåbvej 41, 7183 Randbøl**.**

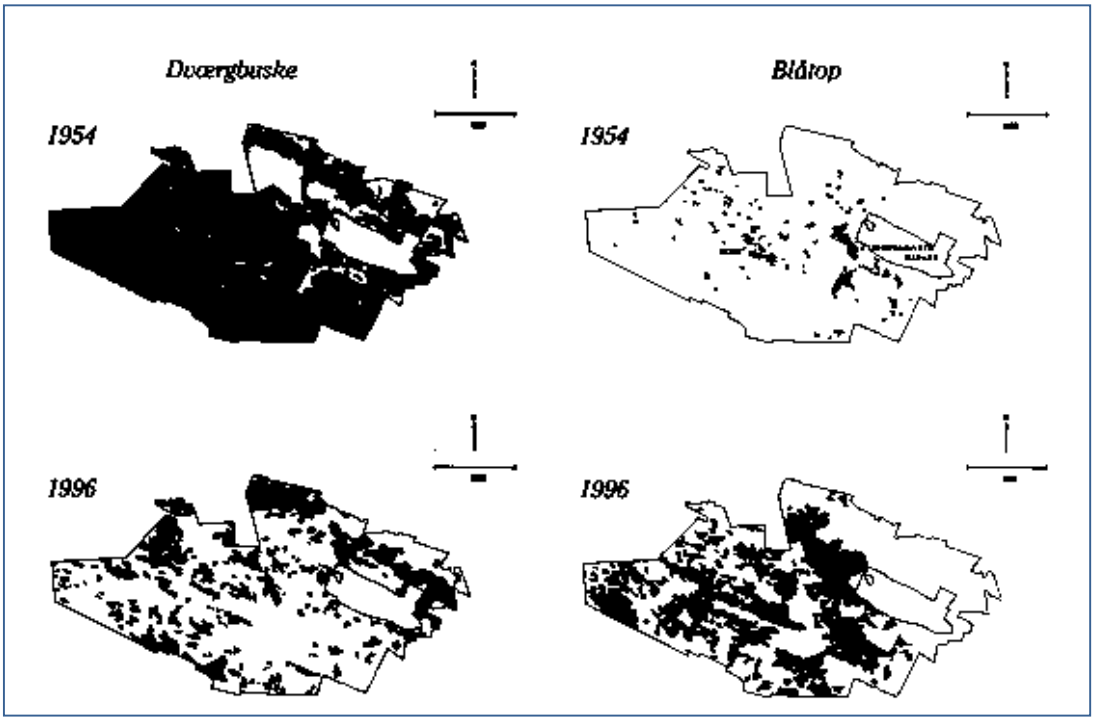
Guides;
Inken Breum Larsen (inb@nst.dk) The Danish Nature Agency, Trekantsområdet.
Claus Simonsen (csi@nst.dk) The Danish Nature Agency, Trekantsområdet.

Keywords; Heathland management, Molinia caerulea



From; maps.google.dk

On the last day, our excursion takes us to Randbøl Hede, about 800 ha of heathland on inland dunes primarily owned by the state. Randbøl Hede was designated conservation area in 1932. It is surrounded by plantations and agricultural fields. The largest dune, Stoltenbjerg, rises 88 m above sea-level. Since the protection, which stated that the heathland should be left untouched, the area has developed from heather dominated heathland to grassland, meinly purple moor grass (*Molinia caerulea*), partly due to lack of management (Fig. 1). Different management methods to control *Molinia* were tested in a project "Management of *Molinia caerulea*" (Buttenschøn at al. 2003 and 2005).



Figur 1; Dværgbuske = dwarf shrub and Blåtop = *Molinia caerulea.* From Degn, H. J. (1997).

A large-scale management program has been established at Randbøl Hede as part of a LIFE project "Restoration of Atlantic heaths dunes in Denmark". Six heathland sites of Community Importance are included in the LIFE project, covering a project site surface of 6566 ha. 8 Different conservation actions are planned at an area of 2304 ha. More actions might take place at the same area.

The actions include:

- Clearing of woody species
- Removal of upper peat soil layer
- Milling of existing and potential heathland habitats dominated by Purple Moor Grass
- Harvest of the heathland vegetation on existing and potential heathland habitats
- Controlled burning on existing and potential heathland habitats
- Historically heathland cultivation on potential heathland habitats
- Acquisition of 60 head of cattle and establishment of grazing on existing and potential heathland habitats
- Restoration of natural hydrology
- Restoration and improvement of potential and existing breeding habitats of Wood Sandpiper and Nightjar

Photo: RMB

The main objective is to improve the conservation status and when possible also increase the heathland areas of Dry sand heaths with *Calluna* and *Genista* (Code 2310), Dry sand heaths with *Calluna* and *Empetrum nigrum* (code 2320), Indland dunes with open Corynephorus & *Agrostis* grassland (code 2330), Northern Atlantic wet heath with *Erica tetralix* (code 4010), European Dry Heaths (code 4030) and *Juniperus communis* formations on heaths (code 5130). The project period is from 2010-2016.
http://www.naturstyrelsen.dk/Naturbeskyttelse/Naturprojekter/Projekter/Vestjylland/LIFE-Hede/English/

References

Buttenschøn, R.M., Degn, H.J. & Jørgensen, S. 2003: Management of Molinia caerulea. Preliminary result from management experiments on Randbøl Hede, Jutland. Abstracts of talks. 8th. European Heathland Workshop 3rd.-11th. July 2003. Camp Reinsehlen, Germany. Pp. 16-20

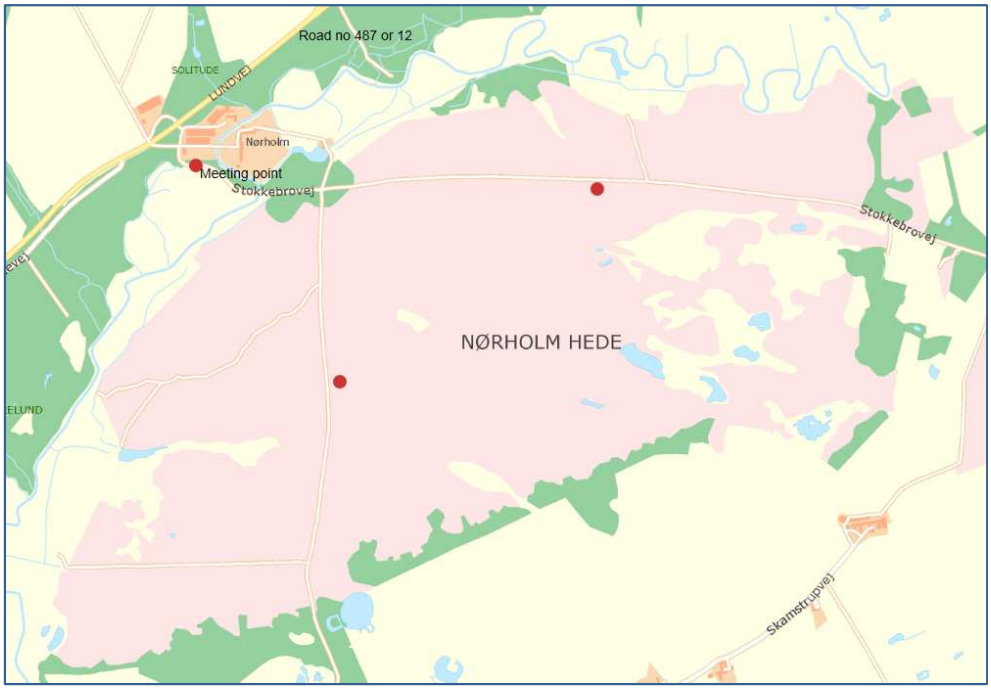
Buttenschøn, R.M., Degn, H.J. & Jørgensen, S., 2005: Bekæmpelse af blåtop på Randbøl Hede. Arbejdsrapport 9-2005, Skov & Landskab. www.sl.life.ku.dk.

Degn, H.J., 1997: Ændringer i vegetationen på Randbøl hede 1954-1995. Flora of Fauna 2, 25-46.

Nørholm Hede

Guides;
Inger Kappel Schmidt, iks@life.ku.dk, University of Copenhagen
Torben Riis-Nielsen, trni@life.ku.dk, University of Copenhagen
Karl Nielsen: Nørholm Gods, Stokkebrovej 3, 6800 Varde, owner of Nørholm Hede

Keywords;
Dry and wet lowland heath, succession on abandoned heathland, former land use, management or natural dynamic



Nørholm Hede (Heath) is situated in the south-western part of Jutland, Denmark about 20 m above sea level. The western part of the heath was cultivated by traditional heathland farming until 1870 whereas the rest was grazed by sheep and cattle until about 1890. Since then, the 350 ha. heathland has been left for free succession. In 1913, the owners initiated a conservation action at the heath to preserve “the picture of wide heathland” and keep it without human influence. The soil consists of fluvioglacial sand with a drift sand layer on top in the eastern part. Most of the heath consists of dry and wet lowland heath (4010 and 4030). Temporary lakes, fens and bogs are present due to insufficient drainage cause by iron pans in the eastern part of the heath. Pollendiagrams from nearby deposits indicate that heathland vegetation started dominating between 2000 and 1000 BC (Odgaard, 1994).

Nørholm Heath and surroundings have been appointed NATURA2000 habitat mainly due to dry and wet lowland heaths (4010 and 4030), which conflicts with the conservation action including no management.

The succession from heather dominated heath over crowberry heath or grass dominated heath towards forest has continued without human interference for about 120 years. Forest & Landscape (now Department of Geosciences, University of Copenhagen) initiated a survey in 1921 to study vegetation changes and forest succession on the heath.

The research on Nørholm Hede includes:

1. Vegetation on the heath has been studied in permanent vegetation plots, see abstract T19.

2. Colonization of trees has been followed in a permanent grids since 1921. The grid covers all 350 ha. of the heath and has been analysed 10 times since 1921.

3. Vegetation maps have been produced covering all 350 ha. of the heath in 1922 and 1995.
Deer were exterminated in the 19th century, but the deer population increased steadily after the first observation of row deer in 1900 and today's population includes both roe deer and red deer exerting large impact on the establishment of, especially, deciduous trees.

The different outcome of the succession may to a large extent be related to former land-use. The results show no clear correlation between vegetation changes and the increase in atmospheric nitrogen deposition as experienced since 1950 as it is commonly suggested. The decrease in lichen abundance or the increase in grass abundance occurred before the increase in N-deposition. The succession pattern may rather be a direct consequence of the lack of grazing and therefore be mainly explained by natural succession. Nevertheless, increased atmospheric N-deposition may be an important driver as it increases the frequency of heather beetle attacks and as such triggers the observed changes in species composition. This is the case on nutrient poor heathlands in the westernmost part of Denmark.

The photo to the left shows the extensively grazed part of the dry heath (out-fields), whereas the photo to the right shows the old cultivated area (in-fields). Photos: Inger Kappel Schmidt

A plant species list from the surveys is available on page 172-181 in the book Riis-Nielsen, Schmidt IK, Frandsen B, Binding T. (2005) Nørholm Hede -En langtidsundersøgelse af hedens vegetationsudvikling og tilgroning. Forskningsserien. Skov&Landskab, KVL. Book. 210 pp.

http://curis.ku.dk/ws/files/20544019/flr35.pdf

http://www.fugleognatur.dk/lokalitet.asp?mode=unik&ID=26300

General informations

Venues

23-27 June 2013

Holiday Center Slettestrand
www.slettestrand.dk
Slettestrandvej 140
DK-9690 Fjerritslev
+45 9821 7044

27-28 June 2013

Fuglsøcentret close to National Park Mols Bjerge
www.fuglsoecentret.dk/english.html
Dragsmurvej 6
DK-8420 Knebel
+45 8635 1355

Internet

Wireless internet is available at both venues. More details will be provided upon arrival.

Speakers

Speakers should make sure to upload the presentation during breaks prior to their talk.

Posters

Poster presentation should be put up Sunday evening or Monday morning so they are ready for the poster session Monday after lunch. Please remove your poster Wednesday evening. Authors should be available during the poster session to answer questions and take part in the discussion.

Transportation

Several participants arrive in cars. During the excursions Monday-Wednesday, we kindly ask you to use the common busses as parking may be a problem at several locations.

Contact info

Rita Buttenschøn +45 2020 6317
Inger Kappel Schmidt +45 2245 8976
Johannes Ransijn +45 5018 5991