

GEO PARK

V E S T J Y L L A N D

MAIN APPLICATION DOCUMENT



**APPLICATION FOR GEOPARK WEST JUTLAND
TO BECOME A UNESCO GLOBAL GEOPARK**

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A. IDENTIFICATION OF THE AREA

A1 Name of the proposed Geopark

The name of the proposed geopark is Geopark West Jutland – Geopark Vestjylland in Danish.

The geopark covers the areas of the three municipalities of Lemvig, Struer and Holstebro and a part of the North Sea out to the Jutland Reef as well as a part of the Limfjord.

The phrase West Jutland is traditionally being used to describe a much larger area south of the Limfjord, west of the Jutland Ridge and north of Kongeåen and sometimes areas further to the north and south are also included. Thus, the geopark is only a part of this wide understanding of West Jutland but nevertheless the name has been chosen as the brand for the geopark because it very

quickly gives people an understanding of which part of the country is being referred to. More importantly, it also gives many people a sense of some of the qualities of the area such as open landscapes, coasts, hardy people that talks with a dialect, wind, sand and lots of space.



Fig. A1 Standard UN-map with the location of Geopark West Jutland

A2 Location of the proposed Geopark

Geopark West Jutland covers the three municipalities Lemvig, Struer and Holstebro in the Central Denmark Region, a part of the Limfjorden and extends about 50 km offshore into the North Sea to include part of the Jutland Reef.

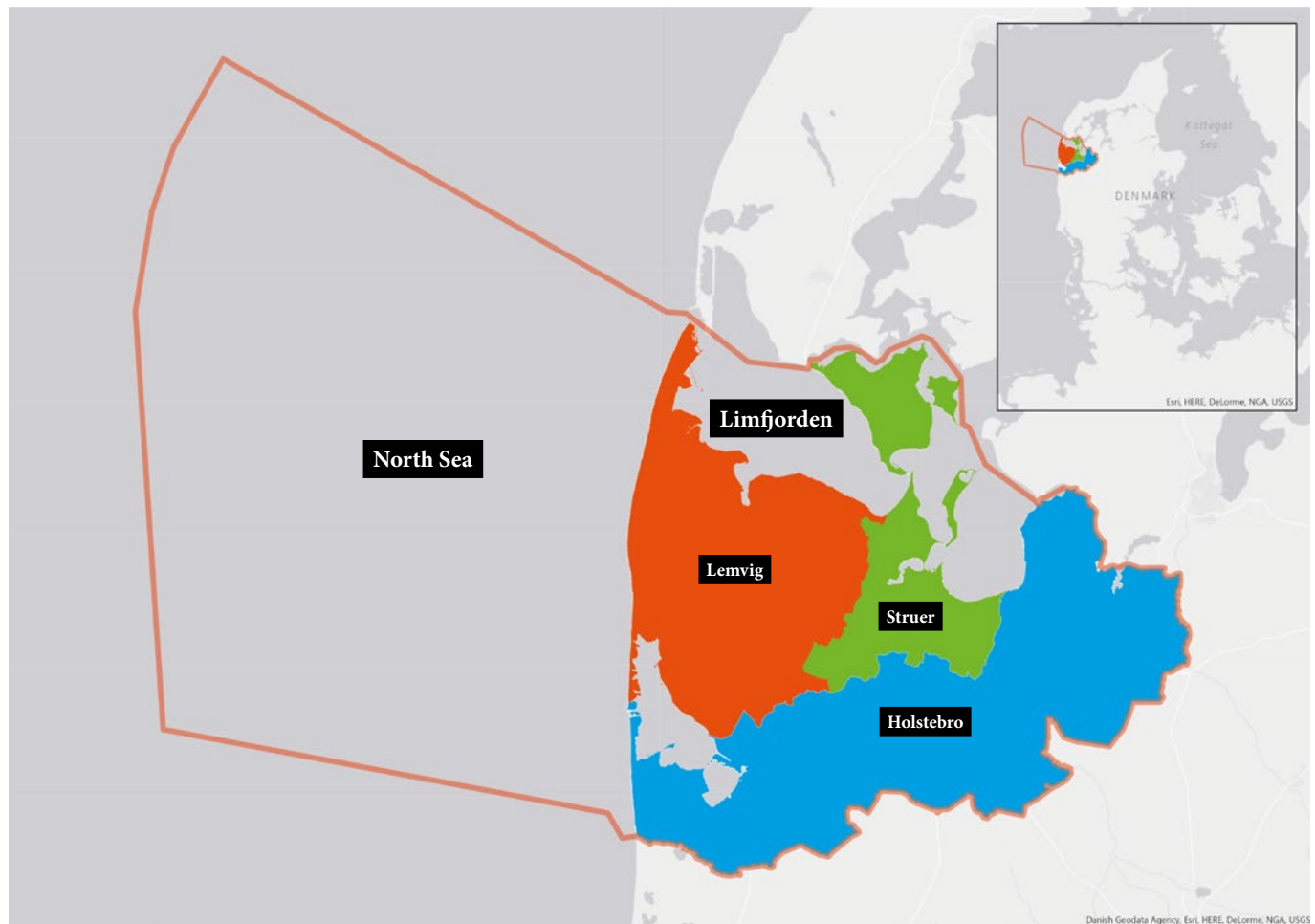


Fig. A2 Map of Geopark West Jutland with the three municipalities Lemvig, Struer and Holstebro

Position	Latitude/Longitude
Northwest corner	56°56'10,3562" North 7°28'35,3907" East
Southwest Corner	56°21'25,7119" 7°22'53,2419"
Northeast Corner	56°29'29,9476" 8°58'49,5268"
Southeast Corner	56°16'54,3436" 8°44'16,9695"

Fig. A3 Positions of the “corners” of the geopark.

A3 Surface area, physical and human geography characteristics of the proposed Geopark

Surface Area

Geopark West Jutland has a total area of 4,759 km². Of this, the land area makes up 1560 km², marine areas in the Limfjord covers 425 km² and marine areas in the North Sea covers the remaining 2,775 km². To the south the Geopark borders on the municipalities Ringkøbing-Skjern and Herning, to the east the municipalities Viborg and Skive and to the north the municipality of Thisted. The coastline along Limfjorden is 168 km long and the coastline along the North Sea to the west is 50 km long. In total Geopark West Jutland has a coastline of 218 km and a 124 km long border to neighboring municipalities.

Major lagoons and lakes in the geopark are:

- Nisum Fjord (70 km²)
- Ferring Sø (3.2 km²)
- Kilen (3.34 km²)
- Flyndersø (4.18 km²)
- Stubbergård Sø (1.5 km²)

A section of the river Storå, which is the second longest river in Denmark with a total length of 104 km, winds across the geopark from east to its outlet in Nisum Fjord to the west. To the east the geopark borders on the Karup River.

The highest point is Bavnehøj on the eastern outskirts of Lemvig at 89.5 m above sea level and the lowest point on land is 2 m below sea level at the bottom of the drained lake Vestersø northwest of Lemvig, which now is used for agriculture.

Demography

The municipalities Lemvig, Struer and Holstebro had a total population of 99,534 in 2015. Over recent years there has been a decline in the populations of Lemvig and Struer municipalities, whereas the population has increased in Holstebro municipality (see Fig. A4 for details).

The biggest cities in Geopark West Jutland are Holstebro (34,873 inhabitants), Struer (10,261 inhabitants) and Lemvig (7,131 inhabitants). There are 29 other cities in the area which in size vary from 200 to 3,000 inhabitants. The average number of inhabitants per km² in 2016 is 66.23 inhabitants per km², which is significantly lower than the average of 131 inhabitants per km² for Denmark as a whole. The Central Denmark Region is the second largest region in Denmark with 1,282,750 inhabitants and a total area of 13,142 km².

The average employment rate in the three municipalities is 72.7% compared to 74.9% nationwide. This number is based on the total population in the area and includes children, senior citizens etc. outside the labour market. Looking at the number of jobs in the age group from 25 to 64 the three municipalities have on average 90 jobs per 100 inhabitants which is higher than the average of 82 for the whole country. The private sector employs 69% of the work force in the geopark which is slightly higher than the national average of 67%.

Transport and trade together with industry and raw materials are the dominating business sectors by number of jobs. Noteworthy is that the primary sector with forestry, agriculture and fisheries employs 7% - 14% of the work force which is much higher than the national average of 4% for this sector.

The average income per citizen in the three municipalities is 279,000 DKK per year. 11% of the citizens have a personal income of more than 500,000 DKK per year. This is equal to the rest of Region Central Denmark but less than the overall national average of 14%. 6% of the citizens earn less than 100,000 DKK per year which is below both the national and the regional average.

The ratio of people with a vocational training background is higher in the geopark area than the average

			2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Men	Popu- lation growth	Holstebro	102	350	148	-132	22	12	15	56	109	142
		Lemvig	-98	-101	-46	-91	-140	-44	-57	-142	-126	-140
		Struer	-23	78	-76	-100	-121	-66	-110	-159	-54	9
	Popula- tion size end of year	Holstebro	28079	28429	28577	28445	28467	28479	28494	28550	28659	28801
		Lemvig	11307	11206	11160	11069	10929	10885	10828	10686	10560	10420
		Struer	11403	11481	11405	11305	11184	11118	11008	10849	10795	10804
Women	Popu- lation growth	Holstebro	18	88	99	-79	83	-20	86	28	47	25
		Lemvig	-148	-69	-75	-65	-96	-126	-104	-148	-150	-118
		Struer	-81	3	46	-59	-172	-26	-142	-154	-40	26
	Popula- tion size end of year	Holstebro	28503	28591	28690	28611	28694	28674	28760	28788	28835	28860
		Lemvig	10930	10861	10786	10721	10625	10499	10395	10247	10097	9979
		Struer	11188	11191	11237	11178	11006	10980	10838	10684	10644	10670
Total population size all three municipalities			101410	101759	101855	101329	100905	100635	100323	99804	99590	99534

Fig. A4 Population size and growth by gender and municipality 2006-2015 (Danmarks Statistik - statistikbanken.dk)

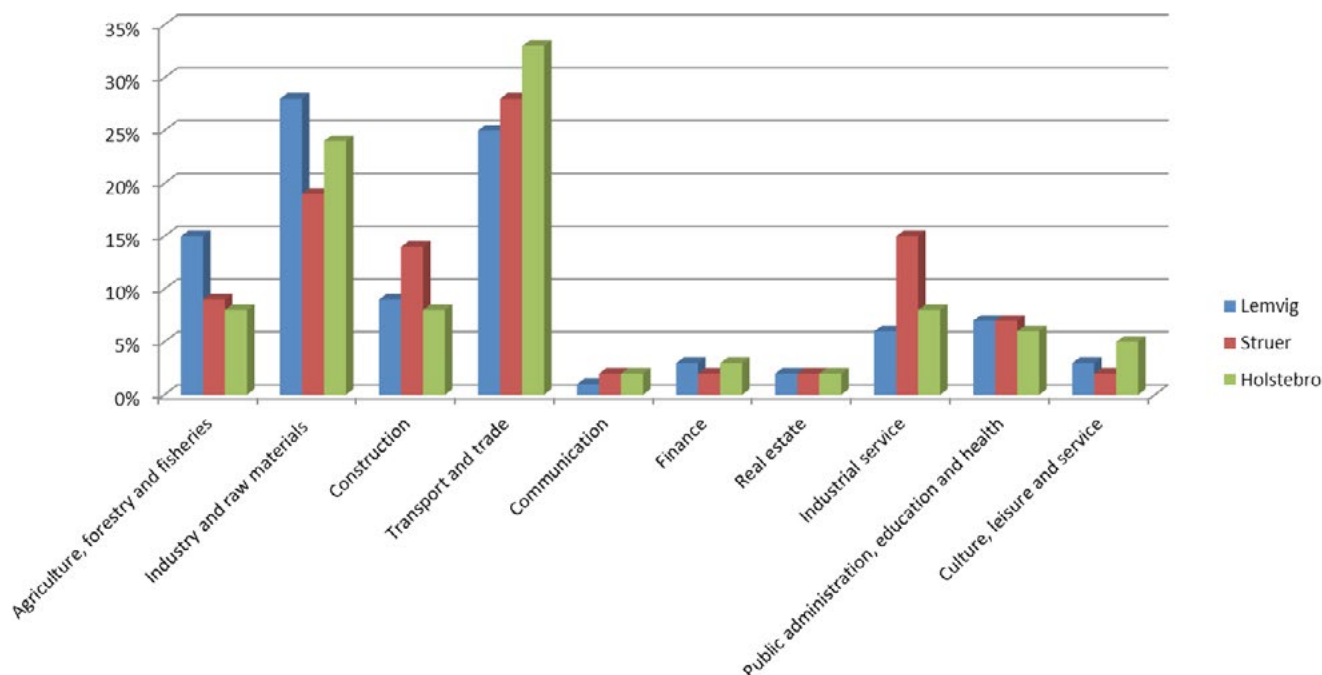


Fig. A5 Employment by sector in the three municipalities (Region Midtjylland 2016)

for the whole country when looking at the present age group between 25 and 64. This is quite the opposite when looking at the number of people with a long higher education (Fig. A5). However, this is apparently changing in the coming 25 years according to calculations done by the Ministry for Children, Education and Gender Equality in the so called Profile Model showing the expected ratio of students with a Lower Secondary school leaving certificate in 2014 who are expected to go on to complete upper secondary level or higher education within the coming 25 years.

Land use

According to the Danish Planning Act land use in Denmark is divided into 3 main zones: urban areas, summer residences and rural areas. The distribution of these zones in Geopark West Jutland is shown in Fig. A8.

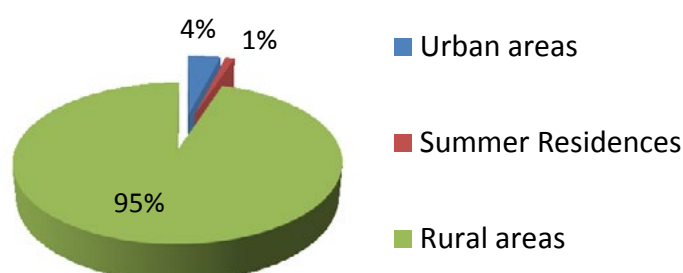


Fig. A8 Land use zones in Geopark West Jutland

	Primary and lower secondary school	Upper secondary school	Vocational training	Short-cycle higher education	Medium-cycle higher education	Long-cycle higher education
Lemvig	28%	4%	46%	3%	15%	4%
Struer	30%	4%	42%	4%	17%	4%
Holstebro	25%	4%	41%	5%	20%	5%
Denmark	25%	6%	35%	5%	19%	10%

Fig. A6 The level of education obtained by the population in the age group from 25 to 64 in the three municipalities

	Lemvig	Struer	Holstebro	Denmark
Upper secondary education completed	95%	93%	94%	93%
Higher education completed	63%	58%	64%	62%

Fig. A7 Number of students with a lower secondary school exam in 2014 expected to complete an upper secondary and a higher education in the three municipalities within the coming 25 years – the Profile Model (Ministry for Children, Education and Gender Equality 2016)

	Holstebro		Lemvig		Struer	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Total forest cover	13108	16.5	7362	9.3	962	1.2
Deciduous forest	2372	3.0	1701	2.1	255	0.3
Coniferous forest	9884	12.5	5191	6.5	707	0.9
Other forest areass	852	1.1	470	0.6	0	0

Fig. A9 Forest cover in Holstebro, Lemvig and Struer municipalities (Danmarks Statistik 2016)

	Total agricultural area	Organically farmed area	
	ha	ha	%
Lemvig municipality	34,393 ha	3,813 ha	11,1
Struer municipality	18,783 ha	572 ha	3,0
Holstebro municipality	50,384 ha	3,334 ha	6,6
Total	103,560 ha	7,719 ha	7,5

Fig. A10 Total agricultural and organically farmed area in the geopark by municipality (Naturerhvervsstyrelsen 2015 and 2016)

Forest cover varies considerably in the three municipalities with Holstebro topping the list with 16.5 % forest cover and with Struer with as little as 1.2 % forest cover (Fig. A9). Most common species are conifers such as spruce and pine, but this is gradually towards more broadleaved species.

The geopark area also holds a number of natural sites with various designations. Altogether there are 13 Natura 2000-sites and 5 Nature and Wildlife Reserves. Lists of these can be found in note 18 in Annex 1 and most of the Natura 2000-sites are described in the list of Non-geological sites also found in Annex 1. Apart from the above designations the Nature Conservation Act under its section 3 sets out a general protection of natural areas such as heath lands, meadows, bogs and mires, species rich grasslands and lakes. Of these Holstebro has 8,400 ha, Lemvig has 5,371 ha and Struer has 1,927 ha. Many streams and rivers are also protected under the Nature conservation Act, and in the geopark there is a total length of protected watercourses of 877 km. Furthermore, a number of sites have been designated Nature Conservation Areas to protect certain features such as scenic views, recreational, cultural and natural values and scenic views.

Agriculture plays a significant role in the geopark occupying 67% of the total land area. Agriculture is an important part of the local economy and also very much a part of the cultural history of the area. Together with the fish industry agriculture contributes a series of food products which is very much part of the image of Central Region Denmark as the Food Region of Denmark.

Infrastructure

Within 2 hours or less it is possible to reach most other parts of the region e.g. the cities Viborg, Aarhus, Herning, Holstebro and the airport at Karup from the geopark.

Public transport is available all over the geopark by rail, road and ferries with good connections to domestic and international airports.

A network of bus routes is available across the region and the three municipalities. The so-called X-busses which are express routes connect the larger cities – e.g. from Holstebro to Randers via Viborg or from Holstebro to Aalborg where there is both domestic and international airline connections.

The airport in Karup can be reached within 30-80 minutes and have several departures to Copenhagen on a daily basis. Billund Airport can be reached within 1-2 hours offering a wide range of international departures.

There are train connections to all three municipalities. Copenhagen can be reached by train from Struer or Holstebro in ca. 3½ hours. With a single change a train ride to Hamburg takes approximately 5.5 hour from Struer or Holstebro. A special and quite famous train service runs between Vemb, Lemvig and Thyborøn named VLTJ. It is not only a part of the infrastructure but very much a treasure in the local area. In the summer tourists can also take a ride with the local train called “Bjergbanen” – i.e. the mountain railroad - from Lemvig Station down to the harbour.

Today the motorway from south ends at Herning, and an expressway continues to Holstebro. A new motorway from Herning to Holstebro is under construction and is



Fig A11 The Railway line known as “VLTJ” – i.e. Vemb, Lemvig, Thyborøn Jernbane – offers a scenic tour in the geopark.

expected to open in 2018. This will connect the geopark area directly with the national motorway system.

There is a ferry connection between Thyborøn and Agger linking Geopark West Jutland to Thy National Park to the north. Another ferry connection connects the island Venø to the mainland. A number of tour operators also run boat trips in the Limfjord offering very fine views of many of the cliffs and coast types.

A wide range of tracks, routes and trails are available in the geopark. Going all along the Danish west coast runs the national cycling route no. 1 also known as the West

Coast Route and another national cycling route no. 12 runs all around the Limfjord. On top of this the geopark in cooperation with its partners offers a wide range of hiking, biking, riding and sailing trails and routes with various facilities. As part of its development plan the geopark is working to improve the existing facilities and develop new experiences. Geopark West Jutland has in collaboration with among others the Digital Outdoor Guide (Friluftsguiden) made it possible for travellers who wish to visit sites in the geopark to find online information about public transportation to and from the site.

A4 Organization in charge and management structure of the proposed Geopark

The initial phase

The initiative to establish a geopark in West Jutland came from John Clausen, a local member of the Danish Nature Conservation Society in Lemvig, in 2011. He was inspired by the initiative to establish a geopark in Odsherred, which in September 2014 succeeded in becoming a member of the European Geoparks Network and later also has become a UNESCO Global Geopark.

A working group was established in the end of 2011 with members from VIA University Teachers Training College, Danish Nature Conservation Society and Lemvig Municipality. In early 2012 representatives from Struer Municipality joined the initiative and initial contacts were made to Central Denmark Region.

In September 2012 representatives from the working group participated in the 11th European Geoparks Conference in Arouca, Portugal. Inspired by the conference and making use of the contacts made in Portugal a two-day combined conference and field excursion was held in West Jutland with local decision makers and stake-



Fig. A12 John Clausen is the man behind the initiative to establish Geopark West Jutland

holders. Special guests at the event were EGN Representative Dr. Vesa Krokki from Rokua Global Geopark and Dr. Andrasanu Alexandru from Hatec Global Geopark together with Professor Nicolaj Krogh Larsen, Aarhus University and Project Manager Nina Lemkow from the (then) aspiring European Geopark Odsherred. The conference aimed at giving an answer to the question wheth-



Fig. A13 In 2012 invited guest from the European Geoparks Network and other experts discussed the potential for establishing Geopark West Jutland.

er there was sufficient potential to establish a geopark in West Jutland and the answer was clearly a yes.

2013-2015

On the basis of the positive outcome of the conference efforts to secure political goodwill, stakeholder support and expand both the national and the international network began in earnest. A number of conferences for various stakeholder groups from local communities, tourism operators and politicians were held and a study tour to the newly appointed European Geopark in Odsherred was conducted to find further inspiration. Applications were made to the three city councils, the Regional Development Committee and Local Action Groups (EU Leader+ Programme) which led to sufficient financial support to launch the next phase and hire a Geopark manager in september 2015 just in time to participate in the European Geoparks Conference in Rokua, Finland.

The present organization and key activities

With the new phase starting in September 2015 a formal organization was established with a Steering Committee, a secretariat and a number of working groups to assist in the development of the geopark and compilation of information for the application to become a UNESCO Global Geopark.

The Steering Committee

The city councils of Lemvig, Struer and Holstebro municipalities approved a steering committee with a director from each of the municipalities, the Head Forester from the local unit of the Nature Agency, a representative of the volunteer society (i.e. John Clausen from the Nature Conservation Society in Lemvig who initiated the geopark project), a representative of the local tourism organisations and a representative of the national organization Danish Coastal and Nature Tourism. The geopark manager acts as secretary for the committee.

The Secretariat

The secretariat is staffed with a full time geopark manager with previous experience as manager of the World Heritage site and National Park in the Wadden Sea. A part time development consultant with experience from UNESCO Global Geopark Odsherred was employed from September 2015 until end of October 2016. Students from Aalborg University and Aarhus University have also been attached to the secretariat as part of their studies. The secretariat receives support from the staff of the three municipalities on a case by case basis. This includes technical service, marketing and communication, tour guiding, GIS-services, nature management and planning. Lemvig municipality also supplies financial management support.

A number of consultants have been hired on a contract basis to assist with:

- Identifying and describing the geological heritage of Geopark West Jutland
- Identifying and describing sites of natural, cultural and intangible heritage
- Creating a new webpage for Geopark West Jutland
- Carrying out a mapping and potential analysis of Geopark West Jutland with a focus on the role of the geopark as a driver of local development, especially sustainable tourism.
- Preparation of the brand description and design manual
- Getting Geopark West Jutland on the Digital Outdoor Guide and develop new features on the platform.
- Facilitation of workshops on Food Culture and Tourism

Key documents for the development of the Geopark that have been prepared are the Development Plan 2016-2020 (see Annex 1, Supplement A4-1), the Brand Description



Fig. A14 *The working group on geology held a two day excursion in 2016 to visit selected geosites and discuss criteria for their selection and description.*

and Design Manual (see Annex 1, Supplement A4-2), the Volunteer Strategy.

The volunteers

Geopark West Jutland has a very strong network of volunteers and volunteer organisations. Right from the beginning two members of the Nature Conservation Society have been actively involved on a daily basis. John Clausen, the founding father of the geopark, has assisted in developing the geopark network, giving lectures and guiding tours, arranging events etc. Søren Raarup, a keen amateur geologist and historian, has a profound knowledge of the geology and cultural history of the geopark. He has set up a database with information on the geology of the area, arranged guided trips and lectures and participated full time in the writing of the application for Geopark West Jutland to become UNESCO Global Geopark.

Working groups

Three working groups on geological heritage, cultural history and outdoor recreation have been established.

The working group on geological heritage involves private consultants and staff from Aarhus University together with volunteers and staff from the geopark. The group has been charged with the overall responsibility of identifying and describing the geological heritage of the geopark.

The selection and description of non-geological sites has been handled by a more informal group with inputs from the Museums for Cultural History in Holstebro, volunteers and staff of the geopark.

Staff from the Nature Agency, the three municipalities and the Jutland Aquarium participated in a working group to identify and describe trails, paths, routes and

viewpoints of special interest for the geopark. The group has and still is uploading the information to the Digital Outdoor Guide to have a common platform for all the outdoor facilities of the whole geopark which is also linked with other parts of Denmark.

Future organization

The present organization is only transitional. When the status of UNESCO Global Geopark has been achieved the geopark will be changed to become an independent commercial foundation in accordance with Danish legislation – an organizational model that is also known from UNESCO Global Geopark Odsherred.

Geopark Foundation and Secretariat

The Geopark West Jutland Foundation will be governed by a board of directors which will be responsible for the overall and strategic management of the foundation and safeguard the interests of the foundation in accordance with its purpose. The board of directors will enter into a financial cooperation agreement with the municipalities and if possible other key stakeholders on annual core financing of the geopark foundation to secure basic operation. The geopark will as part of its operation seek supplementary external funding for development projects.

In the process of setting up the foundation the city councils of Lemvig, Struer and Holstebro municipalities will approve the Articles of Association and Rules of Procedure and appoint the first board including a chairman. The board will include representatives from the three municipalities and key stakeholders.

The executive board will employ an executive manager and other staff with the required expertise necessary for the operation of the geopark and in order to comply with requirements of the UNESCO Global Geoparks program.

Geopark Advisory Committee

The board of directors will establish a Geopark Advisory Committee with members from key stakeholders in the geopark. The Committee will ensure a wider interest and involvement in the development of the geopark and provide inspiration and advice to the board of directors and the secretariat.

Partnership program

Geopark West Jutland will furthermore establish a partnership program with clear criteria for becoming a partner. The partnership program will have different categories with separate criteria. Categories can be commercial companies, local producers, educational institutions,

museums and visitor centers, NGOs and community organisations as well as individual persons. The partnership program will build on the existing cooperation agreements and will define incentives, payments, responsibilities etc. A key element in the partnership program will be the cooperation with volunteers.

Budget and financing for 2017-18

The municipalities are providing core funding covering the cost of management and administration and the remaining part of the budget is obtained through fundraising.

Geopark West Jutland Budget	2017		2018	
Financing:	DKK	Euro	DKK	Euro
Core budget support municipalities	900,000	120,805	900,000	120,805
Central Denmark Region	250,000	33,557	250,000	33,557
LAGs (Local Action Groups - EU)	400,000	53,691	200,000	26,846
Municipal/other public and private funding	600,000	80,537	900,000	120,805
Foundations	1,250,000	167,785	2,000,000	268,456
Total income	3,400,000	456,376	4,250,000	570,470
Expenditure	DKK	Euro	DKK	Euro
Management and administration	1,120,000	150,336	1,625,000	218,121
Infrastructure	1,400,000	187,919	1,400,000	187,919
Communication and information	330,000	44,295	675,000	90,604
Volunteers	50,000	6,711	50,000	6,711
Development project and events	500,000	67,114	500,000	67,114
Total expenditure	3,400,000	456,376	4,250,000	570,470

Fig. A15 Indicative budget for the period 2017 and 2018 (1 Euro = 7.45 DKK).

A5 Application contact person (name, position, tel./fax, e-mail)

The geopark secretariat is presently being hosted by Lemvig Municipality in the Town Hall. Contact person and details are:

Geopark Manager Thomas Holst Christensen
Rådhusgade 1, DK-7620 Lemvig, Denmark

Phone: +45 40 54 71 98

E-mail: mail@geoparkvestjylland.dk

Website: www.geoparkvestjylland.dk – a new website is under preparation and will be presented in January 2017.

Facebook: www.facebook.com/geoparkvestjylland



B. GEOLOGICAL HERITAGE

B.1. GENERAL GEOLOGICAL DESCRIPTION OF THE PROPOSED GEOPARK

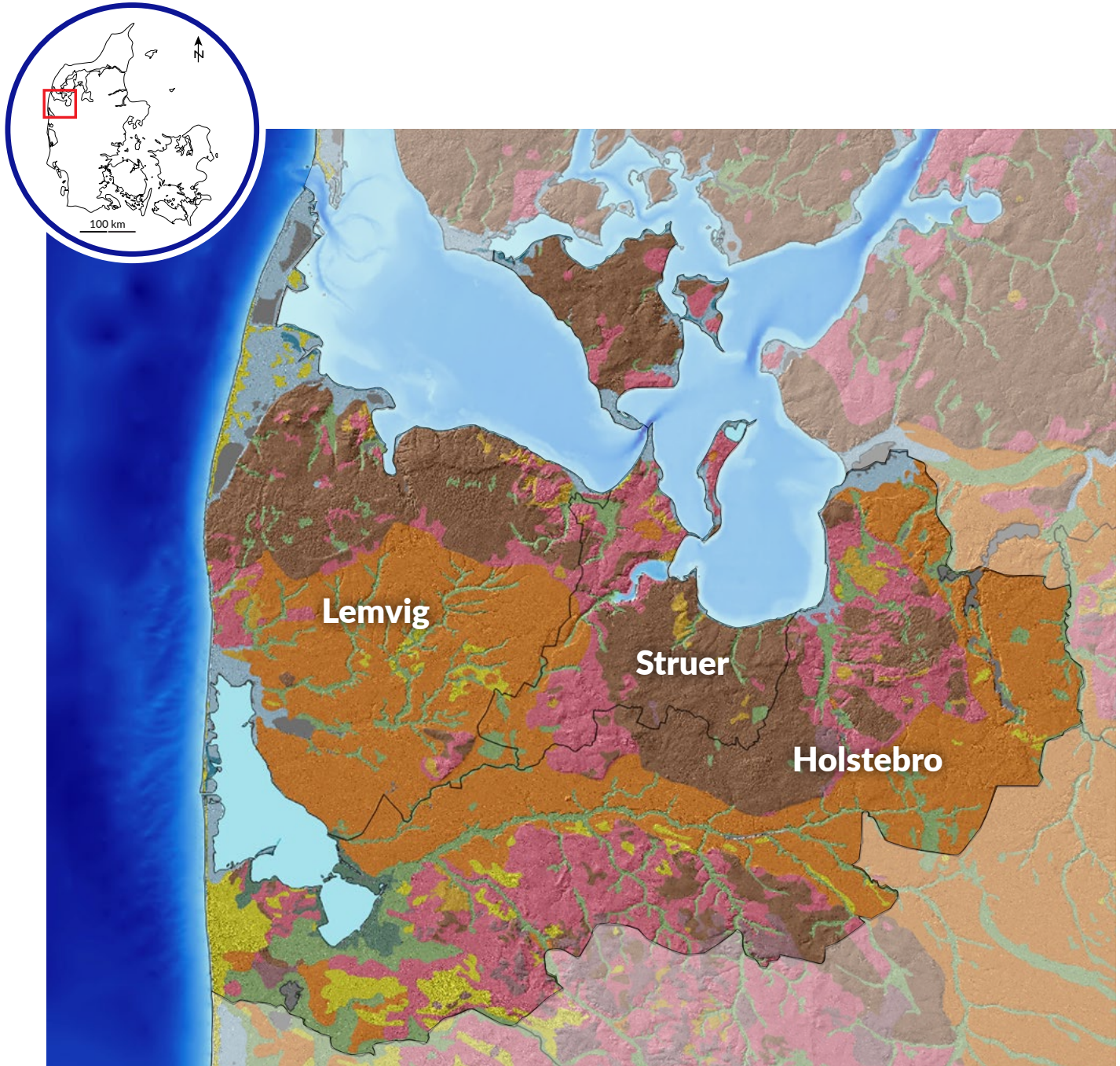
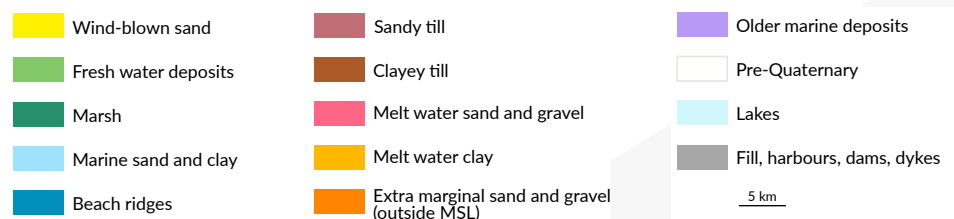


Fig. B1 Geopark West Jutland is situated in the Central Denmark Region and occupies an area of 4,759 km² which includes the land area of Lemvig, Struer and Holstebro municipalities of 1,560 km². Map source: Kort og Matrikelstyrelsen (2009) and GEUS (2011).

Geological map of the near-surface deposits



B. GEOLOGICAL HERITAGE

Geopark West Jutland

– a world class ice age landscape

During the Quaternary period of Earth history, enormous ice sheets sculpted the impressive ice age landscapes that form the core of Geopark West Jutland (GPWJ). These landscapes mark the final period when the Earth was in a deep freezer and when the Scandinavian Ice Sheet extended from the mountains of Norway down to Denmark. In addition to the ice age landscapes there is a series of other landforms that developed after the end of the ice age by rivers and coastal processes, as well as by the powerful westerly winds that characterize the west coast of Denmark. There are also remains of older geological deposits from the Tertiary and the Quaternary in some of the cliffs.

The unique glacial landscape in western Jutland was mapped over 100 years ago by the geologist N.V. Ussing who identified, amongst other features, the Main Stationary Line as a marked boundary in the landscape between a hilly glacial landscape and flat outwash plains.

This landscape developed as a result of repeated ice ages that each contributed to its formation. It was, however, during the last ice age – the Main Advance that took place 23.000 - 21.000 years ago when the ice reached its maximum extent – that most of the landscape in GPWJ was formed.

A brief account of the geology of the GPWJ area is presented here.

The Northern European Lowland – the Danish Basin

Since the Permian, about 250 million years ago, GPWJ has been part of a large sedimentary extensional basin that covered the whole of Denmark, the North Sea, northern Germany and the Baltic. Thick sequences (6-7 km) of sedimentary rocks, primarily sandstone, claystone and limestone were deposited here during the Mesozoic and Cenozoic. Towards the end of the Cenozoic the basin became filled up and Denmark finally became a land area during the Miocene.

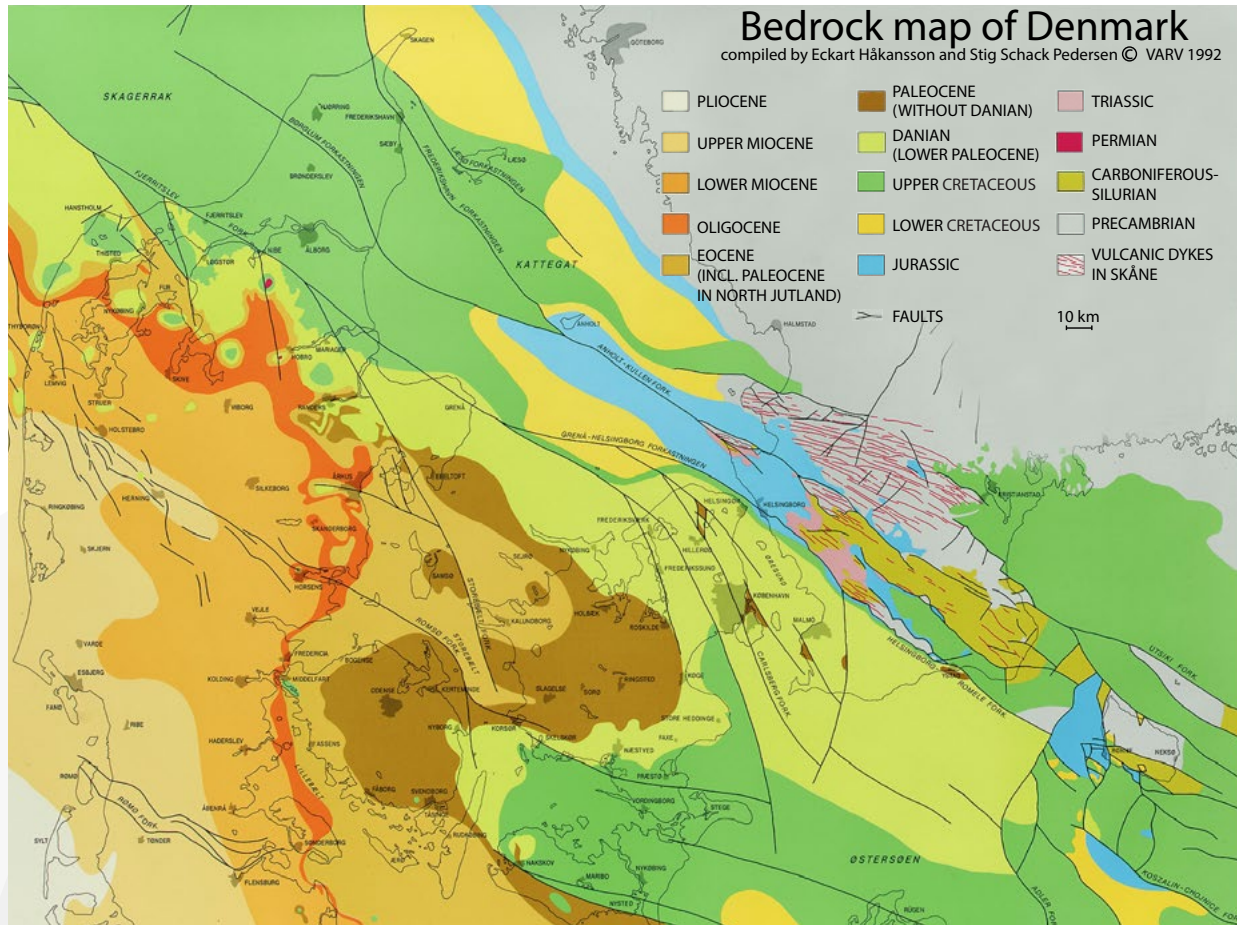


Fig. B2 Pre-Quaternary map of Denmark (Heilmann-Clausen & Surlyk 2010).

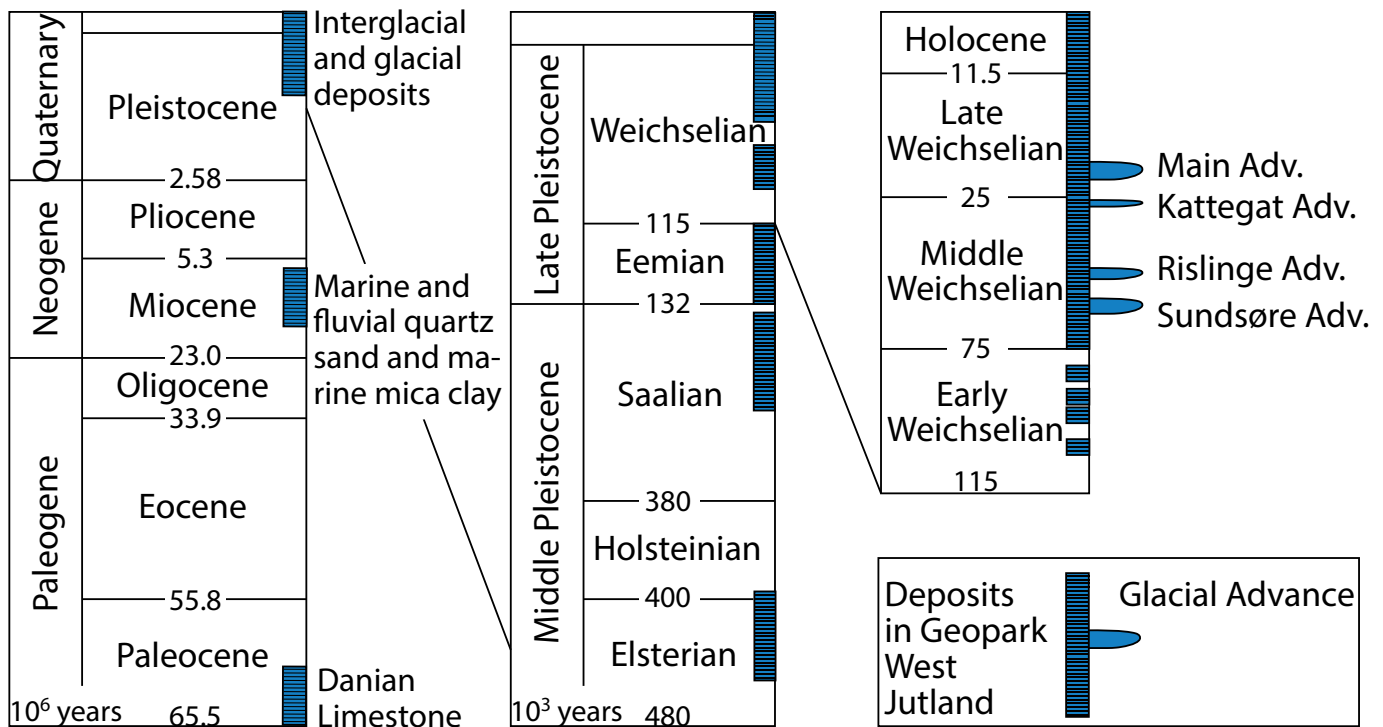


Fig. B3 Stratigraphic scheme showing the layers that are exposed in Geopark West Jutland.

At the present time, the pre-Quaternary surface of Denmark (excluding the island of Bornholm) consists of sedimentary rocks from the Lower Cretaceous to the Upper Miocene. Upper Cretaceous and Danian limestone comprise the surface in northern Jutland, Djursland and eastern Zealand. Younger deposits of fine-grained plastic clay and marl from the Paleocene and Eocene epochs make up the surface in eastern Jutland, Funen and west Zealand. In central and western Jutland the surface comprises sandy, silty and clay-rich deposits from the Oligocene and Miocene. The overall distribution of pre-Quaternary deposits, with the oldest in the north and the youngest in the south, bears witness to the fact that the Fennoscandian Marginal Zone has been elevated and eroded in the Cenozoic (Fig. B2). The reason for this Neogene uplift is unclear, but it reflects either tectonic events or extensive erosion of the Norwegian mountains by glaciers and meltwater which gave rise to isostatic elevation.

The pre-Quaternary deposits in GPWJ consist of a series of Miocene formations of micaceous marine clay and marine fluvial quartz-rich sand (Fig. B3). In addition to these there are exposures of Danian limestone and Paleocene and Eocene plastic clay and marl where salt domes have elevated the overlying sediments and formed sub-surface, circular, dome-shaped structures (Fig. B2).

Quaternary glacial and interglacial periods

The average global temperature has gradually fallen through the past 60 million years, and about 2.58 million years ago a new era started - the Quaternary - that is characterized by cold glacial intervals and warm interglacial periods. During the glacial intervals, extensive ice sheets developed in the northern hemisphere, in particular in North America, Scandinavia and the Himalayas.



Fig. B4 Maximum extent of the Scandinavian icecap in connection with the three last ice ages: Elsterian, Saalian and Weichselian (after Wienberg-Rasmussen, 1966).

The existing icecaps in Antarctica and Greenland became considerably larger. During periods when the ice sheets reached their maximum extents, about 30% of all the continents were covered by glaciers, which resulted in a drop in worldwide sea level by 120-130 m. These repeated decreases in sea level meant that land areas became larger and there was connection between areas that are today separated by the sea, such as Denmark and England. During the interglacial periods the ice sheets melted partially or completely and the climate was similar to - or warmer than - that of today. At the start of the Quaternary the glacial periods lasted for about 40,000 years, but about 800,000 years ago the duration of the ice ages increased to about 100,000 years. This meant that the ice sheets had time to grow even larger. The three most recent ice ages - Elsterian, Saalian and Weichselian - were therefore those that covered the largest areas in Northwest Europe and when all or most of Denmark was covered by the Scandinavian Ice Sheet (Fig. B4).

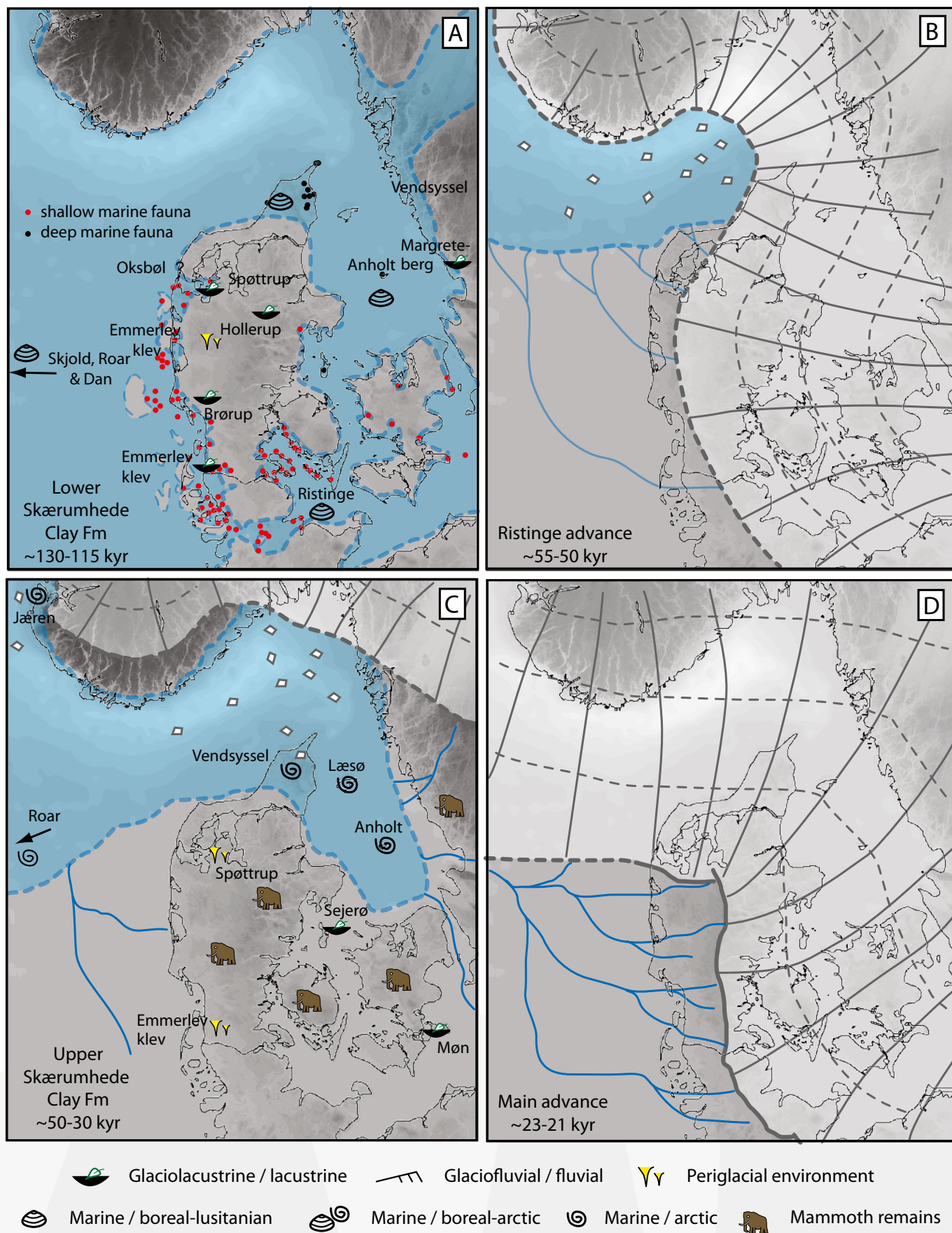


Fig. B6 A) Eemian interglacial, B) Ristinge Advance, C) Mammoth Steppe, D) Main Advance

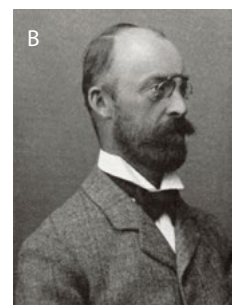
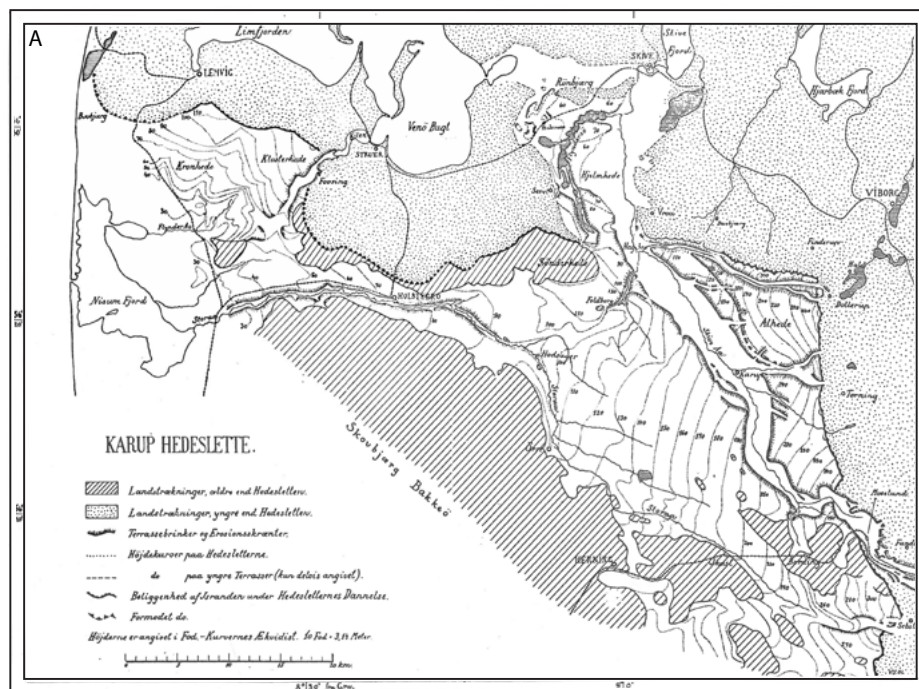


Fig. B7
A) The Main Stationary Line in Western Jutland (Ussing 1903).
B) Geologist N.V. Ussing (1864-1911) mapped the Main Stationary Line and described the glacial land-scapes in Western Jutland (Larsen 2012).

Most of the landscape in GPWJ developed during the last (Weichselian) ice age and the following Holocene interglacial period that started 11.700 years ago. There are, however, many localities where older Quaternary deposits (of Elsterian and Saalian age) can be studied, and there are also a few places where marine or lacustrine deposits from the Holsteinian or Eemian interglacial periods are exposed (Fig. B3).

The Weichselian glaciation

Most of the landscapes and surface layers in GPWJ were formed in connection with the Weichselian glaciation that lasted from 115.000 until 11.700 years ago. During this ice age the climate varied from extremely cold (stadials) to relatively warm (interstadials). Throughout most of the Weichselian Denmark was ice-free and the landscape consisted of tundra plains where, amongst other animals, mammoths, woolly rhinoceros, wild horses and bison grazed. Even though there are no archaeological discoveries of mankind from this period, it seems likely that the large mammals were hunted by Neanderthals. It was cold and there was permafrost, which meant that the landscapes from previous ice ages were smoothed out by soil creep; ice wedges and associated polygons developed. The Scandinavian Ice Sheet only reached the Danish area during the coldest periods of the Weichselian. Based on these climatic variations this ice age has been subdivided into the Lower, Middle and Upper Weichselian.

Early and Middle Weichselian (115.000 to 25.000 years ago)

When the Weichselian ice age started 115.000 year ago the Scandinavian Ice Sheet began to expand in the Norwegian mountains when small glaciers and ice caps coalesced to form a large ice sheet. Denmark was a tundra plain, and in the early Weichselian the cold climate was replaced by two warmer periods (interstadials) when a more temperate fauna and flora became re-established

in the area. Traces of these interstadials are found in, for example, old lake deposits in the hill islands in western Jutland and in the famous bog at Brørup where the interstadial was first recognized; it is now called the Brørup interstadial. Marine clay with drop-stones that was deposited in northern Jutland contains an arctic fauna, which bears witness to the sea becoming colder when the Scandinavian Ice Sheet reached the coast in southern Norway and glaciers calved into the Skagerrak.

Glaciers from the Scandinavian Ice Sheet reached Denmark for the first time between 70.000 and 50.000 years ago in the Middle Weichselian (Fig. B6). The first ice came from the north in connection with the Sundsøre Advance about 65.000 to 60.000 years ago, and the next ice came from the east about 55.000-50.000 years ago in connection with the Ristinge Advance (also called the Old Baltic Advance). The maximum extent of the Sundsøre Advance is not known in detail, but it is believed to have reached past the northern part of Skovbjerg hill island. The following Ristinge Advance from the east reached well into western Jutland. It is difficult to assess the maximum limit of these advances since no terminal moraines have been found. It is therefore not known whether, for example, the Ristinge Advance covered the whole of Denmark or if there was a narrow strip in western Jutland that remained ice-free. Deposits from the Ristinge Advance have been found in several localities in southern Jutland, western Jutland and in the Limfjord area. All in all this means that the traditional view that the hill islands in western Jutland represent Saalian glacial landscapes needs to be revised, since many of them were overrun by ice during the Middle Weichselian.

After these Middle Weichselian glacial advances, Denmark became a tundra plain for more than 20.000 years. This dry, cold, barren plain extended to England, Sweden and large parts of Siberia. This tundra plain is referred to

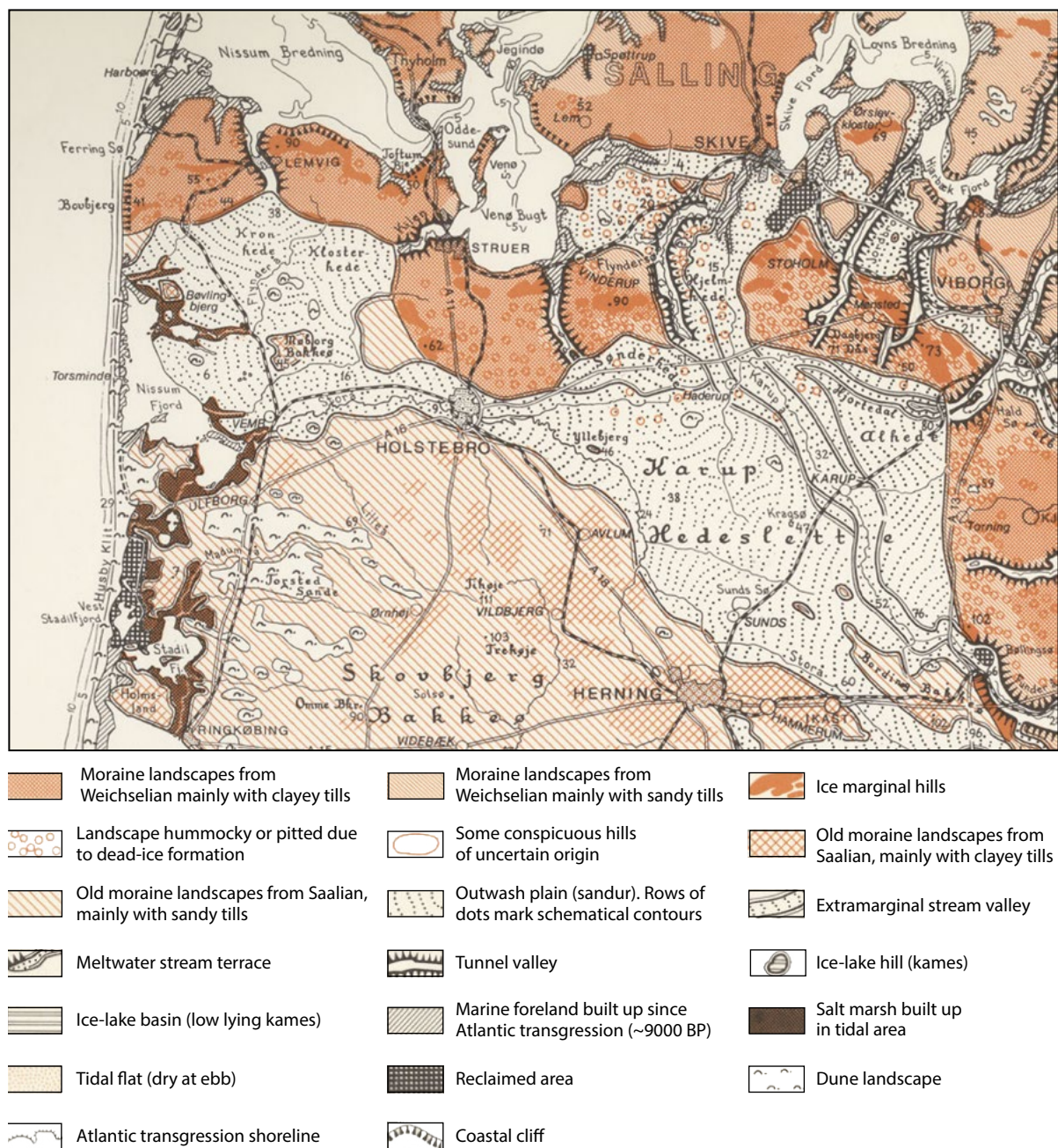


Fig. B8 Glacial morphological map of Western Jutland (after Smed 2012).

as the Mammoth Steppe after the countless numbers of mammoth tusks and teeth that have been found in, for example, western Jutland. Unfortunately, none of these finds in western Jutland have been dated. During the long periods of time in the Early and Middle Weichselian when Denmark was ice-free the landscape was subjected to periglacial conditions that resulted in “smoothing” of the landscape as a result of alternating freezing and thawing. This is evident in, for example, Skovbjerg hill island that stands out as an undulating, elevated area without any clear terminal moraines or other obvious glacial landscape features.

The temperature fell towards the end of the Middle Weichselian and the Scandinavian Ice Sheet spread southwards over Denmark in connection with the Kattegat Advance 29.000 – 27.000 years ago. No glacial land-

scapes remain from this advance, but deposits from this event can be studied in, for example, the Bovbjerg profile in the form of till and deposits from glacial lakes.

Late Weichselian (25.000 to 11.700 years ago)

When the Scandinavian Ice Sheet reached its maximum extent 23.000 - 21.000 years ago, glaciers advanced over Denmark to the Main Stationary Line (MSL) where it formed a marked boundary in the landscape. The eastern part of Denmark was later covered by ice from the Young Baltic Advance 19.000 – 18.000 years ago, but these glaciers did not reach western Jutland. This means that the landscape and glacial deposits from the Main Advance are preserved in GPWJ. The MSL was mapped in the early 1900s by state geologist N. V. Ussing who published a map in 1903 based on the topography and nature of the surface deposits (Fig. B7). He based his interpretation of

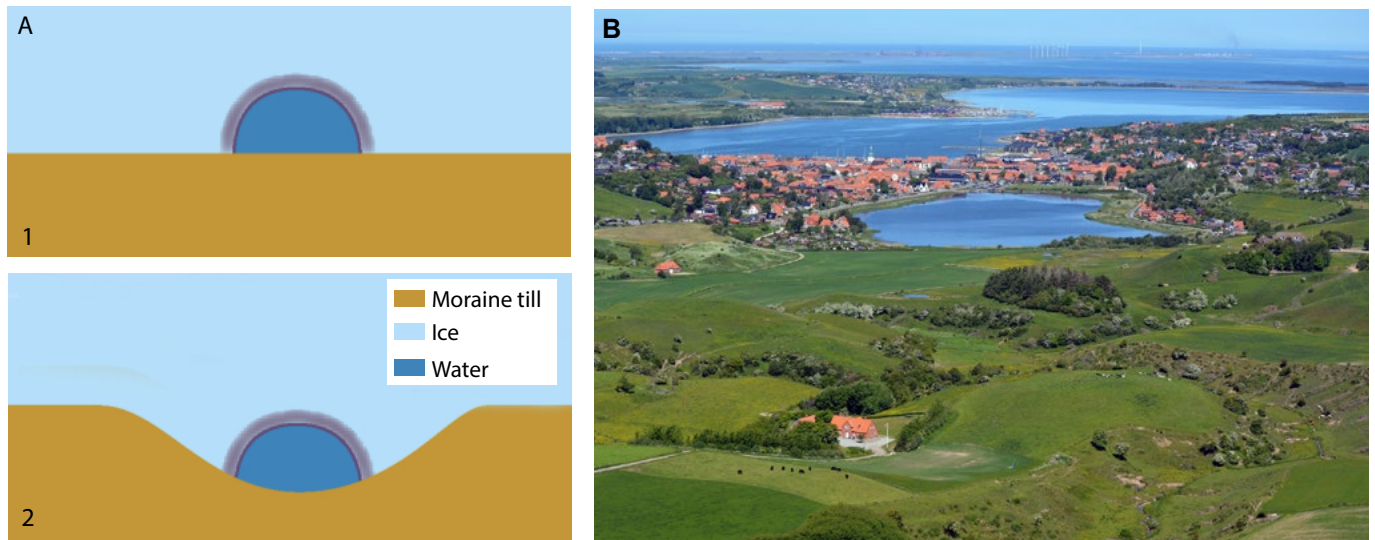


Fig. B9

A) Two stages in the formation of a tunnel valley by meltwater erosion below a glacier (Krüger, 2012).
 B) Tunnel valley at Lemvig with a view over the fjord (Photo: Lemvig.eu).

the location of the MSL on a clear change from an undulating glacial landscape with marked terminal moraines or a zone of dead ice landscape, to the flat outwash plains ahead of the ice front.

It was originally thought that the MSL defined the maximum extent of the ice in Denmark, but, as mentioned

above, recent studies have shown that during the Middle Weichselian glaciers covered a large part of western Jutland, including the hill islands. However, considering the Scandinavian Ice Sheet as a whole, it reached its maximum extent 23.000 – 21.000 years ago which is when it formed the MSL in Denmark.

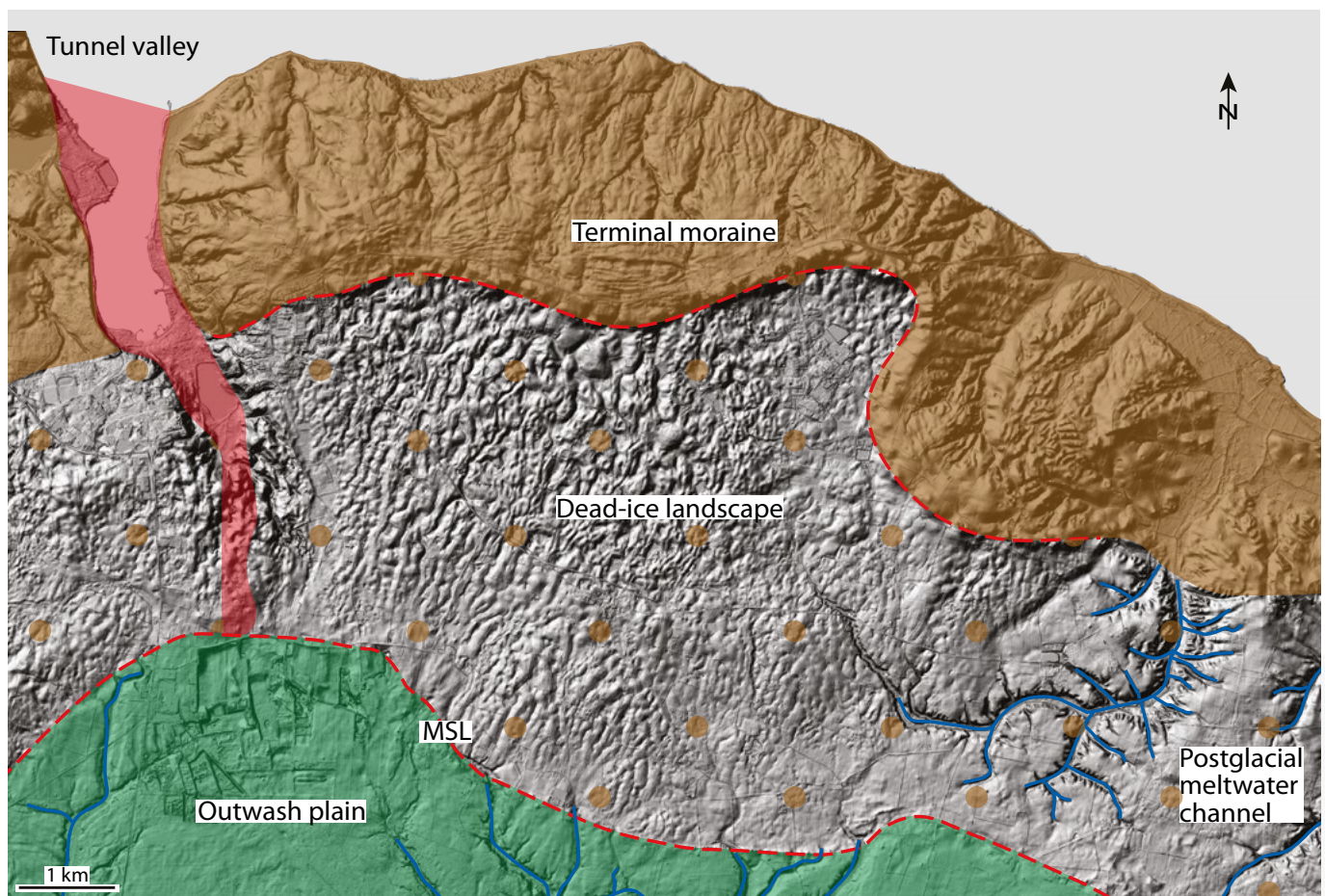


Fig. B10 Glacial geological map of the area east of Lemvig showing the complex landscape around the Main Stationary Line. Map source: Kort og Matrikelstyrelsen (2009).



Fig. B11 The Continental period represents the interval from the end of the last ice age until the beginning of the Holocene when elevation of the land took place faster than rise in sea level and Denmark was linked to Sweden and England (Noe-Nygaard et al., 2012).

One of the most characteristic forms of landscape in western Jutland is the meltwater plains (outwash plains) that developed when the ice was at the MSL (Fig. B8). Meltwater flowed from the ice towards the west and south and deposited huge amounts of sand and gravel. The heathlands of Kronhede, Klosterhede and Sønderhede are all fan-shaped areas of outwash deposits whose top points are at Lemvig, Struer and Sevel where large volumes of meltwater flowed out from glacier portals. Before reaching the ice front the meltwater had flowed under the glaciers in large channels that eroded deep sub-glacial valleys – so-called tunnel valleys (Fig. B9).. These are expressed in the landscape today by fjords or large elongate lakes. There are four tunnel valleys in the GPWJ area - at Lemvig, Struer (Kilen), lake Hellegård Sø and at the Stubbergård sø - Flynder Sø lakes.

Ussing was the first, over 100 years ago, to recognize the connection between the focal point of the fan-shaped outwash deposits and the end of a tunnel valley that was perpendicular to the ice front. Since then there has been discussion as to whether meltwater could carve out these 30 to 40 km long, 2 to 5 km wide and between 100 and 300 m deep tunnel valleys, or whether they could represent older river valleys from the Tertiary controlled by sub-surface neotectonic movements. Modern research has, however, shown that it is possible for meltwater to erode deep valleys below recent glaciers, and most researchers now consider that tunnel valleys were formed primarily by sub-glacial meltwater erosion.

During the general melting of the ice at the MSL, there were periodic glacial re-advances that formed hill-hole pairs, which are hills with closely spaced sub-parallel ridges lying a short distance from their source depressions. Good examples of hill-hole pairs can be seen at Nørlem and Bjerrum arch. In GPWJ, a characteristic dead-ice landscape developed between the MSL and the terminal moraine ridges during a re-advance with many small hills and depressions with no natural drainage that are now occupied by small lakes or bogs (Fig. B10). Continued retreat of the ice meant that the meltwater found a new route to the North Atlantic via Limfjord, and that the large outwash plains in western Jutland dried out. Deep meltwater valleys that cut down into the flat outwash plains south of the MSL are today visible as dry gullies in the landscape.

Even though the ice was retreating, it was still cold in Denmark and the landscape was subjected to periglacial processes. This is evident in the landscape as ice wedges and associated polygons. There was also extensive aeolian activity on the outwash plains, and until vegetation took a firm grip on the landscape several areas of inland sand dunes were formed.

When the ice melted away in late glacial times the load on the crust was reduced and it gradually began to rise again. In northern Jutland this took place slower than the elevation in sea level, which resulted in large parts of northern Jutland becoming inundated by the sea. When the rate at which the ice melted decreased, the rise in crustal level became dominant and we entered the Continental period when Denmark was linked to both England and Sweden. This phase continued into the following Holocene interglacial period (Fig. B11).

Holocene (11.700 years ago to the present)

A significant rise in temperature marked the transition between the Weichselian glaciation and the present interglacial period. This increase in temperature is best documented in ice cores from Greenland, but has also been detected in, for example, lake deposits in western Jutland where there is a steady increase in temperate plant species approaching the Holocene. This gradual increase in temperature culminated at the Holocene temperature maximum about 9.000 – 5.000 years ago. During this interval the remaining portions of the North American ice cap melted away which led to an eustatic sea level rise that again took place at a faster rate than the isostatic uplift of the crust. This resulted in the low-lying parts of Denmark again being flooded by the sea. This is evident in northern Denmark as extensive low-lying flat areas and marked old coastal cliffs that reach up to 13 m above present sea level in northern Denmark. These marine deposits and the coastal cliffs are named after the snail *Littorina littorea* that was prevalent at that time (Fig. B12).

In GPWJ the base of the *Littorina* cliffs is about 2 m above present sea level. Between the *Littorina* cliffs and the present coastline there is a wide variety of forms of coastal landscapes, including beach ridges, spits and la-



Fig. B12

A) Extent of the Littorina Sea during the Atlantic period 9,000-5,000 years ago (after Aaris-Sørensen, 1988).

B) View of the Littorina coastal cliff at Engbjerg (Photo. Søren Raarup).

goons. These combine to form the characteristic features of the west coast of Jutland. The development of these landforms reflects the interplay of a combination of factors, especially the powerful action of waves, coast-parallel currents, and the availability of sandy sediments that comprise much of the surface and sub-surface in Western Jutland. When the North American ice cap had finally melted away about 5,000 years ago, sea level ceased to rise and crustal elevation took over once again and Denmark essentially took on its current appearance. Elevation of the land continues today; northern Jutland is rising at a rate of about 1.8 mm per year whereas south-

ern Denmark is more or less in balance. However, since the global rise in sea level is currently about 3.2 mm per year, the Danish area is overall subjected to a relative increase in sea level.

Some of the youngest sediments and landscapes in GPWJ are the characteristic and striking sand dunes that are developed along the entire west coast of Jutland from Skagen in the north to Skallingen in the south, a distance of about 300 km. Sand dune formation commonly starts with primitive dunes that may develop into crescent-shaped barchan dunes. Free growth of sand

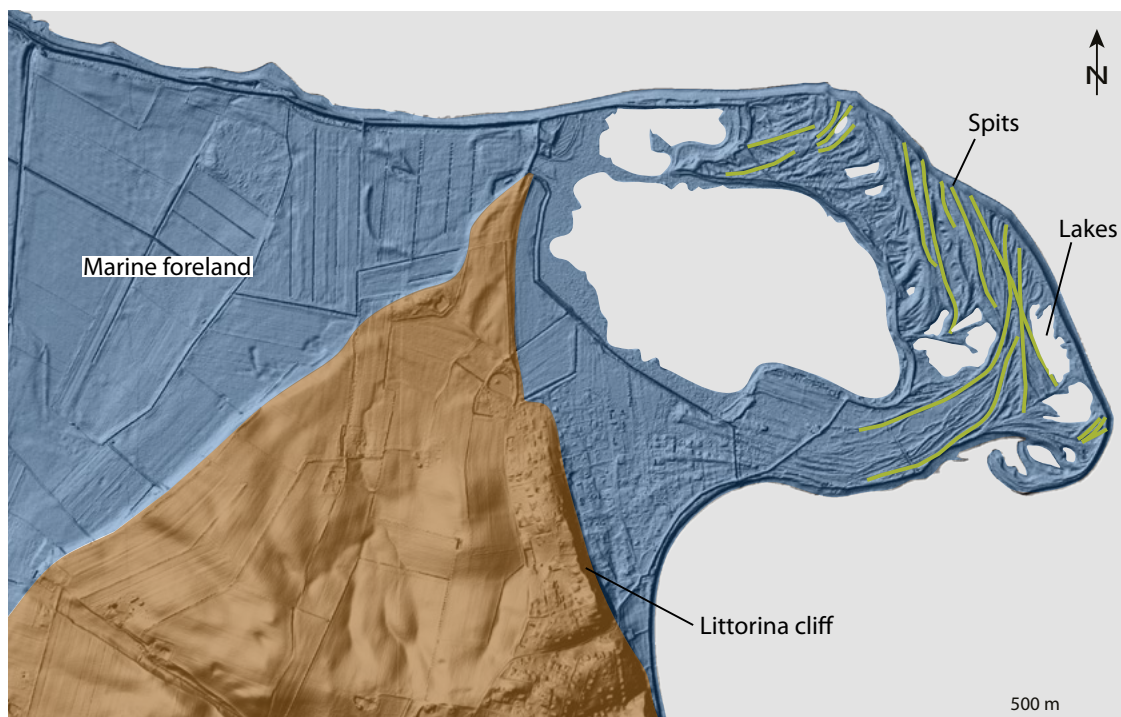


Fig. B13 Coastal landscape at Gjeller Odde. Map source: Kort og Matrikelstyrelsen (2009).

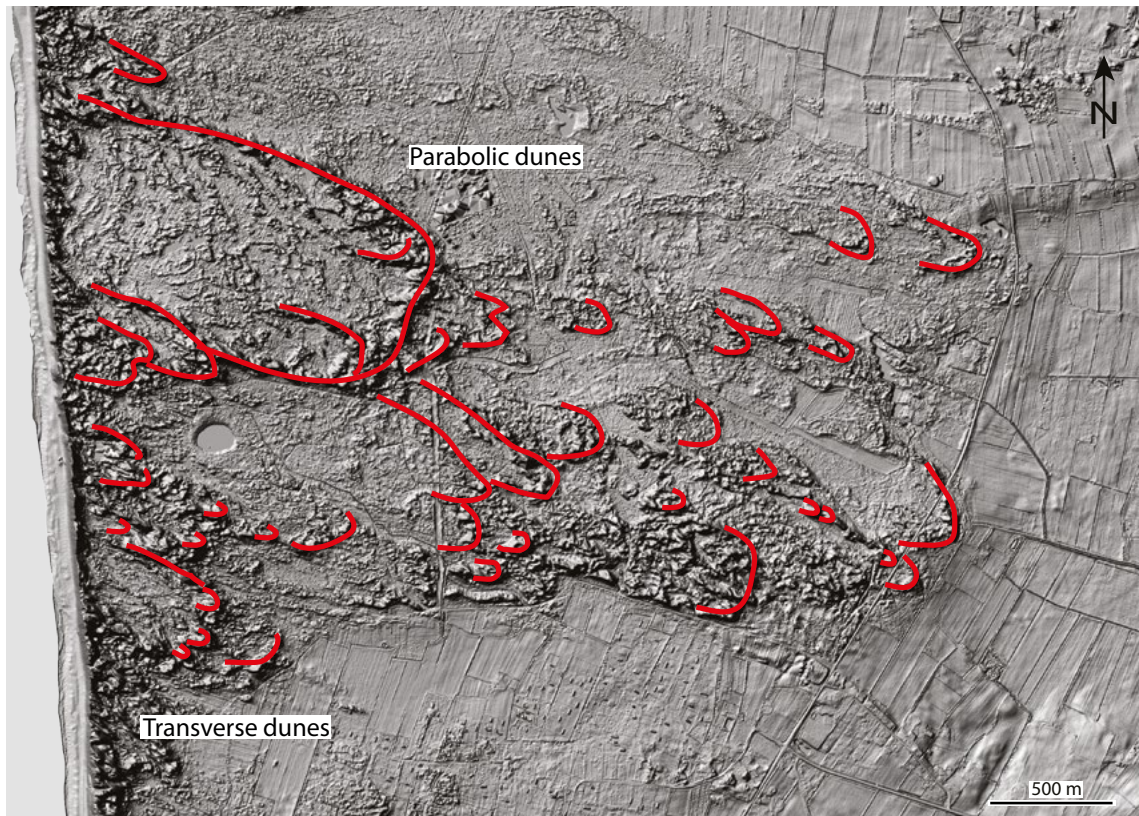


Fig. B14 Dune landscape at Husby Klitplantage plantation. Map source: Kort og Matrikelstyrelsen (2009).

dunes in Denmark is generally inhibited by vegetation and transverse dunes are developed. If a hole develops in the vegetation on a sand dune, extensive wind erosion can take place and a dune hollow can develop. Continued erosion can result in the development of a parabolic dune. In historic times, wind-blown erosion has increased as a result of the clearing of vegetation together with greater storm activity, and many of the dunes can be dated to the Stone and Bronze Ages. Renewed wind-blown sand activity from ca. 1550-1650 to ca. 1900 had catastrophic consequences for farmers who lived near the west coast.



Fig. B15A Bovbjerg lighthouse (Photo: Lemvig.eu).

The Bovbjerg profile – a key locality in Geopark West Jutland

Bovbjerg may be the only place in the world that exposes a section through an entire glacial landscape series with a terminal moraine and source depression (hill-hole pair) and its associated outwash plain. This provides an opportunity to get a three-dimensional impression of the MSL that marks the maximum extent of the ice sheet in the Late Weichselian.

The Bovbjerg profile was first described by E. M. Nørregaard in 1912 and later, more detailed studies, have shown that the profile includes both glacial and meltwater deposits from several glacial and interglacial periods. The oldest glacial deposits are from the Elsterian ice age, whereas the youngest were deposited in connection with the Kattegat Advance and the Main Advance during the Late Weichselian (Fig. B15).

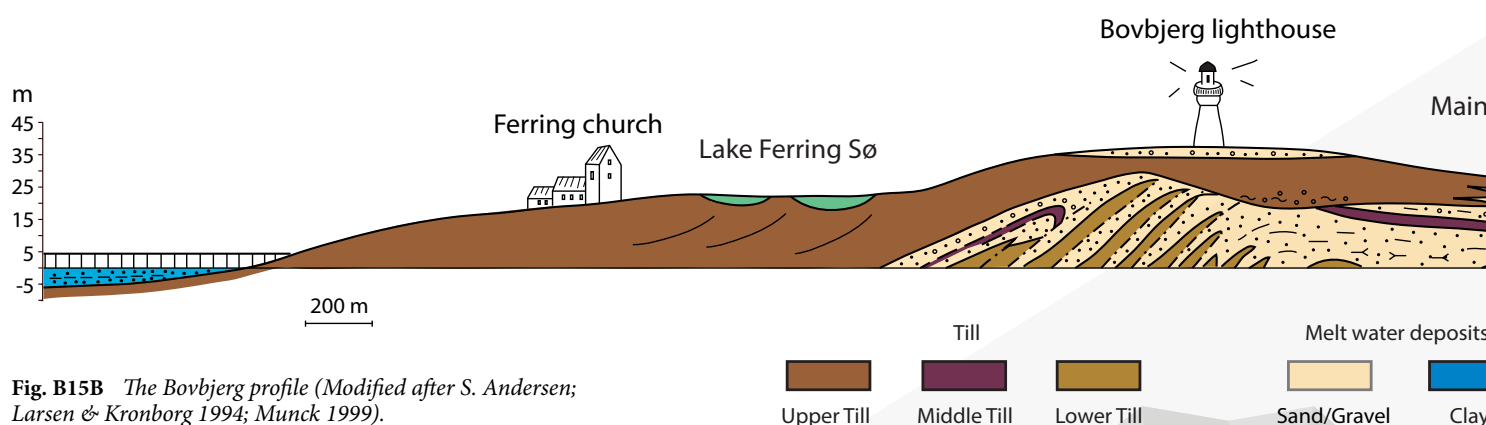
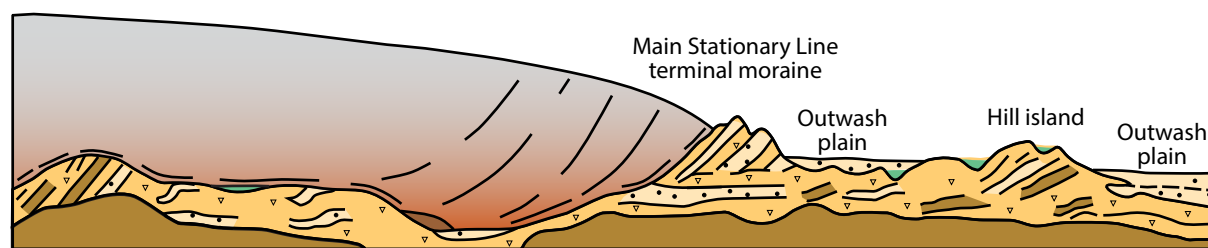
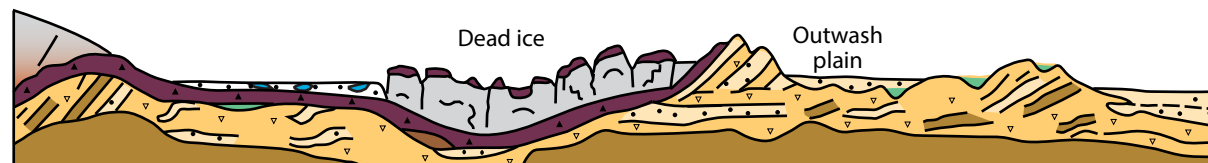


Fig. B15B The Bovbjerg profile (Modified after S. Andersen; Larsen & Kronborg 1994; Munck 1999).

Main Advance 23 - 21 ka



Lateglacial



Present

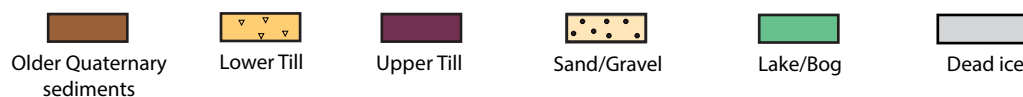
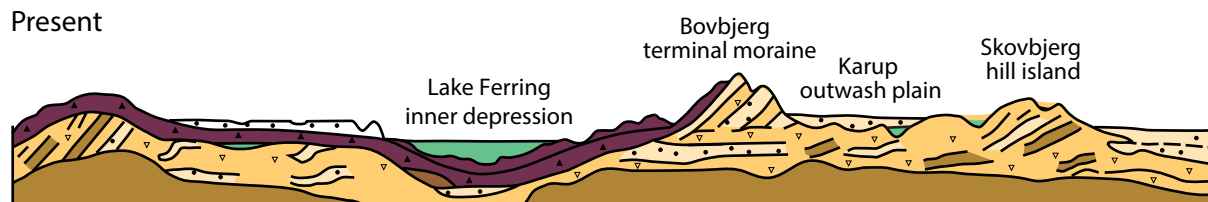
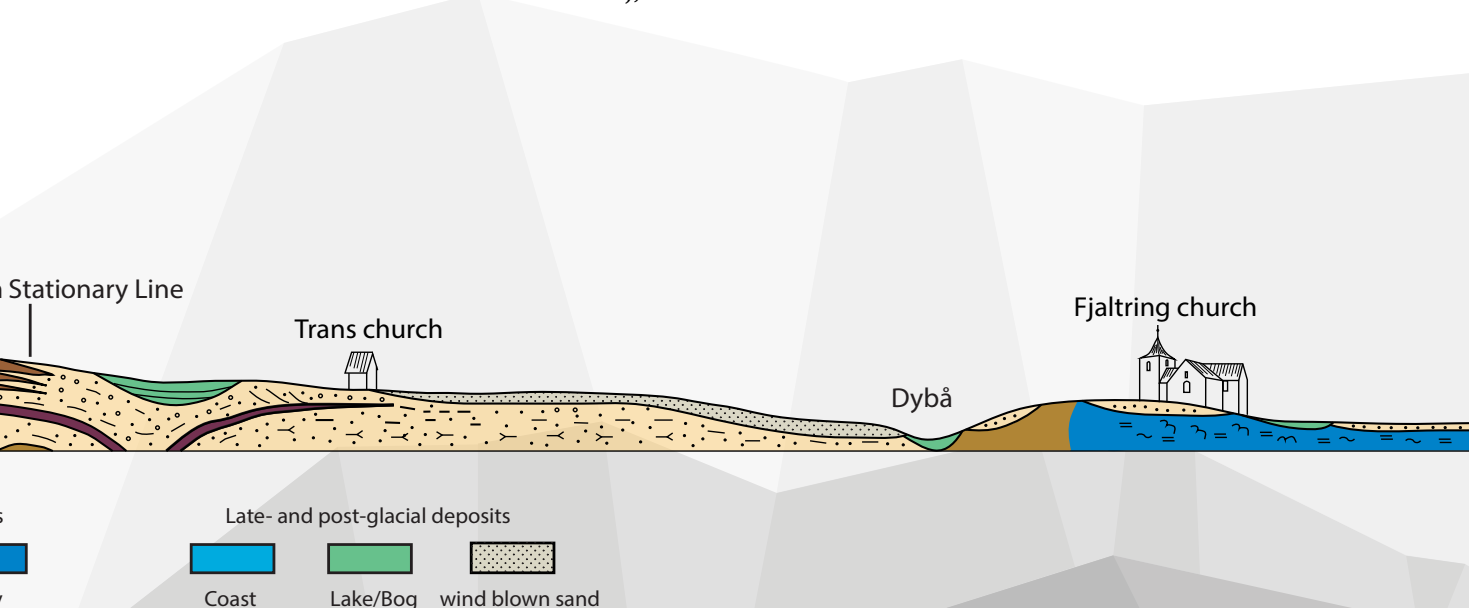


Fig. B16 Conceptual landscape model for Bovbjerg with an inner depression, terminal moraine and outwash plain (after Houmark et al., 2005)

The landscape around Bovbjerg has provided inspiration for the subdivision and interpretation of a glacial landscape system (Fig. B16). During the Last Glacial Maximum (LGM) the Scandinavian Ice Sheet reached the MSL where it formed a terminal moraine composed of up-thrust sheets of older glacial and interglacial sediment that derived from the source depression (hill-hole pair). There are many examples of glaciotectonic deformation with dislocated sediments in GPWJ, but Bov-

bjerg is unique in that it offers a view into the moraine that marks the MSL. In front of the MSL a large outwash plain was formed that extended all the way down to the so-called hill islands that represent older glacial landscapes from Middle Weichselian and/or Saalian times.



B.2. LIST AND SHORT DESCRIPTION OF GEOLOGICAL SITES

The most important geological sites in GPWJ have been selected and described by geologists Mads Kjærstrup, Anette Petersen, Tove Damholdt and school teacher Søren Raarup in cooperation with docent emeritus J. Richard Wilson and associate professor Nicolaj Krog Larsen, Department of Geoscience, Aarhus University. These authors selected the figures in cooperation with Grethe Storgaard, Department of Geoscience, Aarhus University, who prepared the illustrations. The text was translated from Danish to English by J. Richard Wilson.

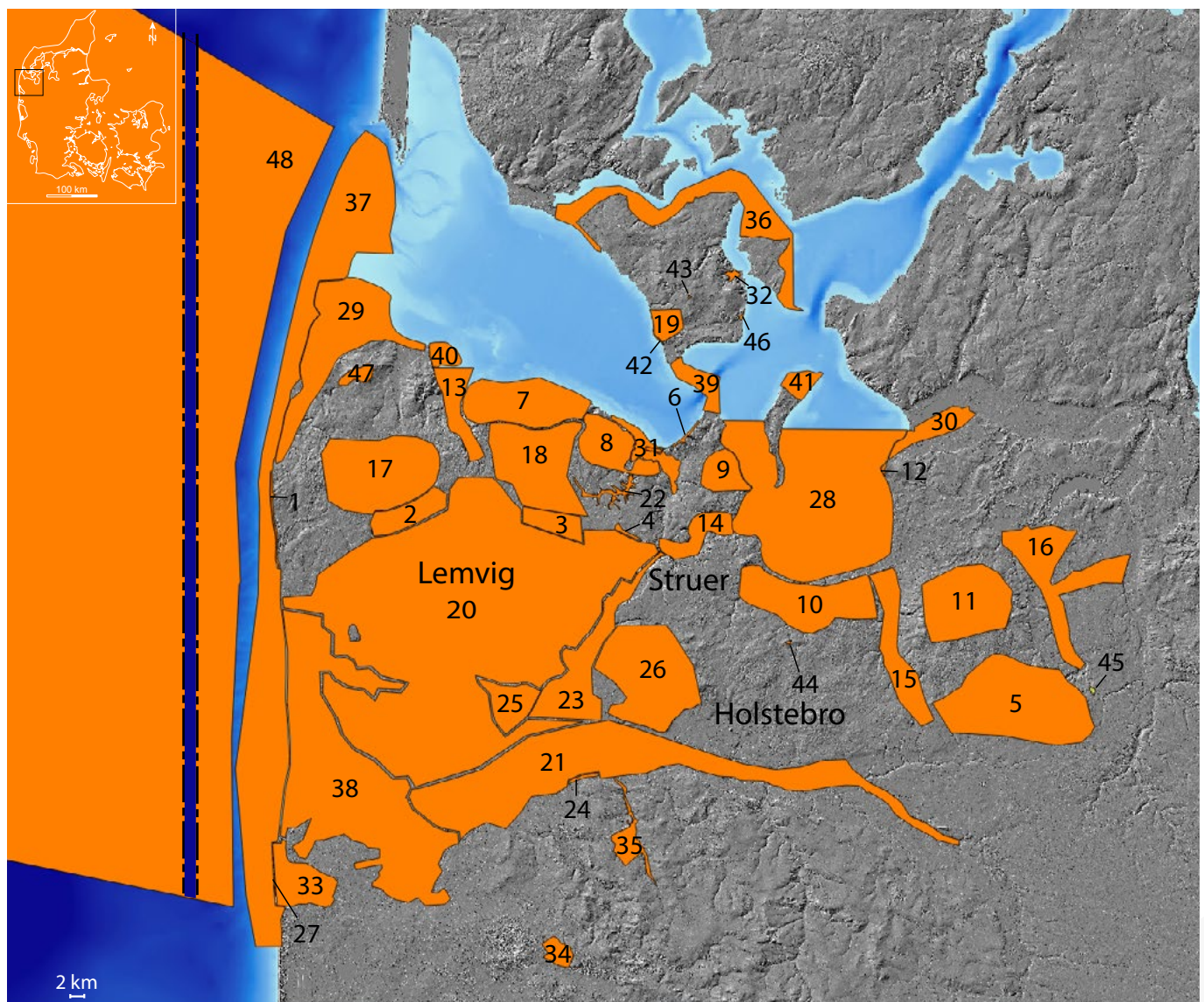


Fig. B17 Locations of the geological sites in Geopark West Jutland. Map source: Kort og Matrikelstyrelsen (2009).

No.	Name	Description	Geological importance
1	The Bovbjerg profile	Cliff profile. Section through the glacial sequence around the Main Stationary Line	NGI 76, NCL 80 and Geosite 4-4
2	Lomborg	Terminal moraine at the Main Stationary Line	NGI 75
3	Fabjergkirkevej	Main Stationary Line and prehistoric traces	NGI 75
4	Skodborg Huse	Terminal moraine at the Main Stationary Line	Local importance
5	Salshøj - Sønderhede	Outwash plain in front of the junction between two lobes in the Main Stationary Line	Local importance
6	Toftum Bjerger	Coastal cliff with deposits from several glaciations. Terminal moraine formed by a Weichselian glacial re-advance	NGI 74 and NCL 85
7	Nørrelem - Nørre Nisum - Kamstrup	Marked terminal moraine formed by glacial re-advance following the Main Advance	NGI 75 and NCL 84
8	Bjerrumbuen	Marked terminal moraine with several kames	Local importance
9	Breinholtbuen	Small terminal moraine and outwash plain	Local importance
10	Gimsing - Handbjerg	Terminal moraine from a glacial re-advance and an inner depression	Local importance
11	Ryde - Sevel	Terminal moraine formed by a glacial re-advance with superimposed landscape forms	Local importance
12	Nygård Hage	Coastal cliff with deposits from two glaciations	Local importance
13	Lem Vig	Tunnel valley with outwash fan deposits	NGI 75 and NCL 84
14	Kilen - Hornet	Winding tunnel valley between Venø Bugt and Klosterheden	Local importance
15	Hellegård tunnel valley	Tunnel valley with thresholds and basins	Local importance
16	Stubbergård Sø - Flyndersø	Pitted outwash plain - Hjelms Hede. Tunnel valley	NGI 64
17	Lomborg - Bonnet - Heldum	Undulating moraine landscape with dead ice features and a terminal moraine formed as a result of glacial re-advance.	NGI 75
18	Nørre Nisum - Fabjerg	Undulating moraine landscape with dead ice features between the Main Stationary Line and a terminal moraine formed during glacial re-advance	NGI 75
19	Odby till plain	Till plain from the last glacial advance in the Weichselian	Local importance
20	Klosterhede - Kronhede	Two outwash plains	NGI 75
21	The Storå valley	From outwash plain to postglacial river valley	NGI 77
22	Trælborgdalen	Periglacial valley	Local importance
23	Fousing valley	Lateglacial periglacial valley	Local importance
24	Burlund	Erosional cliff testifying to the extensive late glacial melt water runoff from Main Stationary Line	NGI 77
25	Møborg hill island	Hill island. Gravel pit profile with traces from three glaciations	Local importance
26	Linde hill island – Sir Lyngbjerg	Part of a hill island in connection with the moraine landscape behind the Main Stationary Line	Local importance
27	The Græm profile	Cliff profile of a hill island. Postglacial wind-blown sand	Local importance

No.	Name	Description	Geological importance
28	Venø Bugt	Inner depression from a re-advance after the main Weichselian advance	Local importance
29	Veserne - Plet - Engbjerg	Marine foreland. Littorina cliff	NGI 76 and NCL 80
30	Sønder Lem Vig - Geddal Enge	Marine foreland. Littorina cliff	Local importance
31	Remmerstrand - Resen Kær	Marine foreland. Littorina cliff	Local importance
32	Hellerød Kær	Marine foreland. Erosional valleys	NGI 71 and NCL 87
33	Husby Klitplantage	Sand dune landscape. Well-developed parabolic dunes	Local importance
34	Sønder Vosborg Hede	Heath with inland sand dunes and parabolic dunes on a hill island	NGI 77
35	Idom Å and Ormstrup Hede	River valley. Open heathland on a hill island	NGI 77
36	Skibsted Fjord - Kås Bredning	Coastal landscapes of the Limfjord	NGI 71 and NCL 87
37	Vestkysten	Simplification and barrier coast. The dynamic coast – coastal erosion and protection	NGI 76, NCL 80 and Geosite 4-4
38	Nisum Fjord	Coastal lagoon and the river Storåen delta. Marine foreland	"NGI 75 (northeast corner) NGI 77 (southeast corner)"
39	Oddesund	Coastal landscape. Spits, beach ridges and beach lakes	Local importance
40	Gjellerodde	Coastal landscape. Cuspate foreland	NGI 75 and NCL 84
41	Venø - Nørskov Vig	Coastal landscape. Cuspate foreland	NGI 72 and NCL 87
42	Odby Klint	Coastal cliff with Danian limestone and flint and evidence of three glaciations	NGI 73 and NCL 86
43	Bjørndal limestone quarry	Abandoned limestone quarry	Local importance
44	Hjerm limestone quarry	Abandoned limestone quarry and mine now used for storing and maturing of cheese	Local importance
45	Sevel limestone quarry	Abandoned limestone quarry with ruins of lime-kilns	NGI 64
46	Søndbjerg Strand	Coastal cliff with Miocene deposits	NGI 72 and NCL 87
47	Hygum Bakke - Kildeplads Engbjerg	Well field – ground water extraction for drinking water. Possible terminal moraine	NGI 76
48	The underwater landscape Jyske Rev	Drowned glacial landscape modified by marine erosion and deposition. Continuation of the Main Stationary Line in the North Sea	Offshore areas are not classified

* NCLxx - National Coastal landscapes
 NGIxx - Site of National Geological Interest
 Geosite - Site of international geological importance

Fig. B18 List of the 48 geosites in Geopark West Jutland with a short description and their designation according to the official Danish lists of Sites of National Geological Interest and National Coastal Landscapes.

B3. Details of the geological sites

In the table below (Fig. B19) details of the 48 geosites are shown with the geological and natural designations of the sites. The table also shows if public interpretation is available in the form of information panels and/or printed or digital information material and whether the geosites are being used for educational purposes and geotourism. A detailed description of the 48 geological sites is included as Supplement B3 in Annex 1.

No.	Name	Scientific importance		Public Interpretation		Education	Geotourism
		Geology/landscape*	Nature**	Panel	Print/web		
1	The Bovbjerg profile	NGI 76, NCL 80 and Geosite 4-4	NCA	+	+	+	+
2	Lomborg	NGI 75				+	+
3	Fabjergkirkevej	NGI 75		+	+	+	+
4	Skodborg Huse	Local importance			+	+	
5	Salshøj - Sønderhede	Local importance		+	+	+	+
6	Toftum Bjerger	NGI 74 and NCL 85	"Coastline is part of NAT28 2 NCAs"	+	+	+	+
7	Nørrelem - Nørre Nisum - Kamstrup	NGI 75 and NCL 84	"Coastline is part of NAT28 3 NCAs"	+	+	+	+
8	Bjerrumbuen	Local importance		+	+	+	+
9	Breinholtbuen	Local importance		+	+	+	+
10	Gimsing - Handbjerg	Local importance		+	+	+	+
11	Ryde - Sevel	Local importance				+	+
12	Nygård Hage	Local importance		+	+	+	+
13	Lem Vig	NGI 75 and NCL 84	"Coastline is part of NAT28 1 NCA"	+	+	+	+
14	Kilen - Horner	Local importance	NWR and 1 NCA	+	+	+	+
15	Hellegård tunnel valley	Local importance	2 NCAs	+	+	+	+
16	Stubbergård Sø - Flyndersø	NGI 64	"NAT41 2 NCAs"	+	+	+	+
17	Lomborg - Bonnet - Heldum	NGI 75		+	+	+	+
18	Nørre Nisum - Fabjerg	NGI 75		+	+	+	+
19	Odby till plain	Local importance			+	+	+
20	Klosterhede - Kronhede	NGI 75	NAT 224 and 65 and 1 NCA	+	+	+	+

21	The Storå valley	NGI 77		+	+	+	+
22	Trælborgdalen	Local importance		+	+	+	+
23	Fousing valley	Local importance	Part of NCA		+	+	+
24	Burlund	NGI 77			+	+	+
25	Møborg hill island	Local importance		+	+	+	+
26	Linde hill island – Sir Lyngbjerge	Local importance		+	+	+	+
27	The Græm profile	Local importance		+	+	+	+
28	Venø Bugt	Local importance	NAT62 and 1 NCA	+	+	+	+
29	Veserne - Plet - Engbjerg	NGI 76 and NCL 80	NAT28 and NWR	+	+	+	+
30	Sønder Lem Vig - Geddal Enge	Local importance	NAT32	+	+	+	+
31	Remmerstrand - Resen Kær	Local importance	1 NCA	+	+	+	+
32	Hellerød Kær	NGI 71 and NCL 87	NAT28 and NWR	+	+	+	+
33	Husby Klitplantage	Local importance	NAT74	+	+	+	+
34	Sønder Vosborg Hede	NGI 77	NAT64 and NCA	+	+	+	+
35	Idom Å and Ormstrup Hede	NGI 77	NAT64 and NCA	+	+	+	+
36	Skibsted Fjord - Kås Bredning	NGI 71 and NCL 87	NAT28, NCA and NWR	+	+	+	+
37	Vestkysten	NGI 76, NCL 80 and Geosite 4-4	NAT28, NCA and NWR	+	+	+	+
38	Nissum Fjord	"NGI 75 (northeast corner) NGI 77 (southeast corner)"	NAT65, NWR and 2 NCAs	+	+	+	+
39	Oddesund	Local importance	NAT28 along western coast	+	+	+	+
40	Gjellerodde	NGI 75 and NCL 84	NAT28	+	+	+	+
41	Venø - Nørskov Vig	NGI 72 and NCL 87	NWR	+	+	+	+
42	Odby Klint	NGI 73 and NCL 86	NAT28	+	+	+	+
43	Bjørndal limestone quarry	Local importance		+	+	+	+
44	Hjerm limestone quarry	Local importance		+	+	+	+
45	Sevel limestone quarry	NGI 64		+	+	+	+
46	Søndbjerg Strand	NGI 72 and NCL 87		+	+	+	+
47	Hygum Bakke - Kildeplads Engbjerg	NGI 76		+	+	+	+
48	The underwater landscape Jyske Rev	Offshore areas are not classified	NAT219-220-247	+	+	+	+

Fig. B19 List of geological sites showing their scientific importance/designation, availability of interpretation material, use for educational purpose and geotourism

* NCLxx - National Coastal landscapes

NGIxx - Sites of National Geological Interest

Geosite - Site of international geological importance

** NATxx - Natura2000 site

NWR - Nature and Wildlife Reserve

NCA - Nature Conservation Area - Designation can be based on values for natural beauty, nature, cultural heritage, scenery, research and recreational use

B4. List and description of other sites of natural, cultural and intangible heritage interest

The cultural and natural heritage of Geopark West Jutland is strongly influenced by the landscape and its geological history. Some of the most immediate examples of this are the early settlement patterns along the Main Stay Line where the early settlers found soil that was light enough for them to cultivate with their relatively primitive implements and yet contained enough clay for them to harvest a decent crop.

The North Sea, the Limfjord and other inner waters have changed dramatically since the ice melted away but have been a source of food and a shipping route with enormous importance for the development of the whole region and its people. The market towns Lemvig, Struer and Holstebro expanded considerably when the Harboøre-Agger isthmus was breached and the North Sea became accessible. Shipping however also faced many challenges and the story of the geopark is also the story of the Iron Coast with shipwreck disasters and the birth of the Danish National Sea Rescue Service.

The intangible heritage of the area such as “The spirit of West Jutland” has certainly been shaped by the harsh conditions along the coast and on the outwash plains and hill islands. For centuries the land south of the Main Stay Line

was open and almost devoid of forests and most of it was covered by heath with meadows along the rivers, lakes and lagoons. The land was excellent for grazing and the raising and export of steers was a major source of income. It also gave local people an outlook when they travelled to the markets in the south.

Wind and water has shaped the landscape in many highly visible ways. If you look at a tree in West Jutland you will almost always be able to tell where West is. As sand drift became an increasing problem the great plantations of the region were planted with stretches of heath and dunes in between. The river valleys shaped by meltwater are also significant landscape elements and together with the many meadows, beaches, lagoons and underwater reefs and other sites the region as a whole is very rich in nature which can also be seen from the many Natura 2000-sites, nature and wildlife reserves and nature conservation areas.

All of the above has led to the identification of 48 sites of natural, cultural and intangible heritage interest that are in so many ways linked to the geological heritage. A detailed description of each site is included as supplement B4 in Annex 1.

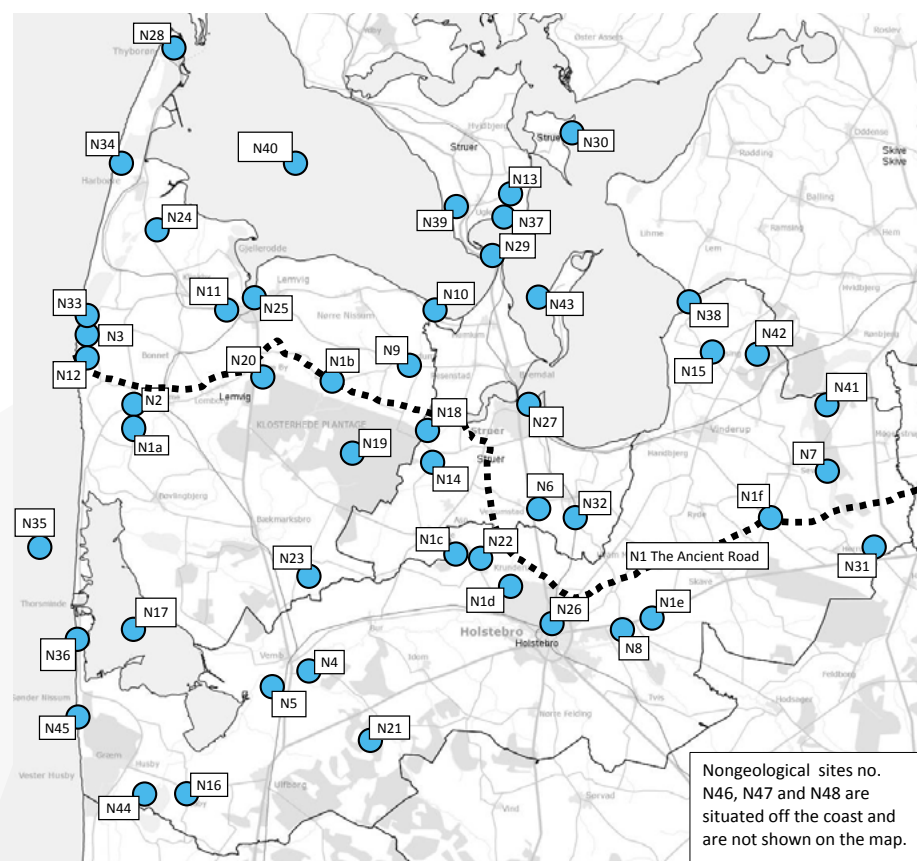


Fig. B20 Map with positions of the non-geological sites of natural, cultural and intangible heritage interest. Sites no. N46, N47 and N48 are situated in the North Sea along the coast and have not been shown on the map.

Fig. B21 List of the 48 non-geological sites in Geopark West Jutland with a short description of their natural, cultural and intangible heritage values. A comprehensive description of each site is provided in Annex 1, Supplement B4.

No.	Non-geological site	Short description
N1	The Ancient Road	Clear traces of prehistoric habitation along the Main Stationary Line marked by barrows and evidence of an ancient road passing through the entire geopark from the North Sea coast to Viborg in the east.
N1a	Barrows at Rammedige	Fifteen of originally 60 Stone and Bronze Age barrows constructed along the Ancient Road with an associated legend of a treasure to be found.
N1b	Barrows along Fabjerg Kirkevej	A fine example of how not only barrows but also Middle Age churches were built along the Main Stationary Line and the Ancient Road.
N1c	Mangeshøj	The name means “Many barrows” which is in agreement with the 13 pre-served barrows on the site. Also found here are traces of the Ancient Road that are very visible as parallel wheel tracks in the landscape together with an old milestone.
N1d	Døeshøjene	A group of 27 preserved barrows of which one has been archaeologically excavated revealing four graves from the older Bronze Age. There is also an old legend associated with the Barrow Langemette that will give visitors a challenge.
N1e	Single Grave Barrows at Mejrup Kirkeby	Five barrows from the Single Grave Culture (2800 – 2400 B.C.) during the New Stone Age when major changes in agriculture took place.
N1f	Salshøj	A group of barrows on top of a terminal moraine where valuable archaeological finds which are now in the National Museum in Copenhagen have been made. The site also has evidence of some of the old road system.
N2	Rammedige	Rammedige is an earthwork from the Iron Age that is believed to have been constructed in the period between 100 and 400 A.D. In 2011 a full-scale model of 30 m of the rampart and trench was built, and the continuation of the now removed part of Rammedige was marked by a series of posts.
N3	Bovbjerg Lighthouse	Bovbjerg Lighthouse has many functions. In addition to its role as an active lighthouse it is a cultural and exhibition centre as well as a cafeteria. It is run by a group of local enthusiastic volunteers under the watchful eye of a “Lighthouse Auntie”. It is located at the top of Bovbjerg cliff that is the most important geosite in Geopark West Jutland.
N4	Skærum Mill	Historical site which today houses the Folk University Centre (Danish University Extension Centre) and a number of unique exhibitions on art, cultural history, geology and a historical forest.
N5	Nørre Vosborg	The more than 700 year old manor house Nørre Vosborg was thoroughly renovated between 2004 and 2008. It is Denmark’s best documented manor house with a close connection to the history of the local area. The house is now a centre consisting of a hotel, restaurant and course facilities.
N6	Ausumgaard	Ausumgaard is one of the few manors that survived the so called slaughter of estates around the year 1800 and is today working to become a Power Hub for production and innovation of high quality locally based food products.
N7	Stubber Monastery and cattle pen	Historical ruin of a former monastery belonging to the Order of Saint Benedict with a nearby example of an ancient livestock pen and traces of the Drovers’ Road
N8	Tvis Mill and Monastery	Scant remains of the foundations of a large Cistercian monastery and an old water mill located between two watercourses of river Tvis Å. Holstebro municipality is establishing a new Tvis Mølle Nature Laboratory for school children, citizens and guests on the site which will also serve as a geopark visitor centre.
N9	Gudum Monastery and Klostermølle	The village of Gudum (God’s Home) was an important traffic junction and spiritual centre in the Middle Ages. Today there are the remains of two nunneries and a restored watermill (Klostermølle). The local population are very active and have been involved in restoring the mill, have established a series of paths (Kløverstier) and have amongst a number of projects rebuilt the former school into a new parish hall.

No.	Non-geological site	Short description
N10	Åmølle	The watermill at Åmølle is about 500 years old and is conserved as one of the most interesting water mills in Denmark. The mill has the only surviving intact example of a Roman drive in Northern Europe. It is located on raised sea floor close to the terminal moraine at Toftum Bjerge. It has been reno-vated and is being run by volunteers.
N11	Heldum Church	A very fine example of the 51 Norman ashlar churches in the geopark. Heldum Church is quite small and unlike many of the other churches it has not changed much since it was built just before 1200.
N12	Trans Church	Norman ashlar church on the west coast. The church has been excavated revealing remains of the previous wooden church and finds of German coins from the late Middle Ages bearing witness to trading connections with the Hanseatic League.
N13	Søndbjerg Church	Norman ashlar church. One of few magnate churches built with a tower. The foundation has Runic in-scriptions telling about who financed and who built the church. The church also tells stories of a late Middle Age fire, legends and ballads and even an earthquake.
N14	Fousing Church	Fousing church dates back to around 1200 and was built in the Norman style with later extensions. The church has a very interesting link to geology because of the many large blocks of rhomb porphyry that have been used for its construction.
N15	Ejsing Church and Landting	Ejsing church is a Romanesque ashlar church with an unusual number of large late Gothic additions. The church represents the story of how local squires influenced the church.
N16	Staby Church	A Norman ashlar church that is famed for its apse with two unique four leaved clover shaped windows and six arched arcades supported by 7 col-umns. Another special feature is the presence of many ashlar blocks of dark reddish-brown “iron sandstone” which sometimes are laid in continuous rows.
N17	Nissum Fjord Nature Park	Nissum Fjord is a natural site of international importance which is also rich in cultural history closely linked with the landscape. Importantly, the site is also the home of the Nissum Fjord Network, a community based organisation working to establish a nature park as a means to promote local development and tourism.
N18	Kjærgårdsmølle	In addition to the history of Kjærgaard watermill this site has a dramatic geological history as Kilen tunnel valley, and was also an important settle-ment in the younger Stone Age with ancient roads and sunken roads. There is a Nature School and the area has been administered in a successful co-operation between Lemvig and Struer municipalities, Nørre Nissum Tea-chers Training College and the Nature Agency since 1977.
N19	Klosterheden	Klosterheden is the common name for both Klosterheden and Kronheden Plantations with a total area of 6.400 ha making it the third largest woodland area in Denmark. The area is rich in ancient monuments and contributes to the story of the succession of plants from the end of the last ice age until today. It also provides insights into the development of local fauna including the site where beavers have been reintroduced to Denmark.
N20	Rom Airfield and World War II	During World War II the Germans build an airfield for fighter planes with hangars, a hospital and bunkers on the outwash plain just south of Lemvig. After the war the airfield was used as a refugee camp for up to 9,000 refu-gees from Eastern Prussia. The site is part of the story of World War II in the geopark.
N21	Stråsø Plantation	In 1891 the Danish state started buying land in this area in order to plant trees to reduce the effect of windblown sand and to produce timber for the region. The plantation gradually expanded up to 1940-42. Part of the area is designated Natura 2000 with heaths, inland sand dunes, mulberry and oak scrubland and a strip along river Idom Å that is one of the cleanest and most undisturbed water-courses in Denmark.

No.	Non-geological site	Short description
N22	Sir Lyngbjerg	Sir Lyngbjerg is a site of high scenic value with a long history as a location for public meetings, celebrations and debates on democracy and freedom, gathering thousands of people. The area has a historical route with eight memorial stones erected over a period of 100 years celebrating events of national importance, royal persons and local people of high regard. The story of the local geology is also communicated.
N23	Møborg Bavnehøj	Møborg Bavnehøj (beacon) is one of many high points in Geopark West Jutland from where there is an excellent view of the surrounding landscape. The beacon is a good example of how the formation of the landscape and cultural history are connected, and how communication can be carried out in cooperation with local volunteers.
N24	Hygum Hill	Hygum Hill is really a former water tower in an area that contains 36 bar-rows and remains of German fortifications from World War II. There is a fine view of the landscape and the site has excellent opportunities for information on where we get our water from.
N25	Lemvig Market Town	Lemvig is a Middle Age market town at the base of a bay with a harbour and road connections to its hinterland which has made the town an important trading centre – especially after 1825 when the Aggertange isthmus was breached and Lemvig gained access to the North Sea. The surrounding area consists of fertile till soil.
N26	Holstebro Market Town	Market town and trading centre located at a crossing point over the Storå river where several roads converge. Holstebro is a cultural centre with modern industry and educational facilities.
N27	Struer Market Town	Struer is a young town that developed as a result of industrialisation in the 1800s with a harbour and railway connections. It was a further development of an old market place and a landing site on the beach. The town evolved around a brick works.
N28	Thyborøn	Thyborøn and the surrounding landscape on the spit Harboøre Tange bear witness to dynamic events and attempts by mankind to tame them. This is an excellent example of an “engineered landscape”. Thyborøn is also home to three information centres on landscape formation, nature and cultural history.
N29	Oddesund	Historically Oddesund has formed a very important connection between north and south. The locality is important in a cultural historical context with ferries, bridges, fishing, fortifications and an eccentric recluse. The location has considerable recreational value and there are plans to make it an experience and communication centre.
N30	Jegindø harbour	Jegindø harbour involves the history of fishing in Limfjord and its development from “sjægten” (a primitive fishing boat with a sail unique to Limfjord used until about 1900) to motorised fishing boats with modern mussel-dredgers and special boats to collect longline cultured mussels.
N31	Sevel Kalkværk (Lime-works)	Sevel Kalkværk (Lime-works) is run by a group of volunteers and is one of the communication sites for the geopark. The story told is about the quarrying of limestone since 1873 until 1960 and the geological explanation for why the quarry exists.
N32	Hjerm Limestone Mine	Hjerm limestone mine provides an opportunity to communicate geology in a first rate combination with cultural history, nature and food produce. The mine, that is part of Geosite nr. 44, has become a home for bats in one section, and a store for the maturing of cheese in another.
N33	The groynes at Ferring	The steep cliffs at Bovbjerg and Ferring are a result of hundreds of years of coastal erosion. Groynes were built perpendicular to the coast in 1875 to reduce this erosion. This was the beginning of the coastal defence system along the Danish West Coast.
N34	Flyvholm Sea Rescue Station	The underwater landscape along the west coast – the so-called “Iron Coast” – has been closely connected with many dramatic shipwrecks through the years. Part of the story concerns the efforts made to save the lives of the crews. Flyvholm Sea Rescue Station was the start of the National lifeboat service.

No.	Non-geological site	Short description
N35	Submarine Stoneage settle-ments	The oldest discoveries of Stone Age settlements in the area under the re-spon-sibility of Holstebro Museum were made off the west coast. These finds serve to emphasize the dramatic changes in the landscape that have taken place since the last ice age.
N36	HMS St. George and HMS De-fence	Marine archaeological finds of international significance from the largest ship-wreck catastrophe on the west coast of Jutland in 1811 when two Eng-lish vessels of the line stranded offshore from Thorsminde and 1408 drowned. The story of this tragic event will be told at a new stranding mu-seum in Thorsminde open-ing in 2017.
N37	St. Mauritii spring	The Holy Spring St. Mauritius on the beach at Serup dates back to the Mid-dle Ages. The name comes from a Roman legionary who became a saint.
N38	Sønderlem Vig and Geddal Tidal Meadows	This site tells the story of the enclosure and draining of a near-coast area to pro-vide more agricultural land and the wide variety of interests that are involved. The area is a valuable nature area with Natura 2000 status and a possible future nature park.
N39	Odby village	From the agrarian development in the Viking age to the industrial age; the role of geology. Odby village provides a good illustration of the special infield-out-field system.
N40	Natura 2000 site no. 28 Agger Tange, Nissum Bredning, Skib-sted Fjord and Agerø	This is the largest single natural area of international significance in Geopark West Jutland. About 85% of the area is maritime with considerable value for recreation and communication.
N41	Part of Natura2000 site no. 41 Hjelm Hede, Flyndersø og Stubber-gaard Sø	This is a varied, naturally infertile area with unspoiled nature in interplay with cultural landscape elements and the potential for a range of experi-ences. The Outdoor Museum Hjerl Hede that is located just west of lake Flyndersø is a splendid communication centre with many visitors.
N42	Natura2000 site no. 61: Skånsø and Tranemose	A heathland and plantation area with a very clean lake with water lobelia plants. The lake developed in a dead ice hole (kettle hole). There is also a small bog and a rather overgrown area where peat used to be extracted.
N43	Natura2000 site no. 62 Venø and Venøsund	Nørskov Vig on the northern tip of Venø island, Venøsund (Venø sound) and the tidal meadows on the mainland west of Venø have considerable natural value with a rich birdlife and many stony reefs. The inhabitants of the island are keen to protect these assets in a sustainable fashion.
N44	Natura2000 site no. 72 Husby Sø	Of the entire Natura 2000 area it is only lake Husby Sø that is part of Ge-opark West Jutland. The lake has a rich flora and fauna and bears witness to land recla-mation projects during and after World War II.
N45	Northern part of Natura2000 site no. 74: Husby Klit	This Natura 2000 site contains valuable sand dune landscapes. Together with Husby Klitplantage (plantation) the area has considerable potential for open air activities and communication regarding cultural history and nature.
N46	Natura2000 site no. 219 Sand banks off the coast from Thy-borøn	The three areas comprise sandbanks and stony reefs that rise from the floor of the North Sea. These areas are the objects of current investigations and are of considerable research interest. They are also of interest from a marine archaeo-logical viewpoint.
N47	Natura2000 site no. 220 Sand banks off the coast from Thor-sminde	
N48	Natura2000 site no. 247 Thy-borøn Stenvolde	

A detailed description of all the 48 non-geological sites is provided in Annex 1, Supplement B4 to this application.

C. GEOCONSERVATION

C.1. Current or potential pressure on the proposed Geopark

Pressure on or threats to the heritage values of Geopark West Jutland can be defined from a number of angles. One of the core values of the geopark has been defined “Fascination”- the fascination of the power of nature, the longtime perspective, the evolution of our cultural history and the future challenges and possibilities. Yet the same power of nature and the natural dynamics are also what we sometimes perceive as threats, for example when a valuable open landscape due to natural processes starts to be covered by trees or when storms and natural dynamics along our coasts threaten the everyday life of people living and working there. Some of these pressures and threats that might be seen as part of natural processes are happening much faster and have far more immediate consequences because they are being fed by what is considered unnatural causes. Other potential threats come from conflicting developments, for example when so called local development puts pressure on nature, landscape or cultural values. Below are some of the most immediate potential pressures and threats on Geopark West Jutland.

Climate change and flooding

According to the Intergovernmental Panel on Climate Change average global temperature increased by 0.85°C from 1880 to 2012. From 1901 to 2010, the global average sea level rose by 19 cm. The Arctic’s sea ice extent has shrunk in every successive decade since 1979, with 1.07 million km² of ice loss every decade. It is likely that by the end of this century, the increase in global temperature will exceed 1.5°C compared to 1850 to 1900 for all but one scenario. Average sea level rise is predicted as 24 – 30cm by 2065 and 40-63cm by 2100. Most aspects of climate change will persist for many centuries even if emissions are stopped.

In Denmark mean temperatures have gone up by 1.50 since 1870 and depending on which climate scenario is chosen the expectation is that the temperatures will continue to go up by 1.20 – 4.0 by the end of this century compared to 1986-2005. Precipitation is estimated to increase by 1.6% to 6.9% annual average at the end of the century with as much as 18% increase during winter and -16.6% in summer meaning possible drought during summer and flooding during winter. Winds and the frequency and force of storms are also expected to increase in this century. Sea level rise in Danish waters is expected anywhere between 0.1 and 0.9 m by the end of the century depending on scenario.

The consequences of climate change in the geopark area have already been experienced with more frequent floodings and increased water levels. Lemvig and Struer have been flooded from Limfjorden and Holstebro from the Storå river. With increased storm frequency and force many of the coastal geosites are likely to be affected more by coastal erosion and cultural sites like Bovbjerg Lighthouse will also be affected.

Invasive species

The official number of invasive species in Denmark is 63, i.e. 34 plants, 25 animals and 4 algae/fungi. Of these the Rugosa rose have been a special concern for a long time along many of the coasts of the geopark where it has been spreading over huge areas displacing natural flora of beach and dune vegetation and affecting both common and rare species. Another plant species that is causing problems on many of the natural areas in the geopark such as inland dunes and heath lands is the dwarf mountain pine *Pinus mugo*. The pine was originally introduced as a pioneer species when the first plantations were established but it is now causing problems by overgrowing many of the open natural areas.

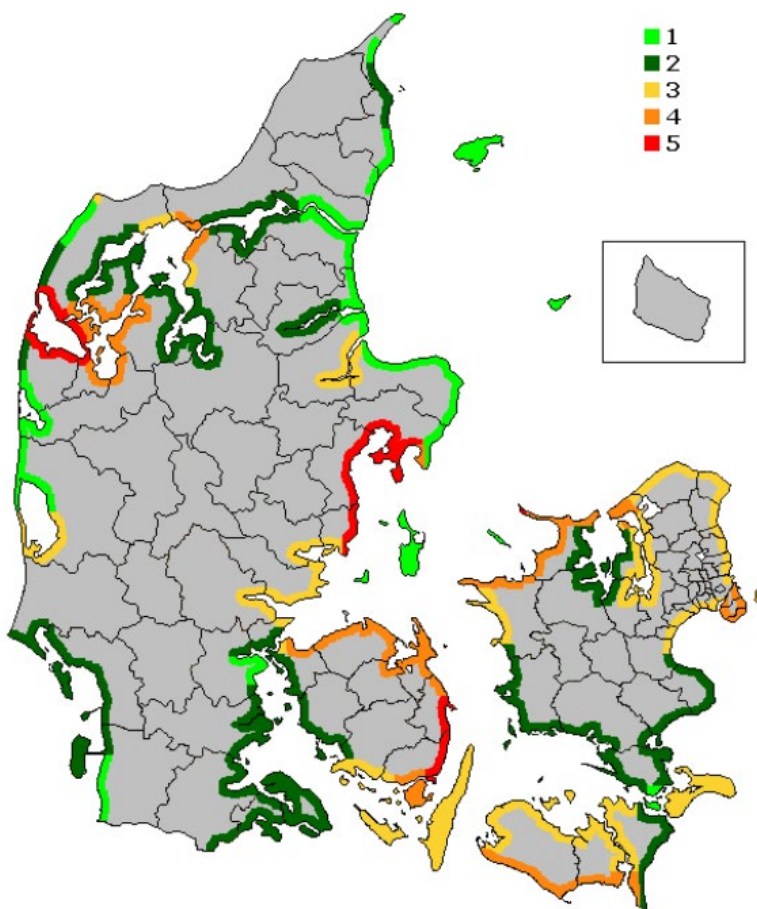


Fig. C1 The map shows the frequency of storm surges on the various stretches of coast in Denmark over the years 1991 to 2009. It is obvious that the geopark area has had its share. (Stormrådet 2009)

Among invasive animal species both the American mink and Raccoon dog are considered invasive causing damage to the native fauna especially ground nesting birds.

In the marine areas a tasty (for some) invasive species – the pacific oyster, has been spreading in Danish waters over the past 20 years. It is feared to displace native species such as the blue mussel and native European oyster and thus it may also affect populations of birds that depend on mussels as food, such as the eider duck and the oystercatcher.

Most of the invasive species cannot be removed but only controlled to a certain degree and the municipalities and the Nature Agency in cooperation with local citizens run various programs for this purpose.

Overgrowing with unwanted trees and bushes

As mentioned above many of the open natural areas are being overgrown by trees and shrubs – not only by invasive species but also as part of a natural succession and often assisted by airborne pollution with nutrients. To overcome this problem grazing, burning, cutting and mowing are being used but are in several cases costly.

Pollution

Pollution in different forms constitutes a threat to the natural, cultural and intangible heritage of Geopark West Jutland in many ways, whether it is solid waste on land, plastic in the ocean, chemicals in the ground water, noise or airborne nutrients or any other of the many different types of pollution. The geopark will have a role to play in informing various target groups on how they can contribute to a cleaner environment and help preserve the values of the geopark and the environment as a whole. Groundwater and the associated management is a topic that combines geology, nature management and planning with a central element of people's everyday life. Clean water that you can drink straight from the tap is taken for granted by most Danes and yet many of them are not fully aware of where it comes from and what needs to be done to protect it. On www.denmark.dk – the official website of Denmark the clean drinking water is highlighted as a selling point for Denmark that can also be used in connection with promotion of Denmark

as an environmentally friendly destination. The geopark in cooperation with the Water Utilities will make this a special topic.

Damage to marine sites

Geopark West Jutland has three non-geological sites in the North Sea which are designated Natura 2000-sites. The basis analyses for these areas mention possible damage to the seafloor by fishing gear being dragged over the bottom and thereby causing disturbance and damage. At present there are not sufficient data on this type of pressure to decide whether regulations have to be enforced, but as part of the Natura 2000 management it will be investigated.

Mining of raw materials

Mining of raw materials in the offshore area of the geopark, especially on the Jutland Reef is the largest operation of its kind in Denmark. Data from the Danish National Statistics show that almost 3.3 mio. m³ is being extracted annually from the North Sea as a whole and in 2014 1.1 mio. m³ was unloaded in Lemvig Municipality. A significant part of the raw materials being extracted from the North Sea is being used for sand nourishment along the coast to reduce erosion.

Disturbance

Flora and fauna can be affected negatively by increased recreational activity causing degradation of natural sites, loss of habitat and disturbance of birds and animals. If not handled carefully increased tourism can also cause disturbance of local culture and everyday life and lead to conflicts. The geopark will have an important role to play in developing geotourism in line with the National Geographic Geotourism Charter.

New developments

Cultural environments and landscapes can be vulnerable to new developments if new infrastructure, facilities and technical installations are constructed without taking the necessary precautions. A good example of this and a much discussed topic in these years are the new wind turbines that are being erected, especially along the coast.

C.2./C.3. Protection and management of geological and non-geological sites within the proposed Geopark

Geological as well as non-geological sites in Geopark West Jutland are protected by national legislation. In Denmark it has been policy that the designation of a geopark, a nature park or a national park will not lead to stricter regulations as a result of the designation itself. The motives for this approach have been the desire to ensure local cooperation and participation and to avoid resistance against the setting up of any of these types of parks. Furthermore, the natural, cultural and intangible values of national, nature or geoparks are considered to be sufficiently protected by existing legislation. In the

following chapter key legislation of importance for the protection of both geological as well as non-geological sites will be mentioned.

Background for planning and management of heritage sites

The basis for the administration of the various sites is data providing the authorities at national, regional and municipal levels with the necessary background for planning and management.

A map of nationally important areas of geological interest (NGIs) was made in the beginning of the 1980s by the Conservation Agency, which is now The Danish Agency for Water and Nature Management. 197 NGIs were identified and since then new NGIs have been added but some have also been taken off the list, so the number remains at 197 NGIs across the country. The sites have been described in series of 6 books that also contain management recommendations for the sites. 38 of the NGIs have also been designated Geosites, which are sites considered as being of explicit international scientific value. The 38 Geosites have been categorized in 12 themes which are described on the homepage www.geosites.dk.

In 2004 the designation and description of 99 National Coastal Landscapes (NCLs) was published. The NCLs are all considered important for their coastal geology, geomorphology and dynamics and as such they overlap with some of the NGIs.

8 of the NGIs are found in Geopark West Jutland and 26 of the geopark's 48 geosites are located fully or wholly in one of the NGIs. 12 of the geosites of Geopark West Jutland are situated fully or partly in 5 of the NCLs. Fig. 1 in the explanatory notes to the Self Evaluation Document in Annex 1 to this application contains a list of the geopark geosites with mentioning of their scientific importance.

Natural sites, population sizes of various species and the location of specific cultural heritage sites, monuments,

buildings worthy of preservation and cultural environments as well as the occurrence of raw materials have been mapped by the responsible authorities and these records form the basis of management in accordance with relevant legislation.

International legislation

In accordance with the Treaty on European Union a number of Directives which are binding for the member states have been issued. In relation to the geopark the Water Framework, the Habitats and Birds Directives are the most important.

The Water Framework Directive aims to secure and preserve the quality and current condition of lakes, rivers and streams, coastal waters and lagoons. The directive also has to secure both the quality and quantity of ground water. The Birds Directive (1979) and Habitats Directive (1992) list a number of species, nature types and habitats that are of special concern and need of protection which is combined in the establishment of a network of Natura 2000-sites.

The Birds Directive, Habitats Directive and the Water Framework Directive are legally binding and offer protection, which in Denmark has been incorporated into the Environmental Targets Act (Miljømålsloven). In Denmark 252 sites have been designated as Natura 2000 in accordance with the EU Habitats and Birds Directives. They are natural sites of international importance and

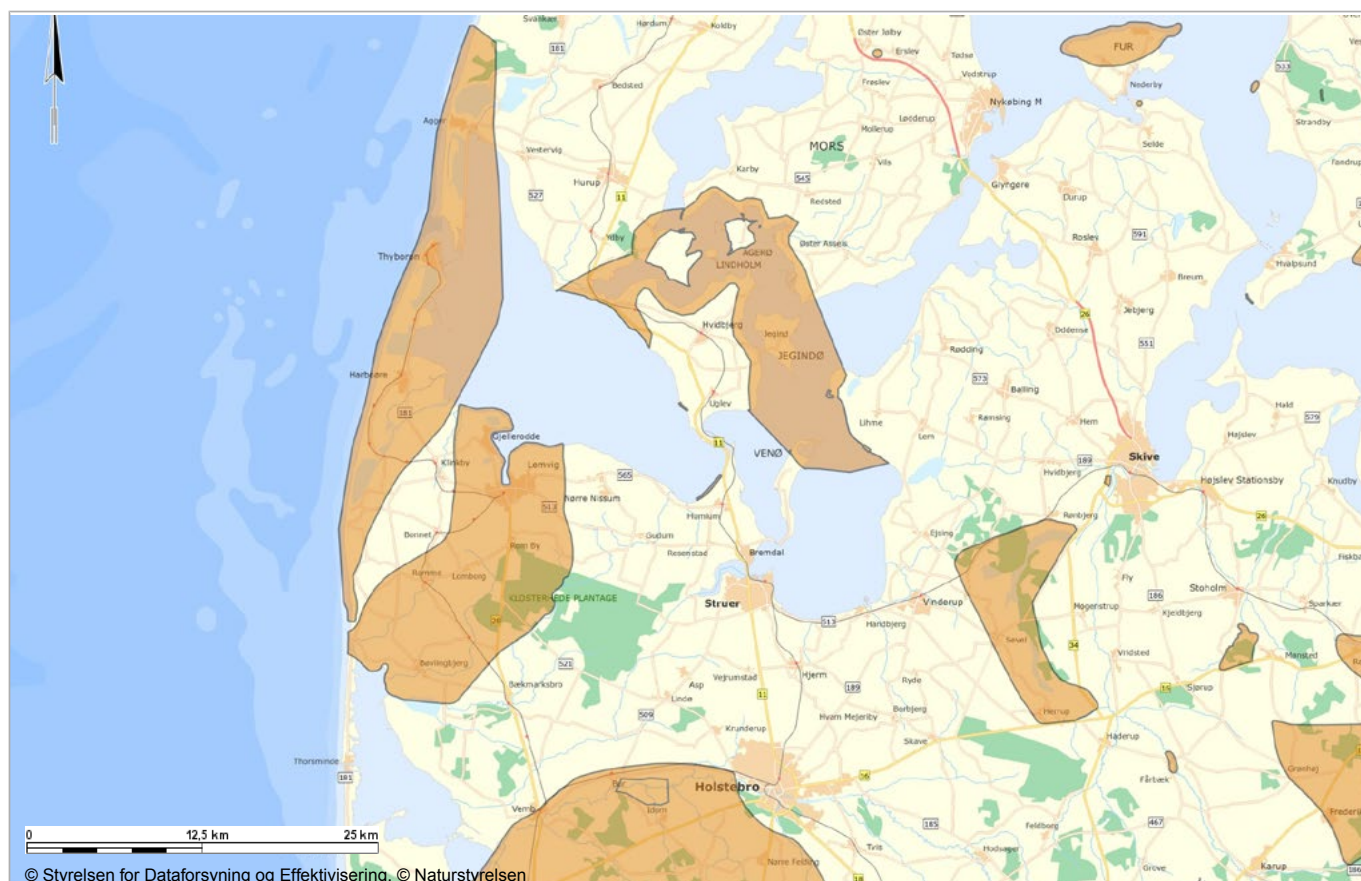


Fig. C4 Map of valuable geological areas from the national database. These are National Areas of Geological Interest (NGIs), National Coastal Landscapes (NCLs) and/or International Geosite (The Nature Agency)

	Size (in ha) of areas protected under Section 3 of the Nature Conservation Act (2006 data)						
	Meadow	Heath	Bog	Dry grass-land	Salt marsh	Lake	Total
Lemvig municipality	676	630	960	437	1139	1528	5370
Struer municipality	281	169	315	177	555	429	1926
Holstebro municipality	1256	2929	2295	256	574	1092	8402
							15698

Fig. C6 The total size of areas protected under Section 3 of the Nature Conservation Act in Lemvig, Struer and Holstebro municipalities – 2006 data (The Agency for Water and Nature Management).

part of a European network of protected sites. For each of the sites a basis analysis is produced as background for a specific Natura 2000-plan. For all privately and municipally owned land the municipalities are responsible for management of Natura 2000-sites. On state owned land the Ministry of Environment is responsible. Fig. 3 in the explanatory notes to the Self Evaluation Document in Annex 1 to this application contains a list of the Natura 2000-sites in Geopark West Jutland which have all been included in the list of non-geological sites.

The Water Framework Directive sets the framework for the protection of streams, lakes, deltas, lagoons, coastal waters and groundwater and defines a set of environmental targets and River Basin Districts. Each River Basin District is subdivided into a number of River Basins. For each River Basin a management plan has to be developed. Geopark West Jutland covers parts of two River Basins which are more or less divided along the Main Stay Line. The Ministry of Environment has the responsibility for the preparation of the overall plans for River Basin Districts and that the environmental targets are met. The municipalities are responsible for the actual implementation at River Basin level.

National legislation

The Planning Act

According to the Planning Act Denmark is divided into three zones: urban zone, summer house areas and a rural zone. The municipalities are responsible for the administration and development in these zones and for drawing up municipal plans, which must contain guidelines for sustainable development. Municipal Plans are to be updated every four years in order to fulfil The National Interests in the three zones. The National Interests are provided by the Ministry of Environment. Fig. A8 in Section A3 is a diagram of the relative distribution of each of the zones in the geopark.

Also in accordance to the Planning Act all municipalities are required to provide guidelines on securing landscape and geological assets worthy of conservation in their municipal plans.

Lemvig municipality mentions 4 particular areas of geological interest where the targets are to conserve and develop characteristic landscape features of high quality and to find the right balance between use and protection of the landscape. The four areas mentioned are Bovbjerg

Cliff, the meltwater plain Kronhede, Lem Vig and the coastal area from Thyborøn to Nissum Fjord. Also listed in the municipal plan are cultural environments which include the Ancient Road, coastal areas around Lem Vig and areas in Klosterheden Plantation. This is consistent with many of the geological and nongeological sites in Geopark West Jutland. With the upcoming revision of the municipal plan the connection to the geopark is expected to be further strengthened.

Struer municipality has revised a land- and seascape character assessment from 2005 leading to the designation of 10 landscape character areas of which 4 are considered particularly valuable. The plan also sets targets for the protection and strengthening of the cultural heritage and specifically mentions Oddesund, the Ancient Road and churches as being focal areas which also corresponds well with the geological and nongeological sites of the geopark.

Holstebro municipality has designated areas around Nissum Fjord, along Storå River, around Stubbergaard Lake, Geddal Strandenge and Sønder Lem Vig as landscapes which are not or only to a small degree disturbed by noise or technical installations. The municipal plan specifies that these landscapes are kept free from new large technical installations. The plan furthermore identifies 5 areas, i.e. Flynder Sø, Bur, Lilleå River, Sandfær and Sønder Vosborg Hede of geological interest where the aim is conserve and protect the areas and secure public access. Where possible the municipality will work to secure the scenic values by grazing and clearing of bushes and trees.

The Nature Conservation Act

The purpose of the Nature Conservation Act is to protect the nature and environment for society to develop on a sustainable basis with respect for both living conditions of Man and the preservation of animals and plants. The act provides general protection of habitats including natural areas of a certain size such as lakes, moors, bogs, marshes, water meadows and dry grasslands. These areas are protected under Section 3 of the Act and owners are not allowed to alter them. The Act also provides the legal framework for the designation of Nature Conservation Areas and establishes protection zones along the coast and streams, around lakes, forests and historical monuments and churches. The Act also establishes a respon-

sibility for the municipal councils to implement Natura 2000-plans. It also contains decisions on public access to different categories of land.

The Consolidated Act on Museums

According to the Museums Act the museums shall work and cooperate to safeguard Denmark's cultural and natural heritage and ensure access to and knowledge about this heritage and its interaction with the surrounding world. The planning authorities are required to involve the relevant cultural heritage museum when preparing a structure plan or local plan affecting assets worthy of preservation. The Ministry of Cultural Affairs is required to inform planning authorities of the presence of valuable cultural heritage. The responsible museum will have to be consulted in connection with the granting of permits for construction work, extraction of raw materials, starting forestry or agricultural activities that may cause harm to cultural heritage. If deemed necessary the museum can demand to carry out a preliminary examination/excavation of a construction site or similar before a project can start.

Ancient relics, monuments and ship wrecks that must be assumed lost more than 100 years ago and which are found in water courses, lakes or at sea in territorial waters belong to the state. It is not allowed to alter underwater cultural heritage.

The Act also provides a general protection of ancient walls of stone and earth, ancient relics and monuments. Cultivation cannot take place closer than 2 meters from barrows and other ancient relics and monuments nor is it allowed to use metal detectors within this zone. Authorities that own ancient monument are required to maintain them. Up to a distance of 100 m from an ancient monument the state of the surroundings cannot be changed.

Fig. C7: Using aerial archaeology Lis Helles Olsen from Holstebro Museum has identified a vast number of historical sites that were hitherto unknown (Lis Helles Olsen, Holstebro Museum).

The geopark area is very rich in ancient monuments. The Ancient Road stretches 110 km from the West Coast to East of Viborg. Of the 110 km 65 km are inside the geopark. Along the entire stretch of the road approximately 560 preserved barrows can still be found and there are records of additional 1300 barrows that have been ploughed over. The cultural history museums of Holstebro look after more than 5,500 ancient monuments in seven municipalities including the three municipalities in the geopark. The Shipwreck Museum St.

George is part of the cultural history museums of Holstebro and has the marine archaeological responsibility for the Danish part of the North Sea from Thyborøn to the Danish-German border. Holstebro Museum has also carried a vast number of flights using aerial photography to discover new sites and traces of our past. In late 2016 they opened a special exhibition on "aerial archaeology" themed History in the Corn.

The Forestry Act aims to preserve and protect existing woodland, to increase Denmark's overall forested area and to promote sustainable management of woodland in relation to economic, ecological and social interests. The Act also aims to preserve and protect the landscape, the natural and cultural history and accommodate outdoor recreation. The modern Forestry Act was developed from Fredskovsforordningen (the Forest Reserve Regulation) of 1805, established by King Christian VII to preserve existing forest and to increase the overall forested area. At that time, woodland only covered 4% of Denmark. Thanks to more than 200 years of forest legislation, Denmark's valuable cultural history has also been protected. The regional administration of the Nature Agency is situated in Klosterheden Plantation.

The Mineral Resources Act aims to secure deposits of mineral raw materials in Denmark. The Act covers stone, gravel, sand, clay, lime, chalk, peat, topsoil, and so on. It is the task of the five Regions to map out raw material resources and to plan their extraction, while the municipalities are responsible for granting permission to extract them on land and provide for the restoration of extraction sites in cooperation with the stakeholders concerned.. At sea the administration of permits for the extraction of raw materials such as sand, stones and gravel is handled by the Agency for Water and Nature Management whereas extraction of oil, gas and salt falls under the Danish Energy Agency.

The purpose of the Water Supply Act is to ensure that the exploitation and the related protection of water reserves are based on exhaustive planning on the basis of an overall assessment. Administration of this act includes establishing the size of water reserves, the needs of the population and businesses for water supplies that are adequate and of satisfactory quality, as well as the protection of the environment and of the countryside, including the conservation of the quality of the surroundings and the use of raw material reserves. In the three municipalities of Geopark West Jutland there are 14 waterworks organised in three municipal utility companies. The Agency for Water and Nature Management are responsible for mapping of the ground water resources.



Fig. C7 Using aerial archaeology Lis Helles Olsen from Holstebro Museum has identified a vast number of historical sites that were hitherto unknown (Lis Helles Olsen, Holstebro Museum).

D. ECONOMIC ACTIVITIES AND DEVELOPMENT PLAN

D1. Economic activity in the proposed Geopark

Employment and business

Transport and trade together with industry and raw materials are the dominating business sectors by number of jobs. Noted is also that the primary sector with forestry, agriculture and fisheries employs 7% - 14% of the work force which is much higher than the national average of 4% for this sector (see Section A3). Unemployment rate has gone down since 2009 and is on average for the three municipalities lower than the average for the rest of the country. Some sectors even find it hard to find candidates for vacancies.

The total number of jobs in the three municipalities is 48,129 of which the 32,539 jobs are in the private sector, although this varies significantly between the three municipalities with 65% in Holstebro and 74% and 71% in Lemvig and Struer respectively. The concentration is largest near the urban communities (Struer, Lemvig,

Holstebro and Vinderup) and the fishing port in Thyborøn/Harboøre. In the period 2010-2013 there has been an average loss of 4.7% of jobs across the municipalities. The losses have been most significant in Lemvig and Struer with respectively 4.9% and 8.7%. The work force is quite mobile between the three municipalities with between 20% and 40% of the employees commuting in or out from neighboring municipalities.

Lemvig and Holstebro municipalities have experienced an increase in the number of new businesses between 2009 and 2013 of 34% and 25% respectively and Struer has experienced a drop of 25% in the same period. Food production and specialized industry are the two business sectors that have the most jobs and where the growth in productivity rates is above national average.

The area is characterized by strong corporate traditions. Bang & Olufsen (2000 employees) in Struer, Valdemar Birn (450 employees) and Færch Plast (1100 employees) in Holstebro are some of the biggest companies in the geopark.

A central part of the west coast culture in the Geopark is associated with fishing and more than 300 million DKK has been invested in the infrastructure on the harbour in Thyborøn in the period from 2001 to 2014. Fishery with associated businesses is responsible for more than 1100 full time jobs and have a turnover of approximately 1,5 billion DKK a year. This makes Thyborøn the 3rd largest fishing port in Denmark.

Tourism

The revenue from tourism in Denmark amounted to 87.2 billion DKK in 2013. 15.7 billion DKK of this amount was revenue generated in Central Region Denmark, of which the 8.2 billion DKK was directly related to tourism, 4.1 billion DKK was revenue generated by tourism in the retail industry and 3.5 billion DKK came from sale of other products in relation to tourism. In the three municipalities, which Geopark West Jutland lies within, the revenue from tourism is approximately 1.6 billion DKK. Tourism contributes to 3.6% of the balance of payments in Denmark, which makes tourism the 4th most important export article.

The number of full time jobs in tourism in the geopark was 2,144 in 2013 which is 7% of jobs in Lemvig and 4% and 3% in Struer and Holstebro municipalities respectively.



Fig. D1 *Thise Dairy is the second largest dairy company in Denmark. They have had a lot of success with cheeses stored at geosites in Geopark West Jutland. They are expanding storing facilities near Bovbjerg Cliff (geosite no. 1)*

	Lemvig	Struer	Holstebro	Denmark
No. of holiday homes	2,290	1,233	2,674	214,753
Estimated no. for rent	790	425	923	39,944
Commercial rent	53%	11%	39%	35%

Fig. D3 Number of holiday homes available for rent per municipality and for the whole country (2014). Commercial rent is the number of weeks that holiday homes were rented by paying guests compared to the number of weeks they were available for rent.

	2010	2011	2012	2013	2014	2010-14
Lemvig	710	695	663	626	650	-8%
Struer	143	164	176	174	185	30%
Holstebro	578	605	597	562	591	2%
Denmark	43,136	44,657	44,468	44,603	46,831	9%

Fig. D4 Number of overnight stays in the geopark municipalities compared to Denmark as a whole. Preliminary figures for 2015 indicate an increase for all three municipalities with numbers above the 2010-level.

Lemvig, Struer and Holstebro municipalities are part of the tourism partnership Enjoy Limfjorden which is a cooperation between 6 municipalities working to attract more visitors to the Limfjord destination, which already now have more than 2.3 mio. overnight stays and a generates a n annual revenue of more than 3 billion DKK.

Section D2 provides information on geo-tourism potential based on an analysis for Geopark West Jutland from 2016.

Food

The Central Denmark Region brands itself as the epicenter of food production and research in Denmark. The food industry in the region is responsible for 52% of the Danish industrial export in the food sector. A lot is being done to promote sustainable and innovative food production from the very small producers to the large scale industry. Central Denmark Region has been awarded the prestigious “European Region of gastronomy Award” for 2017 as one of three European regions. This coincides with Aarhus, the capital of the region, becoming European Capital of Culture. To celebrate these awards a comprehensive and very ambitious program has been planned with many activities focusing on local quality food.

Food production, manufacturing, research and trade also play a significant role in the geopark as mentioned

above. Geopark West Jutland works to promote the geo-food concept through local food festivals, promotion of cooperation between restaurants, tour guides, food producers and local accommodations. In 2016 a Geopark West Jutland Food Award of 1,500 Euro was introduced. The geopark will also play a part in the European Award of Gastronomy Award and the celebration of Aarhus 2017 – European Capital of Culture which includes the whole region. Together with partners from the Wadden Sea World Heritage Site and national park Geopark West Jutland is undertaking a project titled “Oyster Celebration”. The intention is to bring stakeholders working with oysters both in the Wadden Sea and in the Limfjord together to develop common concepts for tourism oriented packages and also to create big oyster events. The packages will involve mussel, oyster and shellfish producers, retailers, restaurants, hotels, visitor centres and travel agents with an aim to promote geofood and geotourism products that can marketed for a long time afterwards.

The geopark has signed an expression of interest to support the development of Ausumgaard (Non-geological site N6) as a power hub for food innovation. The geopark also works together with the Center for Food Innovation (VIFU) in Holstebro which has supported the geopark-project “Food Culture and Tourism” which brought local stakeholders involved in tourism, food production and catering together to foster inspiration and cooperation.

D2 Existing and planned facilities for the proposed Geopark

Geopark West Jutland has formulated a Development Plan 2016-2020. The plan lists a series of activities under the following 8 headlines:

1. Information and communication
2. Guiding, training and education
3. Cooperation with information centres and new projects
4. Recreational infrastructure

5. Geofood and other geopark products
6. Volunteer program
7. International and national cooperation
8. Research

In this chapter existing and planned facilities will be presented. For more details on the contents of the Development Plan please consult supplement A4-1 in Annex 1.

Information Centres and Museums

The Geopark will not establish a new independent Geopark centre. Instead, the geopark will cooperate with the existing information centres and museums and contribute to new exhibitions and activities. In the following a brief presentation of existing and planned information centres and museums will be provided.

Kystcentret (The Coast Centre) provides information on the forces that are shaping the West Coast and the human attempt to stem this through coastal protection. A part of the exhibition covers the story of the Russian frigate *Alexander Nevskij* that stranded with 724 people on board and the rescue of almost all of them. The centre also includes a reptile zoo with a number of animals typical of the nature in West Jutland. A part of *Kystcentret* is a bunker, where the story of the Danish spy, known as “the turtle spy” is told. The centre also provides a school service and guided tours.



Fig. D6 *Kystcentret (The Coast Centre) in Thyborøn offers both indoor and outdoor activities (Visitnordvestjylland).*

Jyllandsakvariet (The Jutland Aquarium) has exhibitions with historical fishing tools and aquariums with fish that can be found in the Limfjord and the North Sea. At *Jyllandsakvariet* it is possible for the visitors both to see and touch many of the different fish. The aquarium also offers a number of excursions on foot to the beach to collect amber, with their tractor-bus to visit a wind mill farm and look for seals, and also a boat safari to the nearby seal banks. It is also possible to go on a guided tour in Thyborøn and to the fish auction.



Fig. D7 *Jyllandsakvariet offers a number guided tours including a seal safari by boat.*

The Seawar Museum is a brand new offer that primarily tells the story about the maritime war in the North Sea during World War I, in particular “The Battle of Jutland” – the world history’s largest naval battle. In connection to the museum a memorial park for the fallen mariners from the Battle of Jutland has been established with sculptures representing each of the ships which sank and the crew members who died during the battle. It is planned to build a marine archaeological centre in connection with the museum.

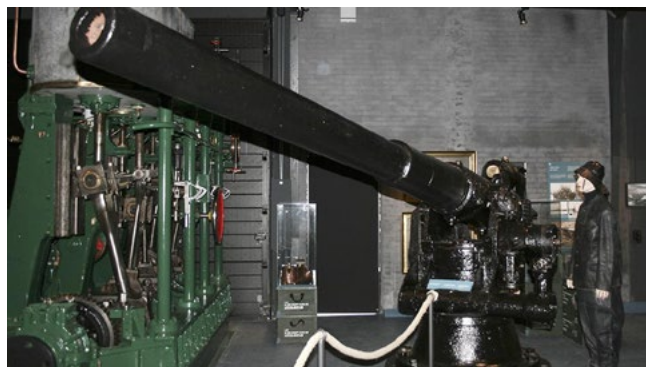


Fig. D8 *The Sea War Museum opened in 2015 with a focus on the Battle of Jutland in 1916 but also with other information on naval warfare during World War I (Visitnordvestjylland).*

Holstebro Museum holds a number of collections and exhibitions on archaeological finds from Older Stone Age till Medieval Times in the geopark area, more recent cultural history from 1536 till the present focusing on Holstebro as a market town, silverware, old toys from 1800s and 1900s and exhibits from the occupation of Denmark during World War II. The museum arranges special exhibitions on a regular basis such as the current exhibition on aerial archaeology.



Fig. D9 *Holstebro Museum shares its buildings with the Holstebro Art Museum*

Strandingsmuseum St. George is being totally renovated and a the new exhibition will open in the middle of 2017 telling of how the west coast of Jutland has always been dangerous. Through the centuries many ships have suffered shipwreck here causing severe loss of life and money. One of the biggest shipwrecks of all times took place on this shore, when the two British ships of the line HMS St. George and HMS Defence were wrecked in 1811, with a loss of about 1.400 men. The museum also tells of how a ship and everything in it reflects everyday life, culture and technical standing of its home country. The thousands of wrecks in the North Sea area tell stories of individuals as well as of nations.



Fig. D10 *The Shipwreck Museum St. George is being totally renovated and will reopen in the middle of 2017 (Strandingsmuseum St. George)*

At the *open-air-museum Hjerl Hede* the past conditions of life in rural areas come to life and handicraft traditions can be experienced live. It is possible to visit a Stone Age settlement and also find out how forests and bogs have been utilised through time. Visitors have plenty of opportunities to be actively involved in activities in cooperation with the museum's many volunteers.



Fig. D11 *At the open-air-museum Hjerl Hede visitors will travel back in time and experience the old way of life (Holstebro Museum)*

Lemvig Museum conveys the stories of Lemvig - the market town known from the cartoon "Livets gang i Lidenlund (The passing of life in Littleville)". A peasant society with the contrast between the green hills with good grazing for cattle and flat thin sandy soil, which 100 years ago was moor. Fjord and sea fishery, dramatic ship wrecks and the beginning of the National Lifeboat Service. An artistic life with the poet Thøger Larsen, the sculptor Torvald Westergaard and the painters Niels Bjerre, Kirsten Bjerre and Jens Søndergaard. The museum has exhibitions in three different locations.



FigD12 *The museum with the work of painter Jens Søndergaard is part of Lemvig Museum and is located on the Bovbjerg Cliff at Ferring (Lemvig Museum)*

Struer Museum provides information on shipping, fishery and railway history with focus on Struer's history as a railway junction. Moreover, stories are told about the author environment in the environs of the Limfjord from 1907-1940, and the painters who used the landscape in the western part of the Limfjord as a scene – especially at Toftum Bjerge and Venø.



Fig. D13 *Struer Museum tells the stories of the market town and the people who have lived there (Struer Museum)*

Nordvestjysk Fjordkultur (North West Jutland Fiord Culture) is a maritime history association run by volunteers. The association is housed at the harbour in Struer with a workshop and a display of different old Danish wooden boats and historical ships which have been part of the Limfjord cultural history. Nordvestjysk Fjordkultur aims to convey the knowledge of the Limfjord and its unique environment and to preserve old handicraft and skills. The association cooperates with Struer Museum and is working to create an exhibition which will be an extension of Struer Museum's exhibition on the railway's history.



Fig. D14 Nordvestjysk Fjordkultur has renovated an old warehouse on Struer harbour and is setting up an exhibition on wooden boats of Limfjorden (Nordvestjysk Fjordkultur)

Bovbjerg lighthouse is a centre for a wide variety of cultural activities with concerts, performances, art exhibitions and lectures. The lighthouse volunteers have an art committee that arranges a new art exhibition each month. Activities for children, markets and a number of special events also take place. The lighthouse has a splendid exhibition of the earlier lighthouse keepers and life in the lighthouse, as well as information about some of the shipwrecks along this stretch of coast. There is also a small exhibition of the geology of Bovbjerg cliff. A ranger is associated with the lighthouse who, together with the volunteers (including a geologist), offers guided tours in the vicinity. The lighthouse has provided a brochure with information about the lighthouse itself and one that explains the local geology.



Fig. D15 Bovbjerg Lighthouse has a small geological exhibition



Fig. D16 Skærum Mølle holds a number of small historic exhibitions like this one on a Co-op grocery store (VisitHolstebro)

The Danish Folk University Skærum Mølle has a number of unique collections and exhibitions of art, architecture, tiles production and co-ops with a clear connection to Western Jutland. At the centre is also class- and meeting rooms and accommodations.

Historical forest: Next to Skærum Mølle the Nature Agency has planted a new woodlot with a “historical forest”. The idea is that the forest will illustrate the development of the forests in Western Denmark from when the ice melted away at the end of the last ice age. It is divided into 5 compartments each with a mix of tree species that are typical for a specific time period.

Bjørndal limestone quarry: On top of Thyholm the story of Bjørndal limestone quarry can be experienced. There is a high observation tower at the location which commands a fantastic view of a wide area and from where the remains of the old quarry can be seen. The local museum and historic association are keen to establish a small information hut at the place.

Åmølle og Klostermølle are two water mills that have been renovated and are being run by voluntary associations. The buildings hold information on the history of the mills and offer basic facilities for visitors. The mills are connected to a system of trails with associated geological and historical information. Different events are held there every year and it is planned to start a small production of locally milled flour on old grains.



Fig. D17 The Klostermølle water mill has been totally renovated and is being run by volunteers.

The Nature School at Kjærgård Mølle is an old water mill which was made into a nature school in 1977 by local municipalities and Nørre Nisum Teachers Training College and the Nature Agency. The school offers education facilities for a wide range of audiences - children and adults alike. It is also possible to book a nature guide/ranger for a special programme and training on specific topics.



Fig. D18 *Kjærgård Mølle is a nature school run in cooperation between The Nature Agency and Lemvig and Struer municipalities (Naturstyrelsen).*

Æ Fywerhus is a local museum on the harbour of the Limfjord island Jegindø. Here you can see fishing instruments and a movie about the fishery on the fjord through times.



Fig. D19 *The small fjord house museum called Æ Fywerhus in local dialect tells the history of local fishing from Jegindø (Struer Museum).*

Ravhuset I Thyborøn (The amber house in Thyborøn) holds a collection of amber founded by Rav Aage ("Amber Aage"), who was both a keen collector of amber and a determined advocate of a nature. Rav Aage's son Bjarne Hansen has like his father opened the doors for visitors to his amber workshop. The exhibition shows both his and Rav Aage's collection of unique amber pieces found along the North Sea.

New facilities in the pipeline

The Climatorium in Lemvig is an independent sub-project of a large EU application from Central Denmark Region with the title "Coast to Coast – Climate Change". Overall the project aims to create new knowledge and exchange of experi-

ences within solutions to counter the climate change. The Climatorium is an innovation - and development centre for several stakeholders and companies with different approaches to new sustainable solutions related to climate change. The Climatorium will also hold an exhibition for both tourists, locals and delegations of professionals. The project will have a clear reference to UNESCO Global Geoparks and information on climate. Geopark West Jutland is contributing to create exhibition components.

The Masterplan for Oddesund aims at changing the location into a place where guests can enjoy nature, outdoor activities and the many historical layers. Local volunteers and Struer Municipality with contributions from Geopark West Jutland are working together to create a recreational site which will act as an entry to Geopark West Jutland from the north. Step 1 in the masterplan focuses on the establishment of an information tower on the northern side of Oddesund.

Sevel limestone quarry contains the ruins of several limekilns (pot-shaped kilns) and a sizeable ring-shaped kiln. A group of volunteers works in cooperation with Holstebro municipality and Geopark West Jutland to preserve the kilns and make a small display house telling about the limestone quarry and the surrounding landscape.

Tvis Mølle Nature Laboratory is an ambitious project under development by Holstebro municipality aiming at creating a visitor centre, a nature school and a playground with a wide host of facilities for outdoor activities, experiments, creative learning and recreation for local citizens, school children and visitors. The project will build on the historic surroundings and the natural values and will also become a visitors centre for the geopark.

Tourism infrastructure

The infrastructure that guides visitors from near and far and gives them access to the geopark consist of the paths, trails and routes with associated facilities in the field and the printed and digital information material that let them find what they are looking for.

In the field

More than 50 paths and routes which already have or can be extended to include information on geopark topics have been identified. These include:

- National bike routes no. 1 along the entire West Coast and no. 12 around the Limfjord
- Panorama Route "Sky, Sea and Art" which is 44 km long bicycle route made as an add-on to the National Bike Route no. 1.
- Bicycle route around Stubbergaard Sø
- A more than 70 km long hiking route around Nisum Fjord with shelters, small harbours, information panels, toilets etc. There is also bicycle and car routes around Nisum Fjord with designated stops on the way.
- Hiking routes and paths in connection with geological and non-geological sites. Many of these were made before Geopark West Jutland was established. The geopark in cooperation with the owners/managers will review the existing signposting, information and facilities and

- update where necessary and as funds become available.
- Two railroad routes: One route is the VLTJ-railroad from Vemb to Thyborøn which stops at many small stations along the way and where information on sites along the route is described (so far only in Danish) on their webpage and in a magazine. Route no. 2 is the Mountain-railroad in Lemvig itself taking guest from the central station on top of a hill to the harbour offering a nice view of Lemvig and the surrounding moraine landscape.
- Two sea-kayak routes in the Limfjord along the coast from Harboøre to Jegindø with shelters along the way and around the island Venø.
- 7 horseback riding trails



Fig. D20 The Geopark pictogram has been put up on signposts along several existing hiking paths

In the immediate pipeline are:

- a signposted hiking and bike route Lemvig and Harboøre as an extension of the already existing Planet Path which is a walk through our solar system on the scale of 1:1 billion
- 4 new hiking trails in cooperation with local community associations in cooperation with the funding mechanism "Trails in the landscape" in connection with nongeological sites no.'s N23, N29 and N43 and geological site no. 7.
- New and improved facilities in connection with the establishment of Nissum Fjord Nature Park.

In the development plan is also the intention to look at the possibility of establishing a hiking and biking route along the Ancient Road (Nongeological site no. 1)

A number of routes will be extended or enhanced with a variety of facilities such as drinking water, electricity for charging electric bikes, smartphones or smaller computers as well as WIFI hotspots. Moreover, in several of the places it will be necessary to build new or renovate parking spaces, restrooms, picnic tables/benches as well as shelters and fire places.

Digital tourism infrastructure printed material

The Geopark website is being fundamentally altered. The current webpage was created in the start-up phase by the volunteers behind the Geopark. In the future the new version to be launched in January 2017 will be based on VisitDenmarks technical platform with the many facilities and cooperation



Fig. D21 This shelter overlooking Nissum Bredning in the Limfjord is a popular place that can be used both from land and from sea.

opportunities it provides. This also means that there will be online-access to GuideDenmark – a national database with information on accommodation, restaurants, facilities, visitor centres etc. All products in GuideDenmark are presented with pictures and in three languages for a chosen geographical area, i.e. the geopark. The geopark webpage is also connected to another national service called Kultunaut providing information on events in various categories.

Information on routes and trails is provided on an interactive map of recreational routes covering not only the whole of the aspiring geopark but most of Denmark. This map is both accessible from the geopark website and from the national platform www.friluftsguiden.dk (The Digital Outdoor Guide). Information is provided in Danish, German and English. Geopark West Jutland has contributed to the development of the platform by adding a new feature allowing geosites to be shown with associated information and also adding a feature so that managers can store information regarding management of the individual sites on the platform for easy access.

The online solutions will be complemented by print versions of a geopark map and leaflet and a number of guides to the many routes.

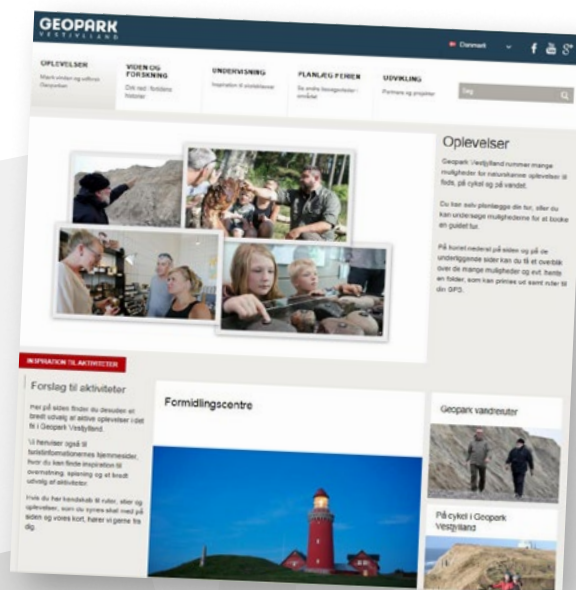


Fig. D22 Screenshot from the new homepage of Geopark West Jutland. The homepage will also include information in English and German.

D3 Analysis of geotourism potential of the proposed Geopark

In the spring of 2016 Geopark West Jutland had a potential analysis of the geopark prepared with a special focus on geotourism. The report was made by Manto Ltd. who has experience from working with the UNESCO Global Geopark in Odsherred. The conclusions of the report are summarised below.

Geopark West Jutland has the potential to create an overall boost to the three municipalities in several areas. The Geopark builds on existing strengths such as a valuable and varied natural environment, a rich cultural history, local food production and an existing tourism sector with many guests as its starting point and creates a common framework for development and cooperation across the three municipalities.

Altogether the three municipalities behind the geopark stand strong on tourism with approximately 1.5 million overnight stays per annum and a total tourism turnover of approximately 1.6 billion DKK. The Geopark has a unique location where the North Sea and Limfjorden meet and have both the raw and wild nature by the sea and the quiet and scenic fjords. It is all spun together by a varied and fascinating landscape with a variety of experience opportunities and attractions. Even so, today the Geopark lies packed away compared to the two largest West Coast destinations to the south (Ringøbing-Skjern and Varde) and to the north (Jammerbugt, Hjørring and Frederikshavn). Geopark West Jutland has the potential to strengthen the destination's profile and visibility by creating an overall story and an increased awareness about the special character of the geopark area both among the local citizens, the operators and the visiting guests.

The gain from and effect of the establishment of Geopark West Jutland is closely linked to the geopark's ability to create local identity and ownership amongst citizens, operators and the political decision-makers. In the assessment of the geopark's potential as a regional driving force or lever it is necessary to look at results and effects in different time perspectives. An immediate effect is expected from the designation of Geopark West Jutland as a UNESCO Global Geopark in the form of positive media publicity and the strength of the UNESCO brand. The effects on growth in the food industry and tourism sector as well as effects on settlement patterns has a longer time horizon and are closely linked to the general developments in society and the overall economic conditions.

It is foreseen that Geopark West Jutland has a potential to generate positive effects for the three municipalities and the region within these particular fields:

- **Growth in the food industry:** The local food industry is already a stronghold for the municipalities and the region. This includes i.a. several major players which either are resident in the municipalities such as

Dansk And (Danish Duck), Jeka Fish and Konsumfisk or companies with a strong local focus such as Thise Mejeri (Thise Dairy). Moreover, it also includes a number of small local producers as well as the agriculture in general. The value of Geopark West Jutland will especially apply to the small businesses who work with the local resources. A closer cooperation among the local operators within the framework of Geopark West Jutland will strengthen the knowledge and network among the operators and across the value chain. The local produced foods achieve a stronger market position locally and regionally through increased visibility and accessibility for citizens and tourists in the region. Through a formalised network and common sales and distributions initiatives the Geopark will be able to support the business' opportunity to achieve a stronger position on the international market. Moreover, it also provides a breeding ground for development of new high quality products related to the geopark.

- **Strengthen local settlement and identity:** The geopark is closely connected to local communities. It is the inherited traditions and stories and the mutual influence between human and nature which forms the geopark's brand story on the areas cultural history. Through the geopark both the overall stories of the Ice Age and nature and the very local stories are told and connected to each other. The Geopark becomes a platform for involvement and activation of volunteers and citizens in local initiatives and projects; both for the benefit of existing volunteer networks that will be put in touch with a wider circle of people and citizens with new initiatives outside the existing networks. By strengthening the cohesion in the three municipalities and create a stronger brand the geopark will help to boost local settlement. The effort in the geopark can make the three municipalities more attractive to newcomers and help to make citizens stay on.
- **Tourism growth:** Tourism has a vital role in ensuring continued development and growth throughout the region. Experiences from other geoparks for example in England and Germany show that the geopark has potential to become a regional driving force of tourism. In the last two years there has been a positive development in the number of overnight stays after a period of years with a stagnant number. The assessment is that the establishment of Geopark West Jutland will contribute to a continued and enhanced growth by stimulating the product development and the opportunity to attract new target groups. Even though the development of overnight stays in the three municipalities have been lower than in other coastal destinations it is expected that the geopark can elevate the development to at least be on par with VisitDenmarks national forecast for growth in overnight stays. A lift to this level will result in an increase in the number of overnight stays of 18% until 2020 and

result in approximately 110,000 new overnight stays, 111 million DKK more in tourism consumption and additional 161 new full time jobs. The geopark's impact is estimated at 67 millions DKK and 98 new full time jobs until 2020. The effect will happen through extension of the season and development of new tourism products and packages, which partly retain the existing visitors from Denmark and Germany and partly attract new target groups with a higher consumption per day. Especially the development of Special Geopark Experiences and an improvement of the basic product quality will contribute to an increase in the tourism consumption. The geopark has the potential to become a national and international brand for the region and part of an international network of geoparks.

- Increased crossborder cooperation between municipalities: The geopark cuts across three municipalities. It has the potential to become a strong platform for developing the crossborder cooperation. Based on the geopark new common initiatives and projects of a bigger scale can be identified and implemented. For example establishment of public-private partnerships across municipality borders and the focus areas nature, culture, business and education. The geopark enhances the possibility of attracting investments or grant funds both regionally and from the EU.

Development recommendations – the 3 strategic tracks

With point of departure in the analysis of stakeholders and opportunities in Geopark West Jutland, three strategic tracks have been identified. Each of the three tracks is a focal point where the geopark already has existing strength which should be used in the future. The tracks are also focus areas to ensure that the geopark lives up to its full potential. The three strategic tracks are:

- *Development of Special Geopark Experiences and improvement of the core products* (i.e. the general quality of accommodation and restaurants, service etc): Today, Geopark West Jutland offers a number of good experiences within both culture and nature. The geopark will be able to strengthen its profile by identifying and developing new Special Geopark Experiences within e.g. nature, cultural heritage and food. At the same time Geopark West Jutland will also be able to strengthen the offers to the tourists by improving the core products to the tourists. Especially within the restaurant business there is a need to strengthen the product.
- *Focus on tourism and food trade*: Geopark West Jutland has the opportunity to establish itself as a platform for business development within tourism and food. There is a need for the geopark to assume the role as a cross-sector tourism operator who supports the individual work of the three municipalities. The food industry is also an important strong hold both for the three municipalities and Central Denmark Region. Here Geopark West Jutland can serve as the local link between the operators and the regional effort to lift the food industry.
- *Knowledge and communication*: Geopark West Jutland has an important task to improve knowledge of the geopark and secure support among citizens, businesses and tourists. For the business community it is important that the geopark strengthens the mutual knowledge across both trades and value chains. The communication of the geopark's special characteristics and offers will also contribute positively to a more unique profile of the area compared to other coastal destinations and thereby attract new target groups with a higher consumption per day.

D4 Overview and policies for sustainable development

Sustainable development is a fundamental topic in everything to do with the geopark. As a candidate to become a UNESCO Global Geopark it has been important for Geopark West Jutland to subscribe to the Geotourism Charter and the definition of geotourism as being tourism that sustains or enhances the geographical character of a place – its environment, culture, aesthetics, heritage, and the well-being of its residents. A second key topic to do with sustainable development is education for people visiting or living in the geopark – young and old – to better understand the challenges facing our planet based on what can be seen and experienced locally.

Geo-tourism and economy – the partnership programme
A central issue in geotourism is involvement of citizens and visitors. Therefore Geopark West Jutland has stated in our Development Plan that we intend to develop a partnership program with a set of specific criteria of how

to become a partner. The program will include different partnership categories such as non-food and food products, accommodation, restaurants, information, education, art etc. As part of the program a set of incentives will be developed such as:

- partners gaining access to use the Geopark West Jutland partner logo in their marketing
- invitations to partner days, development courses and study tours
- experience exchange and joint projects with other geoparks, national parks and nature parks
- partners becoming part of the geopark marketing material
- joint events and projects

The partnership program will be separate from the volunteer program which is described in section D5.

Geo-education

Geopark West Jutland has started a joint effort with VIA University Teachers Training College and representatives from the primary and lower secondary schools in the three municipalities to develop a school programme which will be made available to all primary and lower secondary schools, private independent schools and the so called continuation schools. The joint effort will amongst others draw on the long-time experience of the Teachers Training College with outdoor pedagogy and will also include cooperation with the national school service network.

The museums, exhibition centres and Management Unit West Jutland of the Nature Agency provides outdoor school trips and various facilities for educational use.

Furthermore, the geopark has a number of volunteers providing guided tours and talks with a special program during the Geological Days conducted every year in September as a national initiative.

The geo-education programme also includes the cooperation agreement with the Department of Geoscience at Aarhus University (see supplement D4 in Annex 1)

whereby the geopark and the university will work together to identify relevant topics for student assignments, Bachelor, Master and PhD projects. The university and the geopark will also work to involve high school teachers from the geopark in annual project days on geology.

The national strategy for UNESCO activities in Denmark 2014-17 clearly mentions the value of UNESCO Global Geoparks in conserving and transmitting natural and cultural heritage for sustainable development. The strategy mentions how this provides opportunities for cooperation and partnerships and mentions a specific example of how Aarhus University is offering a new master's degree programme in English called Sustainable Heritage Management.

Geo-heritage

Section C2/C3 of this document describes the legal framework for protection and management of the geo-heritage of Geopark West Jutland. Another and very important part of the protection of geo-heritage is information and outreach which is covered jointly by geo-education, communication and information and the cooperation with volunteers and partners.

Type of educational institution	Lemvig Municipality	Struer Municipality	Holstebro Municipality
Primary and lower secondary schools	9	8	18
Private independent schools	4	2	5
Continuation schools (lower secondary boarding schools)	5	3	5
General and vocational upper secondary education institutions	4*	2	6
Others	1	1	2

* Including VIA University Teachers Training College

Fig. D26 Number of educational institutions in Geopark West Jutland by municipality and type of institution.

D5 Policies for, and examples of, community empowerment (involvement and consultation) in the proposed Geopark

Volunteer Strategy

Geopark West Jutland has been initiated by a volunteer and the development of the geopark relies very much on the cooperation with volunteers. For this purpose Geopark West Jutland drafted a Volunteer Strategy in consultation with many local representatives of community organisations and other NGOs. The draft strategy was later sent to 37 representatives for consultation for 2 months. Only comments were editorial so the strategy was approved by the steering committee. The strategy has 4 main chapters on:

- Organisation and tasks
- The relationship between volunteers and staff of the geopark

- Kommunikation and contact
- Recruitment and maintenance of the volunteer base

Organisation and tasks

Geopark volunteers can be both individuals and groups/organisations wanting to cooperate with Geopark West Jutland. No formal qualifications are required. The volunteers will be organised in three main groups that refer to a volunteer coordinator on the geopark staff.

Voluntary networks which is a big and varied group of people that may or may not be part of an NGO and who are willing to start new projects, arrange events or perform other tasks in cooperation with the geopark usually based on a cooperation agreement.

The relationship between volunteers and staff of the geopark

The table below is included in the strategy and sums up the relationship between the geopark and the volunteers.

	Individual volunteers	Volunteer organisations
The geopark expects	■ Active participation ■ Dedication ■ Interest ■ Loyalty	■ Active participation ■ Activities and events ■ Distribution of geopark information to members ■ Advice on specific topics ■ Sparring
The geopark offers	■ Basic training on geopark content and values ■ Specific courses on request from the volunteers ■ Updates on geopark matters through meetings and news letter ■ Involvement and co-ownership ■ Minimum one annual meeting for all volunteers	■ Possibility for financial contribution to special projects or events ■ Influence on the development of the geopark ■ Marketing ■ A wider network across the whole volunteer base ■ Advice ■ Sparring

Fig. D27 *The relationship between the geopark and the volunteers*

Geopark interpreters are usually individuals with the desire and basic communication skills and often also prior knowledge of a special topic who are willing to be responsible for guided tours, teaching of geopark topics and lectures etc. Some background knowledge is desired but otherwise all geopark interpreters will have to undergo a basic introductory course on the geopark, rules/regulations on access to nature and cultural sites and safety issues.

Helping hands are volunteers who assist the geopark with a number of practical jobs like maintenance of equipment or specific sites or who will distribute materials. It can also be people who take on specific assignments like the huge job that has been done by Søren Raarup and John Clausen in compiling information, making illustrations and writing texts for this application.

The strategy furthermore provides information on insurance, pricing of events and guided tours, rewards, solving of disagreements and termination of the relationship.

Communication and contact

The chapter describes how information can be exchanged and shared through the geopark webpage, newsletters, annual and network meetings and direct contact.

Recruitment and maintenance of the volunteer base

The geopark respects recruitment policies of its voluntary partners. The chapter also describes how the geopark may advertise for volunteers and which incentives may be put to use to attract new volunteers and maintain those who are already involved.

The Geopark Advisory Committee

As described in Section A4 the geopark will be reorganised after (hopefully) becoming a UNESCO Global Geopark and in this connection a Geopark Advisory Committee will be established with key stakeholders from the geopark. The committee will offer inspiration and advice on geopark matters to the geopark board of directors and the secretariat. Through the participation in the committee members will gain insight and become involved.

D6 Policies for, and examples of, public and stakeholder awareness in the proposed Geopark.

National awareness raising so far

Geopark West Jutland has a broad target audience which will have to be reached in different ways. The Geopark Brand Description defines the three core values in geopark communication as being able to create Fascination, Understanding and Identity. To do so a wide spectrum of media and methods will be used which are described in the Brand Description (Supplement A4-2) and the Development Plan (Supplement A4-1).

In the process so far public meetings, guided bus tours and seminars have been extensively used to create awareness and to get feedback and good advice from local citizens, politicians and experts. A lot of attention has been aimed at getting local awareness and involvement. In the past year alone 13 public meetings, a seminar for all municipal councils, presentations for staff in the three municipal administrations, meetings and excursions with possible donors have been held. Furthermore, the annual Geological days, a geological seminar and participation/involvement in two food festivals and an Ice Age walk has taken place.

Articles on geopark themes have been published in the West Coast Magazine, two issues of a geopark newsletter has been sent out to almost 600 subscribers and a Facebook profile was introduced in September 2016.

28 cooperation agreements have been signed with local community organisations and other NGOs after holding individual meetings with all of them. The volunteer strategy was drafted and sent for consultation. Events have been advertised in local media and press releases have been sent out on a number of topics resulting in articles on the progress of the geopark.

Geopark West Jutland has consulted with UNESCO Global Geopark Odsherred on a number of occasions and members of the city councils and senior staff from Lemvig, Struer and Holstebro municipalities took part in an excursion to Odsherred.

Consultations have also taken place between Geopark West Jutland and the Danish National Commission for UNESCO who have provided guidance and shown great support through the whole process of preparing this application.

International Cooperation and awareness raising

Staff from the geopark and partners in the tourism organisations participated in the European Geoparks Conference 2015 in Rokua, Finland and Geopark West Jutland was present during the 7th International Conference on UNESCO Global Geoparks in the English Riviera Global Geopark.

Together with UNESCO Global Geopark Magma in Norway and other Global Geoparks Geopark West Jutland has submitted a joint project proposal to the Nordic Council of Ministers to organise the first Russian-Nor-

wegian International Conference on UNESCO Global Geoparks and sustainable development. Other project proposals have also been discussed with Global Geopark Magma.

Prior to this Dr. Vesa Krokki from Rokua Global Geopark and Dr. Andrasanu Alexandru from Hatec Global Geopark together Project Manager Nina Lemkow from the (then) aspiring European Geopark Odsherred were consulted on the possibilities of establishing Geopark West Jutland.



Fig. D28 During the two food festivals in Lemvig and Struer in 2017 these information columns were introduced. In 2017 there will also be a geopark information trailer available.

E. INTEREST AND ARGUMENTS FOR BECOMING A UNESCO GLOBAL GEOPARK

The firm belief of a dedicated volunteer started the whole process of establishing Geopark West Jutland in 2011. Following up on inspiration from the then aspiring Geopark in Odsherred John Clausen in 2011 involved Lemvig municipality and later on also the municipalities in Struer and Holstebro in the process of establishing Geopark West Jutland. The possibility of combining the geological, natural, cultural and intangible heritage of the area in the UNESCO Global Geopark brand quickly gained support from all stakeholders. The Central Denmark Region and the Local Action Groups for Struer-Holstebro and Lemvig-Ringkøbing-Skjern strongly supported the project and provided the necessary financial support for the initial phase.

A corner stone in the process has been the strong support from local communities who see the geopark as a way of raising pride and building a stronger local identity. In the process of establishing Geopark West Jutland many stakeholders have come to realise and appreciate the unique geo-heritage and its connection to the cultural history of the area. Schools and other educational institutions have also shown interest in the new initiative and are looking to incorporate geopark-information in their curricula .

The geopark is seen as a common brand bringing many stakeholders together to attract more visitors and new citizens. The geopark will add momentum to the already ongoing cooperation between Lemvig, Struer and Holstebro municipalities and strengthen the profile of the area on the West Coast of Denmark where there already are a UNESCO World Heritage Site and national park in the Wadden Sea to the south and a national park in Thy to the north.

The process of establishing the geopark has furthermore inspired a closer cooperation with the Department of Geoscience at Aarhus University which is hoped to also bring more research to this part of Denmark. Through the UNESCO Global Geoparks Network Geopark West Jutland will gain access to a huge international network with a common story to tell and the possibility of exchanging experiences, receive inspiration and find new partners. Geopark West Jutland is already and will continue to seek cooperation with other global geoparks.

REFERENCES

References for this document together with separate references for Section B and the detailed geological descriptions are provided in Annex 1.

GEOARK

V E S T J Y L L A N D

