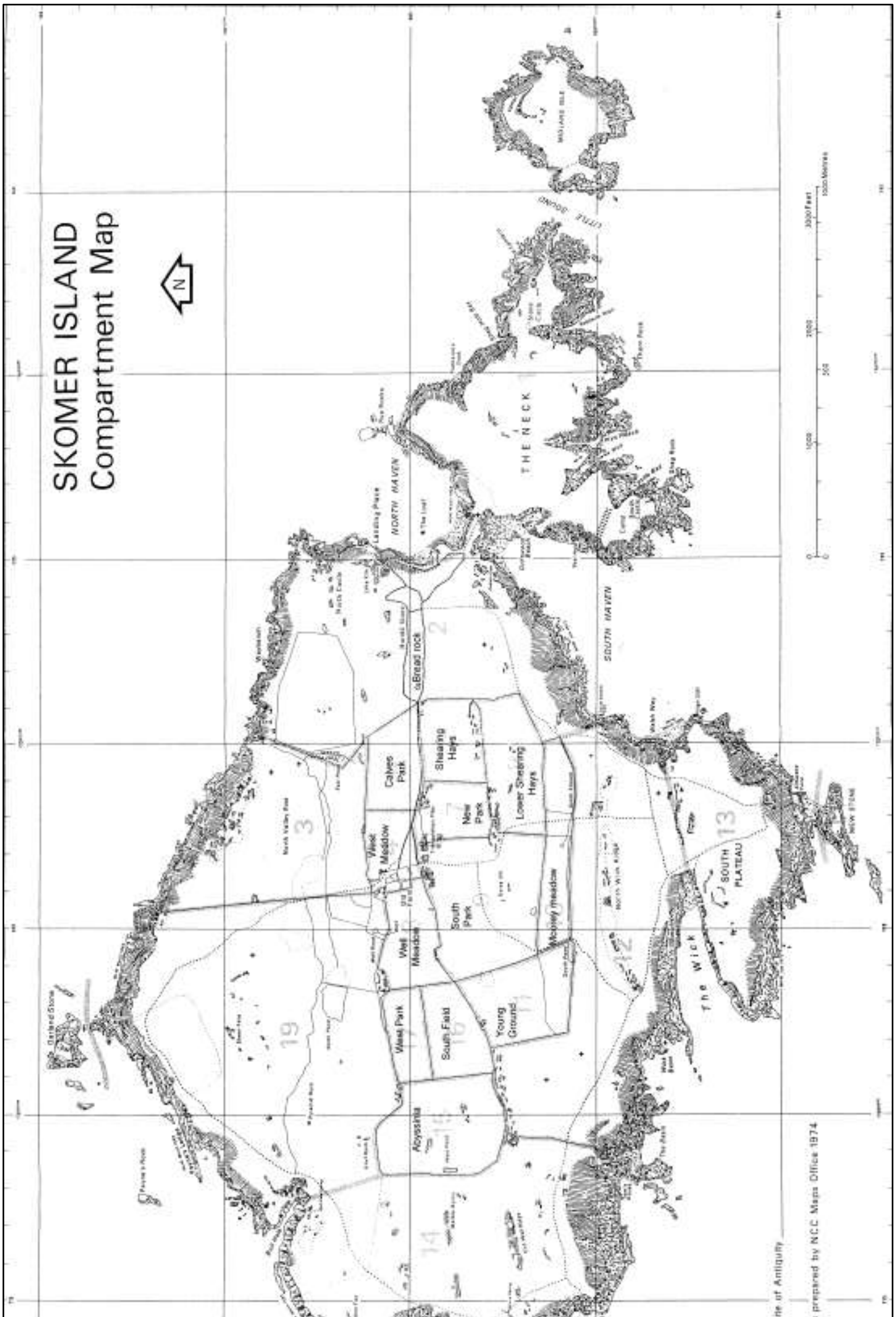
SKOMER ISLAND VEGETATION

Mike Alexander


SKOMER ISLAND
Compartment Map
N
NORTH HAVEN
SOUTH HAVEN
THE NECK
Landing Place
Bread rock
Calves Park
Shearing Hays
Lower Shearing Hays
New Park
West Meadow
South Park
Well Meadow
Mosey meadow
West Park
South Field
Young Ground
Abyssinia
SOUTH PLATEAU
The Wick
Garland Stone
SKOMER HEAD
2
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+ Site of Antiquity
Map prepared by NCC Maps Office 1974

SKOMER ISLAND
VEGETATION

MIKE ALEXANDER

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CONTENTS

INTRODUCTION

This document is intended to guide the preparation of the Skomer management plan. It contains a detailed description of the vegetation, the influences, past present and future are described and discussed, and there are recommendations for future objectives, management and monitoring.

The organisation of a plan for a protected site is usually based on the presence of statutory features; some organisations complement these with an evaluation or rationale which identifies other key, but non-statutory, features. A feature is quite simply something which is sufficiently important in the context of the site to merit specific attention in the management plan. Once features have been identified they provide the focus for all the significant planning decisions. With the exception of one of the maritime cliff and crevice communities and the coastal grassland, which are SSSI features, the remainder of the vegetation on Skomer has no legal status. However, it would make little sense to focus on those fragments of the vegetation which happen to possess a sufficient resemblance to their mainland counterpart to warrant legal protection and forget the remainder.

Skomer is internationally recognised as one of the most important seabird sites in Britain. The seabirds, and a few important terrestrial species, occupy the entire island, and, consequently, we incur a responsibility to ensure, regardless of the intrinsic or scientific value of the vegetation, that it is maintained in a condition which meets the needs of the breeding bird populations. The Island is part of the Skomer and Skokholm Special Protected Area (SPA). The European Union meets part of its obligations for the protection and conservation of birds through implementation of the Bird Directive. One of the main provisions of the directive is the identification and classification of Special Protection Areas (SPAs) for rare or vulnerable species. Together with Special Areas of Conservation designated under the Habitats Directive, SPAs form a network of European protected areas known as Natura 2000.

The main aim of the Habitats Directive is to promote the maintenance of biodiversity by requiring Member States to take measures to maintain or restore natural habitats and wild species listed on the Annexes to the Directive at a Favourable Conservation Status (FCS) throughout the Member States. The UK country agencies made the decision to use FCS for SPAs and at a site specific level entirely for practical purposes. There was no legal requirement to do so, but it is quite difficult to understand how a species could be at FCS within Europe if the most important breeding populations are not at FCS. The practical application of the concept provides an extremely useful, and entirely appropriate, basis for defining the desired status of habitats and species at any geographical scale, from the entire geographical range to a defined area within a site.

The following definition of FCS is based on, and is consistent with, the statutory definition of FCS for habitats and species given in Article 1 of the Habitats Directive.

Definition of Favourable Conservation Status

Habitat features

For a habitat feature to be considered to be at FCS, ALL of the following must be true:

- The area of the habitat must be stable in the long term, or increasing.
- Its quality (including ecological structure and function) must be maintained.
- Any typical species must also be at FCS, as defined below.
- The factors that affect the habitat, including its typical species, must be under control.

Species features

For a species feature to be considered to be at FCS, ALL of the following must be true:

- The size of the population must be maintained or increasing.
- The population must be sustainable in the long term.
- The range of the population must not be contracting.
- Sufficient habitat must exist to support the population in the long term.
- The factors that affect the species, or its habitat, must be under control.

From a vegetation or habitat perspective the requirement to ensure that *'sufficient habitat must exist to support the population in the long term'* is the most significant statement. Although the island can only make a contribution toward the total habitat requirements (marine and terrestrial) of the seabirds, the contribution is obviously essential and it must be protected.

Aside from any legal requirement, the vegetation on Skomer is very special. There may be similarities to vegetation elsewhere, but there is nowhere that is subject to the same range or intensity of influences. The vegetation on Skomer is quite unique and different to anything that exists elsewhere.

In order to bring some structure to this document, I have used a combination of both statutory features and previously recognised plant communities to identify the following divisions in the vegetation:

THE VEGETATION FEATURES:

- Maritime cliff and crevice communities (an independently qualifying SSSI feature)
- Coastal rocky slopes and inland outcrops
- Coastal grassland (an independently qualifying SSSI feature)
- Maritime, dry & wet heath
- Acid grassland
- Bracken
- Scrub, shrubs and trees
- Streams and associated wetlands (marshy grassland, valleys, flushes and ponds)
- Additional miscellaneous features

I will begin with a description of each of these features. This is probably best regarded as a collation exercise, locating and bringing together, filtering and summarising all the relevant information about the vegetation on Skomer, and it is entirely dependent of the work of others.

I have, as far as possible, used plain language. This is because the fundamental purpose of this document, and the management plan which will follow, is communication, and we must communicate with the widest possible audience. This should include anyone who has an interest in the reserve, regardless of how minor that interest may be. We must recognise that most of the people that we want to read the plan will not have a scientific background. Communication in the context of a plan is about sharing our knowledge and decision-making process with others, and encouraging them to take part in this process. Planning should always be an inclusive process, open to all. This is a reflection of our collective responsibility for nature conservation and also the recognition that conservation is an expression of human preferences in respect of non-human life.

I will, occasionally, give an explanation for scientific terms where these are obscure or archaic. The only exception to the use of plain language is the inclusion of both the common English and scientific names for species. I will always introduce the NVC communities with their full titles and will also use the English name for the communities.

"The associations, consociations and societies merge into one another, and become entangled in such an intricate fashion as to defy all attempts at a straight forward method of mapping or recording." (Sadd 1947) This is a wonderful quote that succinctly describes the complexity of Skomer's vegetation, but perhaps it requires some explanation. In Sadd's time the language used to describe plant communities was different to today's: an association was a relatively stable, fully developed plant community, having one dominant species; a consociation was a subdivision of an association; a society was a local concentration, inside an association, of a species other than the dominant species of that association. (Tansley 1920)

The vegetation on Skomer is complex, though probably no more so than comparable places on the mainland. This complexity is mainly the consequence of a range of natural and anthropogenic factors, some of which are unpredictable, impacting on the various plant communities. Wilberforce (1999) suggests that the main environmental variables (factors) are soil (pH, moisture, depth) and vegetation height. In many ways, the most significant anthropogenic factor is past agricultural management and later abandonment. The key to understanding the vegetation is to recognise that it is changing quite rapidly. After so many hundreds of years of human utilisation nature is trying to reassert her influence. This is why I place so much emphasis on describing the factors and the consequential recent history of change.

The National Vegetation Classification (NVC) will be referred to throughout this section of the plan. The NVC is a classification scheme to help us identify and understand vegetation types encountered in the field. It provides, in Britain, a common and widely understood language for describing plant communities. A plant community is an assemblage of plants with a distinct and unique composition and structure. The community contains species which coincide in space and time and have a shared an overlapping dependence on determining environmental factors, for example, climate, soil, biotic impacts and management. (Rodwell 2006) The NVC is published in five volumes. I strongly recommend that anyone wishing to gain an insight into NVC reads 'National Vegetation Classification users handbook' published by JNCC in 2006.

My conclusion, in broad terms, is that we should allow the vegetation on Skomer to develop unhindered by any further human intervention, so I have produced a single objective for all the vegetation on Skomer. This also recognises that there are probably very limited possibilities for significant intervention. Skomer provides an extremely rare opportunity in Wales for allowing nature to take over responsibility for both management and outcomes. It is also an extremely valuable opportunity for study and research.

MAIN SOURCES OF INFORMATION:

1. The description of the island flora produced by Dr W. J. L. Sladen, a report on field work carried out during 1946 and published in 'Island of Skomer' (Buxton & Lockley 1950). This was based mainly on casual observation and was not a systematic survey. However, the author and contributors were some of the most experienced and competent botanist of their day. The chapter on flora was read by Sir Arthur Tansley, one of the most respected British botanists at that time.

2. 'A Preliminary Vegetation Survey of Skomer Island Pembrokeshire' 1947, by J. Sadd. Joe Sadd was an undergraduate student from Aberystwyth University. He spent his summer vacation on Skomer preparing for his honours botany thesis. Sadd's thesis provides an extraordinary account of the island's vegetation at a time when farming, and in particular stock rearing, was coming to an end on the island. The vegetation maps from this period are quite confusing. The map published in the 'Island of Skomer' (Buxton & Lockley 1950) was originally produced by Sadd in 1947. A version of this map was also included in Sadd's thesis (1947), but this is not entirely consistent with the published version. Unfortunately, the only copy of the map which survives is a 'photostat' from the 1940s, and it has oxidised to a point where it is barely legible. The situation is further complicated because Sadd also included an annotated sketch map in his thesis which described the vegetation in the central fields, but there are differences between this and the other maps. I suspect that the version published in 'Island of Skomer' was 'tidied up', and much of the original text was omitted. Unfortunately, these are the only vegetation maps from this period.

3. The 'Skomer botanical survey' (Bray 1981) was the result of research carried out during 1979 and 1980 by Graham Bray, a post graduate student from the Department of Zoology, University College Cardiff. This was the first, and only, detailed systematic survey of the vegetation. Bray's survey was based on sampling 270 quadrats. The quadrat distribution was biased towards ensuring that all the plant communities were included. The island was divided into distinct compartments with the quadrats randomly dispersed within these. At the end of the survey, 90 quadrats were 'permanently' marked. His descriptions are invaluable and provide an essential source of information used in this entire section.

4. The Pembrokeshire lowland heathland survey 1996 by M. V. Prosser and H. L. Wallace, an unpublished report to the Countryside Council for Wales. During this survey the heathland on Skomer was mapped and the various NVC heath communities were identified. Unfortunately, they did not produce a site description or comment on the condition of the heath. The sketch map is indicative of the location of the various heath and other communities that they mapped but does not provide a particularly accurate boundaries.

5. 'Some Vegetation-Environment Relationships on Skomer Island NNR, Pembrokeshire 1997-1998'. This is an undergraduate dissertation by Elizabeth Wilberforce, a student at the Institute of Biological Sciences, University of Wales, Aberystwyth. This study was undertaken with the aim of re-recording the permanent quadrats established by Bray (1981) and explaining some of the changes observed in the data between 1978 and 1998. Many of the metal posts used to mark the original locations had been lost, but 65 of the original 'permanent' quadrats were relocated and sampled. This smaller sample included only very few quadrats in the cliff edge grasslands. This was the consequence of lost markers and the distribution of the original 90 quadrats. Despite the smaller number of samples, this is the most up to date, relevant and informative detailed study.

6. 'Skomer - Some future prospects for the vegetation' 2004 and 'The edge of the Picture' by Professor John Rodwell (2008). These reports on the vegetation of Skomer and other Welsh islands were commissioned by the Countryside Council for Wales. In addition to his general comments on the vegetation, John Rodwell was also asked for his view on the need for an NVC survey. His opinion

was: *'There is no urgent need for a complete NVC survey of Skomer. The definition of the vegetation types in Bray (1981) is certainly not very crisp but most of them can be related, at least in part, to particular NVC communities. Coverage in that survey is not complete, so additional relevés might be collected of vegetation types omitted from the original work.'* (Rodwell was not aware of the dissertation prepared by Wilberforce)

7. The description in the SSSI schedule. This is rather generic and not particularly informative. It is quite difficult to understand the background to, and reasons for, the designation of the vegetation. The status of the qualifying features dictates that they must be addressed in this plan.

8. The National Vegetation Classification

9. A wide range of additional published and unpublished material. (A full bibliography has been prepared for Skomer, and this lists all the relevant botanical papers. These were all reviewed. The full bibliography is appended to this plan, and the papers referred to in this text are given in the references at the end of this section.)

10. Within the limits of my competence, I have also relied on personal experience of the vegetation on Skomer from the 1960s to the present time.

ENVIRONMENTAL FACTORS

It will only be possible to understand the vegetation on Skomer by beginning with a brief consideration of two of the most significant factors or influences, salt spray and soils.

SALT SPRAY

There can be no doubt that salt spray is one of the primary factors influencing the type and distribution of vegetation in a coastal environment (Malloch 1972, Bray 1981). Obviously, it is the western and southern cliffs that are the most exposed on the island. The degree of exposure is best understood by turning to the Ballantine scale, a biologically defined scale for measuring the degree of exposure to wave action on a rocky shore. The scale runs from 1, the most extremely exposed shores, to 8, the extremely sheltered shores. Skomer Head and much of the west coast is described as 1 on the Ballantine scale. In other words, these shores represent the highest limits of exposure. Salt spray is frequently deposited on the western coastal grasslands, and it is not uncommon during a westerly storm to see the cliff tops deluged in seawater, so that puddles fill the hollows. Often in September, following the autumn equinox gales, the bracken fronds over the entire island are burned black by salt spray. There is no shelter: to varying degrees everywhere on the island is at some time exposed to salt water.

Graham Bray (1981) used simple salt traps at twelve locations to measure the varying rates of salt deposition around the island. His data revealed no surprises: deposition is heaviest along the south and particularly the west coasts. Further inland, there is a gradual decline in deposition from west to east. There is little purpose in dealing with anything other than generalities. The detail will be of academic interest, but the important point is that variations in salt deposition are reflected by variations in the vegetation.

Photo 1 The yellow cliffs Skomer head.

The more exposed cliff edges display very obvious zonation, beginning above high water with the splash zone where lichens are the dominant organisms. The bottom of the cliff is populated by a wide zone of the black tar lichen *Verrucaria*, followed by the distinctive bright yellow-orange zone dominated by *Xanthoria*. Further up the cliff, and in occasional sheltered crevices, the first flowering plants appear: thrift *Armeria maritima*, sea campion *Silene uniflora* and buck's-horn plantain *Plantago coronopus* are the most obvious on Skomer. Once soils are able to develop, and salt deposition declines, the maritime grasslands appear. At first, in the absence of heavy grazing, a community mainly comprising red fescue *Festuca rubra* and thrift *Armeria maritima* dominates. A little further inland, or in more sheltered areas, this grassland grades into Yorkshire fog cliff grassland. During earlier times, when rabbits were either absent or heavily controlled, these grasslands would probably have been interspersed with maritime heath dominated by heather *Calluna vulgaris*.

SOILS

It would make little sense to make any attempt at understanding the vegetation on Skomer without beginning with the soils. The soil type will always influence the plant community which can occupy any specific area. The situation is a little more complicated because it is the vegetation, particularly dead and decaying vegetation, that makes a major contribution to the development of soils and the soil type. A further complication is that soils are not static; they will respond over time to both natural and anthropogenic influences, and as these influences change so, eventually, will the soil. The soils on Skomer are continually evolving: soils are forming and soils are lost. As the soils evolve and change so will the vegetation.

We are extremely fortunate to have a report, 'Soils of the Island of Skomer', prepared in 1995 by D.A. Jenkins and A. Owen from the School of Agriculture and Forest Sciences, University of Wales, Bangor (Jenkins D.A. & Owen A. 1995). The report was commissioned by the Countryside Council for Wales, and most of the following text is a précis of this work.

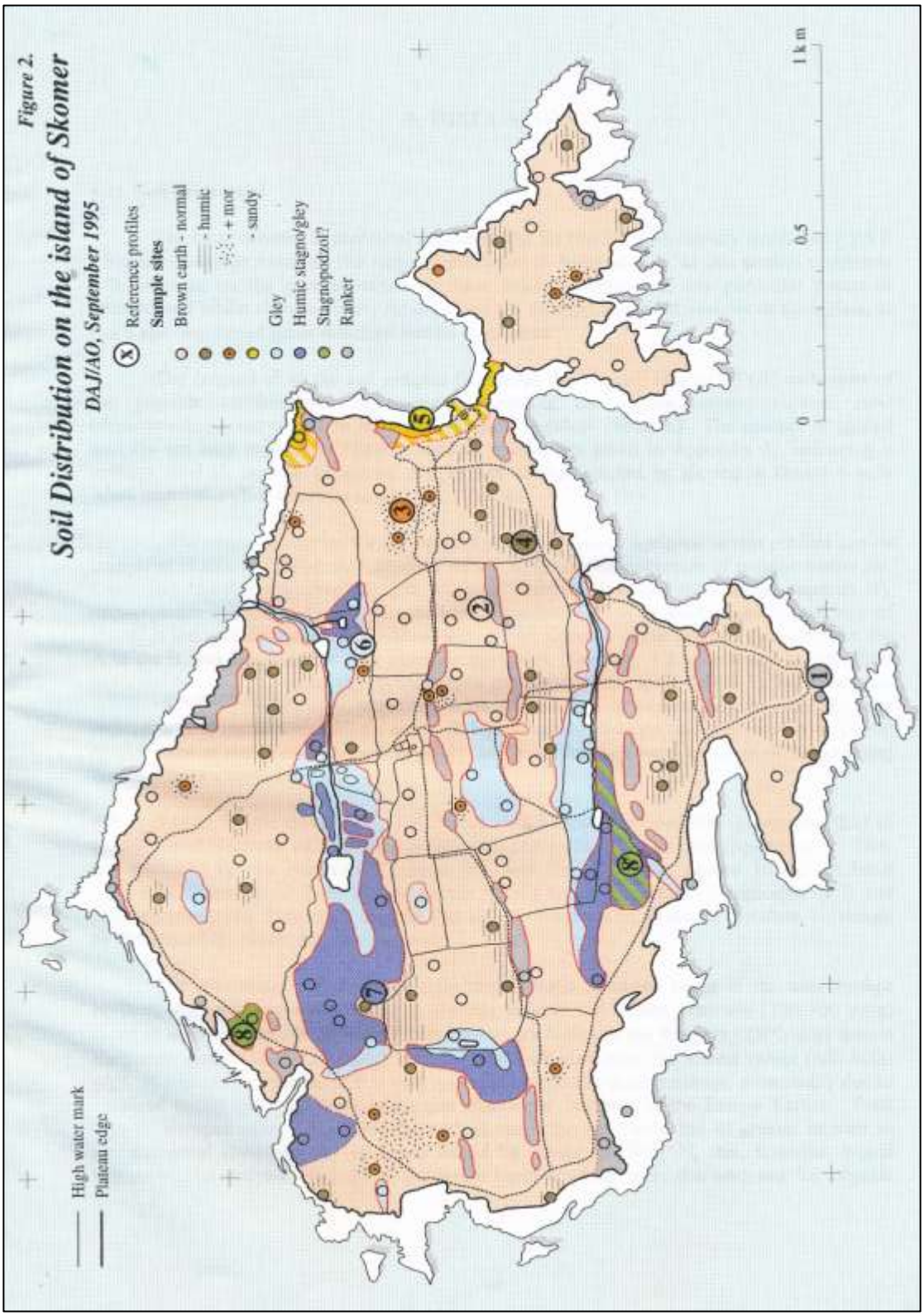

Fig 1 Map of soil distribution on Skomer.

SOIL TYPES:

GROUP 1 RANKERS

Rankers are defined by their shallow depth, 10 to 20 cm over rock outcrops. These are dark soils with a high organic content, and they are acidic (pH 4.1 – 5.5). These soils support the vegetation of the inland rocky outcrops and the extreme maritime vegetation zone on the exposed cliff edges, which grades into the red fescue *Festuca rubra* maritime grassland zone. This was also the original stronghold of the maritime heath.

Photo 2 Inland rocky outcrop

GROUPS 2 – 5 BROWN SOILS

These are the dominant soils of the inland, well-drained areas. Group 2 was described as the 'normal' variant, a dark brown soil with a slightly stony surface. They show a distinctive humic, silty / sandy silt loam. The pH values are moderate, averaging 4.4. Groups 3 and 4 were described as intermediate and developing a mor humus. (Soils with a mor profile have a dark-coloured band of organic matter, including litter, in the upper horizon.) Group 5 are described as *Brown Sands,* and these are sandy loams rather than the more usual sandy silt loams. The pH is over 6 at the surface but declines at depth. These are the lighter soils so favoured by rabbits and burrowing birds and, consequently, are very disturbed in places. This vegetation of this group of soils includes the less exposed coastal grasslands, the acid grasslands, the areas of bracken, bluebells and the surviving patches of dry heath.

GROUPS 6 – 8 GLEYS AND RELATED SOILS

The pattern of soil distribution on Skomer is mainly a consequence of drainage or lack of drainage. The gleys and related soils are distributed within the wet, poorly-drained areas, with groundwater

gleys, adjacent to standing and running water, grading into humic stagnogleys at the head of both North and South Valleys. In association with the latter, on shallow slopes, there are small patches of stagnopodzol. Group 6, the groundwater gleys, are the saturated areas where surface water is usually present. They are characterised by a dark greyish brown A horizon, while the underlying B horizon is a paler grey with orange-brown mottling. The pH is an average of 5 at the surface. Group 7, the humic stagnogleys, are distinguished by a dark peaty surface layer which overlies a stone-free, very dark greyish brown horizon. The surface pH value averages 3.8, rising at depth to 4.6. Group 8, the humic stagnopodsols, was only sampled in two locations, so no generalisations were made. There is an obvious and direct relationship between these soils and the wet valley vegetation. The groundwater gley is easily defined by the presence of purple moor grass Molinia caerulea, while the pattern of parallel stripes of wet heath in North Valley is explained by the underlying corresponding bands of dryer humic stagnogleys.

Photo 3 Purple moor grass and wet heath in North Valley

PARENTAGE OF THE SOILS

The drier soils on Skomer suggest that there is a general cover of loess, with some localised areas of coarser cover sand. These are presumed to be a consequence of periglacial and later postglacial processes, and derived from the wind erosion of glacial deposits. (Periglacial refers to places at the edges of glacial areas which were not buried by glacial ice but were subject to intense freezing cycles.) Most of the soils are stone-free to a depth of c 30cm (Bray 1981). The deeper sections, exposed at the Wick and the Isthmus, are roughly banded with alternating finer materials. These are probably deposits of local material at the edge of the once glaciated area. There is also evidence on the Island of glacial deposits of reddish Devonian rocks from the mainland and occasional erratic boulders, for example, the large rounded boulder of pale grey granite just south of Bull Hole. There are also deposits of gravelly materials which suggest a raised beach or fluvial deposits, but overall these are rare, and the conclusion reached by Jenkins and Owen was that the soil parentage is dominantly periglacial in origin.

IMPACT OF RABBITS AND BIRDS ON THE SOILS

Jenkins and Owen noted that the soils of Skomer are markedly influenced by both rabbits and seabirds. Burrowing activities disturb and mix the soil horizons, returning less leached materials to the surface. Seabirds, in addition to burrowing, have deposited very significant quantities of nutrients: faeces, dead birds, regurgitated fish bones and other similar material. Jenkins and Owen suggested that the annual deposit of phosphorus could amount to 10kg per hectare (this did not include the input from carcases). However, their calculations were based on an overestimate of the total island bird population and did not account for the fact that some of the species, guillemots, razorbills and the cliff-nesting gulls, would have no impact on the inland vegetation. The most important point is that levels of phosphorous are significantly high and this reflects the input from birds.

THE PLANT COMMUNITIES

MARITIME CLIFF AND CREVICE COMMUNITY

Apart from notification, this community has not received any significant attention. It was not described by Bray (1981), but he did point out in his discussion that the cliff-slope communities were under-sampled and that *'a detailed separate survey would be desirable'*. There have been no further surveys since that time. Wilberforce (1999) re-surveyed Bray's quadrats and consequently she did not record this community.

The community which qualifies as an SSSI feature is almost certainly the rock samphire cliff crevice community, NVC MC1 *Crithmum maritimum – Spergularia rupicola* maritime rock crevice community.

There is not a great deal that we need say about this community apart, perhaps, from celebrating its robust naturalness. It is the community that, along with a spectacular assembly of lichens, defines the most exposed Atlantic cliffs. It occupies the extreme maritime vegetation zone on the rocky cliffs, the areas that are battered by gales, frequently saturated with salt sea spray, and desiccated by sun and wind. It is mainly restricted to the crevices and narrow ledges on the cliff faces, and is limited within the area that lies above the grey lichen-covered splash zone, just above high water mark, and below the red fescue *Festuca rubra* maritime grassland zone.

On the extremely exposed western edge of the island, it tends to climb over the top of the vertical cliffs and, in places, it extends over quite large areas of exposed rock. In the more sheltered areas, particularly on the least exposed north coast, it barely exists and is quickly replaced by much lusher vegetation growing in the soils that have accumulated on these cliffs.

Of the two species that give their names to this community, rock samphire *Crithmum maritimum* is not common on Skomer. It has a quite restricted distribution, and is mainly confined to the western edge of the Neck, between Driftwood Bay and Amy's Reach. Rock sea-spurrey *Spergularia* rupicol is much more common and widespread. The most obvious and frequent species are thrift *Armeria maritima*, sea campion *Silene uniflora* and buck's-horn plantain *Plantago coronopus.* The small fern, sea spleenwort Asplenium marinum, is often found in the more sheltered areas.

These areas are not generally influenced by grazing. There may be occasional, very limited, rabbit grazing, but the main species that comprise the community are not palatable to rabbits. Any variation in the community will be the consequence of natural factors, particularly enrichment from sea bird droppings.

There is one additional maritime cliff and crevice community found on Skomer. This is the vegetation that occurs around and below the cliff nesting seabird colonies: the rich green patches found on even the smallest ledges and in crevices on the cliff face. The distribution is easily predicted: the most obvious places are, for example, South Stream Cliff, High Cliff and The Wick. This is a neglected community. It has never been surveyed or sampled and there are no descriptions. It probably the NVC MC6 *Atriplex prostrata-Beta vulgaris ssp. maritima* sea bird cliff community. This is the highly fertilised version of NVC MC1, described as being very variable in its floristics and appearance. It is not included as a component of the SSSI feature, presumably because it has been dismissed by JNCC as having 'limited botanical interest'.

Photo 4 Cliff and crevice community

Photo 5 Seabird cliff vegetation

As an aside, this community is home to a fleshy, succulent and very large type of buck's-horn plantain *Plantago coronopus,* which has leaves occasionally over 20 cm long. These plants created considerable interest during the 1946 expedition, and specimens were sent to Kew, where they were identified as *Plantago coronopus var. maritima,* but there was a some general confusion concerning the varieties of buck's-horn plantain at that time. Sadd, in his 1947 thesis, provided a sketch of a variety that he identified as *ceratophylla*. He found specimens on the cliff faces of the Wick, Bull Hole and the Basin. It also occurs on High Cliff and South Stream Cliff. These varieties are now believed to be within the normal range of variation for this species and sometimes recognised as a coastal ecotype. Ecotypes display adaptations to the specific environments in which they grow, so perhaps it is not surprising that there is such a difference between the small, recumbent forms found in the drier, rabbit-grazed areas and the very much larger succulent form found on the damp, guano-laden cliff ledges.

Photo 6 A large succulent form of buck's-horn plantain *Plantago coronopus* , with Common Scurvygrass *Cochlearia officinalis* on the South Stream Cliff kittiwake colony.

Photo 7 Buck's-horn plantain *Plantago coronopus* on grazed cliff edge grassland.

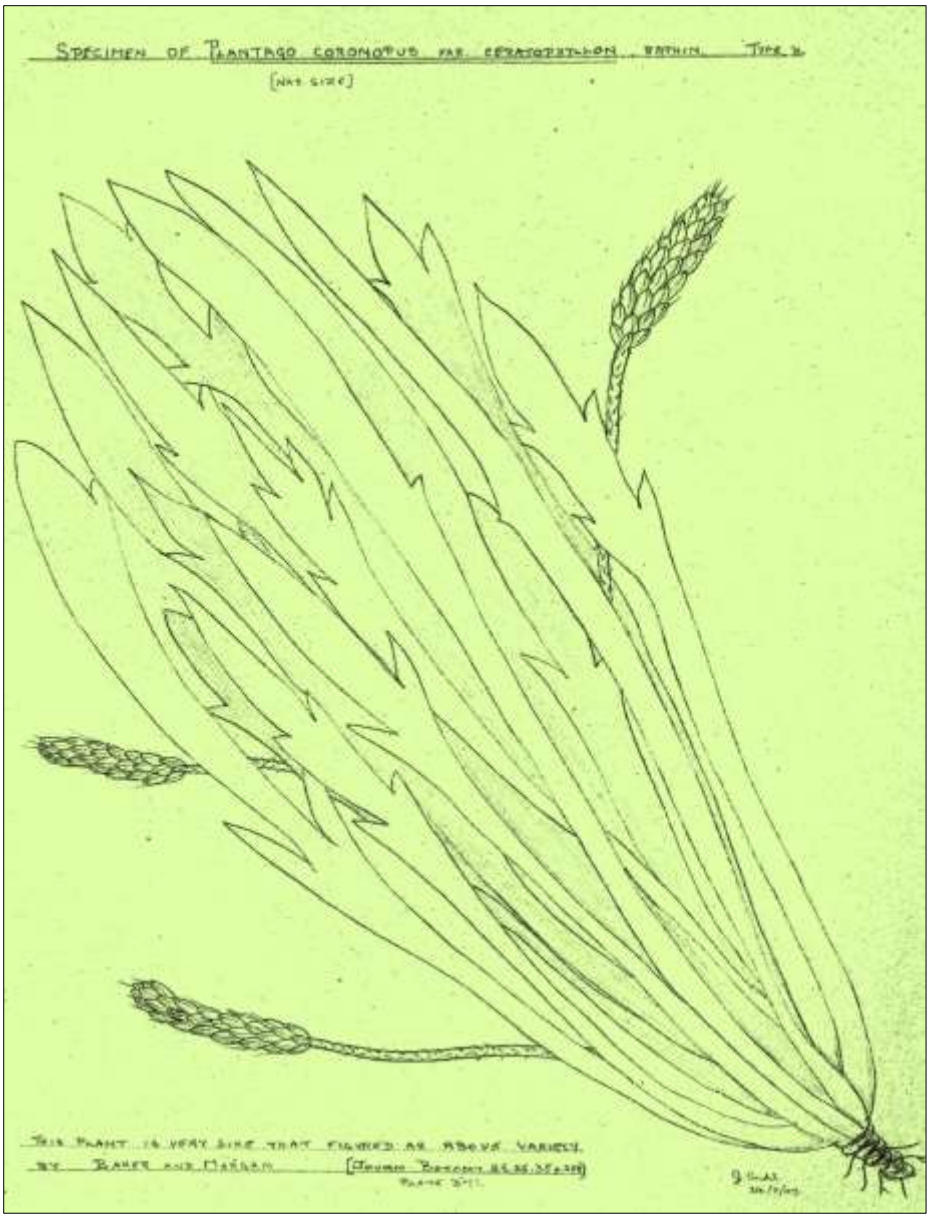

Fig 2 A Sketch of the variety of buck's-horn plantain '*Plantago coronopus* var. *ceratophylla',* from J Sadd's 1947 thesis on the vegetation of Skomer.

COASTAL ROCKY SLOPES AND INLAND OUTCROPS

This is probably the NVC MC5 *Armeria maritima – Cerastium diffusum ssp. diffusum* maritime therophyte community. The English name for this community is 'Sea mouse-ear rock top'; it occupies one of the more inhospitable zones: the exposed cliff tops and some of the inland rocky outcrops - places where salt is often in the air and where the soils are very shallow to non-existent and free draining. These are the places that burn out and turn yellow even during the briefest of dry periods. Many of the species are therophytes: annual plants that complete their life cycle in a short period when conditions are favourable and survive harsh conditions as seeds. The community forms a mosaic with the other maritime grasslands and the cliff and crevice community.

MC5 has not been identified on Skomer. However, Bray (1981) describes a similar community: coastal grasslands - rocky slopes and inland outcrops. Bray suggests that this community is similar to

a community described by Malloch (1972), 'found on the very shallow soils over rocks and in dry, exposed crevices'. Bray describes this as a 'maritime therophyte community'. The typical species of this community are almost identical to those of MC5, as is the physiognomy (appearance and structure).

On Skomer, the species capable of tolerating these extreme conditions include: sea storksbill *Erodium maritimum*, sea campion *Silene maritima,* English stonecrop *Sedum anglicum,* procumbent pearlwort *Sagina procumbens* and common bent *Agrostis capilliaris.* In common with the sea cliff community, this also exists in the absence of any human intervention. Its composition, structure and distribution are almost entirely determined by natural factors.

SEA CLIFF GRASSLANDS

These are generally described as the 'closed' perennial communities of grasses and herbs on the less spray-splashed cliff tops and ledges. Closed implies a lack of open, or bare, ground within the community, and this is how they usually appear on the mainland cliffs, but Skomer is different. Here the cliff communities are most often open, with sometimes large patches of bare ground. These are mainly a consequence of rabbit grazing.

The maritime cliff grasslands comprise four communities which are an approximation of NVC:

- MC7 *Stellaria media-Rumex acetosa* sea bird community. (Chickweed bird cliff community)
- MC8 *Festuca rubra – Armeria maritima* maritime grassland. (Sea-pink grassland)
- MC9 *Festuca rubra – Holcus lanatus* maritime grassland. (Yorkshire fog cliff grassland)
- MC12 b *Festuca rubra-Hyacinthoides non-scripta* maritime bluebell community, *Armeria maritima* sub-community. (Bluebell cliff grassland)
- There is one additional community, which has not yet been described using NVC categorisation. This is the cliff community found only along the most sheltered north-facing coast.

For convenience, I have subdivided the grassland by grouping the NVC fescue communities MC7, MC8 and MC9. The remaining two communities, MC12b and the sheltered cliff grassland will be dealt with individually.

Photo 8 Sea-pink (Thrift) grassland forming a fescue mattress on the nearby mainland east of Musselwick

THE FESCUE COASTAL GRASSLANDS

Bray (1981) described and mapped two maritime grassland communities:

a) Coastal grassland - western slopes. This is the vegetation of the extremely exposed south western coasts: the zone between the rocky sea-cliff vegetation and the more sheltered 'northern slopes grassland'. The key localities are the western edge of the Table, Skomer Head, Wick Basin, the western section of South Plateau and the south west tip of the Neck. Rodwell (2008) suggests that these generally resemble MC8 in the more spray splashed zone. This community was not recorded by Wilberforce (1999) but it would appear from her

map of quadrat locations that she probably did not sample any of the areas containing this community.

b) Coastal grassland - northern slopes. Bray's name for this community is somewhat misleading. In fact, its distribution follows, more or less, the inland, or slightly less exposed edge of the 'western slopes grassland'. The northern slopes grassland extends along the entire west and southwest coast in a narrow band from above the Garland Stone around the Table, and in a much wider zone from above Pigstone Bay to the Wick and much of the exposed areas of South Plateau. It reappears at the isthmus and then extends around the entire south and west coast of the Neck.

(On Skomer, this community is a mix of NVC MC7 and NVC MC9. It merges in some places into the coastal bluebell community, probably NVC MC12).

Wilberforce (1990) identified MC7, MC9 and MC12, and Rodwell (2008) confirmed the presence of MC9. Some doubt remains about the identity of these communities, and, clearly, further survey would resolve these issues, but our current inability to confirm the identity of these communities will not influence management decisions.

The MC8 *Festuca rubra - Armeria maritima* community develops into an extremely dense mattress of fescue, with only occasional occurrences of other species. It is usually found on very exposed cliff-tops, in areas where grazing is absent or at low levels. The best examples in Pembrokeshire are on the exposed, small offshore islands. Gillham (1953) recalls the dense fescue mattress on Grassholm, and identical vegetation is also present on North Bishop. Closer to Skomer, the cliffs between Musselwick and St Brides have excellent areas of fescue mattress. As we move a very short distance, into slightly less exposed areas, the fescue sward is in some places invaded by Yorkshire fog *Holcus lanantus*, along with a few additional species. This is occasionally MC9 NVC *Festuca rubra – Holcus lanatus* maritime grassland. But the more frequent community in these areas is MC7 Stellaria media-Rumex acetosa sea bird community.

Before considering the extremely exposed maritime grasslands on Skomer, it is important to remember that these are very different to their equivalents found elsewhere in Pembrokeshire. This has not always been the case. Sadd (1947) wrote of the 'unfenced grasslands'. These were the areas outside the enclosed central fields which were grazed periodically by stock. He describes the grassland as:
'...biotic climaxes i.e. they are prevented from developing into Pteridetum by the action of grazing beasts. ... The most extensive of these areas is the Festuco-Armerietum found in a band of varying width around most of the south and west cliffs of the island. ...This region is honeycombed by burrows most of which are occupied by seabirds. These areas of Festuco-Armerietum are usually grazed by six large beef cattle.'

It is worth mentioning that these extreme coastal grasslands are some of the very few areas that remain almost free of bracken *Pteridium aquilinum.* Even though it may occasionally invade, it rarely, if ever, persists.

Bray suggested that the most exposed coastal grassland communities are 'grazed derivatives of the fescue mattress'. This was confirmed by current and earlier exclosures at Skomer Head, which clearly demonstrated the impact of rabbit grazing. Within a few years of establishing the exclosures, they contained a vibrant, deep, dense mattress of fescue. After several decades the vigour appears to diminish, dead patches appear, and these are usually colonised by Yorkshire fog *Holcus lanatus*.

Photo 9 Fescue inside the Skomer Head exclosure

Bray writes of 'grazed derivatives', and grazing is the overwhelming factor, but we need to include another significant factor - bird droppings and increased soil fertility. The areas occupied by these communities are the most important places on the island for nesting seabirds. Mary Gillham (1956) points to another factor, the impact of burrowing birds and rabbits. It is also important that the underlying climatic factors are not ignored. Skomer is often battered by extreme gales and occasionally suffers quite prolonged periods of drought, although, more recently, there has been a succession of wet summers. The combined impact of all these factors has delivered visually spectacular and dynamic communities in place of the fescue mattress.

Rabbits will be discussed in detail later in this section. Their impact is considerable, and, for a variety of reasons, the population is unstable and given to extreme fluctuations. The consequence is that, over time, these quite abrupt variations in the rabbit population, in combination with other factors such as higher or lower than average rainfall, can trigger startling variations in the vegetation. It would probably be inaccurate to describe these changes as cyclical, although they can give that impression. The following sequence of photographs, taken at the Wick on the south west coast, is a clear indication of these changes from 1980 to the present time. These are not fixed point photographs, the locations from which the photographs were taken vary, the focal length of the lenses that were used also varied. This is why the images are indicative of change and not a precise record of change.

Photo 10 Thrift *Armeria maritima 1980*

Photo 11 Sea campion *Silene uniflora* 1999

Photo 12 Yorkshire fog *Holcus lanatus* 2008 (this followed several years of high annual rainfall)

The preceding photographs also demonstrate the speed of change. Some areas of Yorkshire fog and sorrel, shown in the third photograph, had been replaced with a dense mat of sea mayweed *Tripleurospermum maritimum* by August 2012.

In the early 1950s, Mary Gillham spent six years studying the vegetation on neighbouring Skokholm Island (Gillham 1954, 1955, 1956). Although Skokholm is different in many ways to Skomer, the most significant natural and anthropogenic factors are the same, although varying, perhaps, in intensity and impact. She describes, and offers an explanation for, the sequential changes in Skokholm's vegetation, and these are similar to the changes on Skomer.

In considering Gillham's work, it is helpful to remember that, in her time, botanists talked about climatic climax communities. Vegetation would evolve to a stable state where the presence of individual species would be dependent on the combined impact of the full range of natural factors, edaphic and climatic. This equilibrium paradigm, the belief that habitats and ecosystems evolve to a balanced or stable state which would be maintained indefinitely, has been replaced by the non-equilibrium paradigm, which recognises that systems or habitats do not exist in a single, internally-regulated, stable state. Plant communities are dynamic and continually changing in response to the influence of a range of natural factors. Sprugel (1990) argues that vegetation would not be stable over long periods of time even without human influence: *'One must recognise that there are often several communities that could be the 'natural' vegetation for any given time'*.

Gillham's starting point was a community that she described as *'the biotic subclimax Armerietum maritimae'*, a community that, in its 'pure' form, was composed almost entirely of thrift *Armeria maritima.* This community, give or take a few additional species, was abundant along the exposed southern and western coastal fringe of Skokholm. She suggested that the presence of *Armerietum* was the consequence of the impact of grazing, by rabbits, sheep and goats, on 'the natural climax of *Festucetum*' (this is the MC8 *Festuca rubra – Armeria maritima* maritime grassland). *Festucetum* barely existed on Skokholm in the early 1950s. The only exceptions were very small areas which were inaccessible to grazing animals. Gillham used the small, remote island of Grassholm, where there is no grazing, as a convenient reference for the community, and confirmed its potential on Skokholm when 'Festucetum' developed, 'in a few months or sometimes after several years', within rabbit proof exclosures. The change from *Festucetum* to *Armerietum* is readily understood: red fescue is extremely palatable while thrift is largely ignored by rabbits. There was a slight complication: in 1951 there were a flock of 96 Soay sheep, 5 goats and a pony on Skokholm. The Soay sheep, introduced to Skokholm in 1939 by Ronald Lockley, apparently grazed thrift. However, Gillham does not focus on this and, presumably, their impact was not significant. Sheep and cattle were also kept on Skomer during the same period.

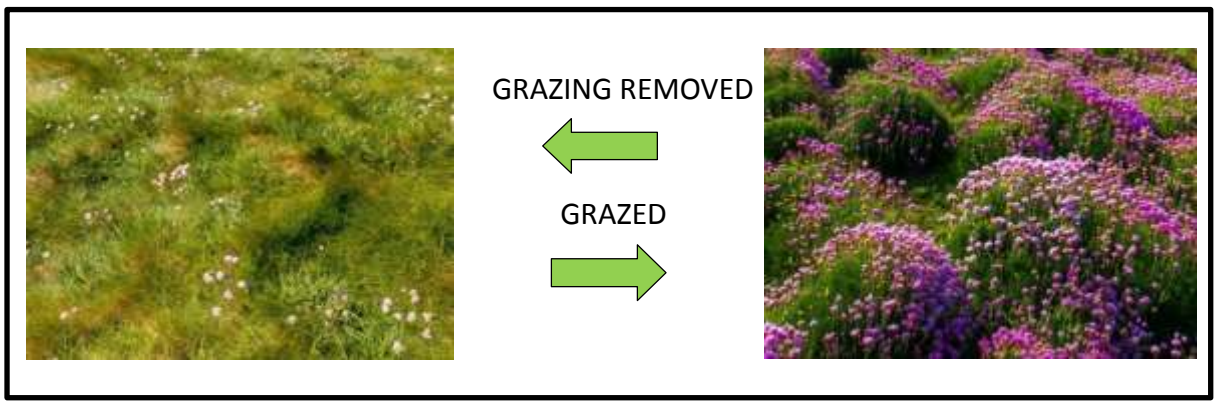

Fig 3 The impact of grazing on thrift grassland

The next factor to consider is the impact of burrowing birds and rabbits. Turning once again to Mary Gillham, in 1955 she published a paper on the effects of treading and burrowing by birds and mammals. The impact of treading is relatively minor and probably not a significant factor but, clearly, it is of academic interest. Gillham considers a wide range of impacts arising from burrowing:

erosion, soil moisture content (i.e. drainage), the relative humidity of air in the burrows and light penetration. She argues convincingly that when *Armerietum* is riddled with burrows (*Armerietum* is one of the more favoured areas for burrowing birds) the thrift tussocks disintegrate and deep-rooted species, pre-eminently common sorrel *Rumex acetosa* and sheep's sorrel *Rumex acetosella,* gain an advantage. She also suggests that the structure of this community - the distinctive thrift tussocks - are also a consequence of the burrows. This view is, to some extent, contradicted on Skomer where there are, or were, some large areas of thrift tussocks in the absence of any burrows.

Ninnes (1997) also concluded that clumps of thrift had been destroyed by rabbits, shearwaters and puffins. His surveys showed that in some places thrift was overgrown directly by sea campion, but he also noted that thrift had died in other areas without any obvious cause. There are many areas on Skomer where thrift has been replaced by sea campion. However, on Skomer, the decline of thrift has not been confined to these 'grassland' areas: thrift is in decline everywhere, even in the maritime rock crevice community.

Photo 13 Sea campion invading an area of thrift 1995 (note the absence of burrows)

Photo 14 Spectacular and extensive areas of thrift were a feature of the 1980s

Photo 15 Thrift on a rock outcrop above South Haven in 1980. By 2013 the thrift had disappeared from this location.

Photo 16 The best surviving area of thrift in 2013

Photo 17 Skomer Head exclosure in 1984. Inside, a fescue mattress; outside, bare ground with clumps of sea campion.

Photo 18 The new 'exclosure', constructed in 1977, photographed in June 2013. Note the replacement of red fescue by Yorkshire fog, and, somehow, bittersweet *Solanum dulcamara* has also appeared.

Photo 19 A carpet of sea campion at Skomer Head in June 2013.

Photo 20 Sea mayweed *Tripleurospermum maritimum* is usually the first species to colonise bare ground.

The next factor to consider is weather, and particularly the extremes of weather: major storms, drought and wet summers. The south and west facing sea cliffs, the Atlantic cliffs, on Skomer must represent some of the most extremely exposed parts of the Welsh coast. Gales are frequent and can occur at any time of the year, though there are generally fewer in summer. Storms are infrequent, but their impact can have the most dramatic effect on the vegetation. One of the most severe events was recorded in the warden's report for 1975: *'The vegetation on the West coast, especially in the Skomer Head area, severely burned by salt in the autumn gales last year, has not regenerated. There is cause for concern as the dry mattress is beginning to break up*'.

An extensive area to the north of Skomer head remained bare, almost devoid of any stable vegetation, for almost 10 years. During this period there were a few years when the area was carpeted with sea mayweed, *Tripleurospermum maritimum*, but it did not persist. It was not until 1983 that significant areas of sea campion began to colonise the area. The exception was the exclosure at Skomer Head where a dense mattress of red fescue had survived.

It is clear from the Skomer Head experience that, even following the most extreme storms, fescue grassland can make a very rapid recovery. However, grazing completely inhibits recovery of fescue and delays colonisation by other species. The ephemeral sea mayweed community is often the first to appear, and the area eventually became covered with a carpet of sea campion.

Periods of drought are not uncommon on Skomer. There have been many summers (1974 and 1976 were notable examples) when the drought was so prolonged that the vegetation was burned out on all but the deepest soils. The cliff edge grassland, particularly the well-drained and more salt exposed slopes, is usually the first to suffer. Drought alone is such a powerful factor but when combined with salt deposition the impact on the vegetation can be extreme. At the end of November 1974 Stephen Evans, wrote: *'What a disastrous summer, we had seven weeks of drought in the early part, then from the beginning of August onwards we seem to have had one long storm'.* Stephen records a visit to Skomer in August 1974, just before the great storm but following the drought. At the Skomer Head exclosure, originally constructed in 1973, he recorded that sea campion *Silene uniflora* and sea mayweed *Tripleurospermum maritimum*, the only species resistant to rabbits, birds, drought and high salt, were doing well outside fence. There was also much die back of the red fescue *Festuca rubra* mattress outside the exclosure. Inside the exclosure the mattress was not as seriously affected but it was not flowering.

The 1974 storm was so much more damaging to fescue because it followed a prolonged period of drought. Salt levels in the soil were so high that red fescue could not obtain any moisture by osmosis. The situation was further complicated by the deeply burrowed, free-draining mattress. There was a clear difference between the 'mattress' and fescue growing on the shallower, damper soils along the footpath: much of the latter survived.

Occasionally, bare areas persist for several years after the extreme events. Ninnes (1997), writing about thrift on Skokholm, noted: *'The colonisation of new areas seems to have occurred where drought killed off grasses and forbs, leaving bare ground. This suggests that thrift requires bare ground to become established.'* This may be the way in which some of the very large areas of thrift, frequent in earlier years (i.e. the latter half of the 20th century) became established. The length of time that rabbits have occupied Skomer, combined with the impact of grazing by domestic stock up until 1959, would suggest that the original fescue grassland probably disappeared a very long time ago. Whatever the process that enables re-colonisation by thrift, it is not currently happening on Skomer.

Higher than average rainfall is also an important factor. The total annual rainfall, particularly the summer rainfall, was significantly higher from the late 1990s to the present time (2013), than in the preceding 30 years. This has been reflected by an increase in ground cover in the coastal 'grassland'. The most notable change was a very spectacular increase of Yorkshire fog.

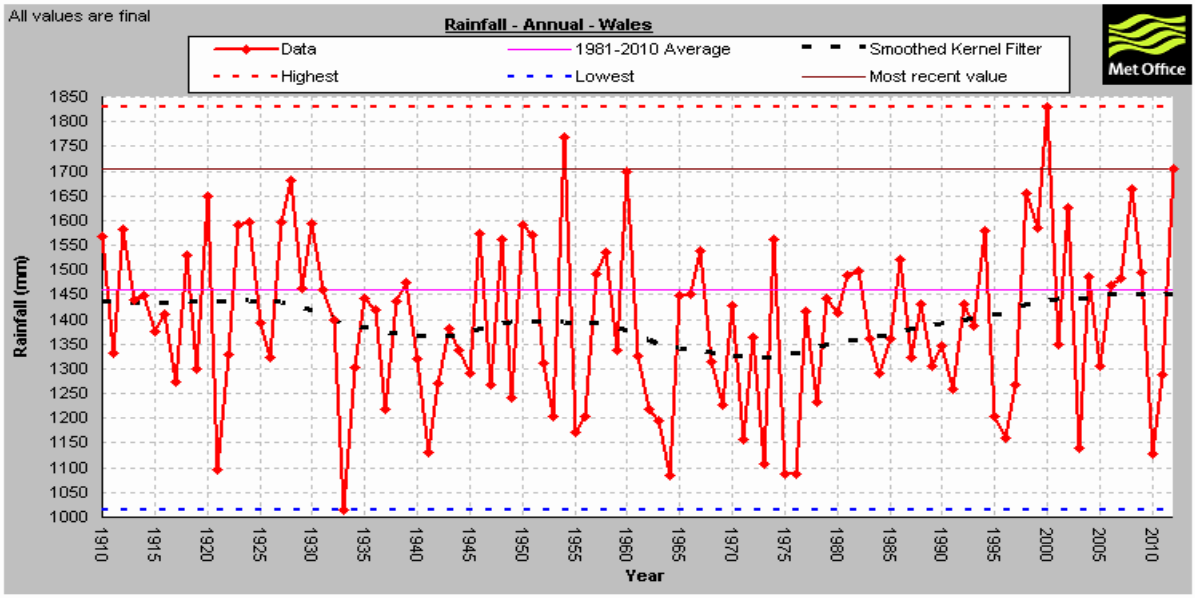

Fig 4 Annual rainfall for Wales 1910 to 2010

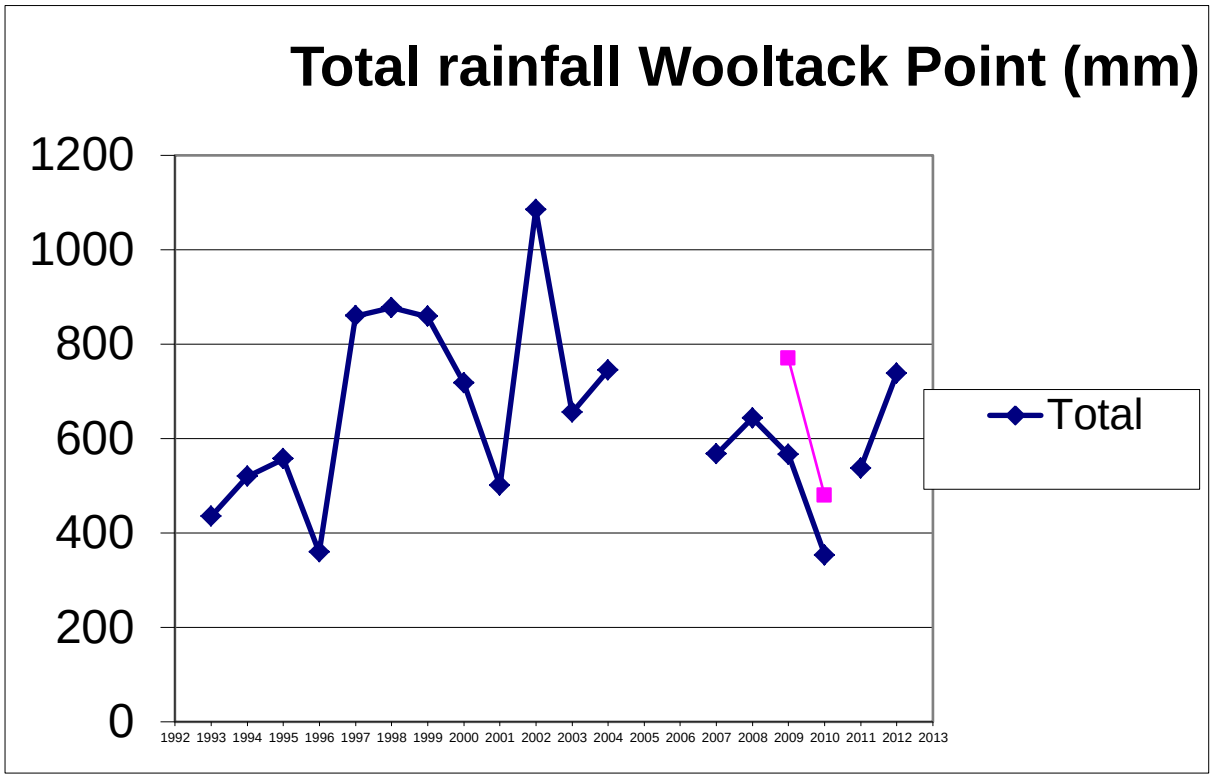

Fig 5 Annual rainfall Wooltack Point 1992 - 2013

Photo 21 South Plateau July 2009 with Yorkshire fog in flower

COASTAL BLUEBELLS

An approximation of the MC12 maritime bluebell *Hyacinthoides non-scriptus* community occurs in several areas of deeper, moist, more fertile soils. These are mainly in the relatively sheltered areas, sometimes forming a mosaic with the other maritime 'grassland' communities. It also occasionally occupies sheltered gullies, even on the most exposed west coast. There is a particularly good example of this community thriving in a surprisingly sheltered hollow above Pigstone Bay on an otherwise extremely exposed section of cliff. On the mainland, the community usually comprises a lush carpet of fescue *Festuca rubra* with bluebells *Hyacinthoides non-scriptus,* thrift *Armeria maritima,* sea campion *Silene uniflora,* Yorkshire fog *Holcucs lanatus*, common scurvy grass *Cohlearia officinalis* and common sorrel *Rumex acetosa.* The community above the spit is an excellent match: all the species mentioned above are present with, of course, the exception of fescue, which is either absent or suppressed. Later in the year, after the bluebells have flowered, this particular hollow is filled with wood sage *Teucrium scorodonia* and occasionally invaded by ragwort *Senecio jacobaea*.

Photo 22 Maritime bluebell community above the Spit

Photo 23 Maritime bluebell community late summer

Photo 24 Coastal flush vegetation Pigstone Bay

COASTAL FLUSHES

There is one other factor - persistently high soil moisture content - that very occasionally has a localised impact on the coastal grassland. Springs emerge at intervals around most of the coast, and some are well defined, for example, at the west end of the Wick. But there are other places (Pig Stone Bay is the best example) where water percolates through quite a large area of exposed seaward slope and reduces the salt content of the soil. These are also the areas long preferred by shearwaters, and their input has produced highly enriched, fertile soils. At first glance, the plant community has the appearance of something that we might find in an undisturbed corner near the dung heap in an old fashioned farm yard. The dominant species are common chickweed *Stellaria media*, scarlet pimpernel *Anagallis arvensis*, sea mayweed *Tripleurospernum maritimum* and sea campion *Silene uniflora*, with occasional corn sow-thistle *Sonchus arvensis* but very little else. To describe this as yet another grazed derivative of the fescue sward is perhaps counter intuitive, and yet it occupies the zone which would have been dominated by fescue and is clearly mapped as coastal grassland - western slopes by Bray (1981).

SHELTERED CLIFF GRASSLAND

This must not be confused with the community described by Bray as 'coastal grassland - northern slopes'. This community occupies the coastal slopes, ledges and terraces which extend east from the cliffs above the Garland Stone to North Haven. This is by far the most sheltered part of Skomer, free of the westerly and southerly gales. Severe and prolonged northerly gales are relatively infrequent and, more significantly, that part of the coast is not often exposed to the heavy Atlantic swells or drenched with salt water. It is also the wettest part of the island: moisture is retained in the shaded slopes, which only ever see the early morning and late evening summer sun. The vegetation, which

remains green even during the worst summer droughts, is so different to almost everything else on the island's cliffs. It is tall, robust, verdant and lush; bracken is present but not dominant. This is the domain of the burrowing shearwaters, and the soils have been enriched by their droppings. During the 1940s, the ledges were grazed by cattle, and this was one of the favourite pastures. Reuben Codd, who farmed Skomer at that time, had difficulty keeping them away from this sheltered and rich grazing. There were several losses as heavy animals slipped when trying to turn on the steep, narrow ledges.

This is probably the least visited part of the island. It was not described by Bray, but Sladden (Buxton 1950) gave it significant attention and provided a wonderful description:

'These delightful cliff-gardens of Skomer'.... These moist and fertile ledges support in spring concentrations of red campion, sea campion, bluebells, scurvy grass, and chickweed, the last named selecting the bare nitrogenous patches trodden by gulls and other birds. These are followed by flowering orpine, Sedum telephium, honeysuckle, sea beet, buck's-horn plantain, sea plantain. Ivy Hedera helix, blackthorn, Prunus spinosa, blackberry with some elder cover the steeper faults..... Among plants of rank growth noted here were woody nightshade, hogweed, hemp agrimony, figwort, foxgloves and ferns: lady fern Athyrium filix-femina and male fern Dryopteris filix-mass'.

The overall appearance is much the same today, and most of the species are present, if not abundant. The area is grazed by rabbits and, in common with everywhere else on the island, the more palatable species have almost disappeared. There are many isolated ledges and banks, inaccessible to rabbits and people: these are the places where there has been the least change and where species lost elsewhere may survive. This is an area which would reward further investigation.

Photo 25 ***'These delightful cliff-gardens of Skomer.'***

MARITIME, DRY AND WET HEATH

This is not a SSSI qualifying feature. Heath has been given so much attention on Skomer, including quite significant management intervention, that there is no choice other than to include it as a feature for discussion in this plan.
The NVC communities, identified in the 'The Pembrokeshire lowland heathland survey' (Prosser and Wallace 1996) are:

Maritime heath
H7 *Calluna vulgaris - Scilla verna* heath. (Squill clifftop heath)

Dry heath
H8a *Calluna vulgaris – Ulex gallii* heath, species-poor sub-community. (Western gorse dry heath)

Wet heath
M16a *Erica tetralix – Sphagnum compactum* wet heath, typical sub-community. (Lowland wet heath)
M25 *Molinia-Potentilla mire.* (Purple moor-grass sward)

Wilberforce (1999) identified:
H1 Calluna Vulgaris-Festuca ovina heath. (Fescue dry heath)

Bray (1981) applied different divisions:
Coastal grasslands - maritime heath
Calluna vulgaris - dominated heathland
Mixed heath

This is an extract from 'The Edge of the Picture ', written by John Rodwell in 2008. It provides an extremely useful summary of the NVC heath communities:

'Most of the vegetation on the better-drained brown earths and rankers of Skomer that has convincingly been called heath in more recent surveys (Prosser & Wallace 1996) and which exists at the present time, is closest to H8 Calluna-Ulex gallii heath, though the gorse itself is very scarce and Pteridium can be quite abundant. Maritime heath was explicitly recorded by Bray (1981), mostly on the cliff tops above The Table, Bull Hole and opposite the Garland Stone, but Prosser & Wallace (1996) noted it only above Wick Basin (where some of the best was in an exclosure) and on Gorse Hill. However, the samples in both these surveys had only sparse records for species such as Armeria maritima and Silene vulgaris ssp. maritima and approximate poorly to the H7 Calluna-Scilla heath. Other vegetation with Calluna and occasionally Erica tetralix on the wetter gleys and stagnogleys alongside the main streams (Jenkins & Owen 1995) would be classified in the NVC as heathy stands of M25 Molinia-Potentilla mire (Rodwell 1991 et seq.); or as heathy M16 Erica tetralix-Sphagnum compactum wet heath typical of seasonally waterlogged shallow peats and humic soils (Rodwell 1991b). These vegetation types were recorded by Prosser & Wallace (1996) and still survived in 2007 with much dead big Calluna bushes but with vigorous regeneration in a patchy carpet in unenclosed stands.'

Skomer has probably one NVC maritime heath communities, a dry heath community, and two wet heath/mire communities. Bray (1981) described three communities: coastal grasslands - maritime heath, *Calluna vulgaris* - dominated heathland and Mixed heath. However, although they may be quite different communities, all the factors, discussion and any future management will be common to all areas of heath on Skomer. To avoid unnecessary repetition in the plan, these communities will be aggregated as a single feature. The total area given for this habitat in the SSSI schedule was 5.4 Ha, with wet heath covering less than 0.2 Ha (date?). By 2008, the total area of heath was 3.1 Ha.

The is no purpose in providing a detailed description of the NVC heath communities found elsewhere in Pembrokeshire, but I include three photographs simply as a reminder of what coastal heath can look like. There is no suggestion that this could ever be obtained on Skomer. It is important that we adopt a strategic approach to managing the Pembrokeshire islands. We don't need everything everywhere, Skomer and Skokholm are internationally important seabird islands, Ramsey is the best place in Wales for maritime heath.

Photo 26 Heath at St David's Head

Photo 27 Heath on Ramsey Island

Photo 28 Heath on the south coast of Ramsey

CHANGES IN THE DISTRIBUTION OF HEATHER ON SKOMER ISLAND NNR SINCE 1947

In 2008, an attempt was made to locate all existing vegetation maps for Skomer (Alexander et al. 2008). The earliest known map was prepared by J. Sadd in July 1947 and published in 'Island of Skomer' (Buxton and Lockley 1950). (In 1995 a 'definitive' set of vegetation maps was produced by CCW, but these were digitised copies of earlier maps which are inaccurate and misleading, so they have not been included this discussion.) The comparisons in this note are based on the following information:

1. The 1947 map.

The first description of the heath was provided by J. Sadd in 1947. He was an undergraduate student from Aberystwyth University. He writes of 'Callunetum' and, although he maps it as 'one association', he recognises a division between wet heath and dry heath. His sketch map is perhaps indicative of the distribution of the vegetation, but the definitions of both bracken and heath are vague. Unfortunately, the distribution of heath on the map bears little resemblance to Sadd's written description of the vegetation. There is good evidence from his text that heath was much more abundant and widespread than depicted on the map. He writes, *'The Callunetum appears to occur fairly evenly over the whole island'.* It is also clear from the text in 'Island of Skomer' (Buxton & Lockley 1950) that there was considerably more heath, or areas containing heather, than shown on the 1947 map. We have to recognise that the distribution of heath shown is certainly an under representation. I suspect that Sadd forgot to label some of the areas which are clearly marked on the map and correspond quite accurately with areas of heath recorded in later maps.

2. The 1969 map

This was based on aerial photographs and field survey. It is the most accurate and reliable of the historical maps and provides a good reference point.

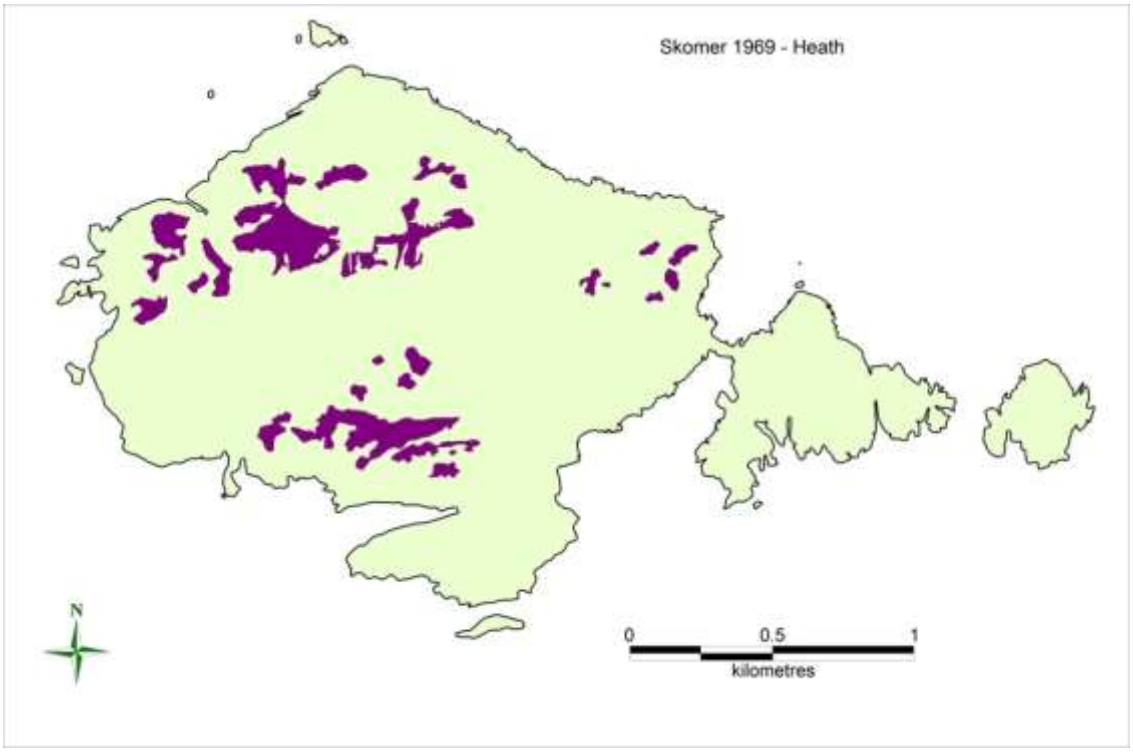

Fig 6 1969 heath map

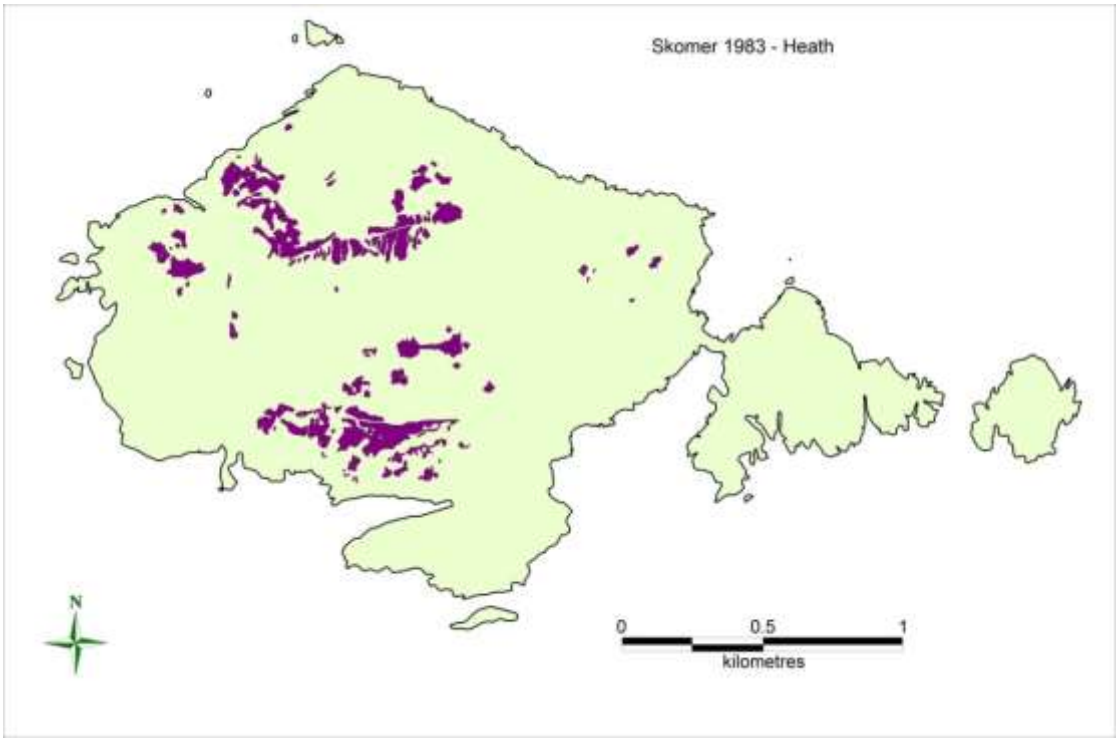

Fig 7 1983 heath map

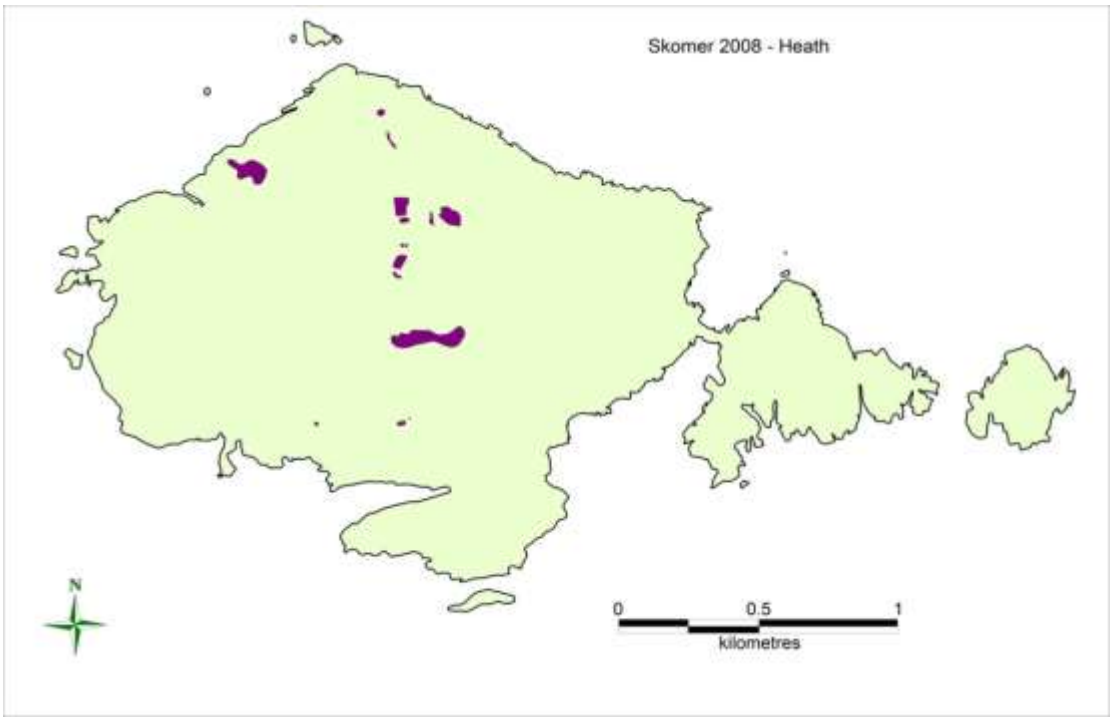

Fig 8 2008 heather map

3. The 1983 map

This map was based on a large collection of low-level aerial photographs. Although not a commercial flight, the photographs were taken at several different times during the year and clearly show the distribution of heath. The aerial photographs were supplemented with a collection of ground photographs.

4. The 2008 heather map

Note: Earlier maps indicate 'heath' but, given the inconsistent way in which heath has been defined in the past, this survey simply mapped heather. In September 2008, the extent of both heather and bracken on Skomer Island was mapped. The survey team used aerial photographs as the basis for the exercise. The photographs were commercial, high-quality images. Apart from the heather, the vegetation boundaries, particularly areas of pioneering bracken, were indistinct and difficult to determine using the photographs alone. However, the photographs did provide an invaluable aid for accurately marking vegetation boundaries once these were located on the ground. The areas which contained heather were mapped, regardless of the density of cover (See photos 20 &21).

Photo 29 Heather 2008 North Valley following a severe outbreak of myxomatosis

Photo 30 Heather 2008 east of Bull Hole

Photo 31 An aerial photograph from 1983. Areas of heather are clearly defined - they are the darkest patches in the photograph. The only exception is the dark area at Skomer head: this was bare ground.

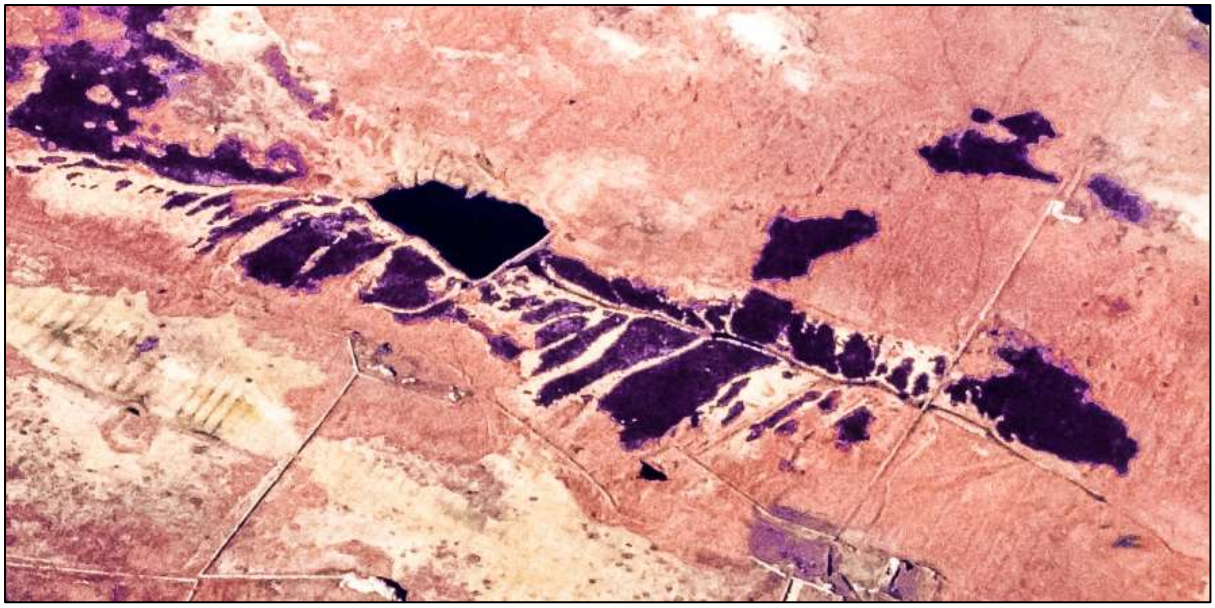

Photo 32 Oblique aerial photo of North Valley 1983 - the dark purple areas are heath. The darker patch is North Pond.

Photo 33 Aerial photo of North Valley 2009. Note the almost complete absence of heath. The drainage patterns are still clearly visible. The lighter areas are purple moor grass with only very occasional moribund heather.

CHANGES IN THE DISTRIBUTION OF HEATHER

There has been an obvious and dramatic decline in the cover of heath on Skomer since 1969. At that time, heath covered 8% of the island. By 1983, the area had declined to 6%, with a further decline to 1% by 2008. Because the 1947 map (Buxton & Lockley 1950) clearly misrepresents the distribution of heath, it was an inaccurate copy Sadd's map, it must be used with caution. Suggestions by some

authors, based on Sadd's map, that heath actually increased between 1947 and 1969 were probably erroneous, but there was certainly a change in distribution. This is best demonstrated in South Park, the large field to the south of the farm. By the 1960 this was one of the best areas of inland dry heath. The 2008 map reveals that it was one of the largest areas of heath on the island at that time. Sadd prepared a very detailed description and sketch map of this field. In his day it was grassland with bracken on the deeper soils around the edges of the fields. The only heather was on the dry, rocky areas on the edges of the field. It is completely absent in these areas today. In 1947, unlike most other grassy areas, this field was rarely grazed by the domestic animals, but it was heavily grazed by rabbits.

The descriptions prepared by Sadd and information available from subsequent surveys reveal a significant decline in the quality of the heath. For example, bell heather *Erica cinerea,* once frequent in the heath communities, has almost completely disappeared outside the exclosures.

' The Callunetum appears from the map to occur fairly evenly over the whole island . . . but it should be noted that what appears on the map as one association is in reality two different ones. Both have Calluna vulgaris as the dominant species and most areas have a certain amount of Erica tetralix.' (Sadd 1947)

THE FACTORS WHICH INFLUENCED THE SURVIVAL OF HEATH:

EARLY HUMAN INTERVENTION

We believe that most of the dry and wet heath on Skomer was an incidental by-product of farming, particularly rabbit control, grazing by domestic stock and burning. Heath, in most situations, is regarded as a plagio-climatic community: a transitional stage which will be succeeded by scrub and, eventually woodland. As a consequence, grazing and/or fire are usually necessary to prevent invasion by scrub.

The maritime heath (H7 *Calluna vulgaris - Scilla verna* heath) may be different, and there is a belief that exposure or impoverishment may be sufficient to prevent succession to scrub even in the absence of grazing. It is generally believed that maritime heath was a natural community of the infertile cliff edges. The single most distinctive difference between the habitat of the maritime heath and the habitats of other heath communities is the impact of salt spray (Rodwell 1991). This is a community which occupies a narrow zone, restricted on the seaward side by the cliff edge fescue grasslands which are more tolerant of salt, and outcompeted on the landward side by inland heath or other communities which are less salt tolerant. Earlier authors suggest that heath on exposed sea cliffs probably represents the climatic climax community although grazing pressure will influence it. Salt and/or grazing pressure will prevent further successional development. More recently, there is a suggestion that past human intervention or exploitation reduced the natural soil fertility, thereby providing coastal heath, particularly heather, with the necessary competitive advantage.

SOIL FERTILITY

On Skomer, the limited zone which could be occupied by maritime heath represents some of the most guano enriched parts of the island, but maritime heath cannot survive in these fertile soils.

In addition to impact of increased soil fertility on the maritime heath, the dry inland heath communities will also be affected. Heather *Calluna vulgaris* can only out-compete other species to form heath communities on poor, infertile, acid soils. The seabird populations, particularly gulls, have substantially increased since the cessation of farming on Skomer. More significantly, the

cumulative effect of their droppings has significantly increased soil fertility. Gillham (1955) working on Skokholm noted that in the areas of *Callunetum* (heath) used by gulls as a roosting ground the *Callunetum* degenerated into an Agrostidetum (Yorkshire fog grassland). This factor requires further research.

RABBITS

Rabbits will be discussed, in detail, later in this section. Rabbit-proof exclosures have been used on Skomer to evaluate the impact of rabbit grazing since the 1960s, and, more recently, they have also been used in an attempt to manage the heath. The lessons learned from the exclosures are particularly informative. Above all, we now know that the main factor which led to the demise of the heath, and prevents its re-colonisation, is over-grazing by rabbits.

TRADITIONAL HEATH MANAGEMENT

Traditionally the favoured management for heath was burning with controlled grazing. More recently, cutting has been adopted where burning and grazing are difficult. In the past, burning management was mainly used to maintain structural diversity in heathland. We know that, as late as 1958 Reuben Codd, was burning heath on the Island. The large area of heath that once extended from South Pond around to the Wick and on towards Tom's House was, in 1960, recovering from a 'recent' fire. The vegetation map prepared by J. Sadd in 1946 shows extensive areas of burned heath to the north west of North Pond. It is reasonable to assume that Reuben Codd burned the heath to encourage fresh, new growth for his sheep. However, burning heath can provide bracken with a very significant opportunity to invade. This is well documented from elsewhere, and there is every reason to suspect that inappropriate burning could have hastened the demise of heath on Skomer. Heath has not been burned on Skomer since 1960.

Invasive scrub, apart from bramble, has not been an issue on Skomer for a very long time, and it is certainly not a current concern. However, following the myxomatosis outbreak 2005/6 there was a significant crop of young blackthorns in North Valley. This would suggest that, providing rabbits remain on the island, that traditional management to prevent scrub encroachment is not necessary. It is a common misconception that heather will not survive unless it is burned: in common with many other plants, heather can regenerate by the layering of stems as well as from seed. There are areas in Wales, notably the Rhinogau, where heath has survived in the absence of burning, but these are extremely infertile areas and they are lightly grazed by goats and sheep.

Heath cannot tolerate heavy or prolonged grazing, but grazing by domestic animals, at an appropriate level and in combination with burning, is one of the most effective management tools. There have been no domestic animals on Skomer since the early 1960s. There are occasional suggestions of reintroducing domestic animals and reducing, if not exterminating, the rabbits. However, before we even think about heavy grazing animals we must turn our attention to the seabirds.

SEABIRDS

Skomer is of primary importance for very large populations of sea birds, particularly the burrow-nesting Manx shearwaters and puffins. The absence of domestic grazing animals for over 50 years, and the consequential lack of soil compaction, has, in many areas, resulted in burrows which are extremely fragile. There is a very high probability that even light grazing by sheep would collapse the burrows and destroy nests. The presence of these internationally important seabird populations means that the reintroduction of grazing animals is not an option.

Photo 34 The exclosure above Wick Basin,

Photo 35 Outside and inside a North Valley exclosure. The heath inside is becoming lost to bracken/bramble scrub.

REVIEW OF HEATH MANAGEMENT ON SKOMER

Exclosures were originally erected on Skomer to investigate the impact of rabbit grazing. When exclosures were placed in areas containing heather there was an initial rapid recovery, but this was not always sustained. In some areas, the sub-shrubs were outcompeted by other species, particularly grasses and brambles. Continuous and considerable effort has been required to clear brambles from the inland exclosures on the deeper soils in North Valley. The exclosure above Wick Basin, was originally chosen to be representative of the seaward edge of maritime heath, was very informative. In the absence of rabbits, the heath/maritime grassland boundary within the exclosure inched to seawards, while the grazed heath outside retreated landwards in the few years after the exclosure was established. Unfortunately, this exclosure is now a completely isolated area of degenerate heath.

In 2000, exclosures were used in an attempt to arrest the decline of heath. A temporary rabbit exclosure was constructed in North Valley alongside the area of heath that had been sprayed with Asulam to control bracken in 1999. The area was chosen because of the presence of many fresh heather shoots. The exclosure was only 50 cm high and intended as a short term measure (two to three years) to give heather sufficient time to pass through its most vulnerable stage. Initially, the exclosures were very effective and there was good colonisation by heath, but, after a few years, the rabbits got in and the heath began to fail. Some blocks of heath have survived in the exclosures, but these contribute little to the surrounding vegetation (or, indeed, to the future of heath on Skomer).

It has also become evident that maintaining the exclosures in a rabbit-proof condition is extremely difficult in the longer term. Sooner or later all the exclosures have failed. The legacy is a collection of unsightly, dysfunctional structures which, in places, diminishes the quality of the island's landscape.

Photo 36 Exclosure above Bull Hole in 2013. Rabbits have invaded the exclosure.

Lesser black-backed gull colonies can completely destroy heath. The area of heath on the Table, west of Bull Hole, was the first to suffer and eventually disappear. Over the last 15 years the gull colonies have, despite reducing in overall size and density, continued to spread into the heath community in both North and South Valleys. Heather provides desirable cover for the nesting gulls, but a combination of gull droppings, vegetation pulling and trampling kills the heather. The management response was to destroy the gulls' nests and, in some years, up to 90 nests were removed.

During the 1970s and 80s the lesser black-backed gulls were perceived as a serious problem and, consequently, were culled. However, by the 1990s the gull population was in serious decline and were regarded as a threatened species. The lesser black-backed gulls became designated as a SPA feature, and in 2001 the revised features list for Skomer include the gulls as a formal SSSI feature. The heath is <u>not</u> a designated feature on Skomer. It is not obvious why management was

implemented to control a designated wildlife feature, in this case a bird population which is clearly in decline, in order to protect heath which does not qualify as a feature. This is even more difficult when the heath is failing as a consequence of other insurmountable factors and is, in any case, a very poor example of this community. There is one additional contradiction: it was decided not to disturb the gulls nesting in the heather to the west of North Pond because a pair of curlew nested in that area. Curlews are *not* an SSSI feature. Nature conservation is not about protecting everything everywhere, and it is not only about protecting species (plant or animal) that we happen to find attractive. Qualifying features on designated special sites provide a mechanism for prioritising management activities, taking account of a much wider national or European perspective.

ACID GRASSLAND

The NVC communities are:

The grassland community in the central fields is the bent-fescue pasture, NVC U4 *Festuca-Agrostis-Galium* grassland. This was identified by Wilberforce in 3 quadrats, two in the central fields and one outside the field system near the west coast, inland from Pig Stone Bay. Rodwell (2004) also identified this community in the central fields. *'This community is the most extensive kind of pasture on better-drained, more base poor mineral soils throughout the cool and wet sub-montane zone of north west Britain'* (Rodwell 1992).

Photo 37 The central fields, with Shearing Hays on the left and Calves Park on the right.

Bent-fescue-sorrel grassland, NVC U1 *Festuca ovina – Agrostis capillaris - Rumex acetosella* grassland, was recorded in 10 quadrats by Wilberforce. These are the rabbit-grazed grassy patches which often form a mosaic in areas which are, or were once, heath. They occupy both the coastal zone between the 'coastal grasslands' and the dense inland bracken areas and also occur in exposed areas of thinner summer-parched soils in the central fields. The community takes its name from sheep's fescue *Festuca ovina*, which is no longer a common species on Skomer. The NVC description states that, '*Festuca ovina is only very locally replaced by F. rubra'*. The two grasses which are most frequent on Skomer are red fescue *Festuca rubra* and common bent *Agrostis capillaris*, but, as a consequence of rabbit grazing, both are extremely suppressed. The community on Skomer is nearly always dominated by sheep's sorrel *Rumex acetosella.*

Between 1979 and 1988 four exclosures were established and recorded in this grassland community on South Plateau. The most obvious change was a rapid increase in the grasses and in particular red fescue which became the dominant species in all the exclosures. The most spectacular change was the increase in biomass and build-up of peat in the more exposed exclosures and an increase in soil humus is the more sheltered eastern exclosure. (Bellamy 1992)

Photo 38 Bent-fescue-sorrel grassland

Bray (1981) identified two grassland communities, 'inland grasslands' and 'disturbed ground', he also includes a community which he describes as 'bracken dominated wetlands'. These are mainly the purple moor grass *Molinia caerulea* marsh grasslands. They will be treated as separate feature.

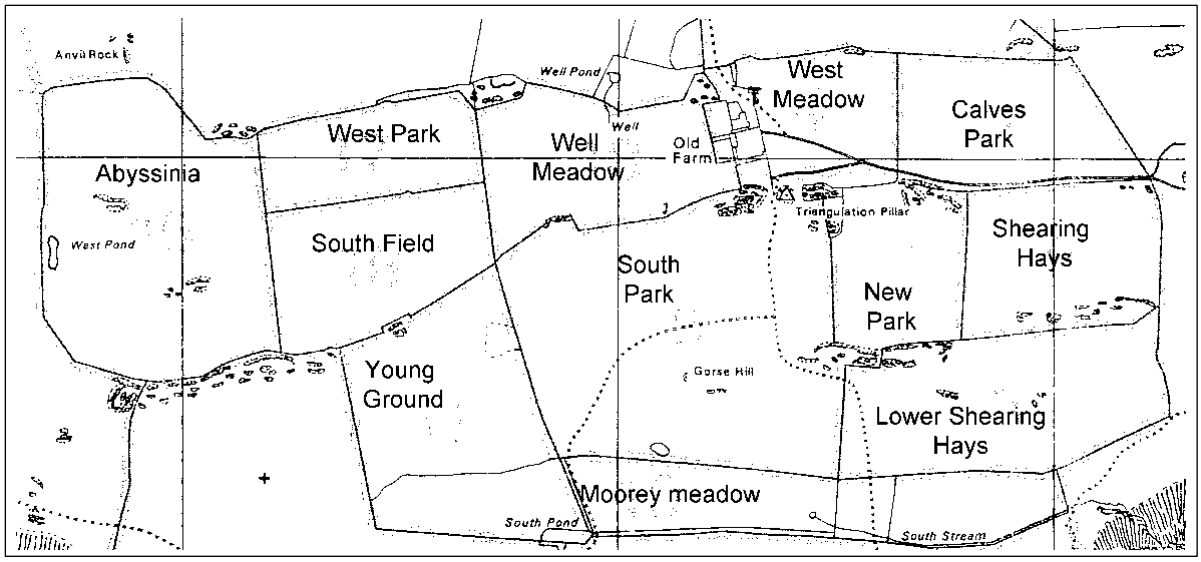

Fig 9 The central fields

Before considering the descriptions of the fields from the 1940s, 80s and 90s, it is worth taking a very brief look at how this land was used at the end of the 19th century. There are no descriptions of the vegetation, but here are some very informative photographs:

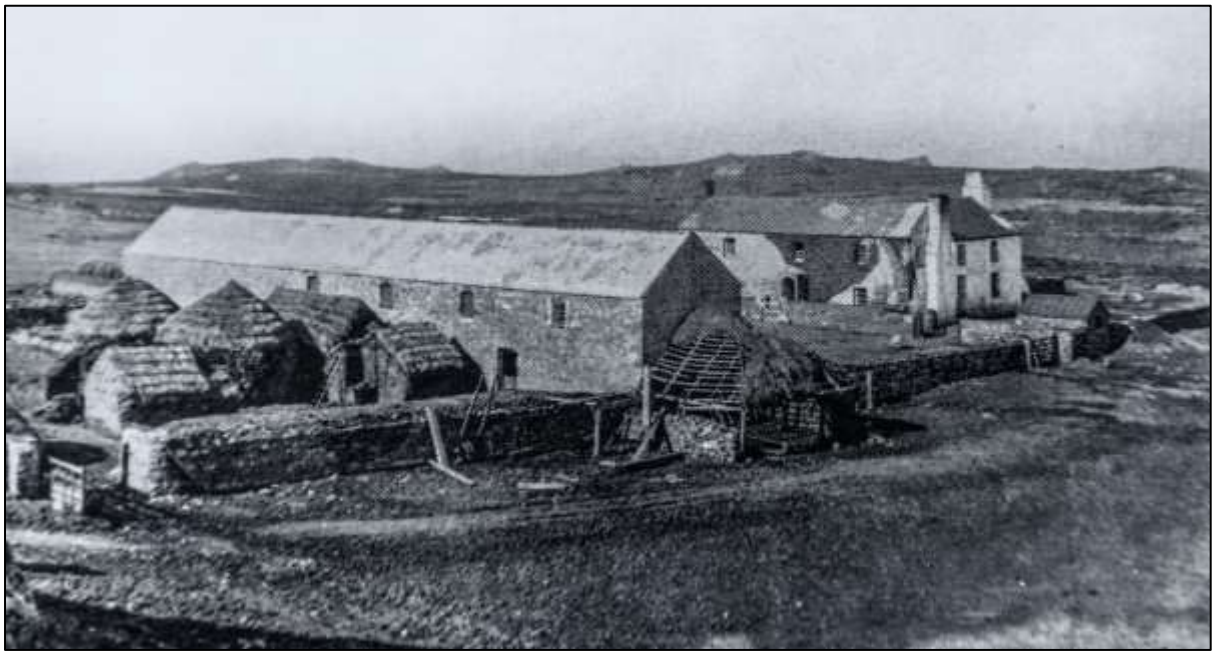

Fig 10. The farm in 1889. Although this does not show the vegetation, the hay or straw ricks provide a very clear indication of how the central fields were utilised.

Fig 11 Liza Stephens at the well in Well Meadow in 1889. It may not be possible to identify any of the plants, but this is clearly a grazed meadow or pasture: a short, floristically rich, grassy sward.

Fig 12 Milking in the farmyard 1889

Fig 13 Washing sheep well meadow 1899

Photo 39 Lime kiln North Haven

There are two lime kilns on Skomer both date from the 1800s, they provide the clearest evidence that the land at that time would have been limed and probably fertilised with farmyard manure to deliver arable crops and hay.

INLAND GRASSLANDS

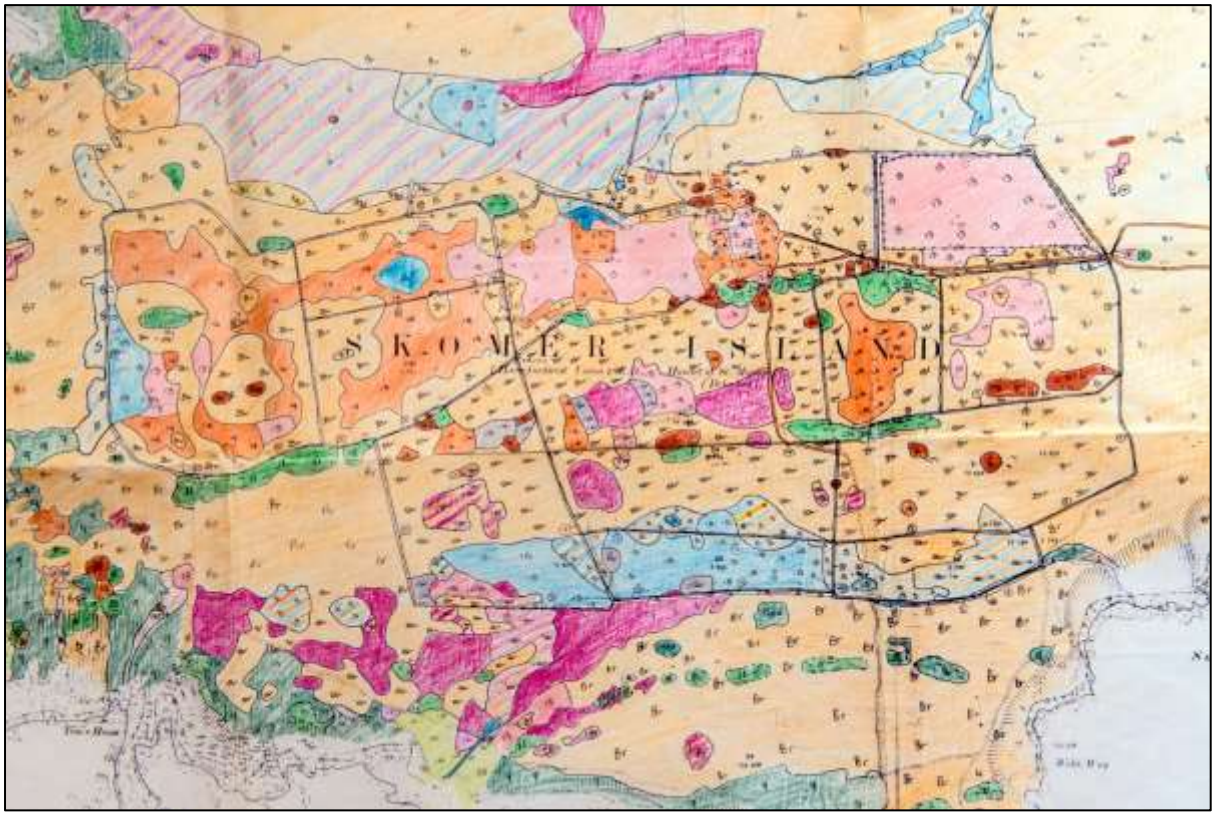

Photo 40 A section of Graham Bray's map showing the central fields. The pink (13) areas are 'inland grasslands', the orange (14) areas are 'disturbed ground' and the yellow (Br) is bracken.

Bray (1981) used the heading 'inland grasslands' to define the rabbit-grazed grassy areas found in the old field system in the middle of the island. We benefit from four earlier descriptions of these areas: Sladden in 1946, Sadd in 1947, Bray in 1980 and Rodwell in 2008. These are presented in chronological order.

In 1946, Sladden described the fields as, *'agriculturally very degenerate and overgrazed by rabbits'*. But, even so, the sward at that time was composed mainly of grasses: sheep's fescue *Festuca ovina*, red fescue *F. rubra*, annual meadow grass *Poa annula*, smooth meadow grass *P. pratensis* , rough meadow grass *P. trivialis* and common bent Agrostis capillaries, with colonies of ragwort *Senecio Jacobaea,* creeping thistle Circium arvense, spear thistle Cirsium vulgare, yarrow *Achillea millefolium,* sheep's sorrell *Rumex acetosella* and common dog violet *Viola riviniana* in the spring.

When Sadd visited the island in 1947, six of the enclosed fields were arable: West Park, Well Meadow, West Meadow, Calves Park, New Park and Shearing Hays. With the exception of West Park, which was planted with oats, Reuben Codd had planted all the remaining arable land with potatoes. The 'weed' species found in the potato fields were, a dense mat of scarlet pimpernel *Anagallis arvensis* with an abundance of '*Brassica campestris'.* The latter was probably wild turnip *Brassica rapa*. Field pansy *Viola arvensis*, sand spurrey *Spergula rubra*, creeping thistle *Cirsum arvence* and ragwort *Senecio Jacobaea* were also recorded. These areas coincide exactly with the areas described as inland grassland by Bray.

Bray's description of the vegetation in 1980, just over 30 years later than Sladden, is quite different. Bray described the community at a time when rabbit grazing was very high. The sward was very

short and dominated by grasses, mainly common bent *Agrostis capillaris* and red fescue *Festuca rubra*. He also mentioned that the sward contained a very rich scattering of dicots, with often more than 20 species present in a sample. These included heath bedstraw *Galium saxatile*, procumbent pearlwort *Sagina procumbens*, birdsfoot trefoil *Lotus corniculatus*, common mouse-ear Cerastium fontanum and common dog violet *Viola riviniana*.

John Rodwell visited Skomer in 2007, following a severe outbreak of myxomatosis. In his report he wrote: 'The vegetation in some of the farm fields was much more recognisably some kind of semi-improved U4b *Festuca-Agrostis-Galium* grassland (Rodwell 1991 et seq.) with a luxuriant rough turf of red fescue*, Festuca rubra,* common bent*, Agrostis capillaris,* rough meadow grass*, Poa trivilais,* Yorkshire fog*, Holcus lanatus,* heath bedstraw*, Galium saxatile,* tormentil, *Potentilla erecta,* field wood-rush*, Luzula campestris,* common mouse-ear, *Cerastium fontanum,* white clover*, Trifolium repens,* germander speedwell*, Veronica chamaedrys,* as well as patches of scarlet pimpernel*, Anagallis arvensis,* ground ivy, *Glechoma hederacea* and sheep's sorrel*, Rumex acetosella, typical of the rabbit-infested landscape and* common ragwort*, Senecio Jacobaea,* spear thistle*, Cirsium vulgare,* wood sage*, Teucrium scorodonia* and stinging nettle, *Urtica dioica* around remaining active burrows.' (Rodwell 2008)

The biggest change since the 1940s has been bracken invasion and consequential loss of most of the grassland in the fields. Species diversity has also diminished. Even by 1979, when Bray surveyed Skomer, sheep's fescue *Festuca ovina* and rough meadow grass *Poa trivialis* were absent in the fields. Since 1980, with the exception of the years when the rabbit population was low following a major crash, there has been a very significant increase in the unpalatable species, including stinging nettle *Urtica dioica,* common ragwort *Senecio Jacobaea, and* ground ivy *Glechoma hederacea,* but the most notable change has been the increase of wood sage*, Teucrium scorodonia.* Today it completely dominates the non-bracken areas of sward. (Sladden did not even mention the presence of wood sage in the fields though he did give ground ivy some attention because it was poisonous to the horses which grazed in the fields.) There is very little grass apart from Yorkshire fog *Holcus Lanatus* and only rather sad remnants of the more palatable flowering species. A small area in the south east corner of Calves Park was used as a store for building materials from 2005 to 2007. During this period the vegetation was destroyed and for several years it remained as mainly bare ground. In 2013 it was covered in a spectacular display of spear thistle *Cirsium vulgare* and creeping thistle *Circium arvense* with a few nettles. In 2013 almost the entire area of inland grassland was covered in common ragwort *Senecio Jacobaea.* I will prove a detailed account of ragwort at the end of the section on communities.

DISTURBED GROUND

The community that Bray (1981) described and mapped as 'disturbed ground' was found mainly in the bracken-free areas in the western fields, Abbyssinia, West Park and South Field. There were also small areas in the middle of Well Meadow, along the northern edge of Young Ground and around the Farm.

Sladden's 1946 description of these same fields to the west and south of the farm is very different to that described by Bray and to the current situation:

'Here we find a springy turf of sheep's fescue, with plants of wild white clover, Trifolium repens, and strong colonies of Bird's-foot trefoil, Lotus corniculatus. Associated with the well-drained pasture are scorpion-grasses, Myostis collina and M. versicolor, and as the summer advances, a host of other dwarf plants come into flower, we find eyebright, Euphrasia offinalis , two bedstraws, Galium saxatile and G. vernum, Tormentil, Potentilla erecta, Common centaury Centaurium umbellatum, milkworts, Polygala vulgaris and P. serpyllifolia,... etc.'

More or less the same areas were described by Sadd in 1947. His study was carried out during July and August, so the spring flowering species were under recorded. The main change between 1946 and 1947 was that West Park was arable, mainly planted with oats, but also with a narrow strip of potatoes along the western edge. Sadd noted that the 'fenced pasture' varied much from field to field. Red fescue *Festuca rubra* was the dominant grass with birdsfoot trefoil *Lotus corniculatus*, wood sage *Teucrium scorodonia*, sheep's sorrel *Rumex acetosella* and white clover *Trifolium repens*. He also describes large patches of yarrow *Achillea millefolium* in Abyssinia.

By 1981, the fields had a disturbed soil surface with bare earth, high moss cover and intensive rabbit grazing, along with rabbit scrapes, burrows and latrines. The frequent species were, common bent *Agrostis capillaris* and Yorkshire fog *Holcus lanatus*, with occasional silver hair grass *Aira caryophyllea*, ground ivy *Glechoma hederacea*, wood sage *Teucrium scorodonia,* procumbent pearlwort *Sagina procumbens*, common dog violet *Viola riviniana,* sheep's sorrel*, Rumex acetosella,* birdsfoot trefoil *Lotus corniculatus,* red clover *Trifolium pratense* and white clover *T. repens.*

The western fields were described by Bray as, 'showing signs of relatively recent agriculture with quite distinct ploughing ridges and furrows'. These are less obvious today but still visible. According to Sadd these western fields were <u>not</u> ploughed in 1947, and Sladden, in 1946, described these fields as grassland. They were probably last ploughed before 1890. These areas, within the central field system, which Bray described as 'disturbed ground' had the least recent agricultural disturbance. However, they were the most disturbed by rabbits. Bray speculated that these fields may have been more exposed to salt spray than the fields to the east of the farm and that this may help explain the differences. Since 1980, the areas of inland grassland in the eastern fields that have not been invaded by bracken are becoming rather similar to Bray's disturbed areas. The most notable similarity is the very substantial increase in wood sage. Today (2013) the area occupied by this community has declined as bracken has invaded, and very little remains. These fields are occupied by one the most dense rabbit populations on the island.

Photo 41 Wood sage in the 'disturbed ground'

BRACKEN

Bracken covers approximately two thirds of the island. The divisions between the different plant communities which comprise this habitat are blurred or complicated by the ways in which the communities have been previously described.

Wilberforce identified two NVC bracken communities: A single quadrat near the west coast was recorded as U20c Pteridium aquilinum - Galium saxatile, bracken-bedstraw stands, this is a community where bracken is the sole dominant species. By far the most common community identified by Wilberforce is the W25 Pteridium aquilinum-Rubis fruticosus underscrub, bracken underscrub. This was confirmed by Rodwell (2004).

Bray (1981) identified 3 divisions within the bracken habitat, although these might be simply regarded as three different phases in the development of bracken. They are immature bracken, mature bracken and semi-mature bracken. For convenience I will use Bray's divisions to describe the bracken areas.

IMMATURE BRACKEN COMMUNITY

This is a species-poor community, with usually less than 10 species present and most often no more than 5. The bracken canopy varies between dense and open, with a sub layer of Yorkshire fog *Holcus lanatus*, common bent*, Agrostis capillaris* and wood sage *Teucrium scorodonia*. This immature community represents the advancing bracken front, beginning with just a few fronds but rapidly developing into an extremely dense phase. In spring, all three bracken communities provide spectacular areas of bluebells and, a little later, drifts of red campion S*ilene dioica.*

SEMI-MATURE BRACKEN COMMUNITY

This follows the immature community. In addition to bracken, it is characterised by the presence of a very small number of species, sometimes no more than 3 or 4. These include bluebells, Yorkshire fog, common bent and sheep's sorrel. The ground layer is littered with dead bracken fronds, below which there are bare areas, devoid of vegetation, and a layer of decomposing fronds.

MATURE BRACKEN COMMUNITY

These areas contain the longest established bracken. They are usually fairly open, allowing plenty of light through to a dense ground flora. In places the bracken disappears, leaving a Yorkshire fog / common bent grassland. Generally, in addition to bracken there are few other species, usually no more than 5 to 8 in any sample, but overall many more species are associated with this community than the earlier bracken phases.

BRACKEN-BRAMBLE UNDERSCRUB

I have decided to include, in addition to Bray's divisions of the bracken areas, the bracken-bramble community W25 Pteridium aquilinum-Rubis fruticosus underscrub. This was not given much attention by Bray, and I suspect that it is included in his description of 'mature bracken'. This is a community of the deeper, drier soils on Skomer. It is always dominated by bracken, with varying bramble cover. It occupies much of the northern slopes of North Valley, extending east almost to North Haven and west from North Pond to Bull Hole. In South Valley it extends, in the drier areas, along the entire valley. There are smaller areas between the Wick and High Cliff and small patches in the most sheltered parts of the neck.

BRACKEN - BACKGROUND INFORMATION

Bracken is one of the oldest ferns, with fossil records dating back over 55 million years. It is a very common species with an extremely wide global distribution, occurring in both temperate and subtropical zones. It is widespread and prolific in Britain, but limited to altitudes of below 600 m and it does not prosper in wet areas, marshes or fens. Bracken-dominated communities occupy a mid-successional position between early-successional, semi-natural communities, such as grassland, heaths and moors, and late-successional woodlands (Marris et al 2000). Bracken was once valued for use as animal bedding, in tanning, soap and glass making and as a fertiliser. It is now generally regarded as a pernicious, invasive and opportunistic problem species.

It is extremely successful, and is the only terrestrial fern that dominates large tracts of land outside woodland in temperate climates. Originally a woodland plant, it has managed to maintain high productivity outside the woodland habitat, probably as a result of being able to restrict its water loss more effectively than other ferns (Pakeman and Marrs, 1992). There are many reasons why bracken is so successful, these include:

- A very large rhizome system containing large carbohydrate and nutrient reserves, and many buds capable of producing new fronds.

- High productivity, which produces a frond canopy that casts deep shade.

- It produces large accumulations of litter which prevent other species from colonizing.

- Bracken is allelopathic (it produces compounds that inhibit the germination and growth of other plants).

- It contains a range of toxic chemicals within its tissues which can prevent it being eaten or decaying.

- The fronds are cyanogenic. They contain a substance known as prunasin that is converted into the poison hydrogen cyanide. The plants, particularly the rhizomes and young fronds, produce type I thiaminase, an enzyme that breaks down thiamine and thus causes vitamin B deficiency. The plants, including the spores, are also carcinogenic.

There is a belief that once bracken is established it will persist forever. However, there is good evidence that bracken exhibits a form of cyclic regeneration. This hypothesis was developed by Watt (Watt, 1945, 1976) and substantiated by Marrs and Hicks (1986). (NOTE: The divisions used by Bray, when describing the three different bracken communities, were based on this hypothesis.)

Bracken is so often condemned on the mainland, and with very good reason, but this is where we need to see Skomer through Skomer eyes. Without doubt, one of the most spectacular and wonderful wildlife experiences in Wales is to view the vast fields of bluebells on Skomer. Loosely paraphrasing the poem 'Proverbial Logic' by Debjani Chatterjee: Where there are bluebells there is bracken too, but the converse sadly is not true.

Mary Gillham (1954) suggested that bracken on Skokholm was possibly a relic of some early forest. The presence of woodland species, such as bluebells and red campion, supported this assumption. Bray took a different view, doubting that woodland which could support these species ever existed on Skomer. He used an argument developed by Tansley (1953) to explain the presence of bluebells. When bracken becomes dominant in the upper field layer it provides a canopy which does not close until late spring. This has more or less that same impact as the tree canopy in a bluebell wood.

Bluebells are poor competitors and need a niche, or some advantage, to secure their survival. They find an opportunity early in spring, before the canopy - bracken or woodland canopy - develops. Other potentially competitive species have been shaded out in previous years and little else flowers this early in the year. The Skomer bluebells are stimulated by seabird guano: they are extremely robust with generally much broader leaves than those on the mainland. Under normal circumstances, bluebells show severely depressed growth following the addition of nitrogen as a consequence of increased shading by grasses (Gillham 1955), but on the island grasses and other potential competitors are controlled by rabbits. Rabbit grazing has the greatest impact during the spring when the bluebells are flowering and there is so little for them to eat.

As an aside, the bluebells on Skomer usually flower two weeks later than those in Pembrokeshire's woodlands, and this is also true of the coastal and fridd bluebells of the West Wales coast and Snowdonia. In most years, trees come into leaf two weeks before the bracken fronds develop.

Photo 42 Bluebells

On Skomer, as the bluebells begin to fade they are followed, in many areas, by red campion - yet another visual delight. Red campion was mentioned by Dr Sladden in 1945: *'In June . . . on the sheltered ledges of the north-east side where there is sufficient soil the luxuriant maritime variety of red campion triumphs over the fading flowers of primrose, bluebell and sea campion.'* (Buxton & Lockley 1950) Red campion was more or less absent in 1960, but by 1964 the south eastern gull colonies were a blaze of pink flowers (Gillham 1964). Red campion is a species which thrives in fertile soils; it is a nitrogen lover. It is not surprising, therefore, that the current distribution of the densest patches coincides with the areas that are, or were formerly, gull colonies. Red campion generally prefers a moist, cool climate. So, in addition to soil fertility, rainfall is also an important factor. Its absence in 1960 followed a severe drought in 1959, but 1960 was a very wet year, and this may have led to the recovery and spread of campion. By 1963, there were extensive areas of campion in the middle of the Neck, to the south of the Garland Stone and above the south east

coast. These areas survived through the drier decades 1970 to 1990. Coinciding with the wetter period, which began in the late 1990s, there has been another spectacular increase in the areas occupied by red campion. The individual plants are extremely vigorous, probably a demonstration of high soil fertility. In some places the campion has almost displaced the bluebells. The most obvious example of this is in the lower part of South Valley, above and to the west of south stream cliff. This was one of the largest and most densely populated lesser black-backed gull colonies on the island during the 1970s. Campion is also present, but has not fared as well, on the more exposed western edges of the island. There is an interesting note in a paper by Mary Gillham (1964). She compares the national distribution of white campion *Silene alba* with that of red campion, and ends the discussion with an intriguing statement about white campion: *'There is a small colony in the garden of the old Skomer farmhouse. Here it hybridises freely with the red campion to give fertile, pale pink flowered offspring capable of back-crossing with the parents'*. I cannot find any other reference to white campion on Skomer.

Photo 43 Bluebells, campion and gulls

Photo 44 Red campion at dawn

Photo 45 Cool blue, warmer pinks

By the end of July, the cool blues and warmer pinks which dominate the landscape of spring and early summer have been replaced with a seemingly endless green sea of bracken. This is perhaps a visual low point of the year but soon, often far too soon, the autumn gales lash the island sending a spray of salt water over almost everything. Within days the bracken fronds blacken and wither, and then the delight of October and early winter, the fresh flush of bright green grass decorated with russet swathes of dead bracken.

Photo 46 Russet swathes of bracken at sunset

BRACKEN DISTRIBUTION SINCE 1947

The increased distribution of bracken since 1947 is best illustrated with a sequence of maps.

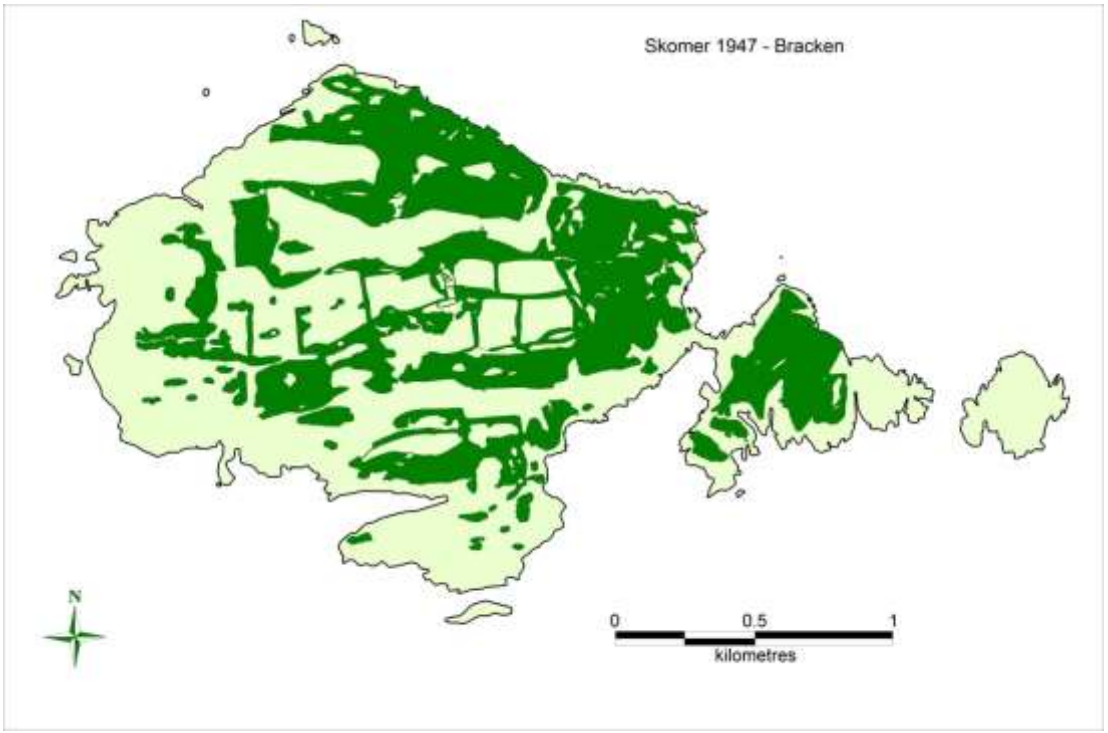

Fig 12 Bracken map 1947

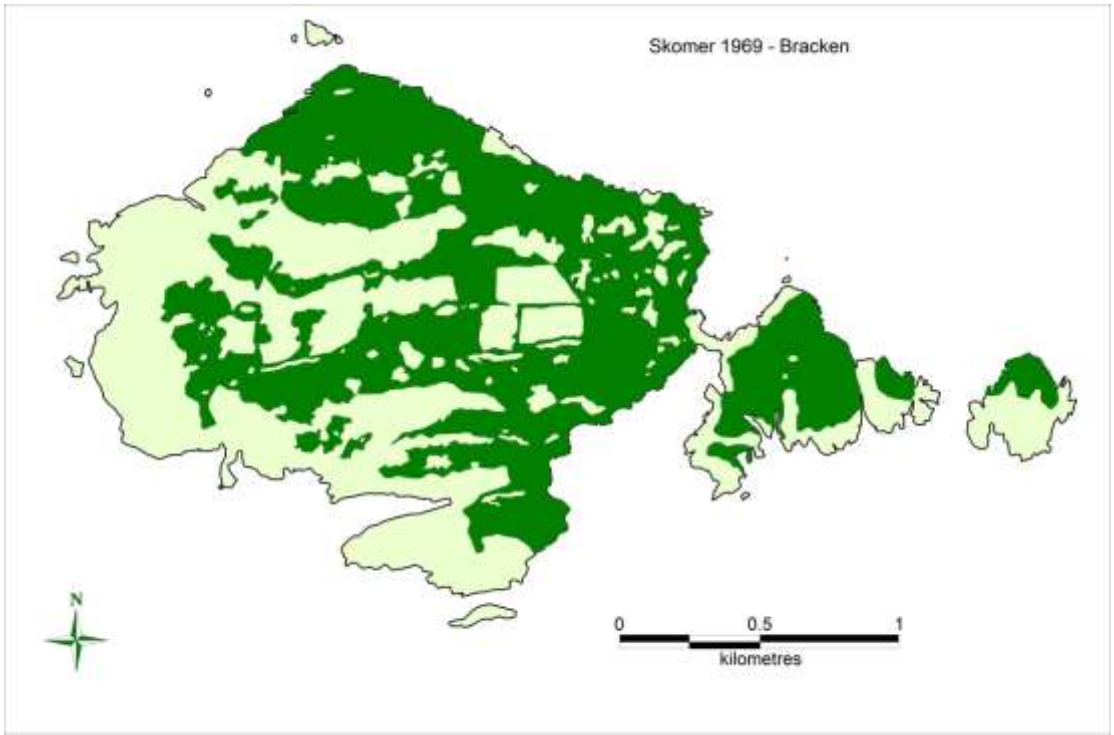

Fig 13 Bracken map 1969

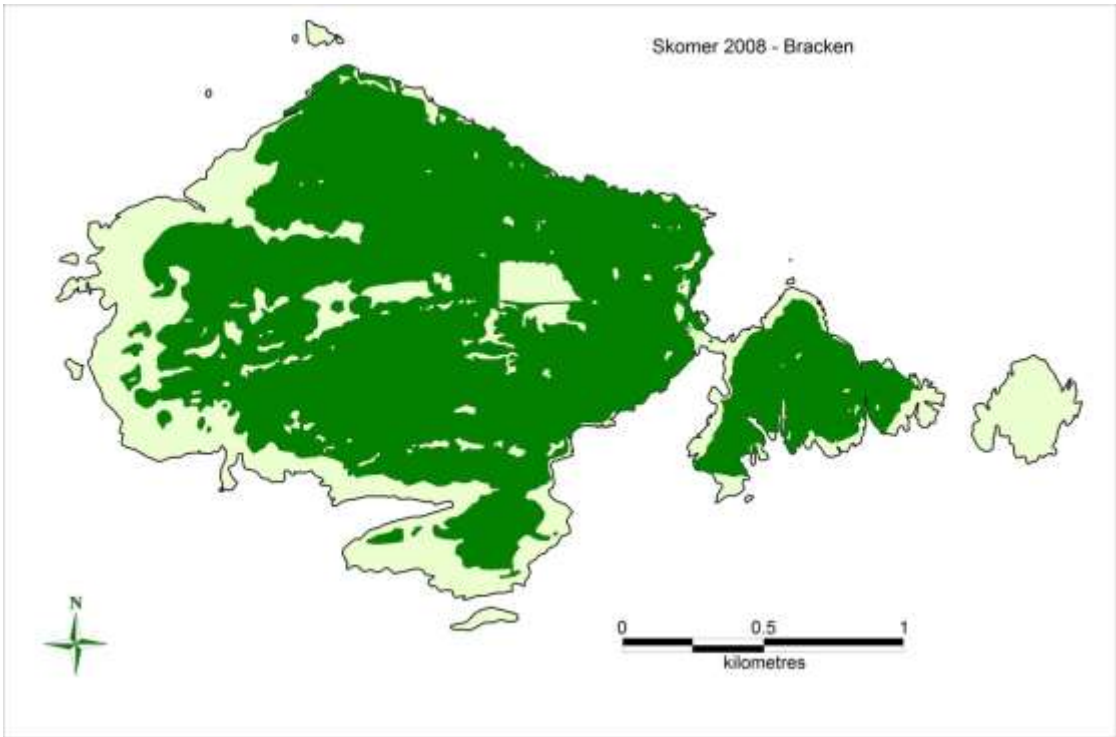

Fig 14 Bracken map 2008

During the 2008 survey all the areas which contained any bracken, from scattered fronds to closed canopy, were mapped as bracken. The 1947 map shows areas of bracken which were defined as, *'land where bracken affords at least 50% cover of the area'.* This suggests that bracken was underrepresented on this map. There is no information for the 1969 map, but it probably does not include the areas where bracken cover was light.

The 1947 map, originally prepared by Sadd, was published in 'Island of Skomer' (Buxton & Lockley 1950). This was prepared during the final years of farming on Skomer. The highpoint of farming on the island was during the second half of the 19th century. It was already in decline by the end of the century and was more or less abandoned after the outbreak of the First World War in 1914. The land was largely neglected until 1946 when Reuben Codd made the last attempt to farm Skomer. The 1947 map represents a snapshot of an island where nature had been reasserting her presence for almost half a century. During these post war years Reuben must have had a very significant impact on the rabbit population, and, without doubt, this would, in part, help to explain the condition of the vegetation at that time. Reuben also made an unsuccessful attempt to grow a potato crop, planting the fields to the east of the farm and Well Meadow to the west of the farm. He cultivated another field due west of Well Meadow, where he planted oats and a small patch of potatoes. This accounts for the complete lack of bracken in these areas during 1947. However, Sadd mentioned that fronds of bracken were growing among the potatoes. Reuben burned large areas of heath, probably giving bracken an opportunity to hasten its invasion. The remainder of the island was rough grazed by cattle, sheep and two horses. Sadd specifically mentioned South Plateau, which, in 1947, was almost completely free of bracken. This was the area preferred by the dairy cattle, and Sadd suggested that it was their presence that suppressed the bracken by trampling. He compared this to the Neck, which was stocked with 20 to 30 sheep, and where bracken was apparently not 'influenced' by the sheep. The spread of bracken was most advanced along the more sheltered north east coast and inland areas. There was very little on the exposed west and south coast. The central valley wetlands were also clear. It may be reasonable to assume that when the

farm was at its most productive bracken would have covered very much less of the land. By 1947 c118 Hectares, or 41% of the island, had already been invaded.

The next map (1969) demonstrates only a modest increase, from 41% to 53%. Along with the main fields and the exposed west coast, the two valleys had remained more or less clear. The increase was a product of consolidation and a general advance of the pioneering edges.

The final map (2008) shows all the areas where bracken occurred, regardless of density. By this time, 74% of the island had been invaded. With the exception of Calves Park and the central areas of some of the other fields, all the areas that could support bracken had been occupied. With few other exceptions, only the extremely exposed coasts and the rocky outcrops were spared. The colonisation by bracken was almost complete.

This is certainly not the end of the bracken story. In long-term studies on unmanaged heathland, there is a cycle where bracken invades grass heath, increases in density and then degenerates to leave grass heath again, although the bracken does not die out completely and may increase again at a later date (Marr & Hicks 1986). Casual observations on Skomer over the past three decades suggest that the 'open' areas of grassland in the mature bracken community have increased quite substantially. There is a very large area extending over most of the north east corner of the island where grasses, mainly false oat-grass *Arrhenatherum elatus*, now overtop the bracken when in flower.

Photo 47 July 2007, the pale green expanse of grass overtopping the bracken.

There has also been a spectacular change to the coastal slopes surrounding North Haven and along the more sheltered sections of the coast around South Haven. During the 1970s and 80s the North Haven slopes were, for the greater part of the year, the dull ochre of dead vegetation, interspersed with bare ground and scattered with dead bracken. Spring delivered some very spectacular bluebell areas, and these later became dense bracken, surrounded by the same dull ochre, but now decorated with occasional bracken fronds and small patches of green Yorkshire fog. Once the bracken had succumbed to autumn gales, October usually delivered a velvet green flush of Yorkshire fog with some common bent. By the middle of winter all was once again ochre.

During the past decade the cover of Yorkshire fog has increased. In May 2008 the slopes were uniform green with a dense, almost luxuriant, growth of Yorkshire fog and almost no bare ground. The canopy in the once dense areas of bracken has thinned and some of the smaller patches of bracken have disappeared. Areas of Yorkshire fog grassland have occupied some parts of North

Haven for many years; they were described by Sadd in 1947. He wrote of Yorkshire fog dominating grassland on the cliff edges in the extreme northern corner of North Haven. He suggested that its presence was the consequence of overgrazing by rabbits and the loss of the more desirable grasses.

Photo 48 Yorkshire fog North Haven May 2008

It is so important that we appreciate how recently the Yorkshire fog grassland, and some of the other communities, have developed on Skomer. Sadd (1947) described a very different place: *'The banks around the Havens are likewise honeycombed by puffin burrows and the vegetation here is virtually a pure consociation of Agrostis tenuis'*

It is also very important that our response is cautious. The bracken may appear to becoming less vigorous, but this may simply be an illusion created by the increase in Yorkshire fog. There are a number of factors which could explain the increase in Yorkshire fog, but perhaps the most likely is the succession of years since the late 1990s with a much higher than average rainfall.

Temperature could also be an important factor. Milder winters certainly favour grass growth, and, with the exception of 2010, mean annual temperatures since 1990 have been higher than all previous decades since 1960.

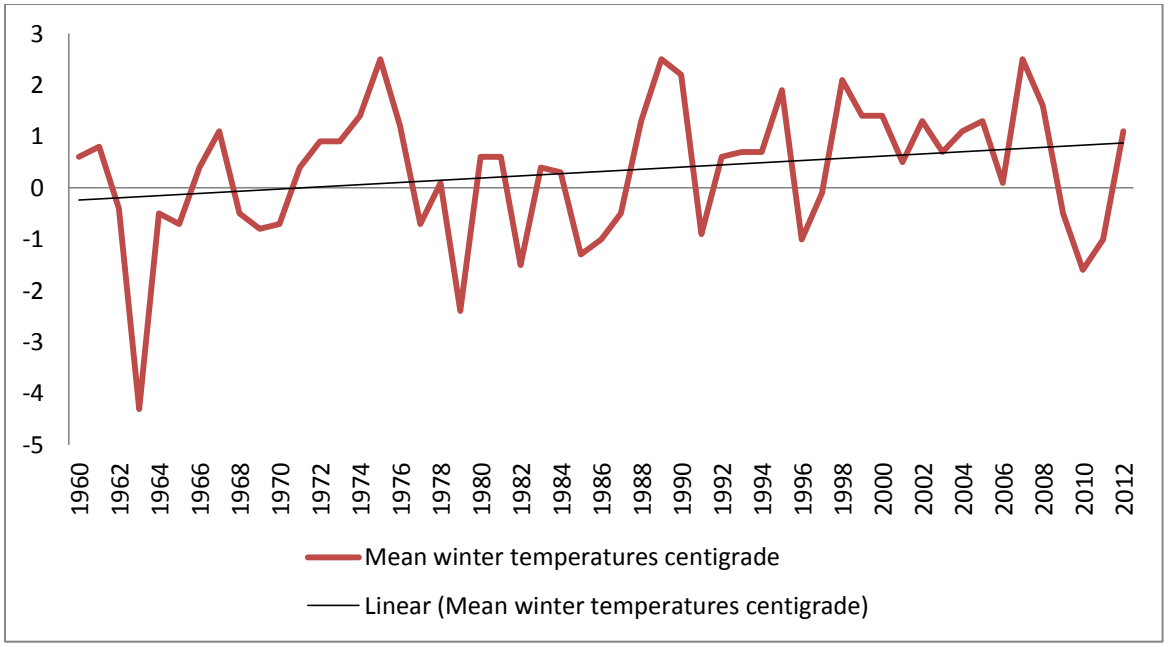

Fig 15 Mean winter temperatures 1960 to 2012

Over the longer term, an increase in soil fertility may have given Yorkshire fog a competitive advantage. Yorkshire fog will survive on low to moderately fertile soils. However, nitrogen availability is a limiting factor in Yorkshire fog, and fertilization is known to improve its competitive ability (Remison and Snaydon 1980). The slopes of North Haven contain some of the densest shearwater and puffin colonies, and their droppings will certainly have had a considerable impact on soil fertility. Nettles *Urtica dioica,* a clear indicator of enriched soils, have been spreading rapidly on the north west corner of the Isthmus. This may be, in part, a consequence of concentrated human activity, but the fact that the plants are thriving in one of the densest bird colonies could suggest that they are responding to guano.

Without wishing to appear too gloomy, it is also important to recognise that bracken 'exhibits a form of cyclic regeneration'. In other words, it may return again, and, possibly, each time it progresses through the pioneer to mature phases more species will be lost.

A REVIEW OF BRACKEN CONTROL

GENERAL

Bracken control measures can have short term dramatic effects, but no treatments can completely eradicate bracken. The herbicide Asulam is one of the most effective controls, but there is relatively rapid recovery, even following repeat applications. A ban on the use of Asulam in EU member states came into effect on 31 December 2011. Since that time, this has been rescinded on an annual basis for restricted use. In 2013, an emergency authorisation was made for the application of Asulam to control bracken in the UK. However, the use is restricted, and weedwipers and drift sprayers (e.g. the Micron ULVA) are not authorised for use. In addition, the only concentration that is approved for use with hand-held equipment is 1 part of Asulox to 100 parts of water. A complete ban in the UK is predicted.

The most successful treatment for bracken is cutting twice yearly for 6 years; frond biomass had reached only 40% of untreated levels 12 years after the last cut (Marrs et al., 1998*).*

BRACKEN CONTROL ON SKOMER

At one time or another most of the Skomer wardens have resorted to bracken bashing. The first record was in 1961 when a small area was 'rolled', but the location is not given. There is no record of a rationale or justification for bracken control until 1978 when Professor Denis Bellamy, University College Cardiff, produced a paper for the island management committee and the Nature Conservancy Council, 'A commentary on the decline in diversity of Skomer Island and some proposed experiments to arrest and reverse this trend'. His main focus was the loss of biodiversity in the central fields, but his proposal was primarily for a research project. More recently, in 2003 a rationale was prepared by the island warden to justify the reconstruction of the Calves Park exclosure:

'At present, intensive bracken management merely gives way to an overgrazed grassland dominated by Teucrium, with little conservation interest. The area is an ideal arena for habitat recreation, as the density of Rabbit burrows is low (and so the species is easier to exclude), and bracken is absent. In the absence of rabbit grazing, a herb-rich grassland would probably develop, with unpalatable species such as Tuecrium and bracken being naturally outcompeted by more vigorous herbs. The meadow habitat would benefit invertebrates and nesting and migrant birds, and where this exists close to the path would provide an opportunity for interpreting such conservation management to education groups and the general public. The field may require occasional subsequent management (by cutting) to maintain floral diversity. Management by altering conditions by excluding rabbits is more desirable than resource-intensive direct bracken control, which will never be effective if conditions conducive to the species' dominance remain.'

The grassland in Calves Park is believed to be NVC U4b *Festuca-Agrostis-Galium* grassland. In the late 1970s the field, at that time enclosed and free of rabbits, was mowed annually. The 2003 rational mentions the need for 'cutting, if the rabbits were removed'. In other words, the enclosed pasture would be treated as a meadow. *'The Festuca-Agrostis-Galium grassland is the most extensive kind of pasture . . . Grazing is of prime importance in preventing the regression of the community . . .'* (Rodwell 1992). In 1947 this field was arable and full of potatoes. Before that time it was probably pasture, and earlier it was arable or a hay meadow. If it had been managed as a meadow, in addition to cutting there would have been aftermath grazing along with the addition of lime and possibly farmyard manure. Grasslands can be managed by grazing alone, but if cutting is the only form of management species diversity in the sward will decline.

In 1968 a borrowed flail was used to cut bracken in the fields east of the farm. Cutting in the central fields continued during most years until 1973, when the flail became unserviceable. There was no further bracken control in the central fields until 1979 when Calves Park was fenced to exclude rabbits and then mowed each year until 1985. The exclosure was effective for three years but, as with all exclosures on Skomer, the rabbits eventually found their way in. Over time, it has become apparent that rabbits are quite capable of biting through wire netting. Netting wire has a very short life expectancy on the island; it is corroded by salt spray and blown apart in the gales. The exclosure was used for a further period for research but was eventually abandoned and removed by 1997.

Asulam, a herbicide specifically designed to control bracken, was trialled on the island in the early 1980s, and in 1986 Shearing Hays was sprayed. The results were disappointing, with the bracken quickly recovering. At that time ultra-low volume applications were not available. There was an almost unavoidable risk of uncontrolled drift when an Asulam/water mix was applied with conventional spraying equipment. Asulam has an impact on a number of species, including ferns and lichens. Following the trial it was decided that Asulam was not suitable for use on Skomer.

In 2002 another substantial effort was made to control bracken in the central fields by pulling, scything and crushing stems. This continued in 2003 when, in addition to mechanical control, Calves Park, Shearing Hays and Well Field were also sprayed with Asulam. There are no records of spraying after that time but mechanical control, mainly crushing stems with canes, continued in the central fields during most years up to the present time. On several occasions there were suggestions that a new exclosure, primarily to provide opportunities for research, should be erected at Calves Park.

In addition to the central fields, Asulam was also used during 1998 and 1999 to control the bracken invading the areas of heath, mainly around the exclosures in North Valley. There is nothing on record concerning the reversal of the decision not to use Asulam, but ultra-low volume spraying equipment was used, and I assume that this was why Asulam was considered suitable for use on Skomer.

Bracken has also been controlled by cutting and pulling around the puffin burrows in North Haven. Bracken growing in these marginal habitats is much more vulnerable and easier to control than the established bracken in the sheltered areas.

With the exception of Calves Park and the central part of Shearing Hays, which have remained more or less clear of bracken, there is very little to show for so many years of intervention. Clearly, the advance of bracken has been slowed in the central fields but, in common with experience of bracken control elsewhere, the results are very disappointing. Bracken management in the absence of grazing control delivers poor quality, overgrazed grassland, dominated by species that are unpalatable to rabbits. The exception is control around the puffin burrows which has been very effective.

Photo 50 Bracken around the puffin colony above South Haven

SCRUB, SHRUBS AND TREES

Prosser and Wallace (1996) identified two NVC scrub communities, NVC W25 *Pteridium aquilinum - Rubis fruticosus* underscrub, bracken - bramble underscrub, and W23 *Ulex europaeus - Rubis fruticosus scrub*, gorse - bramble scrub. Wilberforce (1999) also recorded W23.

The W25 underscrub community is introduced and discussed under the 'bracken' feature.
Gorse *Ulex europus,* barely survives. Sladden, writing in 1947, mentions *'a few ancient furze bushes'*. Gorse is such a palatable plant it is surprising that even a few scattered remnants are able survive. There have been many attempts to propagate gorse cuttings, particularly at Gorse Hill. The justification is shelter for migrants and habitat for nesting linnets, whitethroats and stonechats. Rodwell (2004) pointed out that gorse is something of a cultural relict and that its maintenance would provide a reference to earlier times.

Photo 51 Scrub, elder and blackthorn in North Valley

There has been a significant increase in bramble, mainly in North Valley. Bramble is heavily browsed by rabbits. This is very obvious in the spring, when most bushes accessible to rabbits are completely bare of foliage. Brambles are a deciduous shrub, but in the absence of grazing they often retain their leaves throughout the winter. The exclosures in the North Valley heath also provide very compelling evidence that rabbits are seriously suppressing the spread of bramble on Skomer.

Prior to the 1960s, and the beginning of conservation management on Skomer, the only scrub or trees present were a few gorse bushes *Ulex europus*, a small patch of blackthorn *Prunus spinosa* in the narrow gorge in North Valley (with a vague mention of its presence in South Valley), a very small number of scattered elders *Sambucus nigra* and the single black poplar *Populus nigra* which had been planted in the corner of the farmyard. There were a few garden shrubs, but only the fuchsias

have survived. There were also patches of bramble *Rubus fruiticosus* in the inland sheltered valleys and around the farm.

Following the declaration of Skomer as an NNR there have been many deliberate introductions. Since 1961, willows have been planted in North Stream Valley, South Stream Valley, North Pond, Well Pond and below Green Pond. In 1961 they were even planted around the water tank above the warden's house in North Haven. We can be almost certain that willow was not present on Skomer in 1956 or 1947 (Sadd 1947) (Buxton and Lockley 1950). Monterey pines, blackthorn and privet were planted around the farm in the early 1970s, but these all failed. Elders were collected from North valley and planted around the farm in the 1960s and it is also obvious, although it was not recorded, that some additional blackthorn has been planted. Almost all the planting was an attempt to improve cover for migratory birds or to provide shelter around the ponds.

The planted willows have done well, but there are no signs of natural regeneration. It is now possible to walk beneath a wooded canopy in North Valley, just below Green Pond (although, perhaps wooded canopy is an exaggeration - a scrubby canopy may be a more appropriate description). The elders have increased, with sparsely scattered bushes mainly in North Valley and around the farm, but, with the exception of a few very sheltered plants, most appear to be quite unhealthy.

Photo 52 'Scrub' canopy in North Valley

STREAMS AND ASSOCIATED WETLANDS, INCLUDING PONDS, MARSHY GRASSLAND AND STREAM EDGES

I have followed Bray's (1981) lead: he brings together all the wet areas under the heading 'streams and associated wetlands', but, in an attempt to simplify my description, I will use a number of subheadings.

PONDS

There are small ponds at the head of both main valleys, but these are not natural; low dams were constructed at some time in the distant past. The South Pond dam has not been maintained in recent years and the open water has more or less disappeared. It is probably now best described as a wet depression. The North Pond dam was completely reconstructed in the mid-1960s, and the bottom of the pond was also scraped at that time. Subsequently, the dam has been improved and maintained, and, in all but the driest years, it holds a reasonable area of open water. Streams flow from both ponds in a more or less easterly direction, initially through very gently sloping waterlogged areas, which then terminate in shallow gorges as they approach the sea cliffs. The flow of south stream is interrupted by a dam and small pond at a point mid-way between South Pond and the sea. This was an ancient dam which was reconstructed in the late 1980s. Green Pond, in the lower section of North Valley, was created 1978 when the stream was dammed just below the point where the valley deepens into a shallow gorge. This is the deepest pond on the island but the surface area is very small.

Photo 53 North Pond with bulrushes, Canada geese and a sun dog.

The larger ponds on Skomer provide extremely attractive bathing and preening areas for the gulls, resulting in turbid and highly enriched water which offers limited opportunities for aquatic plants.

The margins are dominated by rushes, mainly soft rush *Juncus effusus* and jointed rush *J. Articulates*, *J. bufonius* and *J. bulbosus*. Some of the more frequent species in the open areas between the rushes are marsh pennywort *Hydrocotyle vulgaris*, bog pimpernel *Anagalis tenella*, water mint *Mentha aquatica* and creeping forget-me-not *Myosotis secunda*. The drying water margin is usually covered with a mix of species, including, water pepper *Polygonum hydropiper,* and amphibious bistort *Persicaria amphibia.* Red goosefoot *Chemopodium rubrum* can dominate the margins of North Pond. Shoreweed *Littorella uniflora,* a scarce plant in Pembrokeshire, has been found on the edge of the mud in the centre of South Pond and at North Pond when it was described as abundant in July 1980.

West Pond on the far western edge of the field system is in fact two, almost certainly, artificial scrapes of unknown antiquity. They could simply have been a means of providing fresh water for stock kept in this field. They are very shallow and tend to dry up during most summers. However, they lay claim to one of the few rare plants found on Skomer, lesser marshwort *Apium inundatum*, which grows in the centre of the dried up ponds. (Lesser marshwort has also been found at South Pond) It is surrounded by a common spike rush *Eleocharis palustris* sward, with marsh cudweed *Gnaphalium uliginosum* and redshank *Persicaria maculosa.* Red goosefoot *Chemopodium rubrum,* another Pembrokeshire rarity, is found around the margin of this pond.

Photo 54 Green Pond

MARSHY GRASSLAND

The NVC communities are; M23 Juncus effusus-Gallium palustre rush pasture, identified by Wilberforce (1999) and M25 *Molinia-Potentilla* mire identified during the 1996 heathland survey.

The M25 Molinia mire is mainly found in the centre of North Valley on either side of the footpath which leads from the farm to the Garland Stone, and there is also a very small area to the south of South Pond in South Valley. The distribution of the remaining purple moor grass *Molinia caerulea* dominated grassland is mainly restricted to the lower lying wet areas in the western level sections of both North and South valleys.

Photo 55 Purple moor grass in North Valley

The central section of North Valley, below North Pond, is the wettest area on Skomer, there are very obvious signs of early agricultural drainage with old, and now completely redundant, ditches which run towards North Stream in the centre of the valley. There are also occasional deep holes, probably as a result of earlier peat cutting. These are now waterlogged and, along with the ditches, provide a rare opportunity for sphagnum on Skomer. Bulrush *Typha latifolia* occurs infrequently in some of the wettest hollows. The areas currently dominated by purple moor grass were, even as recently as the 1990s, mainly wet heath interspersed with narrow strips of purple moor grass. The heath was described in the 1996 heathland survey as NVC H8 *Calluna vulgaris - Ulex gallii* heath. Western gorse Ulex gallii was only recorded as being present in one of nine quadrats; the community comprised mainly heather, bracken and purple moor grass, with a small amount of bell heather *Erica cinerea* in one sample. Most of the samples held less than six species. Some of the strips of purple moor grass followed the line of the ancient blocked ditches, suggesting that there may be some ground-water movement (purple moor grass is most abundant and grows vigorously where there is ground-water movement). Bray mapped this entire area as 'inland heath', and the heath shows very clearly on an aerial photograph taken at that time.

Photo 56 Aerial photo of wet heath in North Valley, 1983. The darker areas of heath are interspersed with pale, purple moor grass.

Photo 57 Drumstick heather North Valley

Since 1983 there has been a very rapid decline in heather cover, and much of what survives is heavily grazed by rabbits and in very poor condition. What little heather persists can be described as 'drumstick' or 'mop' heather. This is usually indicative of prolonged heavy grazing, reducing the

heather canopy to small, compact masses of intertwined and contorted shoots on the ends of scattered, long, bare stems. This can happen on wet heaths even when browsing is not heavy, but obvious signs of continuous rabbit nibbling confirm that it is the consequence of grazing (JNCC Common Standards). The heather and purple moor grass in these areas is very obviously grazed. Brambles have invaded the drier marginal areas and bracken fronds are scattered throughout. Sadd (1947) describes *'a low growth of Calluna in this area almost certainly a stage in regeneration after a previous severe burn. Many charred stumps of much larger Calluna plants were to be seen.'*

South Valley was also significantly modified by earlier inhabitants; a deep, very straight, ditch runs through South Valley from the outlet at South Pond to just above the main coast footpath in lower South Valley. The section between South Pond and Moorey Mere is flanked on both sides by quite substantial walls or raised banks. There is a confused area below Moorey Mere where the ground is waterlogged, but a metre or so to the east of the footpath the ditch reappears, and this lower section is flanked on the south side by a bank or wall. The age of this structure is unknown. It is possibly contemporary with the later central field boundaries, but this should be confirmed. The land to the south of the ditch is quite well drained, deep, peaty soil.

South Valley has some fairly large, and very distinct, areas dominated almost entirely by purple moor grass. There are some smaller patches of soft rush *Juncus effusus* and, on the slightly drier ground, areas of tall vegetation with dense patches of hogweed *Heracleum spondylium* and wild angelica *Angelica sylvestris*. The vegetation in this area has changed very little over the past decades. The only exception is to the west of South Pond, which was once (1960 - 1985) one of the largest extents of heath on the island. The gradation of heath into purple moor grass was at that time a characteristic of this area.

THE DEEPER LOWER VALLEYS

The lowest reach of South Valley is a delightful, small, shallow, but quite steep sided, gorge. It is one of the more sheltered parts of the island and always the first place that bluebells come into flower. The bluebells are followed by dense swathes of red campion. Later, as spring drifts into summer, swathes of purple loosestrife *Lythrum salicaria*, hemlock water dropwort *Oenanthe crocata* and ferns dominate the taller vegetation in the damper centre of the valley. There is no scrub apart from a solitary blackthorn at the head of the gorge and a little bramble lower down. The stream finally tumbles off the cliff into the sea in South Haven. The scrub or 'wooded' area in North Valley was described in the previous subsection. Below the blackthorn the secluded, damp, shaded and sheltered stream edges are places where ferns can dominate. The summer vegetation is almost identical to South Valley.

Photo 58 Spring arrives in South Valley

Photo 59 Lower North Valley

FLUSHES AND SPRINGS

Skomer is rather like a very large bowl with small fractures around its rim. Water seeps through these fractures along the cliff edges from above Bull Hole around the exposed western cliffs to the south coast at the entrance to the Wick. These we recognise as a series of small springs or flushes. The largest is Wick Stream, at the extreme western end of south valley. The spring flows into a small pond created by an ancient dam or wall which has been maintained over the years. It then trickles through a series of very small, ancient, derelict dams and flows into the sea above Wick Basin. The stream is particularly important for one of Skomer's rare plants, three-lobed crowfoot *Ranunculus tripartitus.* This is one of a small assemblage of four nationally scarce plants which qualify as a SSSI feature. It is also on the GB Red List (2005) as endangered. Pembrokeshire has some of the biggest populations of this species in Britain and it is found on all 3 seabird islands. The population has, unfortunately, declined in recent years.

The only other spring which once attracted botanical interest is on the edge of the cliff above Pigstone Bay. In the 1970s yellow-eyed grass *Sisyrinchium californicum,* a coastal plant native of the west coast of the USA, appeared on the edge of the spring. This species, popular with some gardeners, has naturalised and is now regarded as a troublesome invasive. There were suggestions that it reached Skomer 'on wildfowl', but it is more likely that this was human introduction, deliberate or accidental. Fortunately, it did not survive.

Photo 60 Wick Stream

Perhaps the most important spring of all, though not from a botanical perspective, is the above the warden's house in North Haven. This provides water for the house and indeed is the main factor which made it possible for the house to be built in this location.

The flush above the Spit has been described at the end of the section on coastal grasslands. There is one other notable flush, where the western extreme of North Valley approaches the cliffs above Bull

Hole. The slighter wetter and enriched conditions here provide an opportunity for tall vigorous vegetation dominated by wild angelica *Angelica sylvestris* and surrounded by nettles and brambles. There is a similar patch of angelica on the south eastern flank of South Valley.

Photo 61 Angelica above Bull Hole

MISCELLANEOUS

I have added this heading as a convenient way to include vegetation that requires further investigation before we can reach any conclusions, and to introduce aspects of the vegetation which do not fit comfortably under any one of the preceding headings.

Under the former category Rodwell (2004) pointed out that Bray's description of the vegetation missed out some areas, and he specifically mentioned the vegetation on the mortar of the farm buildings. He suggested that this was probably the NVC community OV39 *Asplenium trichomanes - A. ruta-muria,* spleenwort crevice vegetation.

I have not included a description of the vegetation of the inland rocky outcrops with their thin pockets of soil. They were included by Bray in his vegetation type 'rocky slopes and inland outcrops', but I think that the most sheltered inland outcrops would benefit from further attention. Apart from the lichens, which will be described in a different section, the sheltered outcrops provide opportunities, in addition to some of the maritime cliff species, for plants including English stonecrop *Sedum anglicum*, biting stonecrop *S. acre*, navelwort *Umbilicus rupestris* and sheep's bit *Jasione montana*.

Photo 62 Rock outcrop south of the Farm

Photo 63 Farm wall

AQUATIC VEGETATION.

The only description of the aquatic pond and stream vegetation is over 60 years old and many of the species recorded at that time have not been relocated in recent times. These habitats were not regarded as being particularly important in 1947 and, as I doubt that their status has improved, there is scant justification for a survey.

EPHEMERAL INVADERS .

There are two species of ephemeral invaders, ragwort *Senecio jacobaea* and foxglove *Digitalis purpurea,* which occasionally, and usually for brief periods, appear to dominate the island vegetation. Both are biennials, though ragwort can sometimes, for example, when grazing pressure is high, behave as a perennial.

Ragwort is quite a controversial species. In Wales it is subject to the Ragwort Control Act 2003. This act creates a code for the management of ragwort. There are no implications for Skomer as, contrary to popular belief, the act does not place any legal obligation on anyone to control ragwort. Ragwort can germinate anywhere where the soil surface is exposed, and rabbit disturbance on Skomer provides ideal opportunities. For many years there was a sequence of colonisation: often after a very dry year a few ragwort plants would appear, then the following year colonies of the rosette stage dominated significant areas of both inland and coastal habitat, and a year later and the island was adorned with swathes of golden yellow flowers.

Usually, cinnabar moths *Tyria jacobaeae* appeared in small number at this time. (These are beautiful day-flying moths, with unmistakable bright red, or cinnabar, spots and stripes on their forewings and equally bright red hind wings edged in dusty black.) As the ragwort came into flower for the second or third years there was a cinnabar 'population explosion', and the ragwort was rapidly stripped bare by hoards of distinctive black and yellow hooped caterpillars. In some years, the impact was so extreme that it took ragwort several seasons before it once again appeared in any quantity. Since 2007, there have been seven consecutive years when the extent of the ragwort has increased each year. The cinnabar moths were not seen between 2009 and 2012, although a small number reappeared in 2013. Cinnabars have their own limiting factors, being susceptible to nosema, a fungal related parasite, and this may explain their absence. In 2013 there was a greater cover of ragwort on Skomer than anything previously recorded: almost all the central fields were covered. Calves Park was the most spectacular, but further west there was huge expanse extending, almost unbroken, from behind the farm to Skomer Head. The core area was South Field and Abyssinia (the field containing West Pond). The area between Abyssinia and Bull Hole, including most of the Table was also inundated, with smaller patches around the Wick and a little on South Plateau.

Foxgloves are a species of disturbed ground. One of the most spectacular foxglove displays on Skomer followed two years after the extreme drought year 1976. The vegetation was burned out by the long, hot, dry summer and any surviving edible vegetation was eaten by rabbits. There was bare ground everywhere, and this was where the foxgloves took advantage of the opportunity. They are always present in small numbers on the island, waiting for, and rapidly responding to, their favoured conditions.

Photo 64 Ragwort North Valley

Photo 65 Foxgloves

DISCUSSION - GENERAL

The vegetation on Skomer is changing and will continue to change. Any decision about the future must be conditioned by our overwhelming responsibility to ensuring that the globally important populations of seabirds are protected. Their security must always be our prime concern. We need to keep a rather obvious question in mind whenever we think about the future of Skomer: what is the potential future vegetation, and will it continue to provide suitable conditions for the birds?

For more than 50 years the vegetation has been described, 'monitored' or recorded, but at no time have any significant decisions been made about its future. Management interventions have been sporadic but not sustained, and, with few rare exceptions, there has been an absence of any detailed rationale to support any management operations. Managers adopted, quite understandably, a very cautious approach, reluctant to make decisions in the absence of sound evidence. This indecision has had some very serious implications for the vegetation and for our ability to make future decisions. The worst, or perhaps best, example of indecision concerned the removal of grazing by domestic stock. I will return to this later.

The need to make decisions can no longer be avoided, but before coming to any conclusion we need to remind ourselves why the vegetation is changing. We know that for hundreds, probably thousands, of years people have been the major factor in the development of the vegetation on Skomer. The cessation of quite intensive agriculture at the end of the First World War was possibly one of the more abrupt changes in land use. Although there were some agricultural activities after that time, its impact did little more than delay the inevitable process of change. The winter of 1946-7 is remembered as one of the coldest since records began: snow persisted until mid-March, and the ground could not be ploughed until the end of the month. This was the spring when Reuben Codd, the last man who attempted to farm on Skomer, planted his only crop of potatoes. Reuben ploughed and planted late: far too late to produce an early crop. By the time his potatoes were ready for harvesting the prices had collapsed, and his produce was unmarketable. This, apart from some limited grazing, marked the end of agriculture on Skomer. Today, we can only barely recognise the areas described as ‘arable’ by Sadd in 1947. Soon, they will be become indistinguishable from the land that would have been described as arable at the beginning of the 20th century.

When descriptions of Skomer from the late 1940s are compared with contemporary descriptions of similar habitat on the mainland it is obvious that, although there are differences, the overall impression would have been similar. In much earlier times the differences would have been even less obvious, with certainly little difference between the farmed land on Skomer and that of the Marloes peninsula. Since the 1940s change has been rapid, and today the island is very different even to the Deer Park above Martin's Haven, on the closest mainland cliffs. Change is an inevitable and inescapable consequence of agricultural abandonment. In some places the direction of change is reasonably predictable, but on Skomer there are factors that obscure our ability to see the potential futures. Rabbits will be discussed later. Their impact is considerable, and, for a variety of reasons, the population is unstable and given to extreme fluctuations. The consequence is that, in addition to the gradual progression away from vegetation which was mainly the incidental consequence of anthropogenic factors, there are intermediate variations. It would be inaccurate to describe these as cycles, though they can give that impression. These very short-term changes are most easily recognised in the vegetation of the exposed south western coasts: the zone between the extremely exposed rocky sea-cliff vegetation and the more sheltered inland area.

Our ability to make any decisions about what we want to achieve, i.e. our objectives, and what we should do to achieve our objectives is restricted, or limited, by what we *can* do. There is no purpose in preparing objectives that can never be achieved. However, within this limitation, objectives can

be aspirational. The remainder of this discussion will focus on identifying achievable, realistic objectives for the vegetation.

Management to achieve an objective is always about taking control, and specifically taking control of the factors. A factor, in this context, is anything that has the potential to influence or change a feature, or to influence the way in which a feature is managed. Factors can have both a negative or positive impact. Control means the removal, maintenance, adjustment or application of factors, either directly or indirectly. Apart from the obvious natural factors - edaphic, climatic, etc. - the single most important factor which influences the vegetation on Skomer is grazing by rabbits. Taking control of grazing, under normal circumstances, implies an ability to remove, reduce, maintain, increase or introduce grazing. The question, therefore, is, to what extent can control be applied to grazing on the island?

GRAZING BY DOMESTIC ANIMALS

Before discussing rabbits, it is necessary to consider grazing by domestic animals. If it were ever possible to remove the rabbits, in order to avoid some of the negative consequences of this, we would have to consider alternative grazing, by animals that we could control, thereby allowing us to manipulate the vegetation. The issue of reintroducing domestic grazing stock has been discussed at intervals over the years, with varying levels of support for the idea.

No decision was ever taken not to graze Skomer. Up until 1958 Reuben Codd kept sheep, cattle and a horse or two on the island, and this followed centuries of human occupation and utilisation. Once the island became a National Nature Reserve, Ronald Lockley, at that time the Honorary Chief Warden for the Field Society and the 'elected' Skomer Warden, put a flock of his own sheep on the island to ensure continuity of grazing. This and other issues created serious divisions within the Society and, eventually, regardless of any rights or wrongs, with the exception of a small number of Soay sheep, the animals were removed. There was always an intention that the island would be grazed: the Nature Conservancy (the government agency that owned Skomer at that time) had no doubt about the importance of keeping enough sheep or other grazing animals on the island to control the vegetation. The first job description for the Skomer warden suggested that he should keep sheep to supplement his income, but this never happened. Over the years there was much discussion, many file notes, but never a decision. The belief that there should be grazing was never questioned; the only concerns were about the breed and numbers of animals. The final word in the debate was a Nature Conservancy file note written in 1974, stating that the decision would be deferred until the island management plan was completed. The removal of grazing by domestic animals was entirely the consequence of indecision and not the result of a rational or reasoned decision making process.

Could sheep, or any other herbivores, be reintroduced to Skomer? *'The introduction of sheep onto a densely burrowed puffin colony causes widespread collapse of burrows but colonies which have been grazed for many years are remarkably stable. Burrows in grazed areas are deeper and longer and the nest chamber has a solid roof, in non-grazed areas the burrows are short shallow and easily collapse.'* (Harris 1984) The simple answer is no, we cannot at this stage introduce heavy animals, and sheep, with their sharp, penetrating hooves, must be regarded as heavy animals. The shearwater and puffin burrows are so very fragile and vulnerable that, in reality, it is far too late for this debate. Indecision in the early years removed any choice that we might have had today, but is this a disaster? On islands that are grazed by domestic stock and occupied by shearwaters, for example, Ynys Enlli (Bardsey) in North Wales, the shearwaters are restricted to the walls or mountain areas which are not over utilised by grazing animals. This pattern was also probably true of an earlier Skomer, and there are still very low numbers of shearwater burrows in the middle of

the central fields. We have to be cautious, but is it possible that the incredible success of the shearwater population is, in some minor part, because they have so much room to burrow? What would have happened if grazing animals had been retained?

Photo 66 Sheep grazing, North Haven, 1958

RABBITS

Photo 67 Rabbit

There is an extremely large, though unstable and fluctuating, rabbit population on Skomer. Rabbits are native to the western Mediterranean region, and were introduced to Britain sometime in the 12th century, during the reign of Henry II. There were rabbits on Ramsey by 1293. The first record for the Pembrokeshire Islands, and in particular Skokholm, can be found in a document concerning the valuation of Aymer de Valence, the Earl of Pembroke's estate after his death in 1324. It is not known precisely when rabbits were first introduced to Skomer, but David Stanbury (1997) suggests that the date for introduction to Skokholm was probably around 1180, and there is every probability that this was also the time when rabbits arrived on Skomer. By 1387 the islands were under royal control and detailed accounts were kept. The first record of rabbit 'farming' on Skomer was in the following record for 1387-8:

"Particulars of the coney returns of the islands of Skokeholme, Middelholme and Skalmey;

Carcasses sold - 2,318 value £3 17s 3½d
Skins sold - 3,120 value £8 0s 0d"

The same record mentions food for ferrets, salt for salting rabbits, and 'repairs of a house on the island of Skalmey'. From that time, the 14th century, onwards, until 1954, rabbits were an important source of income for landowners and provided a livelihood for ferreters and trappers. The island was an ideal warren, with no ground predators and few significant bird predators.

The last man to make some income from rabbits was Reuben Codd: he caught the rabbits with dogs and ferrets, and his lurcher, Bella, was almost as well-known as her owner. His preferred method was 'lamping': a powerful, hand-held lamp was used to find the rabbits and the dog did the rest. On one night, between them, they caught 190 rabbits. This was during the early 1950s, and by this time Reuben was living at Martin's Haven, but he continued to keep grazing animals on Skomer.

Rabbiting came to a very abrupt end in 1954, when the rabbit disease myxomatosis reached Pembrokeshire and Skomer. By the end of the following year, Gillham (1965) estimated that only 20 animals had survived. This is probably not a credible estimate, and it is sufficient just to say that there were very few survivors. However, by 1959 numbers had increased again, to perhaps two thirds of the previous maximum of 15,000. Large numbers of rabbits died in the very harsh winter of 1962/3 when 2500-3000 carcases were seen and perhaps 20-25% of the population was lost, but numbers had quickly built up again by late summer 1963 (Saunders 1965). There was a further outbreak of myxomatosis in 1965, and in the following year there were striking vegetation changes, chiefly the lush growth of grasses in the central fields and displays of flowering plants which were usually absent or very local (Saunders 1967). Between 1967 and 2006 there were a few notable outbreaks and occasional years when myxomatosis was not recorded. Over the winter 2006/7 an extremely virulent outbreak killed most of the rabbits. An extract from the annual report for 2007: '*It was estimated that only about 5% of the population remained, with a mean of 1.66 per hectare being counted across the plots (compared to 40.8 per hectare in 2006). The centre of the island was almost completely devoid of Rabbits, though a number of animals were still evident on the west coast and Neck. Later in the season, small numbers began to appear at North Haven and around the Farm, but counts at study plots remained consistently low throughout. The disease remained persistent throughout the season.*'(Skomer annual report 2007) Myxomatosis has been recorded at low levels during most years since 2007.

Rabbit viral haemorrhagic disease (RVHD) first appeared on Skomer in 1995, followed by outbreaks in 1996 and 1997. It affected mainly the young rabbits, and blood analysis revealed that c. 70% of the rabbits had immunity.

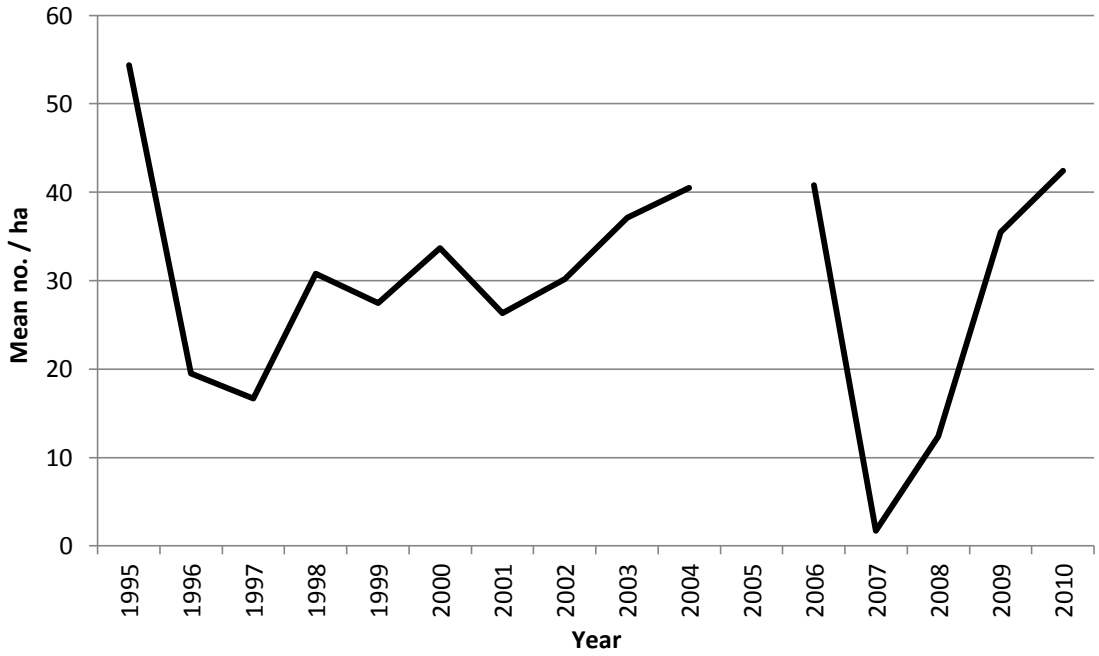

FIG 16 Mean rabbit density (nos. / ha) 1995-2010

Monthly rabbit density has been recorded in study plots at South Plateau, Wick Grassland and Calves Park / Shearing Hays since 1995. This provides an excellent account of changes in the population over this period. The dip in rabbit numbers between 1995 and 1997 was due to outbreaks of rabbit viral haemorrhagic disease, while the huge crash in 2007 was the consequence of a particularly virulent outbreak of myxomatosis.

Prior to 1954, rabbits were exploited for meat and skins, and they were also controlled in the main central fields during the peak agricultural episodes on the island. There is little useful evidence, apart from records of the numbers of animals taken, to help us understand the status of the population during these earlier periods. Since the first outbreak of myxomatosis in 1954, the population has followed a typical boom and bust cycle. Experience on Skomer has shown us that once the population reaches extremely high levels it becomes vulnerable to disease and even, occasionally, to severe winter weather. The most pressing question must be, will this pattern continue?

There is a significant volume of literature on the impact of rabbits on vegetation. Some of the most useful and relevant stems from the 6 years that Mary Gillham spent on Skokholm during the early 1950s. Taken together, the literature confirms the obvious: rabbits are preferential grazers, and their impact varies from plant species to species.

- There are some species, for example heather *Calluna vulgaris*, that, because they are so palatable, are the least resistant and least likely to survive grazing by rabbits. These species are either absent, restricted to occasional isolated areas where rabbits cannot graze, or in serious decline.

- Other species, for example the grasses red fescue *Festuca rubra* and common bent *Agrostis capilliaris,* are palatable and favoured by rabbits. As a consequence they are severely suppressed but not completely eliminated. Under extreme grazing pressure these plants develop into a prostate or creeping form, which is an excellent strategy for avoiding large herbivores, but less effective when challenged by rabbits. Nevertheless, these species do somehow survive and can deliver vigorous displays following crashes in the rabbit population. I also include Yorkshire fog in this category: it is perhaps not severely suppressed, but it is kept in check and sometimes prevented from flowering. Yorkshire fog, according to the literature, is unpalatable to rabbits because of the dense felt of hairs on the leaves and acrid sap, but, whatever happens elsewhere, the rabbits on Skomer eat Yorkshire fog. This occurs mainly in areas, and at times, when there is nothing much else for them to eat.

- Most of the species that are now abundant and dominant - the species that define the Skomer landscape - fall into a third category: species that are almost completely unpalatable and ignored by rabbits, for example, wood sage, bracken, bluebells (only the flowers are occasionally eaten) and red campion.

RABBIT CONTROL

Rabbits (*Oryctolagus cuniculus*) *have been nominated as among '100 of the world's worst' invaders in recognition of their extensive damage to biodiversity and difficulty to eradicate.* (Global Invasive Species Database 2009)

Almost every new generation of reserve mangers, sooner or later, come to the conclusion that rabbits should be eliminated, or at least controlled, because of their impact on the vegetation. I wonder if these attitudes are formed and fuelled by the idea that the vegetation on Skomer is somehow inferior to that on the mainland. Also, many of us engaged in nature conservation are by disposition preservationists and intuitively feel that we must not allow anything to change or to be lost. Efforts made over the years to maintain open grassland in the central fields and to prevent the decline of heath are testament to our attitudes. There is a long history of speculation concerning the potential impact that eliminating rabbits would have on the vegetation and, of course, on the bird populations. We have a sound body of evidence generated by the rabbit exclosures which, at

one time or another, have occupied examples of most of the main vegetation communities on Skomer. The fine detail of change within the exclosures has been recorded, but it is the more obvious gross changes that are most relevant to this discussion.

The rabbit control/eradication debate has been visited by people representing a wide range of human values and ethical positions. Roscoe Howells in his book about Skomer, 'Cliffs of Freedom,' includes an interesting argument in favour of rabbit control. He clearly regards himself as farmer, or at least an advocate of farming interests, but he was also a religious man and something of a 'dominionist', a doctrine that he often refers to in his books:

'Much of the talk, of course, was on the lines of upsetting the balance of nature. Which was just plain humbug. For God gave man 'dominion over all'. And it is clearly evident that rabbits are not indispensable because this country managed well enough without them before they were introduced. They were not indigenous to these islands, so the balance of nature does not enter into it. And the only point in wanting to maintain a rabbit population after their introduction would be if they proved of any use. Which they haven't.'

This is not an uncommon opinion, though few resort to dominionism to support their cause. Most often, people claim that rabbits are not a native British species and therefore cannot be regarded as a natural component of any British ecosystem, so they should be eliminated. The counter argument is that rabbits have been on Skomer since the 12th century, so they have naturalised and become a legitimate component of the island ecosystem. This simple argument cannot be resolved: both sides are adopting something close to ethical positions which have rather more to do with belief than science or logic. This is, perhaps, one of the reasons why the debate remains unresolved and why rabbit control on Skomer has most often been experimental.

Before pursuing this argument any further we need to consider the most pressing practical question: could we, if we wanted to, actually exterminate the rabbits? Ronald Lockley used Cyanogas (calcium cyanide), a powder which produces hydrocyanic acid when exposed to moisture, in an attempt to exterminate the rabbits on Skokholm. Between 1938 and 1940 he managed to reduce the population to c. 400, with the surviving animals mainly in cliff and scree areas, but when control ceased the rabbit population recovered very quickly (Lockley 1947). Today there are a variety of different poisons available, for example, magnesium phosphide, sodium fluoroacetate, sodium cyanide, aluminum phosphide and more. Evidence suggests that it may be technically possible to eradicate the rabbits. There are many examples, mainly from New Zealand and Australia, of successful eradication programmes:

'Rabbit control methods are becoming increasingly efficient, and rabbits have been eradicated, by one method or another, from at least 87 islands'. (Flux 1993)

'Worldwide, rabbits have been introduced to over 800 islands with devastating impacts. There have been at least 48 attempts to eradicate them, with about a five percent failure rate, but even on small islands eradicating them is very difficult and often requires a combination of techniques' (Flux and Fullager 1992).

Although technically possible, the use of poisoned bait to control rabbits is currently illegal in the UK. Even if poisoned bait could be used legally on Skomer, there would be a risk, albeit a small risk, that the small mammal populations, certainly the mice and voles, would also be exterminated. There is no information on the effect of poisoned bait on shrews. It might, in theory, be possible to establish secure captive populations before using poison, but we could not guarantee its success, so could we ever justify the risk regardless of how small it might be?

Control using various gasses in closed burrows is legal. However, the method is not suitable for use on Skomer. It requires that all the burrows in an area are located, a tablet or powder is placed in each burrow entrance, the burrows are then blocked with earth. The gas released when these substances come in contact with moist soil permeates through the burrows and kills everything, even the invertebrates, inside. Taking into consideration the hundreds of thousands of sea bird burrows often used by rabbits in the winter, the impossible task of finding and treating all the burrows, the damage to burrows both directly from stopping and indirectly by trampling, the prospect becomes unthinkable. Even if it were possible to deal with the rabbits in burrows, we would encounter the same problem that led to the failure of this method on Skokholm. Large numbers of rabbits occupy the boulder strewn slopes, particularly along the south and west coasts of Skomer: these areas cannot be gassed.

The more traditional means of control - shooting, netting, ferreting, lamping and trapping - are all very labour intensive and, consequently, extremely expensive. Control of any kind is controversial, and Skomer is a very public place. If a decision was made to 'manage' the rabbits, the work would have to be carried out during the winter closed period. If the decision was to completely eliminate the rabbits, the only time when this might be possible would be immediately following another huge crash in the population. Nothing is impossible. Given the will and almost unlimited resources rabbit eradication could probably be achieved, but what would we gain?

THE IMPACT OF RABBITS ON SKOMER.

NEGATIVE IMPACT OF RABBITS:

The specific impact of rabbits on the vegetation is discussed elsewhere. Rabbits have eaten most of what they can eat, and this has been going on at various intensities for at least 800 years. In all probability, some plant species have become extinct and more may become extinct in the future. For example, almost regardless of any future management intervention, the only heath community likely to survive on Skomer will be 'captive' within exclosures.

- All the plant communities on Skomer have been suppressed, or highly modified, by the rabbits.

- Species that are not palatable to rabbits have come to dominate many of the communities, for example, wood sage is now rampant in what used to be grassland.

- There are records of soil erosion and damage to seabird burrows in some of the more exposed, free-draining areas as a consequence of rabbit grazing. Between 1979 and 1988, four exclosures were established on South Plateau to examine the pattern of vegetation that would emerge if rabbits were eliminated from this area. There was a very significant increase in peat or soil humus in all the exclosures: peat in the most exposed western exclosures and humus in the relatively sheltered east. Outside the exclosures, 50 cm marker pegs were driven into the soil. A few years later the pegs were found on the surface, and close examination revealed that the level of the soil had decreased relative to the underlying rock (Bellamy 1992). Bellamy also looked at other areas along the exposed west coast and observed near Skomer Head, *'a very large set of burrows, which in the early 1970s housed a colony of around 50 pairs of shearwaters, had completely disappeared.'* (Bellamy 1992)

- Then there is the nightmare scenario. Many people have suggested that each time the rabbit population 'booms' the damage that occurs to the vegetation has a long term and cumulative impact. It would be unwise to ignore the theory of 'island biogeography'. The theory builds on the first principles of population ecology and genetics to explain how

distance and area combine to regulate the balance between immigration and extinction in island populations (MacArthur & Wilson 2001). Expressed in simpler language, the smaller and more isolated an island, the more likely it is for species to become extinct. On the mainland, localised extinctions of species are not necessarily a disaster if there are physical links with areas of habitat where the same species has survived. These species can re-colonise the area, if the local factors which led to the original extinction are brought under control. This is not true of isolated small islands. When a species becomes extinct, re-colonisation may never occur without artificial re-introduction. The cumulative impact of the rabbit 'booms' could potentially, over time, dramatically reduce species diversity on Skomer. This would not only be restricted to plants but could include other species - invertebrates in particular - which depend on the quality of the vegetation.

POSITIVE IMPACT OF RABBITS

- We know that the most important of all features on Skomer, the seabird populations and particularly the Manx shearwaters, have thrived in the presence of rabbits and their impact on the vegetation. *'Rabbits and puffins occur together in many places, and rabbits start burrows in places where puffins have difficulty in getting through the turf. These short burrows are then taken over by puffins.'* (Harris 1984) Could this also be true for Manx shearwaters, and even if it is true is it in any way a significant factor?

- The maintenance of a short, open sward, interspersed with patches of bare ground, is good for some invertebrates and their predators, including chough and wheatears.

- Rabbits prevent rank or tall vegetation developing around the puffin colonies. On the island of Craigleith in the Firth of Forth, puffin numbers declined from 28,000 burrows in 1999 to only 14,000 in 2003. This happened because of a dramatic increase of tree mallow, forming dense stands in the area once occupied by puffins. Puffins in nearby colonies, in the absence of tree mallow, have continued to expand (CEH 2005, Harris et. al. 2003). Tree mallow, particularly the young plants, cannot tolerate rabbit grazing. The more significant populations of tree mallow on Skomer are on the rabbit-free, off-lying rocks (the Mew and Garland Stones) with occasional plants on the south side of the Neck. Around 20 plants appeared on the puffin slopes around Amy's Reach following the 2005/6 outbreak of myxomatosis. The bird-fertilised soils around the coast on Skomer provide ideal habitat for mallow, and no doubt in the absence of rabbits it would thrive. Tree mallow is just one tall species, and there are many others that could occupy the puffin colonies. During the early 1980s we were concerned about the impact of bracken on puffins. Observations at the puffin colony on the south east corner of the isthmus led to the conclusion that puffins continued to nest in burrows that had been established before the spread of bracken but that young birds were less likely to prospect for burrows in dense bracken. Our assumption was that the youngsters were too nervous to remain in areas where they were out of sight of other puffins. Once the bracken was cleared, prospecting puffins were no longer deterred. These assumptions arose from casual observations, and we must be careful and not jump to the wrong conclusion. However, we must also be cautious as there is enough evidence to suggest that puffins and tall vegetation don't mix. This should be a topic for further research.

- Rabbits can provide an important source of food for the predatory birds on Skomer, thereby diverting their attention from the seabirds.

- On Skomer the plant communities, and all the associated fauna, have been suppressed or highly modified by the rabbits. Yes, this same statement is given in the 'negative impact' section, but it is also included here because the way in which we perceive and value the vegetation on Skomer is unavoidably subjective. Perhaps we need to think about those aspects of Skomer that both define the island and give enormous pleasure to human observers: the extensive, colourful and spectacular drifts of sea campion, mayweed, thrift and bluebells. These are the positive outcomes delivered by rabbits selectively grazing the vegetation. We cannot be certain about the alternative - an island without rabbits or any other grazing pressure - but we can make reasonably sound assumptions based on experience from so many exclosures. The exposed coastal areas will rapidly develop into a dense fescue mattress with very few other species. Most of the central areas, where soils are deeper, fertile and reasonably free draining, will become completely covered in brambles within a couple of decades. After that, scrub might increase, and this may, over an extremely long period of time, become scrubby woodland. The predicted bramble infestation is based on direct experience from exclosures in North Valley, while the woodland is conjecture. Whatever this future vegetation might become, there is no guarantee that it will be good for shearwaters or other seabirds.

Photo 68 Bramble inside the rabbit exclosure in North Valley, April 2013

IMPACT OF RABBITS DISCUSSION

It is important that we recognise the impact that rabbits have had on Skomer. They have 'naturalised' and have been part of the island ecosystem for a very long time. Following their initial escape into the wild, rabbits adapted their behaviour in order to survive in those new and alien habitats, but, equally, the habitats also changed to accommodate the rabbits. The entire ecosystem and its dependent species changed: some species were lost or suppressed, but others were given very significant advantages. Skomer is not unique in this respect. Elsewhere the positive impact of rabbits on other species became a very serious issue following myxomatosis. The best known example in British conservation was the extinction of the large blue butterfly in 1979. The recovery of the rabbit population resulted in the restoration of optimum habitat for the butterflies and this made reintroductions possible (Lever 2009). We do not have, and will probably never have, a complete understanding of the complexities, the interdependencies, or even the simplest relationships, between the different species that now occupy Skomer, so there is no point in excessive speculation about the detail of what would be lost and what could be gained. If the rabbits were removed, the island would probably be transformed into a species-poor shadow of the mainland coast, and much of what we have come to value so highly about Skomer could be lost.

There is another significant issue that must be considered - the lack of predation. There are no ground predators, and it is unlikely that bird predators will ever have any significant impact. People used to be the key predator, certainly from the time of introduction to the cessation of rabbit harvesting, and, in place of predators, rabbits have been controlled by disease and extreme weather. Both have been discussed previously, but we need to recognise that they are not factors that we can, or would want to, rely on. Both are unpredictable and unreliable. Does climate change point to warmer winters, and will the rabbits become less vulnerable to myxamatosis? There are examples of populations of herbivores living without predation. The Oostvardensplassen in the Netherlands is an interesting example. Initially there was an intention that the populations of herbivores (heck cattle, konik ponies and red deer) would be entirely self-regulating. However, animals dying of starvation was not socially acceptable in the Netherlands and so now, each year, those animals considered incapable of surviving the winter are shot. There is a danger that this discussion will become more and more speculative, but the important point is that we recognise the need to keep the rabbit population under surveillance and perhaps, in the future, accept a need for management.

The next question is perhaps the most difficult to answer. Do we regard rabbits as alien invaders or treat them a naturalised or 'new natural' species? The answer depends entirely on our personal perspective. Some people will always argue that rabbits are not native to Britain: they were introduced by the Normans and, therefore, can never be regarded as a natural factor. Others will claim that rabbits have been here for a very long time - such a long time that we generally speak of 'wild' rabbits. They have become naturalised and very much an integral part of today's island ecosystem.

If we chose to regard rabbits as the 'new natural' and accept their position as an integral component of the island ecosystem then all the significant factors that currently impact on the vegetation could be regarded as natural. Sprugel (1990) suggested that: *'One must recognise that there are often several communities that could be the 'natural' vegetation for any given time'.* **So, on Skomer we could celebrate the very special, dynamic and ever-changing vegetation, and accept as 'natural' whatever nature delivers at any given time.**

INTRODUCTIONS AND BIO-SECURITY

In addition to rabbits, there is one other factor with the potential to affect most of the vegetation on Skomer. People have introduced species to Skomer for as long as there have been people on Skomer. It will probably never be possible to differentiate between the species that are naturally native and those that were introduced at some time by people. The early inhabitants (post Ice Age) would have had animals and probably grown crops. Rabbits were deliberately introduced sometime in the 12th century, but when did the Skomer vole and other small mammals arrive? During the farming heyday there must have been considerable opportunity for the accidental introduction of species, and some species have been deliberately introduced. Just a few minutes walking around the farm will confirm this: fuchsias, narcissi and blackcurrants are all survivors of garden introductions. Sadd (1947) describes the consequences of a lawn which was laid in the farmyard some twelve months before his visit. He discovered perennial rye grass *Lolium perenne*, crested dog's-tail *Cynosurus cristatus* and corn spurrey *Spergula arvensis,* and noted that none of these species had been recorded before the new lawn was seeded. Even since the island became an NNR there have been many deliberate introductions, including willow, Monterey pine, blackthorn and privet. In 1967 and 1968 burr reed *Sparganium* and bulrush *Typha latifolia* were planted at North Pond, *'because the pond was deficient in plant life'.*

DISCUSSION - SPECIFIC PLANT COMMUNITIES

MARITIME CLIFF AND CREVICE COMMUNITY

The cliff and crevice communities exist in the absence of any human intervention, so there is nothing that we need to do and nothing that we can do. Its composition, structure and distribution are the consequences of natural processes and the influence of natural factors. There can be little useful purpose in setting performance indicators or monitoring projects, but it is important that long-term surveillance is developed.

SEA CLIFF GRASSLANDS

For the past 15 years the objective and associated performance indicators for the coastal grasslands have been influenced by the legal status of the feature and the JNCC generic guidance. Each year the feature was monitored and the results reported in the annual report. In addition to the extent of the grassland, which was identified as an attribute, but not recorded, four attributes were used as the basis for monitoring:

- The percentage of the sward below 'ankle height'
- The presence of thrift, red fescue, sea campion and squill
- An upper limit of 33% for Yorkshire fog
- An upper limit of 25% for bracken and scrub

The JNCC Common Standards guidance for the selection of performance indicators for this community states: *'For grazed grassland the sward height should ideally be kept to less than 10cm, especially at sites important for chough'* (JNCC 2004). The Skomer interpretation - 'ankle height'- is a good approximation of this. However, the application of generic guidance which does not take account of local conditions has no value or meaning. On the mainland, in ideal circumstances, the grazing levels can be manipulated to deliver the required sward height, and this is one of the reasons why setting a limit is recommended. On Skomer the height of the sward cannot be managed; it will vary according to the size of the rabbit population and, to a lesser extent, rainfall. When the rabbit population crashes the sward height can increase very dramatically and certainly exceed ankle height. If this happens, should we assume that the feature is unfavourable? Or should we regard these very occasional interludes as extremely favourable periods when the vegetation can, even if only to a limited extent, recover or rejuvenate? The species composition of these dynamic communities on Skomer is unpredictable, extremely variable and completely unmanageable. Therefore, specifying a number of desirable species that should be present, or applying an upper limit for cover by less desirable species, makes little if any sense. Squill in particular should not have been included. On the mainland, squill is an important component of this community, but on Skomer it has a very restricted distribution. It is vital to recognise that the communities on mainland cliffs, which influenced the development of the JNCC standards, do not exist in the same form on Skomer.

JNCC Common Standards contain a pertinent statement: *'There is no reference to sea bird cliff communities (MC6 & MC7), since apart from occasional stands of Lavatera arborea, they are of limited botanical interest. They are also very unstable and ephemeral, often with a cyclical nature depending on the degree seabird activity.'* MC6 is the highly fertilised version of MC1 and possibly MC8. It is dismissed by JNCC because of *'limited botanical interest'*. I struggle to understand this. How can a community that is the consequence of the impact of an entirely natural factor be less interesting than the same community in the absence of that factor?

On Skomer, all the maritime communities are, to some extent, ephemeral, although not necessarily cyclical. So, can we assume that they all have 'limited botanical interest'? In the past, Skomer was described by a notable maritime vegetation expert as a 'bird slum', simply because it did not match his expectation - his bench-mark - which was derived from mainland experience. Rodwell (2008) takes a different view in this extract from his report on the island vegetation:
'The poor fit to the NVC of some of the vegetation types described from the islands may be partly related to differences in survey methodology but it is also a reflection of their isolation and the particular factors at play there. Compared with neighbouring stretches of mainland coast, to be seen, for example, on St David's Head, certain vegetation types look more species-poor, sometimes lacking plants that are constant in or characteristic of the published definitions. Such particularities ought to be a cause for celebrating local distinctiveness, rather than a source of disappointment, either with the plant communities of the island themselves (that they are not 'good examples') or with the adequacy of the NVC (that it 'doesn't work' on the islands).'

If the factors which influence a feature cannot be controlled, and this is not uncommon, then we cannot manage the feature. This implies that there is little or no point, in the absence of legislation which defines an obligation, in specifying a desired stable state for the feature. On Skomer, the maritime grasslands are given to quite extreme variation as a consequence of a number of different and uncontrollable factors. Most, we can argue, are entirely natural, for example, enrichment from bird droppings, storms and extreme weather conditions. Rabbit grazing is by far the most important factor. Earlier, I presented the case that rabbits on Skomer are best regarded as 'naturalised'. I do not believe that we have any choice, and, if we accept rabbits as the 'new natural', then their impact on the vegetation must also be regarded as acceptable. This means that whatever the condition of the community, providing there are no additional anthropogenic factors, it should be considered as being favourable. This also implies that there is no point in setting limits or monitoring, but a robust surveillance programme will be essential.

Maritime and Wet Heath

In 1969, 8% (23.6 ha) of Skomer was covered in heath, but by 2008 this had fallen to 1% (3.1 ha). Heath will inevitably continue to decline unless the negative factors can be brought under control. The key factor, rabbit grazing, can only be controlled within the exclosures, and even then to a very limited extent. We know that, immediately following the removal of rabbits, heath begins to recover. However, in most exclosures other species, for example, grasses and brambles, can occasionally out-compete the heather. This happens for two reasons: soil fertility and the complete absence of selective grazing.

Heath will only thrive when it can out-compete other species. It gains a competitive edge because of its ability to survive in impoverished or infertile areas. When soil fertility increases, heather loses this edge, but, even under these circumstances, providing light or sustainable levels of grazing are maintained, heath can dominate. Animals will selectively feed on the more palatable and competitive species before turning to heather. The reintroduction of domestic grazing animals is not an option, so the only way in which heath might be maintained would require a substantial reduction in rabbit numbers, and this would have to be maintained.

Each time the rabbit population crashes, there follows a year or so when heath begins to recover, even to the extent of new plants growing from seed. Unfortunately, this fresh, tender young growth is extremely attractive to a recovering rabbit population. Over the longer term, the only consequence of these intermittent episodes when the rabbit population is very low is that the inevitable decline, and eventual loss, of heath is slowed down.

I began the description of heath with photographs from Ramsey and St David's. It is important to remind ourselves what good quality heath looks like, and also to appreciate that this will not happen on Skomer. Even if it were remotely possible to maintain the rabbit population at a low and stable level, the best that we could expect would be an impoverished, species-poor community.

For the past 15 years, the heath inside and outside the exclosures has been monitored using a methodology developed for the extensive areas of upland and lowland heath in Britain. This method focused on a perceived need to need to record the different growth phases of heather. As heather grows larger and more woody its growth rate and form changes. The changes are described classically according to four developmental phases: pioneer, building, mature and degenerate. The younger growth phases are much more palatable to domestic animals and grouse than the leggy, tough, degenerate growth.

'There was an encouraging increase in pioneer heather in 2009 which has not been repeated in 2010. Bracken was removed from this exclosure several times this season. The Bull Hole East exclosure clearly shows a massive increase in mature heather and a decrease in building. This might be a sampling error – either the randomness of quadrats or more likely due to the subjective nature of classifying between building and mature heather types which gets harder towards the end of the building phase.' (Skomer annual report 2009)

This is an extremely laborious and tedious procedure which, on Skomer, delivered ambiguous results. We must question the validity of taking a methodology that was designed to monitor vast grouse moors and applying it on Skomer. All that we really needed to know was that the heather cover was stable, increasing or decreasing. A simple sketch map or photograph would have been adequate.

Acid Grassland and Bracken

Photo 69 Summer bracken

Any decision about the future of bracken on Skomer must begin by taking into account our ability to effectively manage this species. Experience elsewhere points to Asulam as probably the most efficient means of control, but, for now, Asulam cannot be used on Skomer. ULVA spraying is not permitted and alternative methods of application pose a high and unacceptable risk to other species, particularly the lichens, which are a protected feature on Skomer. The most effective means of control is repeated annual mechanical cutting. With the exception of the central fields, mechanical cutting can never be an option because of the burrowing shearwaters and puffins. Hand cutting with scythes or brush-cutters is acceptable and extremely effective in and around the puffin colonies, and there is no doubt that this should be continued.

The obvious question must be, what has 30 to 40 years of bracken control in these fields delivered, and what can we expect in the future? There has been limited success in the central fields, but only in the sense that the advance of bracken has been slowed down. The resulting sward is extremely poor, dominated by wood sage and other unpalatable species. There are very occasional periods, following a crash in the rabbit population, when other species have a very brief respite, but there has been an inevitable decline in species diversity. The traditional management that would be required to restore species-rich acid grassland is almost certainly impossible on Skomer, and the wildlife benefits would be insignificant and short-lived. It could be argued that the open fields are an important landscape feature, a reference to Skomer's past. They speak of the cultural heritage, but the messages are quite obscure. This was originally arable land, but there is virtually nothing, apart from the walls, remaining as testament to that era. In any case, the field systems, particularly the walls, will be exposed and visible from the end of September through to June each year, even if they are completely invaded by dense bracken. West Meadow, the field immediately east of the farm buildings, is now one of the best bluebell areas on the island. This was a potato field in 1947, and was in exactly the same condition as both Calves Park and Shearing Hays at that time. Since 1990, bluebells have begun to follow the invading bracken in Calves Park, providing further evidence to suggest that, if bracken were allowed to invade, there is a very good chance this could become a bluebell field.

Photo 70 Mowing Calves Park in 1980

CONCLUSION

We have little or no choice when preparing objectives for the important seabird populations: they are features of the SPA or SSSI, and there is a legal obligation to protect them. This means that we are obliged to define what we want to achieve for these populations, and our objectives are expressed in terms of minimum population size, survival rates, productivity, etc. This approach is usually referred to as 'management by defining outcomes'. There is no need to adopt this approach when considering the vegetation on Skomer. There are only two SSSI features: the cliff and crevice vegetation and the coastal grasslands. The status of both communities as features is rather dubious, and at some time it should be reviewed. The remaining plant communities do not have legal recognition, and this provides some freedom when making decisions.

There is an increasingly popular view that there is a need to move away from an approach to nature conservation that is almost entirely based on achieving defined outcomes. Although it will not be possible to recreate wilderness, it will be possible in some circumstances, and I believe that Skomer is one of these places, to adopt an approach that enables natural processes. The outcomes may not always be predictable, at least in terms of the detail, and we would have to be content with whatever nature delivers.

George Peterken (1993) developed the concept of 'natural' in the context of nature conservation management. He identified 3 varieties of naturalness, two of which are relevant to this discussion. He described 'original naturalness' as the state that existed before man became a significant ecological factor and 'future naturalness' as the state that would develop if man's influence were completely and permanently removed. Is 'original naturalness' something that we should attempt to recreate? There are many people who appear to hold this view. Some of the most often used words in the nature conservation vocabulary are: reintroduce, restore, recreate and (more recently) re-wild. Often there is an implied intention to recreate something that happened at some time in the past (although when is not defined). The key questions could be: when was yesterday, or, which yesterday do we want for tomorrow? We have a very limited understanding of what might have been on Skomer before people became a significant factor, and, of course, we have no means of recreating that past. Would it ever be possible to completely obliterate past human influence? Even if we could, we would probably destroy all that is now recognised as being so very special. Original naturalness is not disputed - it happened - but future naturalness is no more than a concept. It can never really happen, certainly not for as long as people populate this planet.

For over 50 years conservation management on Skomer has sought, in places, to maintain something which is representative of a time when agriculture was in decline. By this I mean the poor grassland which developed originally as the consequence of abandoning once arable land and the relict heath, another product of less intensive agriculture. This, of course, raises the obvious question: why did we believe that an approximation of something that happened between 1890 and 1960 was so important? The value of using a reference point based at some time in the past to guide future management must be challenged. Nature conservation on Skomer should be more concerned with what we require of the future, and not about recreating the past. We should rely, as far as possible on natural processes. The only condition is that we should ensure that opportunities for wildlife, particularly the seabird populations, are optimal.

The most appropriate management option for the vegetation on Skomer is minimal intervention. This implies that the only justification for management interventions would be an actual or perceived threat to the globally important populations of breeding seabirds or other legally protected features, wildlife or archaeological, on the island. The precautionary principle should be applied. In simple terms this means that actions could be taken to control the vegetation even when there is no evidence to demonstrate, beyond any doubt, that the threat is real.

With the exception of clearing bracken from puffin colonies, if further research can substantiate the need, there is little, if any, justification for bracken control for nature conservation elsewhere on Skomer.

Heath should be regarded as something that once had a place on Skomer. We must recognise that the factors that influence the community can no longer be controlled and understand that there is a high probability that, regardless of any intervention, heath will eventually be lost. We can have no certainty about the future, particularly at a time when our ability to predict future change is obscured by the uncertainty of climate change. This is the main reason for advocating a reasonably low risk approach. Heath will be maintained for as long as is reasonable within a limited number of exclosures, but there is little hope that it will survive outside. If anything (i.e. factors) significantly changes in the future, and there is an opportunity for heath, the exclosures will provide reservoirs for re-colonisation.

Nothing in the preceding paragraphs will restrict the vegetation management necessary for footpath or other infrastructure management.

It is essential that we recognise the potentially disastrous consequences of inappropriate introductions. There must be no further introductions, unless an extremely robust case can be prepared and approved. I am less certain about the propagation of species currently growing on the Island, even when these are known to be recent introductions. At very least, careful thought must be given to any activities of this kind, and approval must be granted by The Wildlife Trust of South & West Wales and Natural Resources Wales before any work commences.

Skomer has, since 1960, provided scientists and conservationists with one of the most important field laboratories in Wales. Seabird research, study and monitoring have made the most outstanding contribution to our understanding of seabird biology and ecology. These activities are of immeasurable value to conservation management, both on Skomer and elsewhere in the world. Unfortunately, there has been very little interest from academia in the vegetation. This needs to change. In the following section, I will present a case for moving from monitoring the vegetation to a more appropriate surveillance programme. This will require input from a range of specialists, botanists and ecologists. Science has much to gain from working in partnership with conservationists on Skomer

We must see Skomer through Skomer eyes, and we must not be disappointed when the vegetation does not match something that happens somewhere else on mainland cliffs, or that happened at some earlier time on Skomer. We should recognise that the vegetation on Skomer, particularly on the very exposed coasts, offers something unique and very special. This is something that should be celebrated, enjoyed, cherished and enabled. Skomer should be managed to become one of tomorrow's wild places, a future small wilderness.

OBJECTIVE FOR VEGETATION

To enable the natural development of all the plant communities on Skomer, in so far as any change is compatible with maintaining the breeding seabird populations and other legally protected features, wildlife or archaeological, on the island.

MONITORING /SURVEILLANCE

Monitoring: *'Surveillance undertaken to ensure that formulated standards are being maintained'.*

Surveillance: *'A continued programme of (biological) surveys systematically undertaken to provide a series of observations in time.' (JNCC 1988)*

Given that the objective for vegetation, in its simplest form, is to 'enable natural processes', there can be no purpose in establishing performance indicators, or monitoring. We cannot, and should not, set meaningless targets for any particular species or any manifestation of the community.

Surveillance, however, will be very important. We need to observe, record and, hopefully, understand the development of the vegetation. The SSSI features, for as long as they continue to be features, must be given specific attention. In addition, the key factors that influence the vegetation must also be recorded. The obvious factors are rabbits, soil fertility and weather. The less obvious focus for recording stems from the decision to apply a condition to the vegetation objective: changes to the vegetation will only be tolerated if they are conducive to maintaining the qualifying seabird populations and other important features. This imposes a requirement to monitor the impact of vegetation change on the seabirds and the other features that could be affected. Obviously, most of this information will be generated incidentally by monitoring the other features. But there is one instance where the need for some additional monitoring is obvious: this is the potential encroachment of bracken, or other tall vegetation, into the puffin colonies. Consideration should also be given to the potential impact of vegetation change on the shearwater population. This would need to be a long term study and would probably require the development of a project to map, or otherwise sample, changes in the distribution and density of the shearwater burrows. The impact on the island's archaeological heritage will also need careful consideration.

RECORDING PROJECTS:

Vegetation surveillance. Commission low-level, high-resolution aerial photography. In the first instance, in order to provide a baseline, there should be two flights: the first, in June, can be used to map some of the obvious spring flowering communities, and a second, in October, to map bracken and its various developmental phases. This will also reveal the areas of purple moor grass. The June flight should be repeated at 5 year intervals and the October flight every 10 years. The interval between sampling must be reviewed if there are concerns about the speed or direction of change.

Fixed point photography surveillance. Develop fixed point photography, having regard for all past photo recording projects.

Permanent vegetation quadrats.
90 fixed or permanently marked quadrats were established by Bray in 1979, and 65 of these were relocated by Wilberforce in 1997. They provide an excellent basis for developing a detailed vegetation surveillance project. The original locations were based on randomly selected locations within defined areas of vegetation. This method was entirely appropriate for the initial and repeat survey, but it requires modification for future use. The purpose of a revised surveillance programme will be to record the development of the vegetation. Therefore, it would make sense to locate quadrats in the more stable blocks of the main vegetation communities and to supplement these

with quadrats placed in areas that are most likely to change, or where there is potential for conflict with other features. It is also important that, in addition to establishing the distribution of the quadrats, the total number of quadrats is restricted to the minimum that will deliver a statistically robust sample. Thought must also be given to the detail recorded in each quadrat. Simple presence or absence of a species is probably far too crude, the measurement of cover/abundance using the Domin scale would probably be the most appropriate approach. There is also a need to decide which species and factors need to be recorded. If a sub-set of the most significant species is considered sufficient, this would both speed up the recording process and enable the work to be carried out by less expert personnel. Finally, the interval of recording must be established, although this need not be more frequently than every 10 years.

Rabbit surveillance. Continue with the existing project.

Soil fertility surveillance. Develop a simple, cost-effective methodology.

Weather recording. Investigate the value of maintaining the weather station on the island when a fully automated station is situated on Wooltack Point.

Monitor bracken encroachment into puffin colonies. Bracken should be mapped along the edges of the colonies that are likely to be invaded. Acceptable boundaries should be defined and subsequently monitored. If the puffin population continues to increase, these boundaries must be reviewed.

Inspect the ponds / dams. The ponds on the island are all artificial, and we believe that most date back to the Iron Age occupation. Since the 1960s, dams have been built, rebuilt and maintained. The dams will always be vulnerable and must be checked at reasonable intervals. This would be best carried out each year during early spring, when the cover of vegetation is at its lowest. South Pond, at the head of South Valley, has received least attention, and some thought should be given to its future. Is there any justification for restoring the dam, and would this achieve anything unless the pond bottom is scraped? Perhaps the decision will be to accept the ephemeral nature of ponds.

MANAGEMENT PROJECTS

Bracken management. In general bracken will not be controlled, there are three exceptions:

- Bracken management around the puffin colonies. This will be in response to the monitoring project.

- Bracken control to protect heritage features, these activities will be supervised by qualified archaeologists.

- Bracken control to maintain footpaths.

Heath management. There is no justification for new management exclosures. Some of the existing heath exclosures could be maintained. In addition to protecting small areas of heath, they will also fulfil a research and educational role. The collection of exclosures above Bull Hole should be replaced with a single, well-maintained exclosure which has significantly less visual impact on the landscape. Two further exclosure should be retained: the small exclosure alongside the footpath between the farm and the Garland Stone, and the large inland exclosure south of the farm. All the other exclosures should be dismantled once they cease to be rabbit-proof.

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