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Current status of important nature values in the Vega archipelago

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Sammendrag

Denne rapporten beskriver de mest unike og karakteristiske naturverdiene og gjensidige avhengigheter mellom arter og naturtyper i Vega verdensarvområde, og hvordan disse habitatene er avhengige av menneskelig påvirkning i form av skjøtselstiltak. Deretter blir mulige endringsfenomener og trusler vurdert og diskutert for de mest karakteristiske og viktige naturverdiene i Vega.

Summary

This report describes some of the most unique and characteristic natural features and interdependencies between species and nature types at the Vega world heritage site, and how these habitats are intertwined with the continuity of human intervention. Foreseeable threats and change scenarios are then presented and discussed for the key natural features in Vega.

LAND/COUNTRY:	Norway
FYLKE/COUNTY:	Nordland
KOMMUNE/MUNICIPALITY:	Alstahaug
STED/LOKALITET:	Tjøtta

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Anders Nielsen	Anders Nielsen
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Preface

NIBIO was assigned by Instead Heritage to provide a summary of available and relevant information on the status of important nature values in the Vega archipelago. The assignment was structured as a series of tasks in view of Instead Heritage requiring specific insights to inform their World Heritage impact assessment carried out in the context of the "Program of supplementary assessments to the Helgeland Intermunicipal Master Plan for Vega" commissioned by Vega Municipal Council. The report summarises available knowledge and identifies knowledge gaps and is based on available information stemming from our own, and others', previous work in the area.

Ås 15.09.22

Anders Nielsen

Content

1 Natural features and processes of the Vega archipelago

1.1 The unique characteristics of Vega

The Vega archipelago hosts a unique landscape, shaped through a long history of human activity and management of smaller islands far off the coast. The land mass of the World heritage includes a large part of the main island of Vega, and more than 6500 islands and skerries. Of these islands and skerries, more than 80 have been inhabited, and much of the remaining landscape was utilized for their subsistence.

Here, people found ways to make a living for centuries, with the limited but sufficient land-based resources in an extreme environment far out at sea. By combining rich and plentiful fishing recourses, traditional management of the limited land area, and a close relationship with both eider ducks and livestock, people managed to sustain themselves of the resources available. This way of living resulted in management of the land resources that could be sustained for centuries, without industrial mechanisation or fertilizers. The result is a close relationship between the local community and the natural resources, and the rich and varied semi-natural landscape throughout the archipelago that we find today.

A key feature of Vega is the unique geographic location of the area. The gulf stream creates a warmer climate, providing mild winters compared to other areas at the same latitude (~66°N). The islands are protected from extreme weather and rough sea, due to the long and shallow strandflat stretching from the coast to the outermost skerries in the far west, with thousands of islands and skerries occurring throughout. The continuous settlements, and consequent management, since the last ice age, combined with the physical nature and geographic location of the landscape, contributes to a varied and rich environment, where a combination of semi-natural, mountainous, and oceanic species can be found together.

A wide array of habitats, many in need of traditional management regimes, can be found at the Vega archipelago (Carlsen et al., 2012). The long history of human settlement and activity has created a high abundance of semi-natural habitats, rich in species. Several of these habitats are assessed as nationally or regionally important and valuable (category A and B, respectively, in assessment reports; Bär & Carlsen, 2018, 2019; Carlsen & Bär, 2018b; Carlsen & Kvalvik, 2012; Thorvaldsen & Bär, 2021). In addition, there is a gradient from less calcareous soils in the south-eastern part, to extremely calcareous areas in the north-western part, making a considerable amount of the landscape red-listed by The Norwegian Red List of Ecosystems and Habitat types (Artsdatabanken, 2018). A list of relevant habitats is compiled in table 1 and a detailed description of their status in Vega can be found in the next section. The long history and the high abundance of semi-natural habitats with interdependencies between nature and humans is one key characteristic of Vega, and is at the heart of the inscription of the Vega Archipelago's on to the World Heritage List as a cultural landscape. This report therefore pays particular attention to on the semi-natural habitats found in Vega.

Table 1: **Important, red-listed habitats found in the Vega archipelago and their status on the Norwegian Red List of Ecosystems and Habitat types. See below for a more detailed description of the different habitat types.**

Habitat type (English)	Norwegian name	Red list status
Semi-natural habitats		
Coastal heathland	Kystlynghei	Endangered (EN)
Boreal heathlands	Boreal Hei	Vulnerable (VU)
Hay meadows	Slåttemark	Critically endangered (CR)
Semi-Natural Pastures	Naturbeitemark	Vulnerable (VU)
Semi-natural wetland	Semi-naturlig myr	Endangered (EN)
Semi-natural beach/mesic meadow	Semi-naturlig strandeng	Endangered (EN)
Natural habitats		
Calcareous shallow soils in southern boreal zone	Åpen grunnlendt kalkrik mark i sørboreal sone	Vulnerable (VU)
Calcareous and rich ponds, dams, and lakes	Sterkt kalkrike pytter, dammer og små innsjøer	Vulnerable (VU)
Calcareous helophyte-swamps	Kalkrik helofyttsump	Vulnerable (VU)

The red-list status of habitats is based on a similar system as the Norwegian red-list of species. This system is based on the IUCN (International Union for Conservation of Nature) red-list, but assess the risk of species extinction *in Norway* (Artsdatabanken, 2021). The status is a result of thorough evaluations by expert committees which evaluate species to different categories of risk. The categories are extensively used in this report and are therefore explained briefly in table 2 below:

Table 2: **Overview of the abbreviations and red-list categories referred to in this reprot and an explanation of the categories.**

Abbreviation	Red-list status	Explanation
LC	Least concern	Population is stable or do not fulfil any of the criteria of the other categories.
DD	Data Deficient	When there is large uncertainties in how the species should be categorized anywhere between LC and CR.
NT	Near Threatened	The status of a species is close or expected in near future to fulfil the criteria of the threatened categories VU, EN, CR.
VU	Vulnerable	Species with a high risk of extinction.
EN	Endangered	Species with a very high risk of extinction.
CR	Critically Endangered	Species at extreme risk of extinction.
RE	Regionally Extinct	The species is extinct and not reproducing in the country.

1.2 Key red-listed semi-natural habitats in Vega

1.2.1 Coastal Heathland (EN)

Coastal heathland is a semi-natural habitat where trees and shrubs are cleared, and active management like prescribed burning and grazing by livestock create an important habitat. The coast of Norway currently hosts a third of the remaining coastal heathland of Europe, which once stretched from Spain, and all the way up to the Northern part of Norway (Gimingham, 1972; Loidi et al., 2010; Måren et al., 2010). Having seen a dramatic decline in the area covered, due to abandonment, this habitat is considered endangered (EN) also in Norway (Hovstad et al., 2018a). Management of the coastal heathlands was traditionally implemented to increase its forage value throughout the year. Traditionally the heath was burned patch-wise to initiate succession with grasses and herbs and to remove old heath to pave way for younger plants more edible for livestock. In addition, the animals were moved around to graze in areas where the quality of the vegetation were highest. This created a mosaic of grassy patches and young edible heath which could sustain the old and robust breeds of livestock year-round.

Remains of this habitat can be found scattered across Vega, with parts of it still being managed. Active policy to preserve this habitat type has helped to increase awareness of the value of this habitat, and courses in management are being organized to maintain this knowledge (Bär & Carlsen, 2016). Burning is an important management practice for maintaining the regional variation that can be seen along the latitudinal gradient along the coast. The coastal heathland found in Vega is typical for the northern variation of this habitat, with mountainous plant species occurring frequently among lowland and coastal species. Although few species occur solely in coastal heathlands, there are several red-listed species associated with this habitat. In addition, the coastal heathlands provide important browsing and grazing areas for old breeds of sheep, and the critically endangered (CR) coastal goat.

1.2.2 Boreal Heathland (VU)

Boreal heathlands differ from the coastal heathland by the lack of burning as traditional management. Islands where signs of such management cannot be detected are therefore often described as boreal heathland. It can be difficult to distinguish between boreal- and coastal heathland, particularly in the northern part of Norway, as burning regimes are often less frequent than further south, due to slower growth. Both coastal heathland and boreal heathland does however contain much of the same species in Vega.

1.2.3 Hay meadows (CR)

Hay meadows are one of the most species rich habitats in Norway (Norderhaug & Svalheim, 2009). On calcareous soils they can be particularly rich and house numerous, red-listed species. Rich meadows can contain up to 50 plant species per m^2 (Direktoratet for Naturforvalting, 2009), and can in Vega include species characteristic for heathlands and adjacent beach-meadows (Carlsen & Bär, 2018a). Manually cut hayfields generally house more species than semi-natural pastures, including a high number of species adapted to extensive management regimes (Bonari et al., 2017). Various taxa of fungi, like *Entoloma*, *Hygrocybe*, *Ramaria*, and *Geoglossum*, are also typically linked to hay meadows, several of them red-listed as a result of diminishing habitat. Hay meadows is also an important habitat for insects (Vanbergen & Initiative, 2013). However, data on insects found in Norwegian meadows is limited. Svalheim (2012) found 25-30 red-listed species of insects in a hay meadow-like habitats in southern Norway. This may however be an extreme case and is probably not the case in the northern parts of Norway, like Vega. It may however emphasise that this habitat is important also for that taxon. The main threat to hay meadows is abandonment, leading to encroachment of shrubs and trees, or intensified use, e.g., conversion to monocultures of crops, or more intensive management, including use of fertilizers.

1.2.4 Semi-natural pastures (VU)

Semi-natural pastures are generally considered slightly less species rich than hay meadows in terms of vascular plant species, although as much as 563 species have been registered across semi-natural pastures in Norway (Bratli et al., 2011). Of these species are 36 red-listed, and 27 considered grassland specialists and thus dependent on this habitat. As much as 195 species of fungi are associated with semi-natural pastures, and of these are 57 red-listed, and 56 considered grassland species (Bratli et al., 2011). Like hay meadows, this habitat is also threatened by a continuous trend of abandoned use or intensification in management, which alters the key habitat characteristics important for many species.

1.2.5 Semi-natural beach meadows (VU)

Semi-natural meadow-like habitats occurring adjacent to the ocean, creates beach meadows. This habitat is not as common the other habitats but does occur somewhat frequently in Vega. This habitat has lacked priority in mapping and is therefore under-reported in the national databases in Vega. Semi-natural beach meadows are characterized by salt tolerant species such as red fescue (Festuca rubra), sea thrift (Armeria maritima), and sea milkwort (Lysimachia maritima) especially where the vegetation is regularly flooded. Some of these meadows are naturally open, while others are kept open by grazing livestock. There is however uncertainty to what degree beach meadows depend on grazing in northern Norway. These meadows can therefore be difficult to distinguish from naturally occurring beach meadows based on the composition of the vegetation, although they often hold a few more semi-natural species. However, beach meadows are an important grazing resource, especially early spring, since the vegetation gets a head start since there is little to no snow cover, and therefore become energy-rich faster than other vegetation.

1.3 Other red-listed natural habitats in Vega

1.3.1 Calcareous shallow soils in southern boreal zone (VU)

This habitat is naturally open due to factors such as shallow soils, drought, wind, or salt spray from the ocean, which prevent trees and forest from establishing. The calcareous soils provide the necessary nutrients for more demanding species. Calcareous shallow soils in the southern boreal zone can also occur in a mosaic with coastal heathlands and semi natural pastures where the soil is shallow, or the bedrock is exposed.

1.3.2 Calcareous and rich ponds, dams, and lakes (VU)

This habitat can occur within other calcareous habitats, and is home to a relatively high number of red-listed or threatened species (*Chara tomentosa, C. rudis, C. polyacantha, C. vulgaris, C. curta, C. contraria*, *Potamogeton lucens*, *Stuckenia vaginata, Zannichellia palustris*) compared to the relatively tiny area it occupies (Direktoratet for Naturforvaltning, 2011).

1.3.3 Calcareous helophyte-swamps (VU)

Calcareous helophyte swamps are habitats found in the gradient between land and ponds/lakes. This habitat is characterized by sedge species (*Carex spp*.), which typically make out nearly all of the vegetation.

1.4 Characteristic species and their occurrences at Vega

1.4.1 Plants

Due to the long history of traditional management and the diversity of habitats, Vega hosts a large number of species. One of them, a sub species of *Galium normanii,* ("Vegamaure"), is only found at this location in Norway. Various additional red-listed species are found in this area, several of them in large numbers where they occur. A few characteristic, red-listed plant species are listed in table 3 below.

Table 3: Characteristic threatened or near threatened plant species at Vega.

Latin name	English name	Norwegian name	Red-list status
Rorippa islandica	Yellow-cress	Islanskarse	EN
Galium normanii	Slender bedstraw	Vegamaure	VU
Ranunculus hyperboreus* subsp. *Arnellii	NA	Tunrasoleie	VU
Botrychium lanceolatum	Lance-leaf moonwort	Håndmarinøkkel	VU
Carex lepidocarpa	Long-stalked yellow-sedge	Nebbstarr	NT
Ophioglossum vulgatum	Adders-tongue	Ormetunge	NT

1.4.2 Bird life

The wetlands and various protected islands at Vega, host a rich bird life. With 222 bird species registered in the area, 110 of them nesting, the archipelago plays an important role in providing habitat for the avian fauna. The largest breeding colony of cormorants (storskarv) in Norway is found here, illustrating the value of Vega as an important location for this species. Vega also acts as a staging post for the whole population of barnacle geese. The nature reserves on the Vega islands hosts a large part of the avian diversity, especially waders, and a total of 67 red-listed bird species are currently registered in Vega, according to the national database of species (Artsdatabanken.no).

Traditional management of eider ducks is also a key feature of traditional living on the islands. See section 2.1.2 for more details on this practice.

1.5 Conclusion:

The red-listed habitat types and species found in the Vega world heritage site are largely linked to continuous traditional management, and the geographic location of the islands, from near the coast and far out at sea. The Vega archipelago is also home to many non-red listed species, and thus help protect and maintain those populations as well. Vega is therefore playing a key role in managing natural values of global, national, and local scale through the traditional use of the landscape.

2 Interdependencies in the semi-natural landscape

2.1 Vegetation and wildlife

Several of the species found in the Vega archipelago are highly dependent on the long history of traditional management. Species such as southern adders-tongue (formerly considered Vulnerable, VU) thrive in the semi-natural landscape where mowing and grazing creates favourable conditions for this species. Hay meadows, and the species composition of these habitats, depend on continuous management to maintain the plant communities adapted to this regime.

Some habitats, e.g., bird-fertilized pastures, have intricate interdependencies. These pastures depend on birds nesting in large numbers so as their excrements can provide a fertilizing effect, but also depends on grazing livestock, or mowing, to prevent encroachment that will make the vegetation unfit for nesting by birds. While these habitats are scarce, hay meadows and natural pastures demonstrate how human management facilitate rich botanical values, which in turn provides important habitats for wildlife.

2.1.1 Livestock

Old breeds of livestock such as the old Norwegian sheep and the coastal goat are adapted to survive on scarce resources through winters and are hence useful for traditional management of semi-natural habitats. The use of these animals to exploit and manage the scarce resources in an inhospitable environment is an efficient way to both conserve valuable habitats and produce food from otherwise barren land. Management of the semi-natural habitats with these breeds are ideal for creating a diverse cultural landscape but also contribute to conservation of these breeds themselves, by maintaining populations of the traditional livestock. These breeds are thus good examples of interdependencies where livestock is important for maintaining threatened habitats and species, while these habitats provide the resources needed to preserve these traditional breeds.

2.1.2 Bird life

The bird life at Vega is also shaped by an intricate interdependency between people and wildlife. By building small shelters around their settlements, local residents facilitate nesting for eider ducks by deterring potential predators solely by their presence. In return, the local people collect down remaining after the ducks abandon their nests, which generates income for the islanders. Interestingly, work by Sickel, Hatten, and Elven (Master thesis and unpublished work, 1988) suggest that the rich bird life may have contributed to introducing rare and nationally threatened plant species, like the slender bedstraw (*Galium normanii*) and *Rorippa islandica* from Iceland, and that birds play a key role in spreading freshwater plants between ponds.

Reserves and protected areas on the islands currently hold colonies of a number of nesting birds and there are several red-listed bird species associated with meadows/grasslands, e.g., black guillemot (*Cepphus grylle*, VU), common eider (*Somateria mollissima*, NT), common starling (*Sturnus vulgaris*, NT), and the twite (*Carduelis flavirostris*, NT), among others.

2.2 Conclusion:

The many characteristic and vulnerable species at Vega depend on the intricate interdependencies between humans tending varied habitats that house vulnerable species. Those habitats then provide resources for humans in the form of feed or a home for livestock, and bird life. These relationships

were more important for humans when they solely depended on these habitats and the local fisheries for survival while living permanently in the seascape. This leaves the vegetation, livestock, and birdlife vulnerable to abandoned use.

3 Features and processes sensitive to change scenarios

3.1 Foreseeable change scenarios

There are several ways in which the habitats and species found at Vega could be affected by foreseeable change scenarios. These are typically related to altered land/sea-use, invasive species, and climate change. Atmospheric pollution is considered in the assessments of the red-list status of species, and can reduce species richness and composition (Field et al., 2014). In Vega, the level of air pollution, both today and in the foreseeable future, is limited (Aarrestad & Stabbetorp, 2010) and the issue is therefore not discussed further.

3.1.1 Altered sea/land use

Abandoned management or altered use is a key threat that causes negative changes or acts in synergy with other threats and degrade the important habitats and features found in Vega. Abandoned use tends to cause encroachment of trees and shrubs. This process outcompetes species adapted to an open landscape and a regular management regime of disturbance in the form of cutting or grazing. This may lead to increased erosion, problems with the water vole, and can increase the risk of more severe bushfires when coastal heathlands are not regularly burned in a controlled manner. Abandoned or less intense use also facilitate the establishment of alien or problematic species.

Altered use, particularly in the form of agricultural intensification tend to severely deteriorate the diversity of semi-natural habitats. Fertilizers and disturbance of the soil quickly remove grassland fungi, and the increased growth of nitrogen limited species will be favoured, outcompeting the diversity of the traditionally nitrogen poor semi-natural habitat types. Another threat for hay meadows is the conversion to semi-natural pastures. This change in management regime is less labour intense and therefore a common trend. The problem with this is that grazing is more selective than manual cutting, and thus result in a different and often less species rich composition.

Other forms of altered use scenarios are increased tourism or industrialization. Tourism could affect plant communities through trampling and enforce stress on birds and other animals as described in the next section. Industrialization such as aquaculture could affect the marine ecosystem, but also affect bird life by reducing food availability and enforcing additional stress form boating and other activities. These effects are therefore discussed in more detail below.

3.1.2 Industrialization and tourism

Activities such as tourism come with their own risks. While tourism can result in the introduction of alien species (Anderson et al., 2015), the potential impact at Vega is difficult to assess. However, tourism and intensive visitation in cultural landscapes can cause erosion (Bär et al., 2010), which can degrade the landscape, and facilitate the introduction of alien species as disturbed soils are often suitable habitats for such species. Additionally, tourism could negatively affect birds and other wildlife during breeding and nesting periods. Cumulatively, a lack of management and planning of tourism could cause a considerable impact on habitats and wildlife at Vega. It is therefore important that activities are performed in a well-managed form, where the negative impacts are outweighed by the positive aspects, such as stimulating activities that help populate the islands and encourage continuity in the management of the landscape.

The effect of emerging industries on the terrestrial habitats found at Vega are difficult to assess. How realities such as aquaculture, sea or land-based, or windfarms interact with these habitats is poorly

understood in a holistic way. Most of what is known about potential effects is limited to effects on specific taxa, or that loss of habitat from land use change is a significant threat in general. Studies have investigated direct effects of aquaculture on sea birds and mammals, and on indirect effects on other marine life like crustaceans. Potential impacts could stem from chemicals affecting crustaceans (Grefsrud et al., 2019), and thus reduce the local availability of food for birds feeding in the sea. If this then affect eider ducks, this could negatively affect the eider tending activity characteristic at Vega. The nature of such mechanisms is however poorly understood.
A more direct effect is the activity and disturbance of eider ducks. Follestad (2015) suggest that boating activity can cause disturbance and consequently stress for the animals. Such disturbance might accumulate with other stressors, particularly in the moulting period (the process of shedding and growing new feathers), when adult birds are at their most vulnerable. A fleeing response in adults with offspring can also lead to offspring being abandoned or left vulnerable to predators. Whether the activity in relation to emerging industries like aquaculture will have a significant impact is however difficult to assess. There is already considerable activity around many of the islands, and the added impact of emerging industries will depend on the location and routes of activity.

3.1.3 Invasive species

Invasive species can be either alien or native to Norway, but are characterized by spreading into habitats and threaten the native biodiversity of this habitat. There are currently registered 15 alien plant species in Vega (artsdatabanken.no). The most prominent being sitka spruce (*Picea sitchensis)*. This species has been actively planted, but is now spreading into the other habitats, and establishing in habitats such as coastal heathland or semi-natural pastures with abandoned use. Shore pine (*Pinus contorta*) has also established in some areas and is evaluated to have a severe invasion potential (Elven et al., 2018). Such trends could increase the risk of the semi-natural habitats being over-grown by these fast-growing invasive tree species.

The common roadside thistle is a native species to Norway, which appears to be gradually colonising new areas in this region. This is reducing the value of the land for grazing animals, and increasing the effort needed to restore or manage semi-natural pastures. Increased temperatures, due to global warming, will further elevate the risk of new species entering new habitats, potentially becoming invasive and pose a risk to the local ecosystem.

The European water vole (*Arvicola amphibius*) is another native but problematic species. This species has always had a cycle in their populations, with peaks causing damage to various habitats. However, outbreak intervals have been shorter, while the outbreaks are lasting longer in recent years. These problems mostly arise in abandoned semi-natural habitats on islands characterized by regrowth, where the voles are less prone to predation and have plenty of food (Thorvaldsen et al., 2019). The digging and other activities of the water vole cause severe soil erosion that combined with winter storms can dramatically reduce soil levels and disturb the vegetation. This disturbance facilitates establishment of invasive or problematic plant species which often thrive in disturbed soils.

The current “health” of the natural features and processes at the Vega archipelago therefore varies, with some areas being in good condition with a rich flora, while abandonment and problematic or invasive species are altering species compositions and the grazing value in other parts of the semi-natural landscape.

As for the eider ducks and the general bird life, species such as mink or otters pose a risk. The mink (*Neogale vison*) is an alien species which is doing harm to a lot of bird life and poses a threat to eider ducks. The otter is a protected species but is nevertheless reported by the islanders as a problematic species for their eider ducks.

All this exemplifies the challenges of managing both natural and alien species shifting ranges or with new population trends introducing them into new habitats and areas where they can outcompete the natural biodiversity.

3.1.4 Increased temperatures

A warmer climate is already altering the structure and dynamics of ecosystems around the world (Häder & Barnes, 2019; Salick et al., 2019; Steinbauer et al., 2018). Although the ecosystem level changes to be expected at Vega are hard to predict, a warmer climate will most likely affect the local biota in contrasting ways (Pecl et al., 2017).

A common result of global warming a shift of species towards higher altitudes and latitudes, which has been observed in several habitats and ecosystems (Häder & Barnes, 2019). Such effects could alter the characteristic composition of species found in the Vega archipelago. Given the scarce amount of semi-natural habitats and the limited altitude and longitudinal extent of Vega, such shifts are not feasible, and a lack of connectivity and available habitat would make a shift toward suited areas at higher altitudes difficult and unlikely. Unfortunately, the most vulnerable species in Vega are typically habitat specialists, often with a limited geographical ranges (Sætersdal & Birks, 1997). This means that already vulnerable species occupying marginal and rare habitats are facing the most severe consequences of increased temperatures.

Species loss and colonisation by new (invasive) species, and encroachment are common observed effects of climate change and human activity worldwide (Bullock et al., 2011). While such transitions are expected to be slow, a changing climate resulting in elevated temperatures or increased water stress (drought and flooding) tend to favour mobile and fast growing generalist plants (Fourcade et al., 2021).

3.1.5 Altered precipitation patterns

Water stress, in the form of drought and more intense rainfalls, could pose another threat (Hopkins, 2009). This is expected to impact coastal and northern semi-natural habitats such as Vega in particular, where the soils are shallow and the vegetation prone to drought and flooding. Drought could also increase erosion from wind, removing soils that have been built up over centuries. Extreme weather like more intense droughts and storms could therefore cause both short-term stress on the vegetation, but also long-term removal of the soil which the vegetation depends on.

3.1.6 Changes in sea level

According to the models and predictions of the Norwegian mapping authority, the sea level at Vega could rise or lower between -0.10 to 0.55 meters towards 2100 (Kartverket, 2021). This depends on the location, climate, and rate of rising of land mass due to post-glacial rebound. Despite the uncertainty, rising sea levels will affect low laying natural- or semi-natural habitats like meadows or pastures, as well as beach meadows. However, tidal variation in water levels and stormy weather is already affecting several habitats in this region, and the extent of impact from sea level rise on these is therefore difficult to assess. The habitat most vulnerable to such rising sea levels will be semi-natural beach meadows, potentially being permanently submerged below sea level. These long and shallow beach meadows are likely to see a change in the fine-tuned zonation of regularly and occasionally flooded parts of this habitat. Since these habitats depend on a stable disturbance of sea water flooding (although always susceptible to post glacial rebound), the lower parts of these habitats may be permanently flooded while the upper parts may be regularly flooded rather than just at high tide. Such scenarios would alter the zonation and extent of beach meadows even with limited seal level rise. Whether these habitats can adjust and adapt to the expected rate of change is thus uncertain.

4 Detailed descriptions of potential effects in the three most important habitats

4.1 Coastal heathland

A lack of management, combined with climate change, and invasive species is expected to act in synergy and alter these habitats, but little is currently known about the relationships among these factors and their combined effect (Hovstad et al., 2018a).

4.1.1 Land use change

The knowledge of how to burn and manage heathlands is key to maintaining this habitat. However, this knowledge and the interest in continuing the practice needs to be passed on to new generations for the nature type to survive. Whereas we have documentation of the practical aspects, the interest and passion to do this in the long term is crucial. Loss of interest and abandoned use is therefore a severe threat for coastal heathlands as they will encroach with shrubs and trees. The landscape characteristic will change back to what it was, from an open landscape to forest, leading also to strongly changes in vegetation composition. The naturally occurring common juniper (*Juniperus communis)* is in some cases a threat, as it forms a low "blanket" along the vegetation and outcompetes other species when the landscape is left unused. In addition, crowberry (*Empetrum nigrum)*, a species occurring more frequently in northern coastal heathlands, is spreading in the same way, and will without a burning regime diminish grazing resources. This regrowth may lead to increased risk of fire, especially in synergy with increased temperatures and more frequent droughts, as well as erosion an loss of soil from increased activity from water voles (Miljødirektoratet, 2013).

4.1.2 Invasive species

As the climate is changing, new species could slowly move into new habitats in Vega. While this risk is acting more slowly, a more severe risk is posed by alien species intentionally or unintentionally introduced into the landscape. Sitka spruce (*Picea sitchensis*) was eagerly planted in the period 1950-1990, as a timber resource, as well as acting as an effective wind shield when planted as a wall around houses. As the stika thrives and reproduces well, it is spreading on islands and altering habitats such as coastal heathland (Thorvaldsen, 2016).

4.1.3 Increased temperatures

Increased temperatures in coastal heathlands could force species with low and narrow temperature tolerances to higher altitudes. With the flat topography of most of the islands, such shifts could be difficult for the affected species, and hence alter species composition and potentially further threaten vulnerable species. This may especially alter the portion of alpine species which are characteristic for coastal heathlands in Vega. A potential positive effect for coastal heathlands with increased temperatures is that recovery after burning could be accelerated with increased temperatures as the growth season could be extended. However, increased droughts and higher temperatures can, particularly in synergy with abandoned use and encroachment lead to large amounts of dry biomass and consequently result in large and uncontrolled fires. Active management with prescribed burning is therefore an important measure to prevent such incidents.

4.1.4 Altered precipitation patterns

A climate with more precipitation could change the composition of coastal heathlands into more wet variants, and thus change habitats and the home of many red-listed species (Aamaas & Berg, 2019). Climate variability could also increase drought duration or intensity, which in later years seem to have caused damage and death of heath in the area during winter droughts (Aarrestad et al., 2015). Such effects, in turn, alter the availability of fodder for winter grazing animals, and affect their ability to manage the cultural landscape. However, a recent study found northern coastal heathlands to be relatively resilient to substantial drought events (Haugum et al., 2021). It is therefore uncertain how this habitat will be affected by future changes in precipitation patterns.

4.2 Semi-natural meadows: Hay meadows and semi-natural pastures

Effects of climate change on hay meadows and semi-natural pastures is poorly understood, and what is known is not in all instances specific for hay meadows.

4.2.1 Land use change

Abandonment can negatively affect the species in semi-natural meadows relatively quickly. With cease of management, especially in moist and nutrient-rich meadows, a few species tend to rapidly dominate, e.g., meadowsweet (*Filipendula ulmaria),* reed canary grass *(Phalaris arundinacea*), bulbous oat grass *(Arrhenatherum elatius),* water avens *(Geum rivale),* and lady's mantle *(Alchemilla spp.)*, and consequently reducing the ability of other species to thrive. Because of regrowth, populations of European water vole (*Arvicola amphibius*) appear to increase with abandoned use (Thorvaldsen et al., 2019). This has previously had a considerable negative impact on the cultural landscape through their digging behaviours causing soil erosion and favourable conditions for alien plant species thriving in disturbed soils (Carlsen et al., 2010). Vole populations are controlled by predators, like birds of prey, dogs, and cats when the landscape is open, while increased vegetation cover provides shelter from predators.

Both a lack of, but also a change in management regimes is among the threats to semi-natural meadows. Many hay meadows experience a shift towards use of livestock for management, as this is less labour intensive. Such shifts will negatively affect plant species depending on the uniform cutting regime and removal of biomass in traditional management and consequently transform hay meadows into semi-natural pastures.

Semi-natural pastures on the other hand are often threatened by nitrogen fertilization, which promotes certain plant species, making them able to outcompete other species, and ultimately altering the structure of the plant communities. Fertilization also makes the soil inhospitable for most fungi, many of them red-listed.

4.2.2 Invasive species

The occurrence of invasive species in the county of Norland is low, compared to the rest of Norway (Daugstad et al., 2018). However, as for coastal heathlands, sitka spruce is posing a risk in areas prone to encroachment. Ornamentals found in gardens or crops could also find their way into these habitats and alter the species composition. Their need for active management and their open nature make hay meadows and semi-natural pastures particularly susceptible to encroachment from strong competitors like the sitka spruce. Regrowth by sitka spruce is particularly problematic because well managed and nitrogen poor hay meadows or semi-natural pastures in many instances keep their species composition for long periods after abandoned use. This makes it possible to restore these habitats if most of the original and characteristic species remain nearby. Encroachment by sitka spruce does however transform species composition and other abiotic factors in the long term, making restoration

challenging. Local populations of threatened or rare species therefore risk being outcompeted by strong competitors like sitka spruce, with limited means of recolonisation in the event of restoration efforts aimed at removing the alien species.

4.2.3 Increased temperatures

The specific effects of increased temperatures on hay meadows and semi-natural pastures are poorly understood (Hovstad et al., 2018b). Species redistribution and unfavourable conditions for habitat specialists may lead to altered plant community composition as different species could have a different tolerance for increased temperatures (Sætersdal & Birks, 1997). International studies have shown that increased temperatures and variation caused by climate change may create a mismatch in flowering and pollination by insects, and thereby affect seed production (Hegland et al., 2009; Kudo & Cooper, 2019). If such effects occur in hay meadows or semi-natural pastures, this could reduce the reproduction of specialist species occurring in these habitats.

Increased temperatures may also prolong the growth season, and thus the biomass. This will have a particularly negative effect acting together with abandoned use, where it will result in a faster encroachment, making restoration more challenging. The traditional cutting regime only consists of one round of cutting the hay meadows, but a longer growth season may create a need for a second round of cutting or leave biomass for the next year. Leaving more biomasses left for the next season would have a negative fertilizing effect, as well as preventing germination of vulnerable species the next year. This could therefore have a particularly negative impact in hay meadows. Managing this sort of landscape and habitat could therefore be more labour intensive and may lead to decreasing interest in continuing this sort of use, increasing the threat of abandoned use. A longer growth season would on the other hand have less impact on semi-natural pastures, as the increased biomass could be adjusted by increasing the number of grazing animals or prolonging the grazing period. There is however a risk of land users converting their hay-meadows to semi-natural pastures, as manual cutting becomes too labour intense, thus resulting in less species rich habitats, and accelerating the trend which is already occurring.

4.2.4 Altered precipitation patterns

Knowledge on the effects of altered precipitation patterns in hay meadows and semi-natural pastures is limited. Increased rainfall, or droughts may affect the species composition if the hydrology or weather patterns change. Studies on this in Norway are limited, but foreseeable effects could be a lowered biomass production if precipitation decreases, or increased production with elevated temperatures in combination with increased precipitation, both of which could alter both semi-natural pastures and hay meadows.

5 Status of the main features and processes in the Vega archipelago

The current health status of the habitats in the Vega archipelago is highly variable. For natural habitats, a good condition would imply limited impact and disturbance from human activity. However, for the semi-natural cultural landscape, a continuous, low intensity, disturbance in the form of active management is needed to uphold the desired nature values. Since obtaining the status as world heritage site, the interest and will to fund restoration and management of the characteristic semi-natural landscape has increased, and thus extensively increased the current health of the semi-natural habitats. Through restoration and active management, parts of the landscape are now classified as "A" and "B" localities which indicate that they are of national or regional importance, respectively. This contrasts with the period from 1960 till 2004, which was characterized by abandonment, resulting in decay of much of the semi-natural landscape.

5.1 Coastal and boreal heathlands

Coastal heathlands require careful management and provide limited output in the form of fodder for livestock. Current management is therefore mostly performed to maintain this nature type, and is viable only through subsidies for prescribed burning. Boreal heathlands are more common as these in essence are a type of extensively used semi-natural pastures, and fairly easy to maintain. The tradition of burning patches of coastal heathland is diminishing, and so are therefore also the habitats. Some areas are still classified as coastal heathlands, as they are used for grazing, but not burned any longer. These areas are thus slowly converting to boreal heathlands and losing their characteristic features, according to the way these habitats are described by the new system of mapping and characterization. Another trend has been encroachment of sitka spruce which has been planted and then spreading through the landscape.

The current "health" of the coastal heathland is therefore good in areas where they are still in use, but this makes up only a small part of the area covered by this habitat. Boreal heathlands currently make up a larger area than the coastal heathland as they are more easily managed.

5.2 Hay meadows

Although traditional hay meadows have been common on most larger islands in the Vega archipelago, the number of actively managed hay meadows is now low compared to the first half of the twentieth century. However, the density of meadows is relatively high, compared to Norway as a whole, as many meadows which were previously abandoned, are now restored and managed. Like coastal heathland and semi-natural pastures, some of these habitats have been overgrown by sitka spruce. Conversion to semi-natural pasture through altered management is another cause of change which has degraded some of this habitat. The state of hay meadows therefore varies, but with several habitats in good condition or in the process of being restored.

5.3 Semi-natural pastures

Semi-natural pastures make up the largest part of semi-natural and red-listed habitats at Vega. Although the area used previously were larger, as every small island and skerry was used, the larger and more easily accessible islands are still used for livestock grazing, as this is a relatively cheap and easy way to feed livestock and manage the landscape. Abandoned use and sitka spruce spreading are the main threats to this habitat. The status of the semi-natural pastures at Vega therefore varies

strongly with parts being actively managed and used, while there are also areas not in use, or in a deteriorated state.

Use and management of the habitats at Vega is hence the most positive and important driver of change in these environments. However, invasive ornamental species can be a challenge in some areas, particularly around settlements, where they have escaped from flower beds. Other species, such as the spear thistle (*Cirsium vulgare*) are not classified as invasive species in Norway, but are now finding their way into Vega, where they thrive, and are difficult to manage, particularly in the semi-natural pastures. Both invasive and problematic (invasive characteristics) species in this area can degrade these systems in terms of altering the plant communities and make management more demanding. Such species could also increase the risk of landowners/stakeholders losing interest or motivation for management.

5.4 Bird life and eider ducks

The current status of bird life varies but is of concern for several species. The status of the most integral bird of Vega, the eider duck, is particularly concerning as estimates suggest that up to half of the population along the north-western coast of Norway has been lost over the last 25 years (Fauchald et al., 2015). A large number of species of birds can be found in Vega, and several of them use the area as key habitat for critical life stages such as breeding (Hagen et al., 2018). The current pressure from tourism/trails is not considered to affect wildlife on land (Hagen et al., 2018), but this could change with increased activity. The problem for the eider duck population does however seem to be a national problem, and not a caused by the local conditions in Vega. The decline is however of concern, as this may make the tendering of eider ducks more demanding and affect the motivation of the local residents.

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Appendix

Characterisation of the three most important semi-natural habitats; coastal heathland, hay meadows, and semi-natural pastures:

Coastal Heathlands:

GENERAL OVERVIEW:
Habitat category:
Terrestrial
Habitat type:
Coastal heathland
Habitat representativity / distinctiveness:
Coastal heathlands are found all along the coast of Norway up to Lofoten, but scarcely distributed, and often in a deteriorated condition. While coastal heathlands were common along the northern coast this habitat has seen a dramatic decline, with less than 10% now remaining in Norway. *Vega hosts a varied combination of rich and poor variations of this habitat, and with several actively managed and restored areas. The combination of northern, southern, and mountainous species contributes to its distinctiveness. The relative amount of this habitat at Vega is likely higher than the average for other representative coastal municipalities.*
Habitat status:
☐ Critically Endangered ☒ Endangered ☐ Vulnerable ☐ Near Threatened ☐ Least Concern
Image:
 *Coastal Heathland at Mangdalsøya at Hysværet, Vega. The mosaic of patches with grass and heath is visible. Photo: Annette Bär.*

Locations:
 *Coastal heathland is registered both on the main island and throughout the archipelago after the system DN-Håndbok 13.*

PHYSICAL CHARACTERISTICS:
Height asl:
Mostly 0-100 m asl.
Bathymetry / topography:
Typically sloped or rugged, and consequently unfit for more intensive use like hay meadows and semi-natural pastures.
Substrate / soil characteristics:
Nitrogen limited. Covers a wide span from wet to dry and poor to calcareous soils.
Climate:
Related solely to oceanic climate along the coast associated with mild winter without heavy snow fall and a relatively long growing season. Typically exposed to wind and weather.

BIOLOGICAL CHARACTERISTICS:
Dominant and keystone plant species:
The keystone plant species is heath (Calluna vulgaris). In the north, like at Vega, crowberry (Empetrum nigrum) is also common. Due to the burning regime, a characteristic mosaic of heath and grass is created. Besides dominance of C. vulgaris and E. nigrum, northern bilberry,

(Vaccinium uliginosum) and common juniper are common (Juniperus communis). Common grass/sedge species are Anthoxanthum odoratum, Agrostis cappilaris, Avenella flexuosa, Carex panicea, and herbs such as Potentilla erecta, Chamaepericlymenum suecicum, Campanula rotundifolia, Veronica officinalis, Solidao virgaurea, Lotus corniculatius are charactheristic. On calcareous soil, herbs and grass are increasing, often with many orchid-species occurring as well.

Various mosses and lichen species can dominate on the ground level, depending on water availability.

Coastal heathlands can also border to semi-natural pastures, semi-natural beach meadows and other wetlands, creating several variations with different species composition.

Dominant and keystone animal species:

Light livestock like sheep or goats.

Important for many spiders and wild pollinators (butterflies and bumblebees), as well as bird life. Species such as the Twite (Linaria flavirostris, previously NT) and the European stonechat (Saxicola rubicola, EN) are considered to be strongly connected to coastal heathlands, and species such as Eurasian curlew (Numenius arquata, EN), Parasitic jaeger (Stercorarius parasiticus, VU), Common snipe (Gallinago gallinago, LC), and Meadow pipit (Anthus pratensis, LC) are also associated with this habitat, while the Eurasian skylark (Alauda arvensis, NT) is associated to cultural landscapes in general, and the Eurasian eagle-owl (Bubo bubo, EN) is known to use coastal heathlands among other habitats.

Threatened or protected species:

Southern adderstongue (Ophioglossum vulgatum, NT)

Small White Orchid (Pseudorchis albida, VU)

Marsh gentian (Gentiana pneumonanthe, VU)

"Vegamaure" (Galium normanii, EN)

European stonechat (Saxicola rubicola, EN)

Eurasian curlew (Numenius arquata, EN)

Parasitic jaeger (Stercorarius parasiticus, VU)

Eurasian skylark (Alauda arvensis, NT)

Eurasian curlew (Numenius arquata, EN)

Eurasian eagle-owl (Bubo bubo, EN)

Biological processes related to dominant and keystone species:

The key biological process of the coastal heathland is the rejuvenation of the common heather after burning. This is characterized by 4 stages: 1: The pioneer stage (0 - 5 years) where grass is dominating and C. vulgaris is soft and lacking woody structures. 2: The building phase (6 - 15 years), where C. vulgaris is reaching maximum growth rate and dominates- 3: The mature phase (15 – 25 years), when growth is staggered, and the branches become thicker and less suitable as fodder. Mosses then establish. 4: The degeneration phase when branches become thick, and C. vulgaris is vulnerable to frost and insect attacks.

Coastal heathlands are assumed to play an important role for insect life, but this is currently poorly understood.

FACTORS AFFECTING THE HABITAT:
Environmental trends:
Alien species, mostly sitka spruce, is however a problem as this species can establish rapidly and transform the ecosystem and make restoration difficult when degradation has become too severe. *Increased temperatures and variation in precipitation could negatively affect some species with narrow temperature ranges, and drought could cause death in heath. However, some results suggest that northern coastal heathlands are relatively resilient to substantial drought events.*
Human interactions:
Active management by patch-wise burning and ideally year-round grazing is key to preserve this habitat. A lack of management is the most serious threat. This leads to regrowth and makes the habitat vulnerable to other environmental threats such as encroachment by alien species. Building or establishing cabins or houses is also one threat that could threaten this habitat.

RESEARCH:
Key publications and data:
Aarrestad, P. A., & Stabbetorp, O. E. (2010). Bruk av bioindikatorer til overvåking av effekter av atmosfærisk nitrogen i naturtyper med lav nitrogentålegrense. Pilotprosjekt for Naturindeks for Norge. NINA Rapport, 567, 47. *Aarrestad, P. A., et al. (2015) Naturtyper i klimatilpasningsarbeid. Effekter av klimaendringer og klimatilpasningsarbeid på naturmangfold og økosystemtjenester. NINA Rapport 1157.* *Carlsen, T., & Bär, A. (2018b). Skjøtselsplan for kystlynghei. Holandsosen naturreservat, Vega kommune. NIBIO Rapport, 4(5).* *Haugum, S. V., Thorvaldsen, P., Vandvik, V., & Velle, L. G. (2021). Coastal heathland vegetation is surprisingly resistant to experimental drought across successional stages and latitude. Oikos, 130(11), 2015–2027. https://doi.org/https://doi.org/10.1111/oik.08098* *Hovstad, K. A., Johansen L., Arnesen, A., Svalheim, E. & Velle, L. G. (2018). Kystlynghei, Semi-naturlig. Norsk rødliste for naturtyper 2018. Artsdatabanken, Trondheim. URL: https://artsdatabanken.no/RLN2018/74 (03.01.2022).* *Kvalvik, M. S., Carlsen, T., Johansen, L., Thorvaldsen, P., Dyrhaug, M., & Bär, A. (2013). Verdifulle kystlyngheilokaliteter på Ytre Helgeland. Resultater fra kartlegging av kystlynghei fra Bindal i sør til Rødøy i nord. Bioforsk Rapport 8(156).* *Miljødirektoratet. Faggrunnlag for kystlynghei (2012) URL:* https://www.miljodirektoratet.no/globalassets/dokumenter/publikasjoner/rapporter/faggrunnlag_kystlynghei.pdf *(03.01.2022).* *Miljødirektoratet. (2013). Kystlyngheiene i Norge.* *Skartveit, J. (2009). Det kryp og kravlar i lyngen - dyrelivet på kystlyngheia. Naturen 2009, 2. Universitetsforlaget.* *Thorvaldsen, P (2016). Sitkagran Picea sitchensis i stor spredning i det norske kystlandskapet. Eksempel fra Stadtlandet, Selje kommune. Blyttia 74: 160-171* *Thorvaldsen, P., & Bär, A. (2021). Skjøtselsplan for Torsøya kystlynghei, Vega kommune, Nordland fylke. NIBIO Rapport, 7(184)*

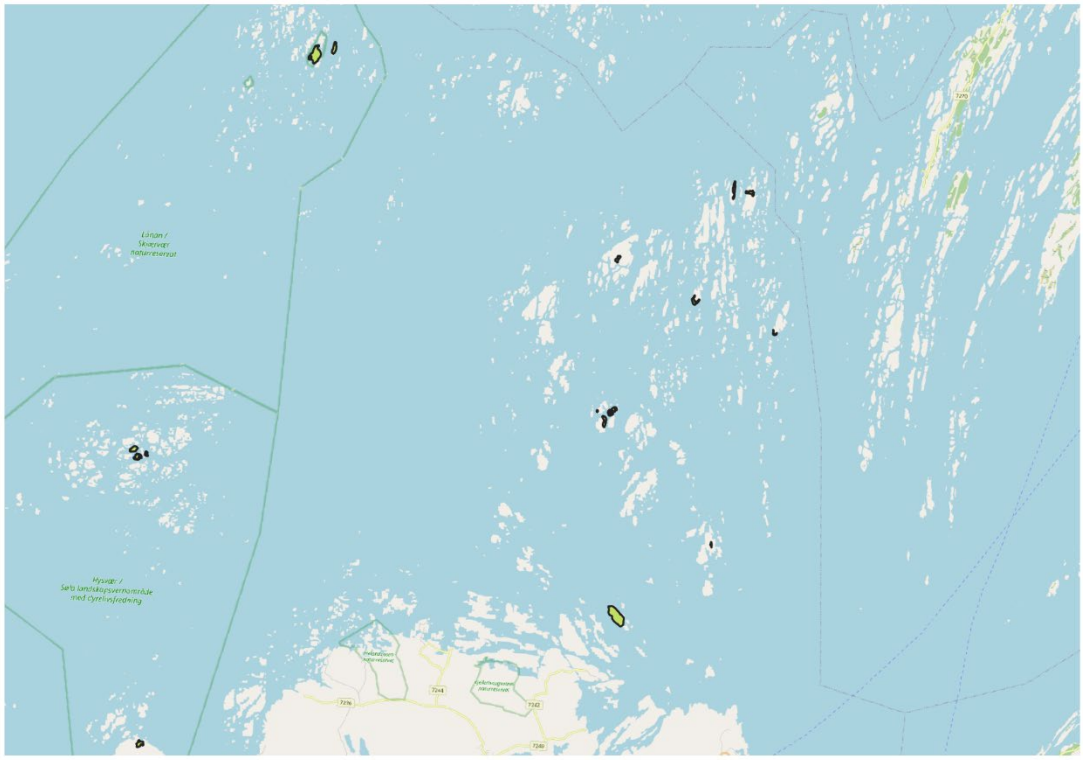
Knowledge gaps:
Less is known about the coastal heathlands in northern Norway. The insect life related to this habitat is poorly studied. Focussing some future effort on this could thus have the potential of providing new and important knowledge about the function and importance of the coastal heathlands at Vega. *The archipelago has previously been mapped by an old system (Fremstad, 1997). These maps are however not digitally available in online tools, but can be found in different reports. The system DN-håndbok 13 is digitally available, but mostly used in areas with restoration potential, or for making management plans, and not a completely covering all the locations of the different habitat types. It is therefore difficult to assess the amounts and frequency of different habitats.*

Hay Meadows:

GENERAL OVERVIEW:
Habitat category:
Terrestrial
Habitat type:
Hay meadows
Habitat representativity / distinctiveness:
This habitat was previously common, covering large areas, but nearly all has been converted to farmland or abandoned. Little is remaining, and only part of the remaining patches is well and properly managed. This habitat is therefore among the most threatened habitats in Norway. Well managed and intact habitats are thus rare, and the habitat is therefore critically endangered. Most of this habitat occurs on the mainland, and the occurrence out at sea at Vega is therefore less common, making it more distinct.
Habitat status:
☒ Critically Endangered ☐ Endangered ☐ Vulnerable ☐ Near Threatened ☐ Least Concern
Image:

Hay meadow from Steinsholmen at Hysværet, Vega. This hay meadow is under restoration. In areas with shallow soils, grass and herbs are still dominating, while Meadowsweet (Filipendula ulmaria) became dominant where the soil is thicker. Management is challenging with the varying soil and vegetation conditions in terms of mowing equipment and patchy restoration measures. Photo: Annette Bär.

Locations:



Hay meadows are scattered throughout Vega. They are often found in relation to islands with houses or people living nearby. Similar habitat mapped by an older system (Fremstad, 1997) is not available, and only selected habitats that have been mapped by DN-håndbok 13 or NiN2 are accessible by web services.

PHYSICAL CHARACTERISTICS:

Depth / height asl:

Can vary, and occur at most altitudes, but the majority at Vega occur at lower latitudes, often near houses or farms, but not always.

Bathymetry / topography:

Usually fairly flat terrain, but now often found in slopes, as these were less attractive for intensified agriculture as for the trend in Norway. The remoteness of the islands at Vega has contributed to making intensification here less attractive, and thereby preserving them.

Substrate / soil characteristics:

Removal of hay leads to impoverishment of nitrogen, thus making the habitat suitable for weaker competitors which require less nutrients and good light conditions. Calcareous soils do however increase the biodiversity of plants considerably.

Currents / climate:

The climate at Vega provides mild winters, but this is not a determining factor for this habitat. Hay meadows can also occur in more mountainous areas with long winters.

BIOLOGICAL CHARACTERISTICS:
Dominant and keystone plant species:
Hay meadows are characterised by a mixture of grasses and herbs and are one of the most species rich habitats in Norway, with up to 30-50 species per m2. Species which thrive and increase by the cutting regime of hay meadows are for example: yarrow (Achillea millefolium), red fescue (Festuca rubra), common bent (Agrostis capillaris), and meadow buttercup (Ranunculus acris). *Calcareous meadows are the most species rich variation and are widespread in Vega. More calcareous meadows are characterised by species such as ox-eye daisy (Leucanthemum vulgare), harebell (Campanula rotundifolia), short lived perennial grass (Anthoxanthum odoratum), purging flax (Linum catharticum), as well as several orchids.*
Dominant and keystone animal species:
60% of butterflies (Papilionoidea) found in Norway are associated with meadows, and particularly traditional hay meadows. The richness in plant species also leads to an increase in bees and other pollinators. Hay meadows are therefore an important habitat for many pollinators, and the pollinators play an important role in pollinating the plant flora.
Threatened or protected species:
Various red-listed species can be found in the hay meadows at Vega, like: *Southern adderstongue (Ophioglossum vulgatum, NT)* *Blue sedge (Carex flacca, NT)* *Scandinavian primrose (Primula scandinavica, NT)* *Hvitkurle (Small White Orchid, VU)* *Leathery grapefern (Botrychium multifidum, VU)* *Several other species are connected to hay meadows in general, like:* *Mountain arnica (Arnica montana, EN)* *Leafless Hawk's-beard (Crepis praemorsa, VU)* *Thalictrum simplex subsp. Boreale (VU)* *Gymnadenia nigra (Nigritella nigra, EN)* *Several insect species are also often found in hay meadows, like Narrow-bordered five-spot burnet (Zygaena lonicerae), which is endangered (EN).*
Biological processes related to dominant and keystone species:
Interdependencies between the plant and insect communities. This results in important pollination services. *At Vega, the presence of humans can make this habitat suited for eider duck nesting if a shelter is provided.*

FACTORS AFFECTING THE HABITAT:
Environmental trends:
Climate change and altered weather patterns increasing droughts, flooding and erosion could have a negative impact.

Alien or invasive species may be the most important threat, as these can be difficult to manage and severely alter the habitat, further making management an effort stake holders are not willing to make.

Human interactions:

Continued cutting and removal of grass key to maintain the habitat. This reduces nitrogen levels and provide a disturbance which benefits the grass and herbs characteristic of hay meadows.

Abandoned or altered use has a negative impact. Altered use to semi-natural pastures is common, as this is less labour intensive, but does not provide the same key disturbance as the unselective cutting regime of hay meadows. Abandoned use typically leads to larger shrubs and then trees establishing and gradually shifting the habitat towards a forest habitat.

RESEARCH:

Key publications and data:

Direktoratet for naturforvaltning (2009). Handlingsplan for slåttemark. URL: https://www.statsforvalteren.no/siteassets/utgatt/fm-sor-trondelag/dokument-fmst/miljo-og-klima/naturmangfold/slattemark/dn_handlingsplan_2009-6_nett_21.pdf (03.01.2022).

Direktoratet for naturforvaltning (2007). DN-håndbok 13 - 2.utgave 2006: Kartlegging av naturtyper - Verdisetting av biologisk mangfold.

Hovstad, K. A., Johansen L., Arnesen, A., Svalheim, E. & Velle, L. G. (2018). Slåttemark, Semi-naturlig. Norsk rødliste for naturtyper 2018. Artsdatabanken, Trondheim. URL: https://artsdatabanken.no/RLN2018/76 (03.01.2022).

Miljødirektoratet (2015): Veileder for kartlegging,verdisetting og forvaltning avnaturtyper på land og i ferskvann. URL*: https://www.miljodirektoratet.no/globalassets/alle-tema/naturkartlegging/okologisk-grunnkart/faktaark---kulturmark.pdf (04.01.2022)*

Norderhaug, A., & Svalheim, E. (2009). Faglig grunnlag for handlingsplan for trua naturtype: Slåttemark i Norge. URL: https://nibio.brage.unit.no/nibio-xmlui/bitstream/handle/11250/2468780/Bioforsk-Rapport-2009-04-57.pdf?sequence=1&isAllowed=y (03.01.2022).

Thorvaldsen, P., Dyrhaug, M., & Dorn, W. (2019). Vånd (Arvicola amphibius) i jordbrukslandskapet. Resultat fra casestudie på faktorer som påvirker skadeomfang av vånd på Helgelandskysten og forslag til skadedempende tiltak. NIBIO Rapport, 5(20).

Knowledge gaps:

There is a lack of knowledge about management which could benefit and promote insect diversity. The literature on this in Norway is marginal and scattered, and even less is known about the status in the northern parts of Norway, like in Vega.

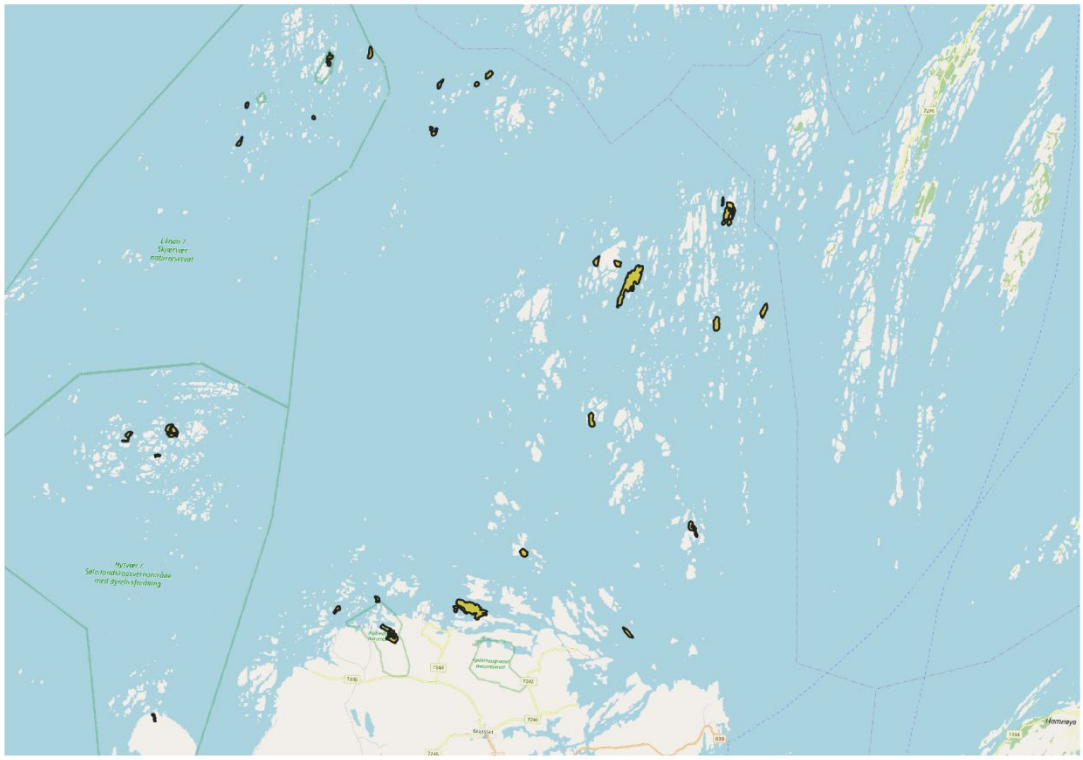
The archipelago has previously been mapped by an old system (Fremstad, 1997). These maps are however not digitally available in online tools, but can be found in different reports. The system DN-håndbok 13 is digitally available, but mostly used in areas with restoration potential, or for making management plans, and not a completely covering all the locations of the different habitat types. It is therefore difficult to assess the amounts and frequency of different habitats.

Semi-Natural Pastures:

GENERAL OVERVIEW:
Habitat category:
Terrestrial
Habitat type:
Semi-natural pasture
Habitat representativity / distinctiveness:
This habitat occurs fairly regularly around the county at both mountainous and coastal areas. The extent of this habitat is estimated to have declined by 60% from 1950 to 2014. The estimated loss of this habitat is however highly uncertain as the knowledge and mapping of these habitats is limited. As semi-natural pastures are found throughout Norway, they are not unique to Vega, but the high frequency and size of calcareous and species rich semi-natural pastures makes the occurrence at Vega special.
Habitat status:
☐ Critically Endangered ☐ Endangered ☒ Vulnerable ☐ Near Threatened ☐ Least Concern
Image:

Semi-natural pasture at Rognan, Vega. An old breed of sheep is grazing on this old semi-natural pasture. Photo: Sven Emil Hinderaker

Locations:



Locations of semi-natural pastures registered in Vega. There are however more locations which are not registered, due to the unavailable data of the Fremstad (1997) system.

PHYSICAL CHARACTERISTICS:

Depth / height asl:

Occur from sea level to mountainous areas. Species composition therefore spans over a wide range of gradients: moisture, nutrient, substrate type/calcareous amount, topographic, climate) can therefore include species with salinity tolerance or mountainous species.

Bathymetry / topography:

Typically in more rugged terrain than hay meadows as this was more labour intense to cut, but suitable for animals to graze on.

Substrate / soil characteristics:

Can be shallow or deeper soils, from poor to calcareous rich soils, and wet to dry. All these characteristics affect species composition and diversity. These habitats are typically somewhat deprived in nitrogen, but not to the same degree as hay meadows.

Currents / climate:

The climate at Vega can be windy, but with mild winters. This creates a generally wet environment, with a long growth period.

BIOLOGICAL CHARACTERISTICS:
Dominant and keystone plant species:
Semi-natural pastures are more grass-dominated than hay meadows, and naturally contain more grazing tolerant species with low growth points or deterring compounds or morphology: *Purple moor grass (Molinia caerulea)* *Matgrass (Nardus stricta)* *Tufted hairgrass (Deschampsia cespitosa)* *Sheep fescue (Festuca ovina)* *Red fescue (Festuca rubra)* *Alpine bistort (Bistorta vivipara)* *Catsfoot (Antennaria dioica)* *Species composition is more patchy than a hay meadow due to both selective grazing and redistribution of nutrients from excrements. Semi-natural pastures can also border to coastal heathlands, semi-natural beach meadows and other wetlands, creating several variations with different species composition.*
Dominant and keystone animal species:
Grazing animals such as sheep, goat, horses, or light cattle are key in shaping this habitat and providing a consistent disturbance. *Insects are important for pollination of many of the herbs.* *Fungus (closer to animals than plants):* *More than 140 species of fungus prefer and occur mainly in unfertilized pastures and may meadows. Several of these are red-listed or threatened.*
Threatened or protected species:
Blue sedge (Carex flacca, NT) *Fibrous tussock-sedge, (Carex appropinquata, NT)* *Southern adderstongue (Ophioglossum vulgatum, NT)* *«Vegamaure» (Galium normanii, EN)* *Islandskarse Rorippa islandica (EN)* *As well as several of the species from hay meadows which can find their way into this closely related habitat.* *European Starling (NT)* *More than 90 species of fungus associated with semi-natural pastures were in 2006 on the Norwegian red list, and most on other European red lists.*
Biological processes related to dominant and keystone species:
Species like starlings (NT) and other birds are dependent on semi-natural meadows like semi-natural pastures. Wet variants of this habitats bordering to wetlands or beach meadows are important for many other bird species as either nesting or feeding habitats.

The habitat may also be suitable for Eider ducks, as long as young and curious grazing animals are kept away. The activity of grazing animals can however also be positive by deterring other predators of the eider ducks.

FACTORS AFFECTING THE HABITAT:

Environmental trends:

The effect of climate change and atmospheric pollution is unknown, but alien or invasive species is assumed to lead to a slow but significant reduction of the habitat much like in coastal heathlands and hay-meadows. Climate variability may also cause increased erosion or alter the composition and characteristics of the pastures.

Human interactions:

Abandoned use is the most important factor causing a decline in this habitat. Active management through keeping grazing animals is key to provide the necessary disturbance regime for this habitat.

RESEARCH:

Key publications and data:

Bratli, H., Jordal, J. B., Stabbetorp, O. E., & Sverdrup-Thygeson, A. (2011). Naturbeitemark-et hotspot-habitat. Sluttrapport under ARKO-prosjektets periode II. NINA Rapport.

Daugstad, K., Thorvaldsen, P., Bele, B., Bär, A., Fløistad, I., & Hanslin, H. M. (2018). Fremmede skadelige karplanter i kulturlandskapet og områdebasert prioritering av tiltak–sammenstilling av kunnskap. NIBIO Rapport, 4(92).

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Hovstad, K. A., Johansen L., Arnesen, A., Svalheim, E. & Velle, L. G. (2018). Semi-naturlig eng, Semi-naturlig. Norsk rødliste for naturtyper 2018. Artsdatabanken, Trondheim. URL: https://artsdatabanken.no/RLN2018/72 *(05.01.2022).*

Knowledge gaps:

This summary briefly characterises a selection of features of semi-natural pastures. Classification and characterisation in this field is still ongoing and understanding how environmental factors affect this habitat is not completely understood. In the case of Vega, some aspects like the occurrence of some threatened or red-listed vascular plants is fairly well mapped.

Fungus and insect life is poorly mapped, but could have a significant potential for revealing interesting discoveries and house many threatened or red-listed species.

As for habitats, the archipelago has previously been mapped by an old system (Fremstad, 1997). These maps are however not digitally available in online tools, but can be found in different reports. The system DN-håndbok 13 is digitally available, but mostly used in areas with restoration potential, or for making management plans, and not completely covering all the locations of the different habitat types. It is therefore difficult to assess the amounts and frequency of different habitats.

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