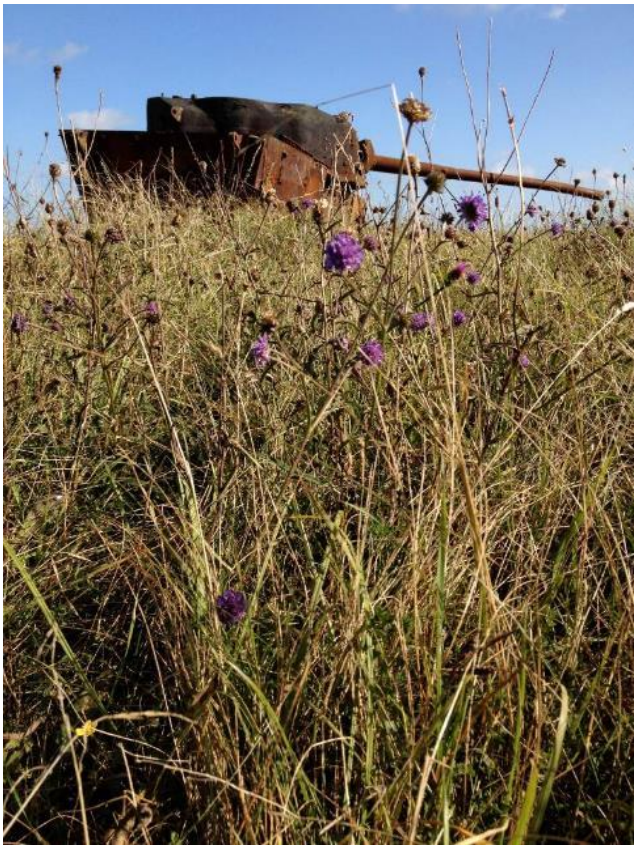
Cyfoeth Naturiol Cymru
Natural Resources Wales

Assessment of Marsh Fritillary Habitat Quality on Castlemartin Range, Pembrokeshire in 2015

Dr. Deborah Sazer

Evidence Report No. 152



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- Securing our data and information;
- Having a well resourced proactive programme of evidence work;
- Continuing to review and add to our evidence to ensure it is fit for the challenges facing us; and
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Mae britheg y gors *Euphydryas aurinia* yn rhywogaeth warchodedig Ewropeaidd Atodiad II. Mae'r glöyn byw a'i gynefinoedd yn nodweddion sylfaenol Safle o Ddiddordeb Gwyddonol Arbennig (SoDdGA) Maes Tanio Castellmartin, yn ne Sir Benfro. Fe ddarganfuwyd y feta poblogaeth yn 2003, yn rhy hwyr i'w gael ei gynnwys yn yr Ardal Cadwraeth Arbennig (ACA) Arfordir Calchfaen De-orllewin Cymru, ond wedi'i gynnwys fel nodwedd SODdGA allweddol yn y Cynllun Rheoli Craidd (CMP) ACA (CCGC 2008).

Mae britheg y gors yn byw mewn beta poblogaethau, lle gall diflannu a chytrefu clystyrau ddigwydd yn rheolaidd dros gyfnod o amser. Er mwyn cynnal y poblogaethau dros yr hir dymor mae rhwydwaith fawr o safleoedd addas yn hanfodol.

Fe gomisiynwyd yr arolwg hwn i archwilio potensial cynefin britheg y gors ar y Maes Tanio ac i bennu cyfanswm a chyflwr y cynefin sydd ar gael ar gyfer y feta poblogaethau. Roedd y safleoedd wedi eu lleoli i gyd ar Ardal Hyfforddi'r Weinyddiaeth Amddiffyn yng Nghastellmartin, sydd yn gorwedd o fewn Parc Cenedlaethol Arfordir Sir Benfro. Mae ardal yr arolwg cyfan o fewn SoDdGa Maes Tanio Castellmartin, ac mae'r rhan fwyaf ohono wedi'i gynnwys yn ACA Clogwyni Calchfaen De-orllewin Cymru.

Cafodd yr arolwg ei gynnal rhwng 28^{ain} Awst a 11^{eg} Hydref 2015. Fe gategorïwyd a mapiwyd addasrwydd y cynefin drwy ddefnyddio dulliau safonol Cyfoeth Naturiol Cymru, er bod y rhain yn cael eu diwygio i adlewyrchu'r cynefinoedd unigryw ymhle mae britheg y gors yn byw. Fe ddosbarthwyd y tir fewn i chwe chategori yn ddibynnol ar swm, taldra a ffurf llystyfiant thamaid y cythraul *Succisa pratensis*, planhigyn cynhaliol y larfa glöyn byw.

Fe aseswyd tri chant a chwe deg pum hectar o laswelltir a rhostir dichonol. Categorïwyd tua 80 hectar o gynefin yn cynnwys *Succisa,* yn Dda, Addas neu Ddichonol. Fe gofnodwyd tri deg tri hectar o gynefin mewn Cyflwr Da - 21hectar yng Ngorllewin y Maes Tanio a 12hectar yn Nwyrain y Maes Tanio.

Mae gan SODdGA Maes Tanio Castellmartin y feta poblogaeth britheg y gors a rhwydwaith cynefin fwyaf sy'n bodoli yng Nghymru. Mae'r 73hectar o gynefin mewn cyflwr Da ac yn Addas a geir yn yr arolwg hwn yn uwch na'r Statws Cyflwr Ffafriol gofynnol ar gyfer britheg y gors a'i gynefinoedd. Mae'r diffiniad ACA CMP o'r Statws Cyflwr Ffafriol (FCS) o'r 100 hectar fel Cynefin Da neu Addas (50hectar Da) yn afrealistig, a dylid ei ddiwygio, gan ei fod yn uwch na'r cyfanswm o blanhigion cynhaliol darganfuwyd ar y Maes Tanio. Mae monitro tymor hir yn hanfodol i ddiogelu beta boblogaeth britheg y gors arwyddocaol, a'i gynefin.

2. Executive Summary

The marsh fritillary *Euphydryas aurinia* is an Annex II European protected species. The butterfly and its habitats are primary features of the Castlemartin Range Special Site of Scientific Interest (SSSI) in south Pembrokeshire. The metapopulation was discovered in 2003, too late to be included in the Limestone Coast of South West Wales Special Area of Conservation (SAC), but it is included as a key SSSI feature in the SAC Core Management Plan (CMP) (CCW 2008).

Marsh fritillaries exhibit metapopulation dynamics, experiencing regular extinctions and colonisations of suitable patches over time. A large network of suitable sites is essential to maintain their populations in the long term.

This survey was commissioned to examine potential marsh fritillary habitat on the Range and to determine the total amount and condition of habitat available for the metapopulation. All survey sites were on MOD Castlemartin Training Area, which in turn lies within the Pembrokeshire Coast National Park. The entire survey area is within the Castlemartin Range SSSI, and most of it is included in the Limestone Cliffs of Southwest Wales SAC.

The survey was carried out between 28th August and 11th October 2015. Habitat suitability was categorized and mapped using standard Natural Resources Wales methods, although these were revised to reflect the unique habitats occupied by Castlemartin's marsh fritillaries. Land was classed into six categories according to the presence and amount of the butterfly's larval foodplant devil's-bit scabious *Succisa pratensis,* vegetation height and structure.

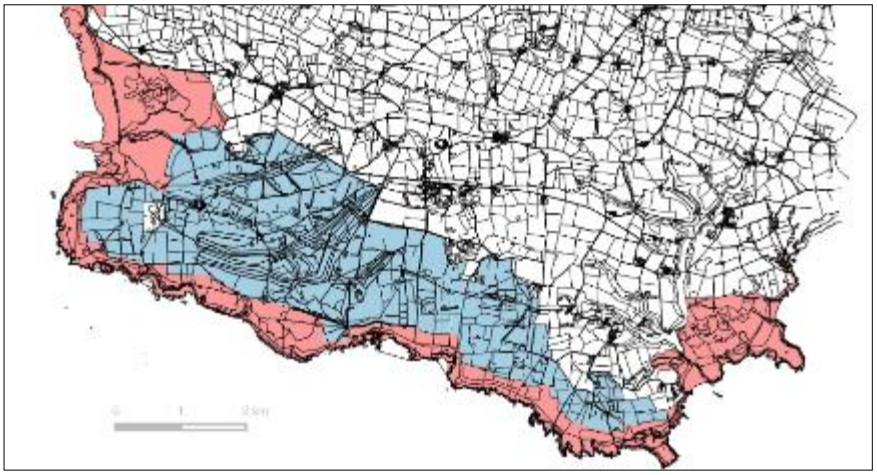
Three-hundred and sixty-five hectares of potential grassland and heathland were assessed. Nearly 80 hectares of habitat containing *Succisa* were categorised as Good, Suitable or Potential. Thirty-three ha of Good Condition habitat was recorded - 21ha on Range West and 12ha on Range East.

Castlemartin Range SSSI holds the largest extant marsh fritillary metapopulation and habitat network in Wales. The 73ha of Good and Suitable condition habitat found in this survey exceeds the minimum Favourable Condition Status (FCS) for the marsh fritillary and its habitats. The SAC CMP definition of FCS of 100ha Good or Suitable Habitat (50ha Good) is unrealistic and should be revised, as it exceeds the total amount of foodplant found on the Range. Long-term monitoring is essential to safeguard this significant marsh fritillary metapopulation and its habitat.

3. Introduction

3.1. This survey

The marsh fritillary *Euphydryas aurinia* is a European protected species, listed on Annex II of the EU Habitats & Species Directive. The marsh fritillary is a key feature of Castlemartin Range Special Site of Scientific Interest (SSSI) in south Pembrokeshire (renamed from the Castlemartin Cliffs and Dunes SSSI when it was extended to 2089ha in 2011). The butterfly's presence was only discovered by Countryside Council for Wales on Castlemartin in 2003, too late to be included in the designation of the Limestone Coast of South West Wales/Arfordir Calchfaen De Orllewin Cymru Special Area of Conservation (SAC). However, as an Annex II species, the marsh fritillary's protection is enabled through SAC designations, and it is included as a SSSI feature in the SAC Core Management Plan (CCW 2008). Castlemartin holds the largest extant marsh fritillary metapopulation, and the most extensive habitat network, not just in Pembrokeshire but probably in all of Wales.

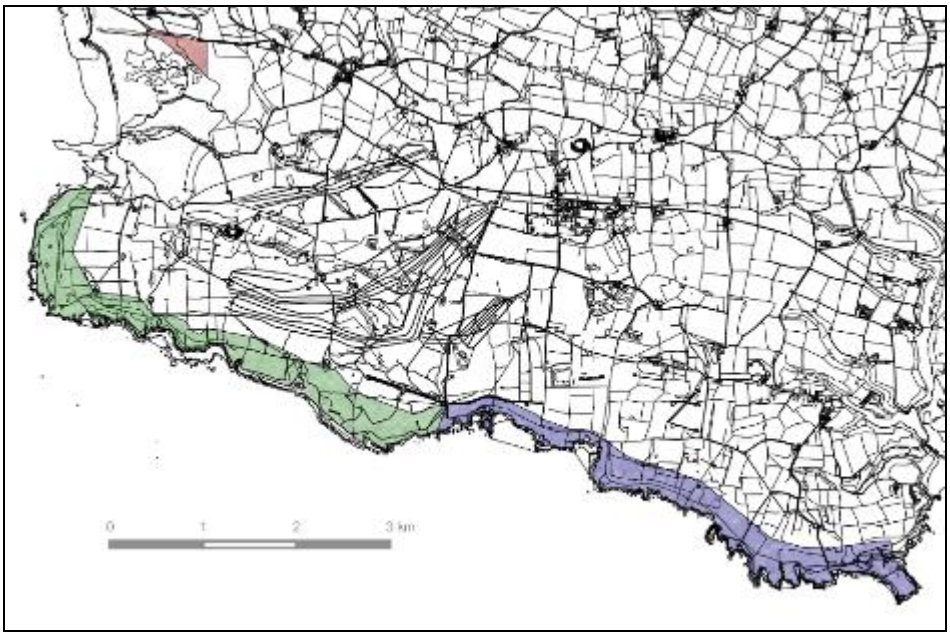


Map 1. Limestone Coast of South West Wales SAC (pink) within the Castlemartin Range SSSI (blue).

Marsh fritillaries experience regular extinctions and colonisations of suitable habitat patches over time, exhibiting classic metapopulation dynamics. Therefore, they require a large network of suitable sites to maintain their populations in the long term. This survey was commissioned to examine all potential habitat on Castlemartin Range in order to determine the total amount and condition of habitat available for the butterfly.

This project is part of Natural Resource Wales' (NRW) reporting process on Favourable Condition and Favourable Conservation Status (FCS) for SACs and SSSIs. FCS is defined as a combination of the Favourable Condition of the species and the means to ensure its secure future on a site. It is defined by a Conservation Objective that is assessed by monitoring appropriate attributes against agreed thresholds. The marsh fritillary was considered to be in Favourable Condition on Castlemartin Range in 2007 (CCW 2008).

NRW's standard method for marsh fritillary landscape quality assessment covers both the 'core' and 'functional' landscape of the marsh fritillary. The core landscape is the area within a 1km radius of recent marsh fritillary records (encompassing the typical dispersal distance of a female marsh fritillary – up to 510m). The functional landscape includes all potential habitat within a 2km radius of the core; this covers the average dispersal distance of the males – up to 1300m (Fowles, 2005). Nearly all of the functional landscape lies within Castlemartin Range, and there is a large amount of potentially suitable habitat between recorded marsh fritillary adult and larval locations across the site. Therefore this survey covered most of the 14km stretch of potential cliff-top habitat including and between the areas with recent marsh fritillary records, along with a separate area of 15.9ha at the northern end of Brownslade Burrows East, where 50 marsh fritillary larvae were recorded in 2011. In total, 365ha were surveyed.



Map 2. Survey area:
Brownslade Burrows East (red), Range West (green), Range East (blue).

The survey area lies within the MOD Castlemartin Training Area, which in turn lies within the Pembrokeshire Coast National Park (PCNP). The entire survey area is included in the Castlemartin Range SSSI and most of it is included in the Limestone Cliffs of Southwest Wales SAC (Map 1).

3.2. Castlemartin Range

Most of the marsh fritillary habitat at Castlemartin is unique for Wales. The butterfly is typically found in damp tussocky rhos pasture dominated by purple moor-grass *Molinia caerulea* or other tussocky grasses. Castlemartin Range offers a series of large, connected patches of devil's-bit scabious *Succisa pratensis*, the butterfly's larval foodplant. However, these are found in maritime and dry calcareous grassland as well as maritime and dry heath. Additionally, the *Succisa* tends to be smaller at Castlemartin than it is in most rhos pasture sites. A more typical mix of *Succisa* and *Molinia* does occur on the damp floor of former sand quarries on Brownslade

Burrows East, which is managed in particular for petalwort *Petalophyllum ralfsii,* a key SAC bryophyte species.

Except for Brownslade Burrows East, the habitat patches lie along 14km of fairly level, south-facing carboniferous limestone cliffs, 30-50m above sea level. The thin, well-drained soils warm quickly, and winter temperatures rarely fall below 0ºC (Met Office data for nearby Tenby).

The soils reflect variations in the underlying limestone sequence, as well as salt content and water levels. The coast is exposed to intense salt-spray and strong south-westerly winds, which create and maintain an open vegetation structure along the most exposed cliff tops, featuring patches of bare ground and rock exposures. *Succisa* is missing from these areas; presumably, it cannot tolerate the high salt content of the soil here. Severe winter storms can spread salt far inland - in winter 2013/14 even gorse *Ulex* sp. suffered dieback (B. Haycock, pers. comm.).

Figure 1. Maritime grassland lacking *Succisa pratensis.*

Human activity also influences habitat condition. The site has been owned by the MOD since World War 2, so it has avoided most modern intensive agricultural methods. This has protected a very large extent of unimproved grassland, heathland and other habitats. The scattered effects of military firing activity can be seen in areas of uncontrolled burns as well as scrapes, tracks, target areas and debris, including burnt-out tanks and lorries.

3.3. The marsh fritillary on Castlemartin Range

Marsh fritillaries were first recorded by NRW on Castlemartin Range in 2003, and their origins are unknown – there are occasional records from the Angle Peninsula from the 1960s and in 1980. The first organised survey in 2004 found an estimated population of 1000 spring larvae (Haycock, 2005). Since then, large numbers of adults and larvae have been recorded regularly.

3.4. Management

The cliff-top habitats of maritime grassland, dry calcareous grassland, maritime heath, dry heath and scrub are managed for a whole suite of important species e.g. 27 rare or scarce invertebrates (Knight 2008) and large numbers of breeding and passage birds. The needs of all of these species must be carefully incorporated into management planning. For example, the Limestone Coast of Southwest Wales SAC is also designated a Special Protection Area for chough *Pyrrhocorax pyrrhocorax.* The Range's 15 to 20 pairs of breeding chough (and many other species of birds and invertebrates) require open short-grazed turf in which to feed. The current extensive mixed grazing regime, in combination with the natural coastal conditions, aims to provide the right balance.

The Integrated Rural Management Plan (IRMP) (Hawkeswood 2011) and the Castlemartin Range SSSI – Consenting Protocol 2011-2016 (CCW 2011) detail the conservation management of Castlemartin Range as agreed between the Defence Infrastructure Organisation and NRW. The following details and data about Range grazing and other habitat management were provided by Paul Culyer and Jon Hudson (NRW) and MOD Deputy Training Safety Officer Steven Phillips-Harries.

For many years the Range has been extensively 'ranched' by sheep and cattle in large grazing compartments, with no or light summer grazing and higher intensity grazing in winter. Stock numbers decreased steeply and grazing patterns changed around 2003 when military activity increased. Numbers of both cattle and sheep are expected to rise in the future (S. Phillips-Harries, pers. comm).

Sheep grazing

Six thousand sheep (2011-2012 figures) winter-graze Range West from November to around Easter. Traditional 'Hafod a Hendre' transhumance over at least the last 60 years sees flocks transported to Castlemartin from their summer range on the Preseli Hills. The sheep are hefted onto different parts of the Range. They prefer the western end of Range West and the coastal strip during the day and tend to move inland at night. Two shepherds move the sheep weekly. When firing is scheduled, the sheep are moved off the coastal areas into large inland pens (away from any marsh fritillary habitat).

Over 3000 sheep winter-graze Range East, where Crickmail Down is deliberately tightly sheep-grazed for chough.

Cattle grazing

Range West: Based on 2011-2012 figures, cattle grazing peaks at 400 to 500 in August and mid-winter, with smaller numbers on parts of the site year-round.

Range East: Small numbers of cattle are on Trevallen Down year-round, with winter cattle grazing on the rest of the coastal strip.

Brownslade Burrows East is winter grazed by both cattle and sheep.

All graziers are under tenancy or grazing agreements with the MOD, and it is the responsibility of the Defence Infrastructure Organisation to ensure they adhere to the management plan.

Other management
Rabbits create and maintain turf lawns and bare ground, although numbers have declined due to rabbit haemorrhagic disease (B. Haycock pers. comm).

A scrub management plan is agreed annually with NRW. Scrub is recognised as an important habitat feature, in particular small patches dominated by ancient blackthorn *Prunus spinosa* or western gorse *Ulex gallii*. Scrub management includes removal of bramble *Rubus fruticosus*, blackthorn and bracken *Pteridium aquilinum* that encroaches onto the grassland. Some mature scrub (mostly European gorse *Ulex europaeus* and blackthorn) is broken up into smaller patches, and rides and firebreaks are created. Open bracken is accepted, as it may provide shelter for marsh fritillaries and birds, but dense bracken is discouraged. All cuttings are removed to prevent nutrient enrichment.

Figure 2. Strips cut through dense gorse.

The agreed SSSI maintenance programme is delivered by Landmarc Support Services.

Burning is discouraged as a management tool, although it may occasionally be employed to control small patches of invasive scrub. Military activity occasionally leads to uncontrolled burns, which are monitored by MOD staff (Maps 20, 21 and 22, based on maps provided by L. Houlston). While no burning is allowed by NRW in key marsh fritillary areas, larvae are occasionally killed in accidental burns caused by firing (B. Haycock, pers. comm.). In addition to directly damaging the habitat, burning can lead to an increase in available potash, which can stimulate bracken growth.

Military activity zones, such as the location of targets, trenching and disposal of waste materials, are agreed with NRW. A low level of disturbance is beneficial in creating bare ground for some plants and invertebrates.

Access
Range West is closed to the public except for occasional Pembrokeshire Coast National Park guided tours and a controlled number of climbers, surfers, surveyors and other individuals who apply to the MOD for access.

The Range East coastal path and St Govan's/Trevallen Down are open to the public on most weekends, and all of August. Visitor numbers are monitored, with an estimated 13,059 visitors passing through the St. Govan's gate in 2015 (L. Houlston, pers. comm). Access is regulated by on-site rangers.
The majority of visitors appear to visit St. Govan's Chapel and Head, although many people and dogs walk the cliff path west as far as the other access point to the coastal path at Stack Rocks carpark. The site is also extremely popular with rock-climbers.

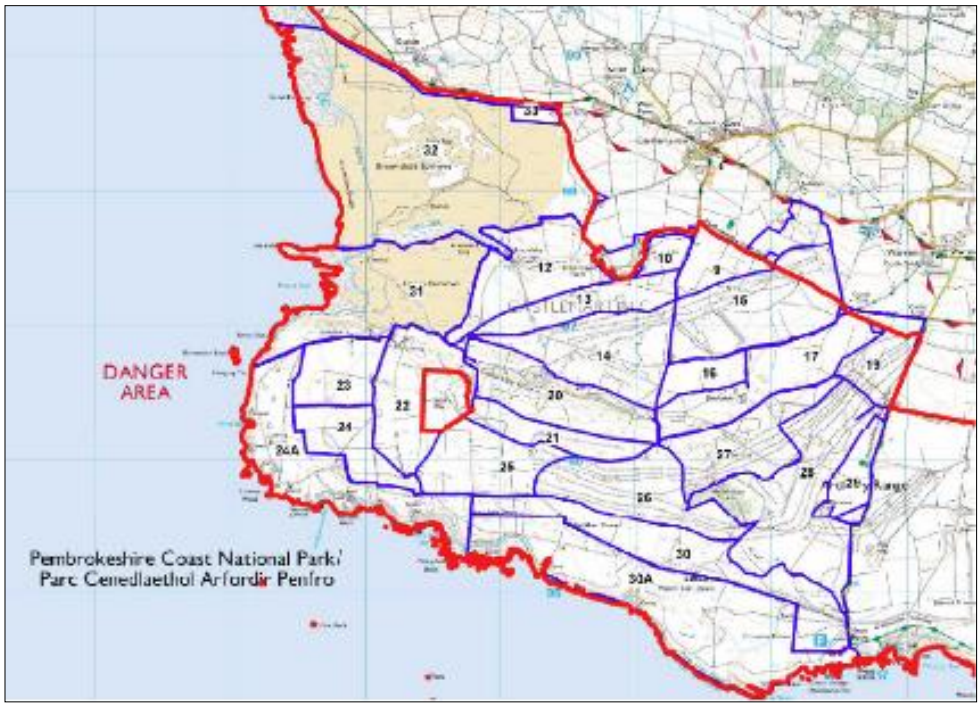
4. Methods

4.1 Maps
NRW supplied the contractor with an outline map of the survey area, identifying approximately 360 hectares of grassland and heathland along the Castlemartin coast (Map 2, above). These areas were believed to include all vegetation communities with the potential to support marsh fritillaries on the Range. NRW also provided their Phase II vegetation maps as well as Aerial Imagery and Ordnance Survey Mastermap layers under license (*© Crown copyright and database rights 2015 Ordnance Survey 100019741, © Hawlfraint y Goron a hawliau cronfa ddata 2015 Arolwg Ordnans 100019741*).

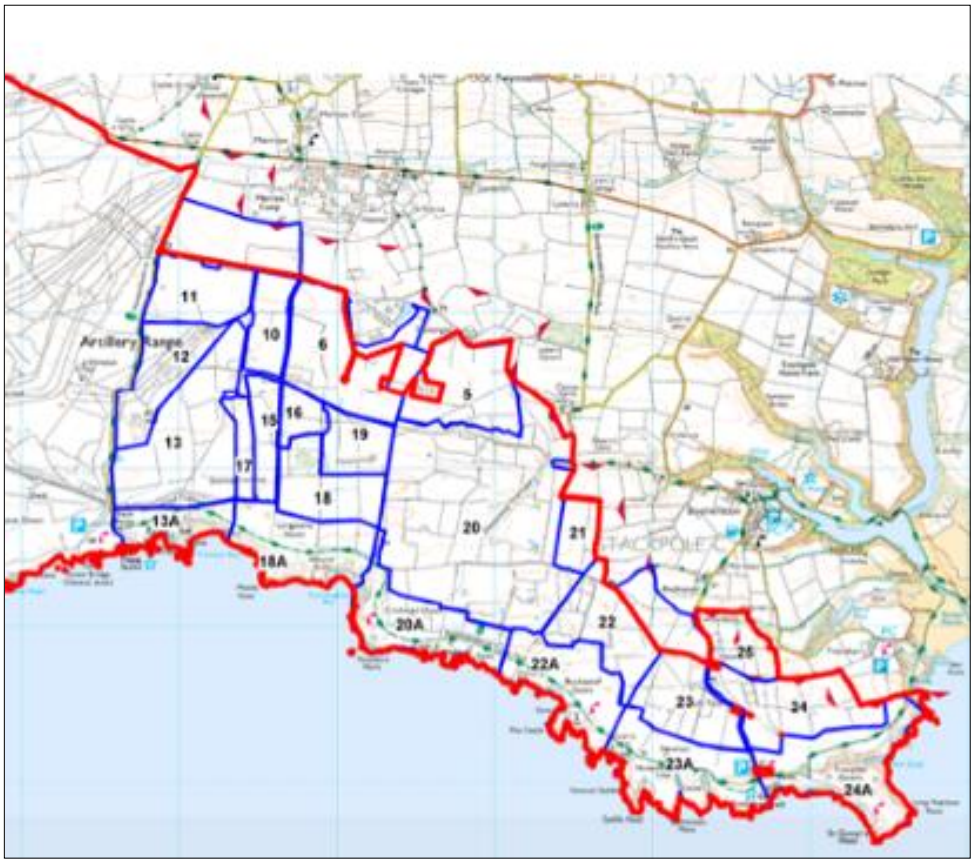
4.2 Ownership and Access
The entire site is owned and operated by the Ministry of Defence.

NRW staff facilitated an introduction to Steven Philipps-Harries, who arranged all site access. Access was only possible on weekends (from 4:00pm Friday until Sunday evening), as well as a few Fridays when no firing was scheduled. MOD, NRW and PCNP staff provided assistance and information. Due to staff illness and holidays, NRW staff were not available to meet with the surveyor on site, but Jane Hodges, David Harries, Bob Haycock and Graham Clarke led very useful site visits before and during the survey.

4.3 Field numbers
Field numbers were taken from the Castlemartin Range SSSI – Consenting Protocol 2011-2016 (CCW 2011; Maps 3 and 4). Prefixes were added as identifiers in the GIS database to differentiate between Range West ('WCM') and Range East ('ECM').



Map 3. Range West field numbers.

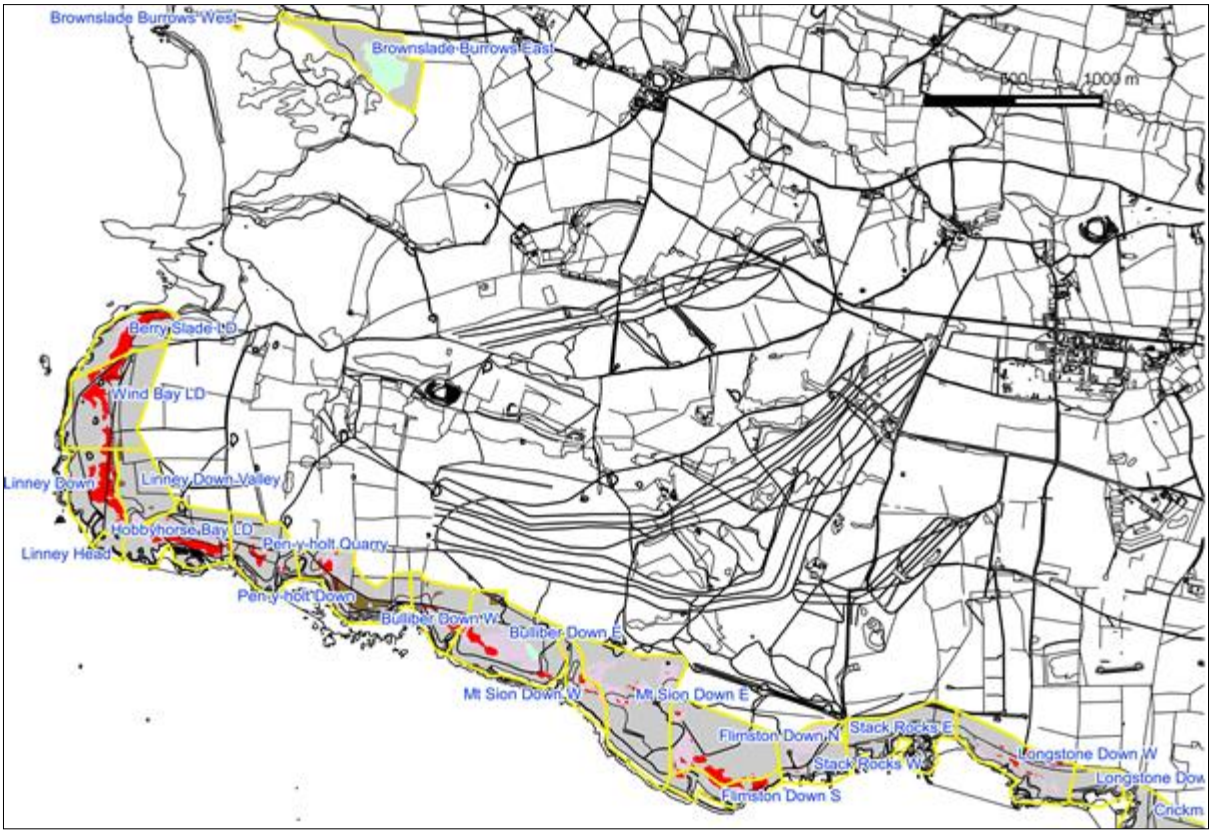


Map 4. Range East field numbers.

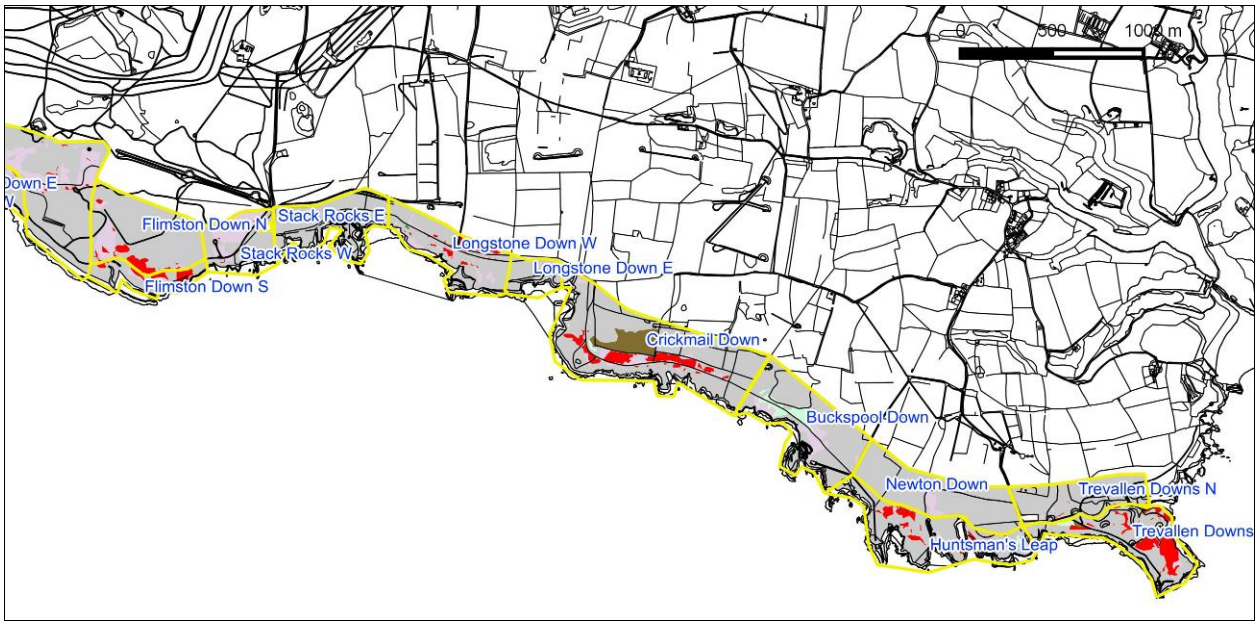
The discussion below uses 'field' names, which are based on the marsh fritillary recording zones identified in the Pembrokeshire Marsh Fritillary Survey Report 2013

(Map 5). These are smaller and more specific than the field numbers for the large grazing compartments (Maps 3 and 4).

Map 5. Pembrokeshire Marsh Fritillary Recording Group survey areas (PMFRG 2013).



Map 6. Expanded 'recording zones': Range West.



Map 7. Expanded 'recording zones': Range East.

4.4 Marsh fritillary larval webs

Larval webs were recorded in the course of the habitat surveys. There was insufficient time to do a systematic transect survey, so these are only 'casual' records. The webs were most plentiful on the first survey weekend (28th - 30th August), and declined through the survey season, with the last ones recorded on 4th October. Some exact 10-figure grid references were recorded, while others were counted within a habitat patch (6 figures). Details can be found in Appendix 1.

The lack of webs was not proof that a habitat patch was unsuitable. However, the presence of dense web populations on 28th - 30th August highlighted the varied breeding habitats that marsh fritillary use on Castlemartin Range.

4.5 Surveys

The survey was carried out on the 3-day weekend of 28th August and then four consecutive weekends from 18th September to 11th October 2015. The survey took approximately 165 survey hours (at least two surveyors on all days, with three surveyors on two weekends). The entire survey area was examined, along with a few areas of suitable habitat that lay outside the boundary.

All habitat was mapped following the standard NRW methodology outlined in Fowles 2005 (Figure 3). Land was classed into six categories, according to the presence and abundance of devil's-bit scabious. A tussocky sward structure is usually considered essential for marsh fritillary larvae, to provide shelter, hibernation and spring basking sites. Nearly all Welsh marsh fritillary populations are found in this type of habitat on damp rhos pasture.

Habitat code	Habitat Classification	Definition
GC	Good Condition	For at least 80% of sampling points, *S. pratensis* is present within a 1m radius & the vegetation height is 12 to 25 cm. Scrub (>0.5 metres tall) covers no more than 5% of the area.
SU	Suitable Undergrazed	*S. pratensis* is occasional/frequent/abundant and vegetation height is >25cms. **Or** sward height is between 12-25 cm, but scrub (>0.5 metres tall) covers > 5%.
SO	Suitable Overgrazed	Frequent/abundant *S. pratensis* but which is currently over-grazed or mown such that the sward is below 12cm on average.
SS	Suitable Sparse	Rare/occasional *S. pratensis* & vegetation height <25cm on average.
PR	Potential Rank	Scattered *S. pratensis* plants, but currently under-grazed or neglected so the sward is > 25cm on average, rank & tussocky.
NS	Not Suitable	All other habitat types, including ones that could potentially be restored for marsh fritillaries, but only with considerable resource input
NA	Not Accessed	Irrelevant to this study, as all habitat within survey area was accessed.

Figure 3. Standard NRW habitat codes (only used for Brownslade Burrows East site).

However, the Castlemartin Range marsh fritillary webs occupy several contrasting habitats, and so the standard NRW habitat categories required re-definition. The Brownslade Burrows East site was the only area with habitat similar to the typical Welsh rhos pasture and so the 'standard' habitat classification was used here.

The Core Management Plan for the Limestone Coast of Southwest Wales SAC (CCW 2008) describes the ideal marsh fritillary habitat as short lawns and anthills for larval basking, with taller tussocky grassland and sparse bracken for shelter. It aims for a vegetation height between 7 and 20cm, although it describes the coastal turf as less than 5cm in April when the spring larvae feed prior to pupation.

In this autumn survey, high concentrations of larval webs were found on three types of habitat. The first was a grassy but rarely tussocky sward with plentiful devil's-bit scabious at the 'standard' Good Condition height of 12 to 25cm (Figure 4). However, dense colonies were also seen on a second habitat type of shorter (3 to 11cm) grassy vegetation (Figure 5), and on a third habitat of short, open maritime and dry heath, where the only shelter was provided by low heather and sedges (Figure 6). Some of the sites with abundant larval webs and short swards featured numerous anthills, which provide basking sites and shelter for active larvae (Figure 7).

Figure 4. Taller ‘standard height’ Good Condition habitat.

Figure 5. Short Good Condition habitat.

Figure 6. Small larval web on short heather.

Figure 7. Anthills in medium-height turf.

An initial attempt was made to map these three habitats separately. However, it quickly became evident that this was unfeasible. Not only would it take a huge amount of time, but the three habitats frequently graded into and mixed with each other. Therefore, all three of these habitats were judged to represent Good Condition (GC), since marsh fritillaries were clearly breeding successfully on them. Suitable Overgrazed (SO) was defined as turf less than 3cm tall, as this provided no shelter at all for larvae. The standard definition for Suitable Undergrazed (SU) is turf >25cm, and Suitable Sparse (SS) is defined as turf <25cm with sparse *Succisa* - these definitions were adhered to, although most of the SS was much shorter than 25cm. Finally, there was no 'classic' Potential Rank (PR) habitat of tall, rank, tussocky sward with scattered *Succisa.* For the purposes of this survey, PR was re-defined as dense gorse and/or tall heather *Calluna vulgaris* with sparse *Succisa.* While this could be considered SU, since scrub covers more than 5%, it is a better match with the PR criterion of a long-unmanaged sward that theoretically could be restored, but only with considerable resource input. This PR was detected in places where rare *Succisa* was observed around the edges of dense scrub stands or amongst scrubby areas that had been recently cut. Undoubtedly, there is more *Succisa* in PR habitat within some, but not all, of the inaccessible tall scrub within the survey area. Figure 8 below describes the revised Castlemartin definitions.

Habitat code	Habitat Classification	Revised Habitat Definition
GC	Good Condition	Grassy or heathland vegetation between 3cm and 25cm on average, *Succisa pratensis* abundant
SU	Suitable Undergrazed	Sward height >25cm, *Succisa pratensis* occasional/frequent/abundant
SO	Suitable Overgrazed	Sward height <3cm, *Succisa pratensis* occasional/frequent/abundant

SS	Suitable Sparse	Sward height <25cm, *Succisa pratensis* occasional/rare,
PR	Potential Rank	Dense gorse, heather or other scrub with rare *Succisa pratensis*
NS	Not Suitable	No *Succisa pratensis*
NA	*Not Accessed*	*Irrelevant in this study, as all habitat within survey area was accessed.*

Figure 8. Revised habitat codes for all of Castlemartin except Brownslade Burrows East.

Due to the very large extent of habitat to be mapped, efforts were also made to streamline the standard NRW definition of 25m^2 minimum habitat patch size for mapping. Isolated patches of this size (and occasionally even smaller) were mapped. However, small neighbouring patches of SS were grouped together where they lay within an obvious block.

The final maps have been supplied with this report as a Mapinfo GIS file, and are illustrated in Maps 8, 9 and 10 (overviews) and in more detail on Maps11 to 19.

5. Results

5.1 Owners and access

The entire survey area was accessible for survey during permitted hours.

5.2 Survey results - Habitat Condition

Overview maps below: Figures 8, 9 and 10
Detailed maps below: Figures 11 to 19

Over three hundred and sixty-five hectares of heathland and grassland were assessed. Thirty-three hectares of Good Condition habitat were identified, while Suitable habitats covered nearly 40ha. Most of the Suitable habitat was Suitable Sparse (32ha). The newly defined scrubby Potential Rank habitat covered 6.7ha. Together, there were 79.6ha of Good, Suitable and Potential marsh fritillary habitat (Table 1, Figures 9 and 10, overview Maps 8, 9 and 10).

Habitat condition	Area (ha)	Totals
Good Condition	**33.18**	
Suitable Undergrazed	**0.09**	
Suitable Overgrazed	**7.33**	
Suitable Sparse	**32.32**	
All 'suitable'		*39.74*
All GC and suitable		*72.92*
Potential Rank	**6.70**	
GC, all Suitable and Potential		*79.62*
Not suitable	**285.81**	
Total		**365.43**

Table 1. Habitat condition results: Castlemartin Range.

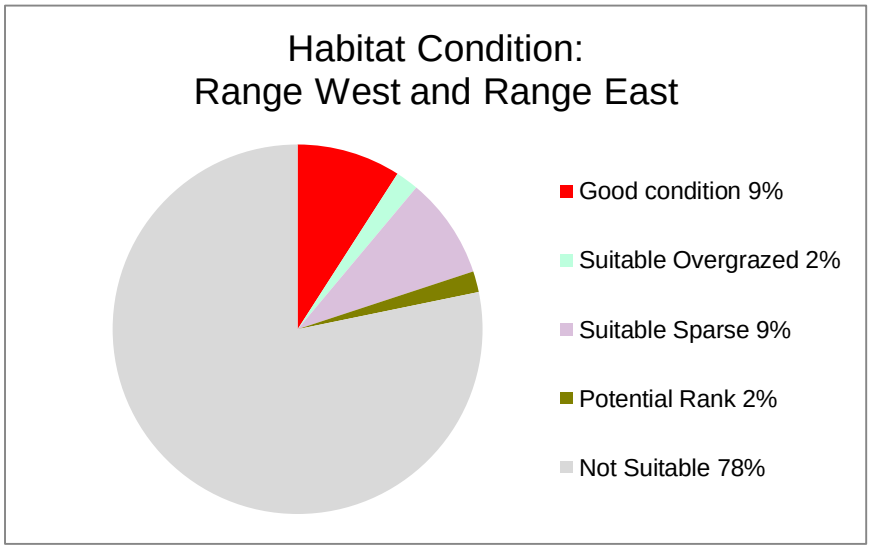


Figure 9. Habitat condition of Range East and Range West.
(0.02% Suitable Undergrazed has not been included, as it is too small to appear on the graph)

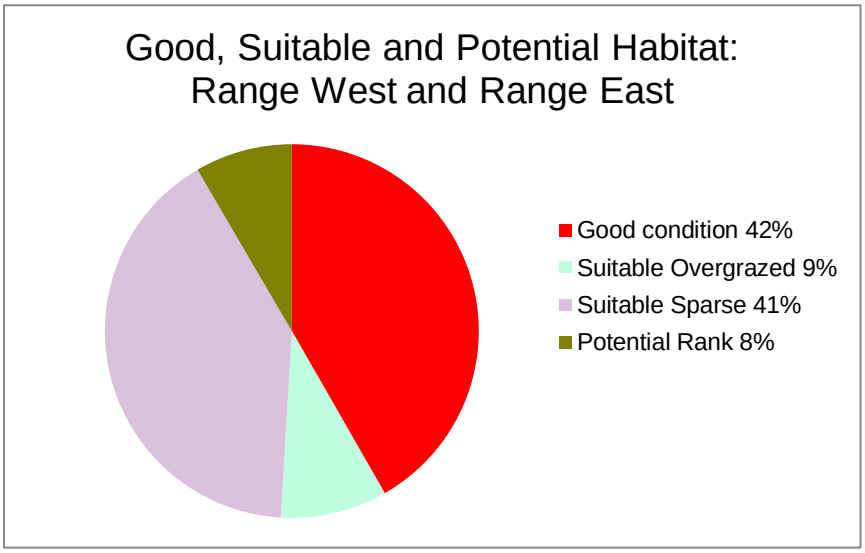
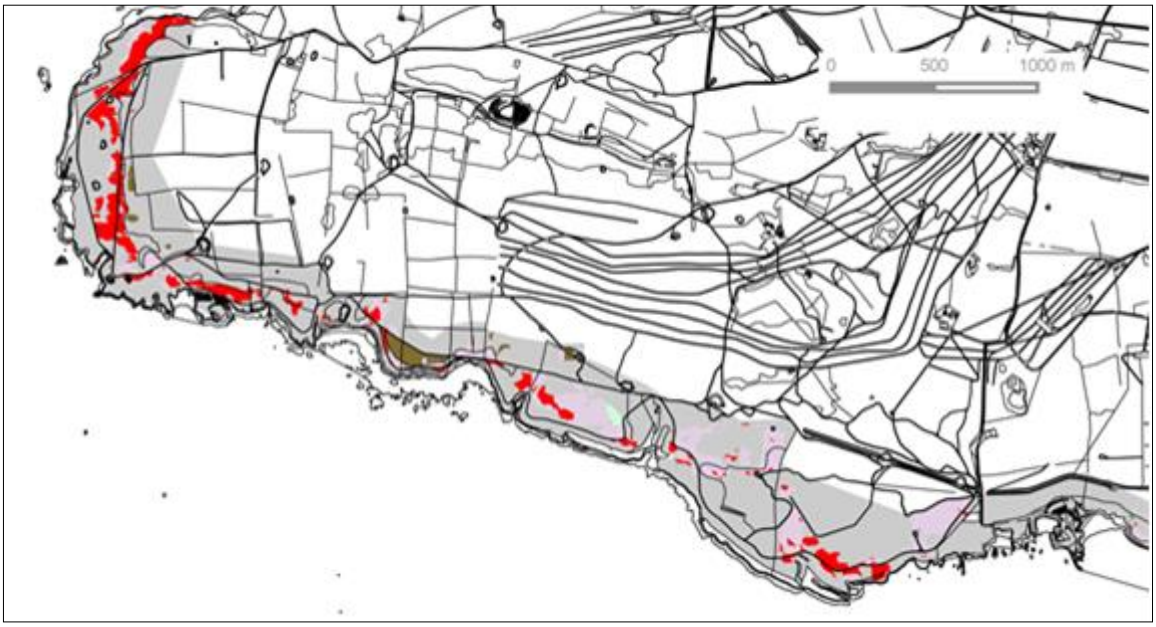


Figure 10. Good, suitable and potential habitat on Range East and West.
(0.02% Suitable Undergrazed has not been included, as it is too small to appear on the graph)

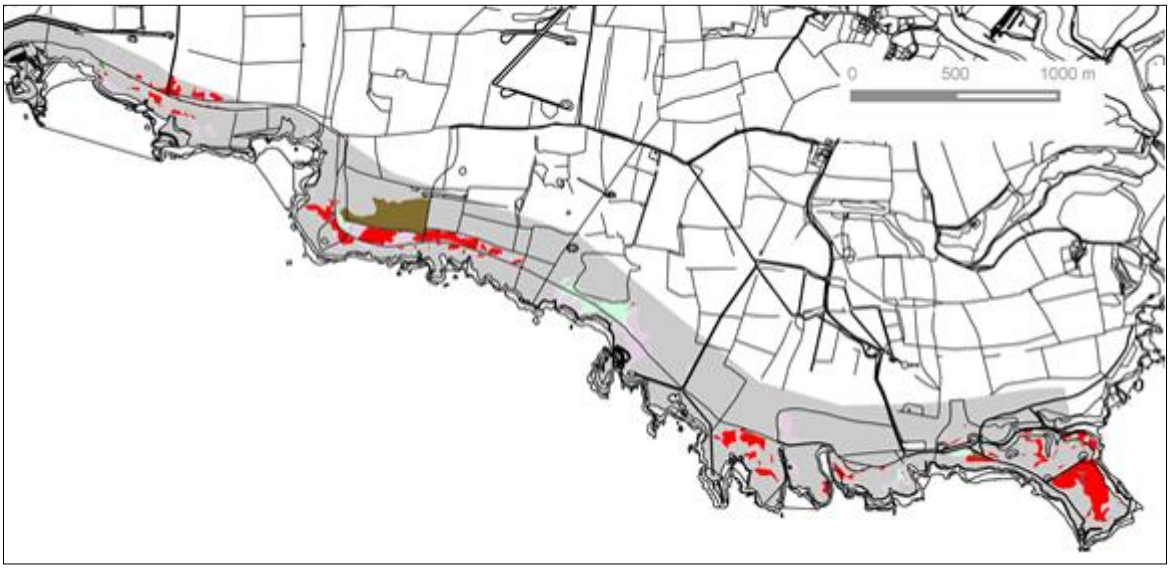
	Good Condition
	Suitable Undergrazed
	Suitable Overgrazed
	Suitable Sparse
	Potential Rank
	Not Suitable

Figure 11. Key to Habitat Condition Maps.

Map 8: Habitat Condition Overview: Brownslade Burrows East.



Map 9: Habitat Condition Overview: Range West.



Map 10. Habitat Condition – Range East.

5.3 Survey results – Range West v Range East and Brownslade Burrows

Almost all the marsh fritillary records for Castlemartin Range are on Range West, with a few occasional sightings on Range East. This survey reveals that there is significantly more habitat on Range West, particularly Good Condition (21ha on the west, 12ha on the east) and Suitable Sparse (23.9ha compared to 8.4ha). Nearly sixty-six percent of all Good, Suitable and Potential habitat is on Range West.

Just under two-thirds of the Suitable Overgrazed habitat is on Range West, but most of that (3.9ha) is ‘standard’ definition SO with *Molinia* on Brownslade Burrows East (Table 2 and Figure 12). A tiny patch of GC (0.01ha) was 'accidentally' found to the west of the survey area. The rest of this dune grassland was not surveyed, as it lay well outside of the survey area.

Habitat condition	Range West	*Totals*	Range East	*Totals*
Good Condition	**19.01**		**12.10**	
Suitable Undergrazed	**0.01**		**0.08**	
Suitable Overgrazed	**0.60**		**2.86**	
Suitable Sparse	**27.63**		**8.43**	
All 'suitable'		*28.24*		*11.37*
GC and suitable		*47.25*		*23.47*
Potential Rank	**2.99**		**3.71**	
GC, Suitable and Potential		*50.24*		*27.18*
Not suitable	**149.44**		**136.90**	
Total		**199.68**		**164.08**

Table 2. Habitat condition results: Range West and Range East.

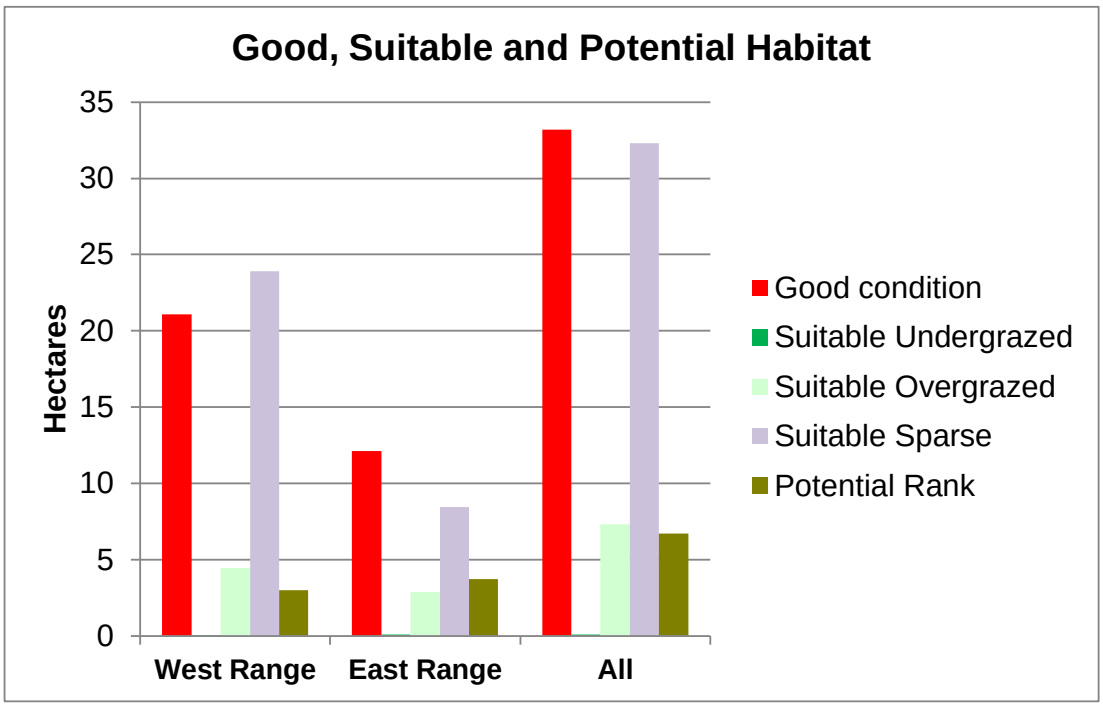


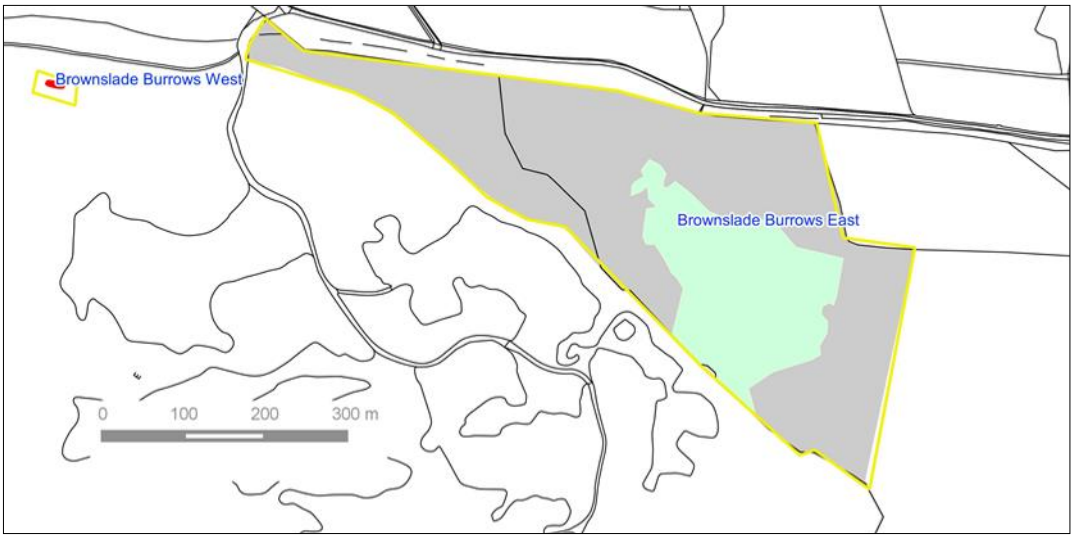
Figure 12. Comparison of Good, Suitable and Potential habitat on West Range, East Range and entire Range.

Good Condition (GC)
The greatest concentrations of the 33ha GC were found on Range West, on Linney, Bulliber and Flintstones Downs. On Range East, the greatest amounts of GC were on Crickmail and Trevallen Downs.

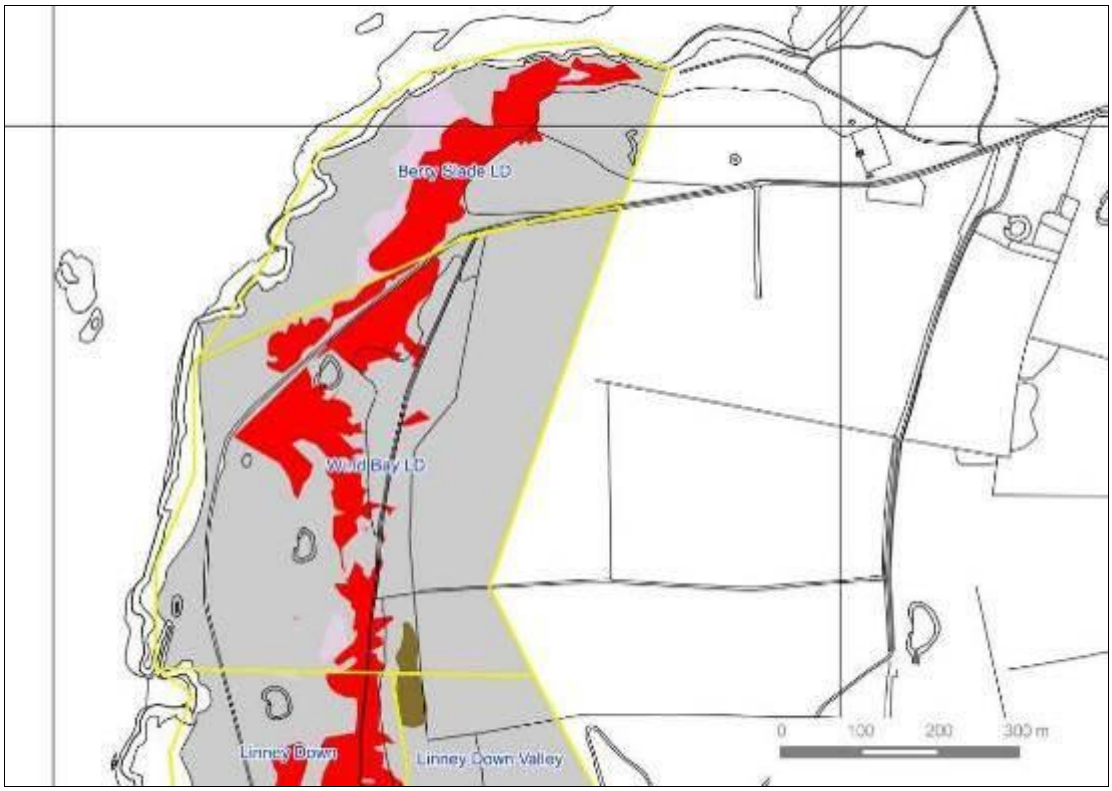
Suitable Undergrazed, Suitable Overgrazed and Suitable Sparse (SU, SO and SS)
Nearly 40 hectares were covered by the three 'Suitable' habitats (not including Good Condition), most of which (32ha) was Suitable Sparse. There was almost 24ha SS on Range West and 8.4ha on Range East. There was a negligible amount of SU on either Range (too little to show on the charts, Figures 9, 10 and 12 above). In contrast, when Brownslade Burrows East is removed from the Range West figures, there was more SO habitat in the east – 2.9ha on Range East compared to only 0.5ha on the west.

Potential Rank
Nearly 6.7 hectares of Potential Rank habitat were recorded, with similar amounts on each Range – 3h on Range West, 3.7 on Range East. This is probably an underestimate, since it could only be seen where the scrub had been cut, or around the edges of dense scrub.

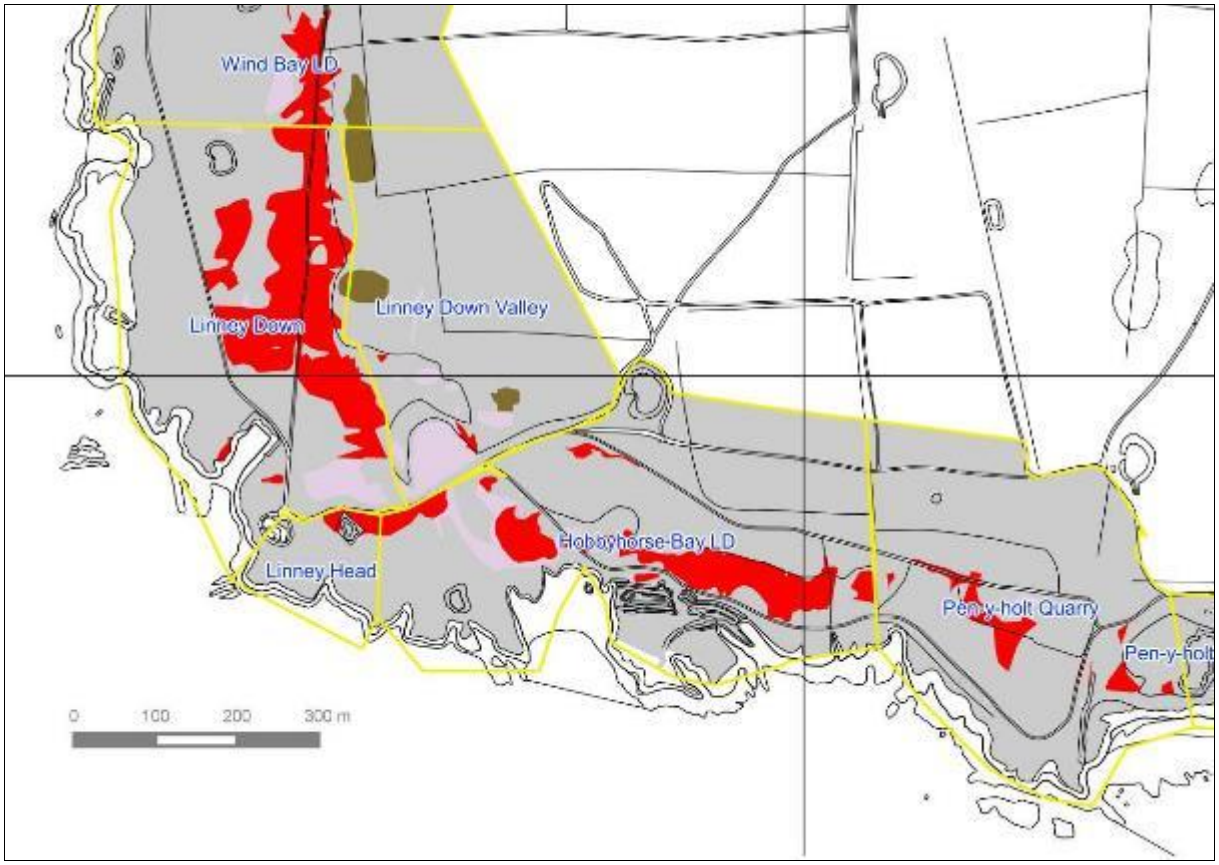
Not Suitable
Seventy-eight percent (286ha) of all assessed land was Not Suitable. The NS grassland was mostly neutral or maritime grassland. There was also a considerable amount of NS scrub, particularly dense gorse, and several large stands of bracken. As shown by the newly defined PR category, *Succisa* is able to tolerate gorse/heather shading for a time, re-appearing when the stands are cut. Shading over years will cause *Succisa* to die out, which can be seen in some of the cut stands. However, no *Succisa* was seen in or around dense bracken patches, which may indicate an intolerance to the more acid conditions favoured by bracken.



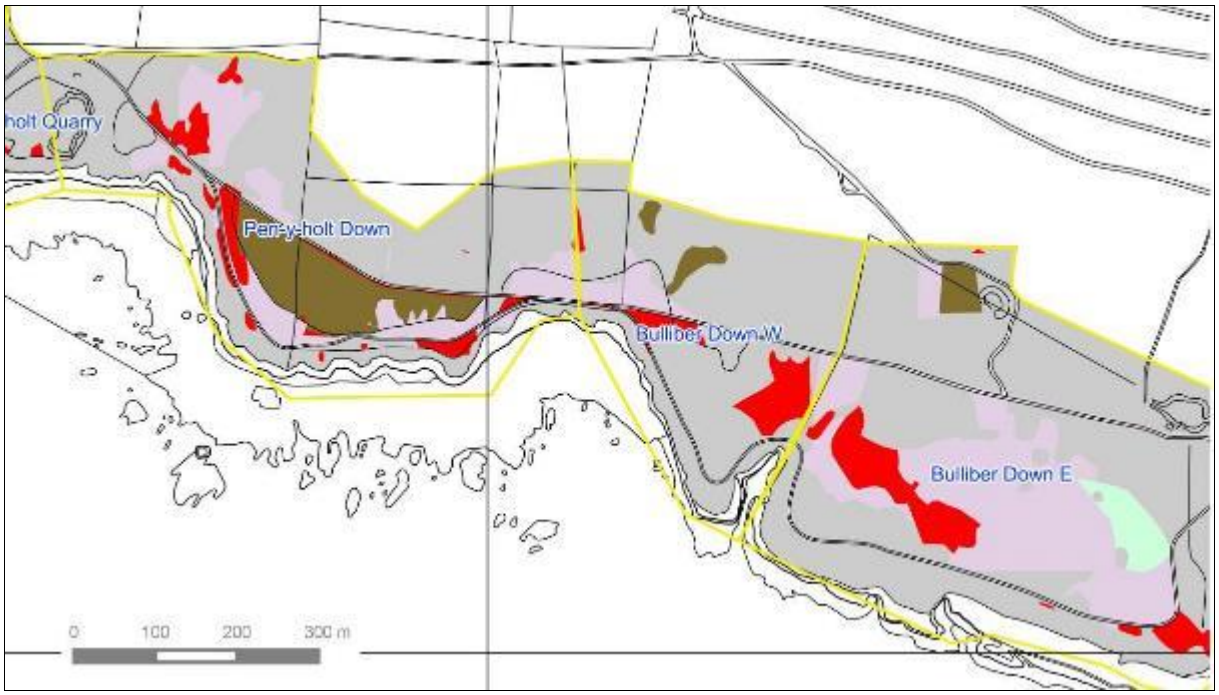
Map 11. Habitat Condition – Brownslade Burrows.



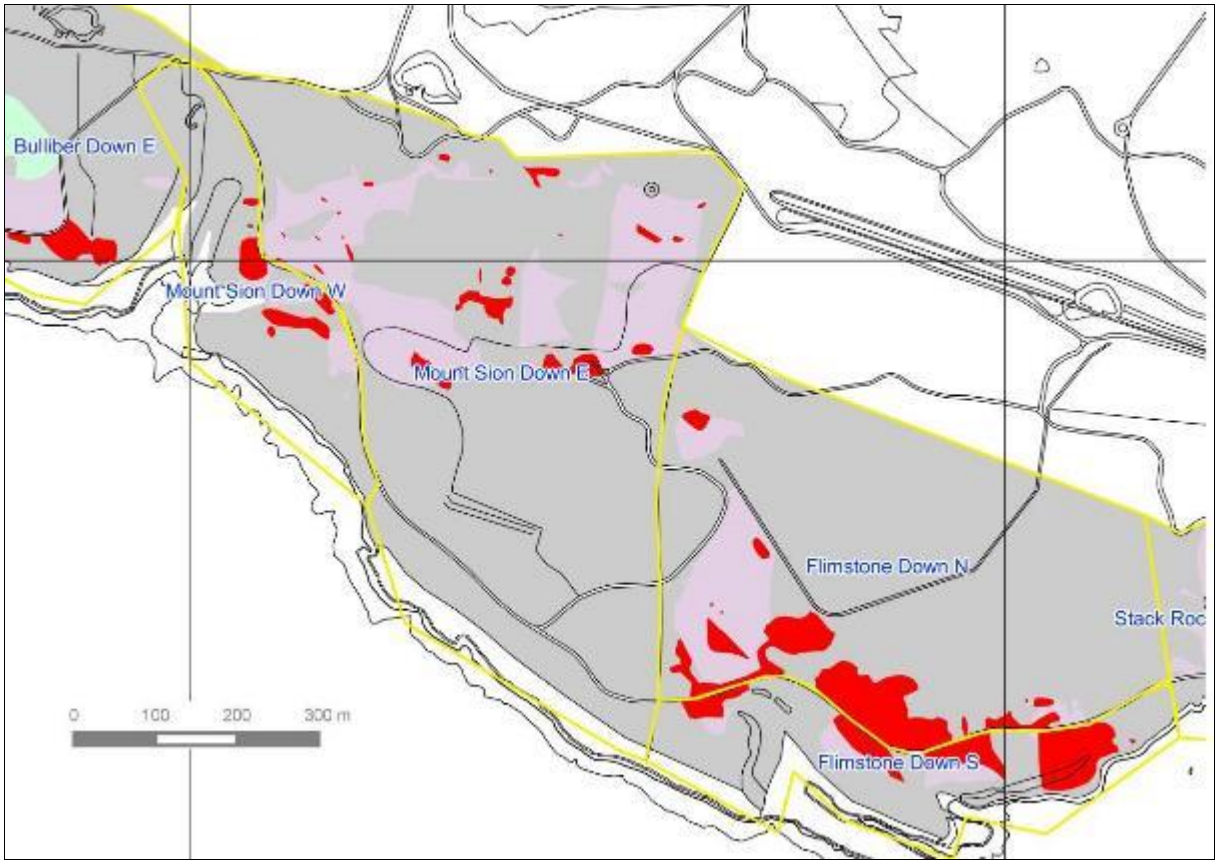
Map 12. Habitat Condition – Linney Down north.



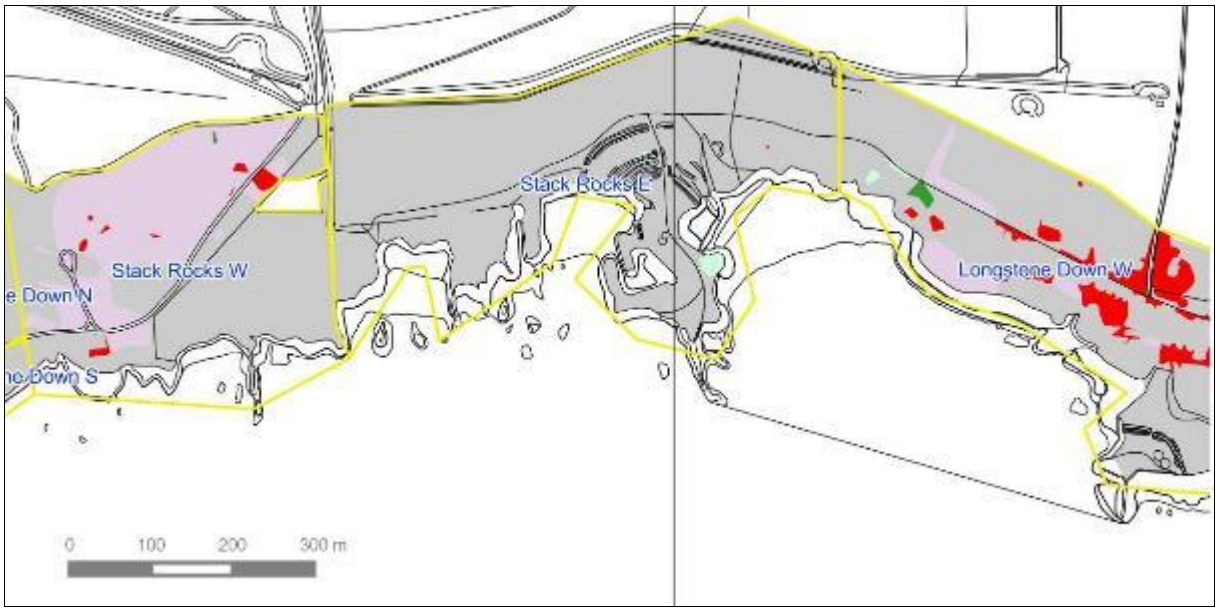
Map 13. Habitat Condition – Linney Down South, Pen-y-holt Quarry.



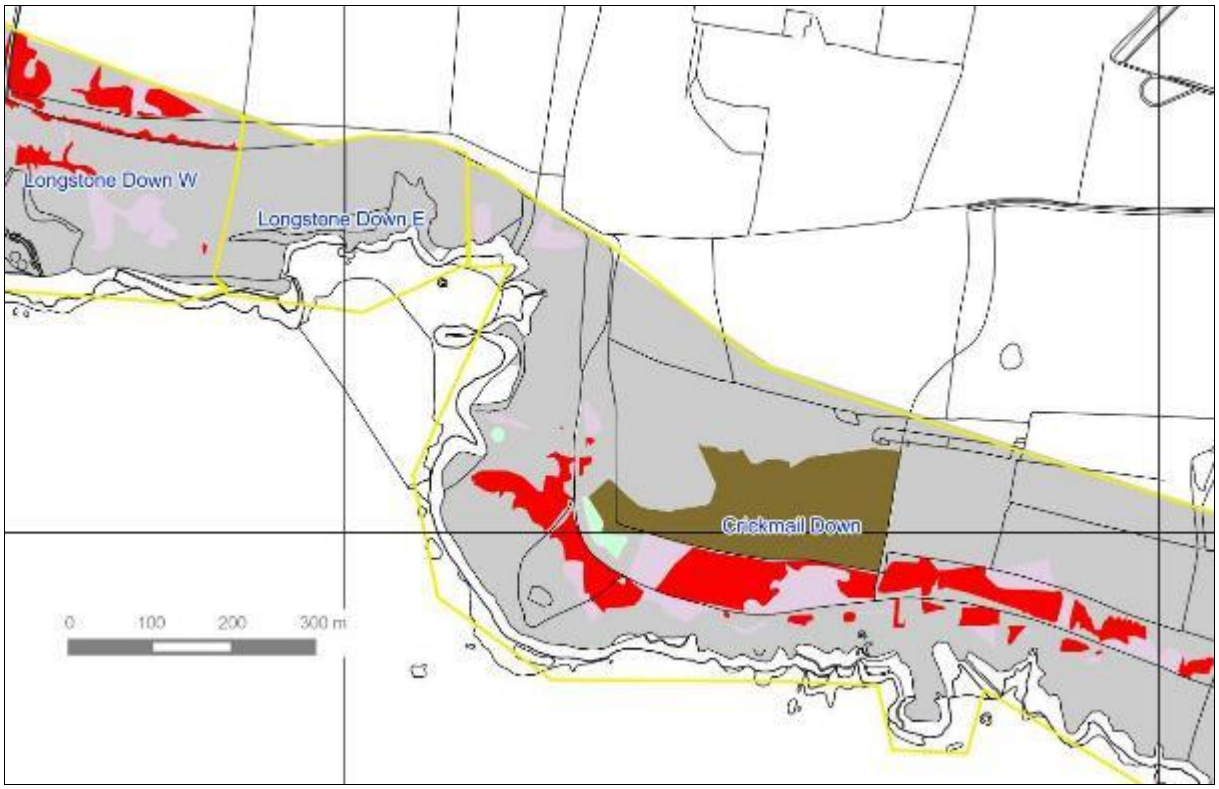
Map 14. Habitat Condition –Pen-y-holt Down to Bulliber Down East.



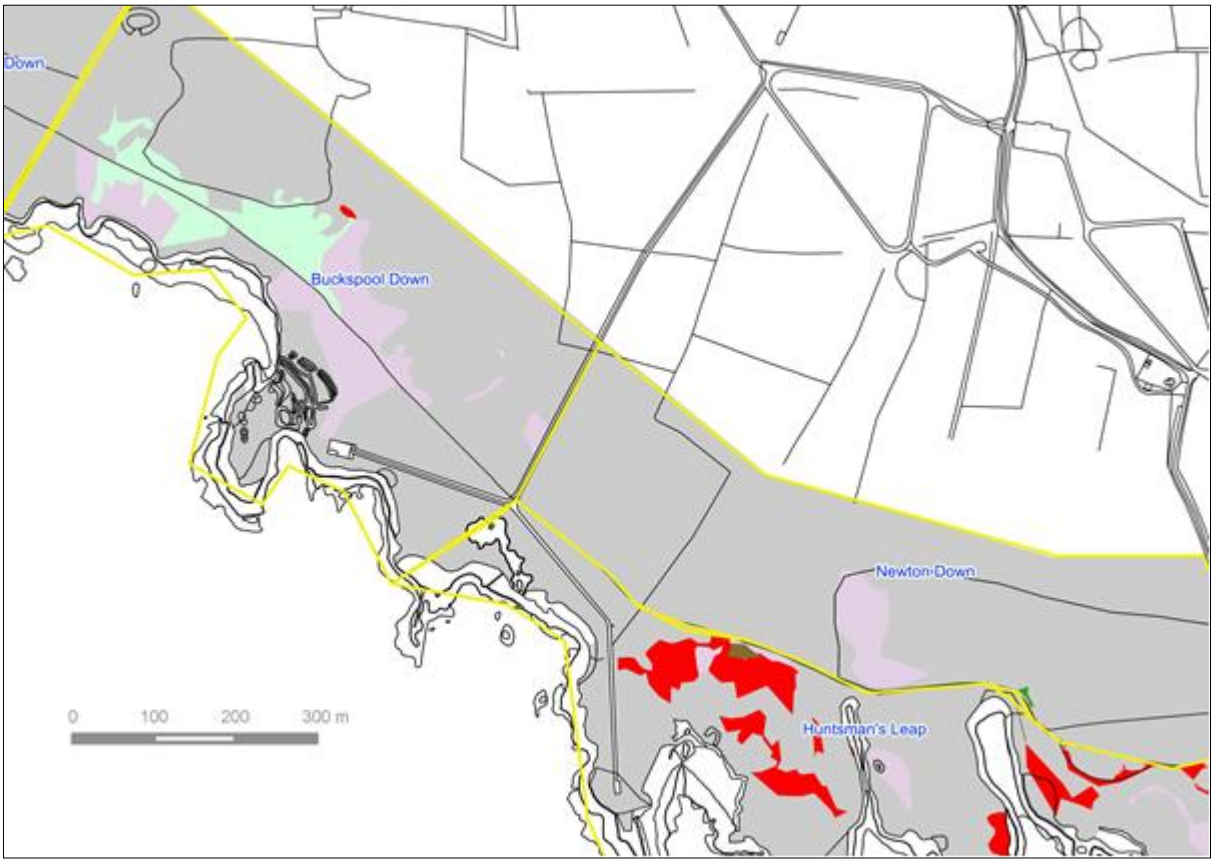
Map 15. Habitat Condition –Bulliber Down East to Flimston Down.



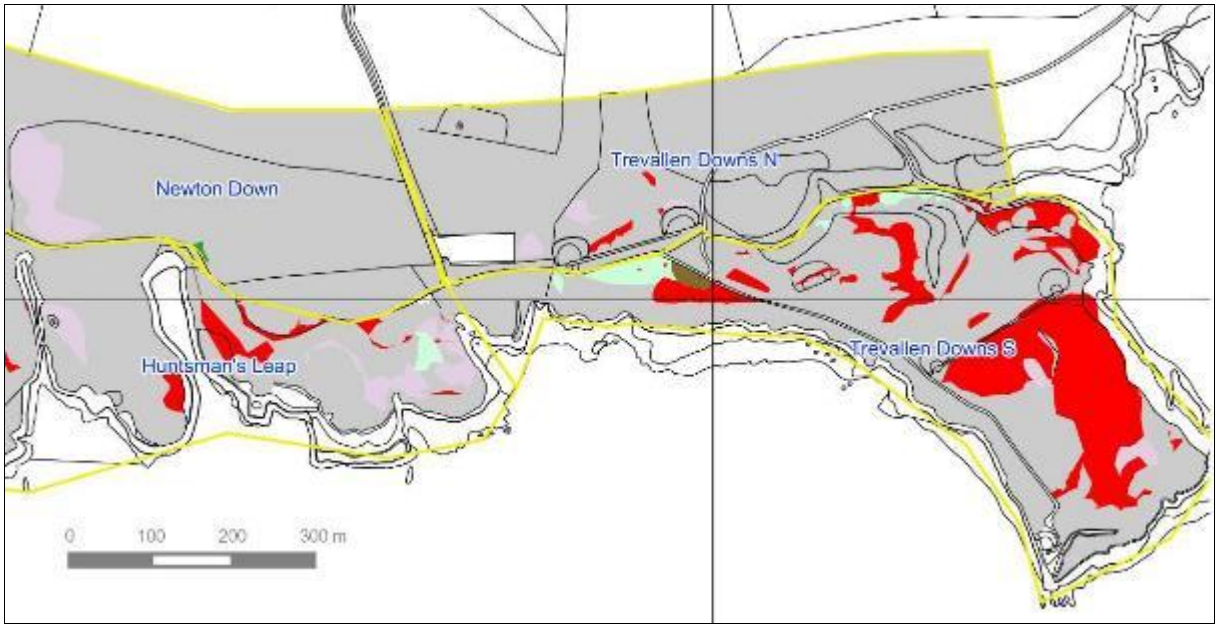
Map 16. Habitat Condition – Stack Rocks to Longstone Down West.



Map 17. Habitat Condition –Longstone Down West to Crickmail Down.



Map 18. Habitat Condition –Buckspool and Newton Down, Huntsman's Leap.



Map 19. Habitat Condition –Newton Down, Huntsman's Leap, Trevallen Downs.

5.4 Management

Castlemartin's large marsh fritillary metapopulation illustrates that the short turf produced by the extensive mixed grazing management regime is generally appropriate. Some areas, particularly on Range East, are too short even for the

Castlemartin marsh fritillaries, with no habitat structure at all. Some short areas are deliberately grazed very tight for other key species such as chough.

There are large dense patches of *Succisa* with few or no flowers, particularly on Linney Down.

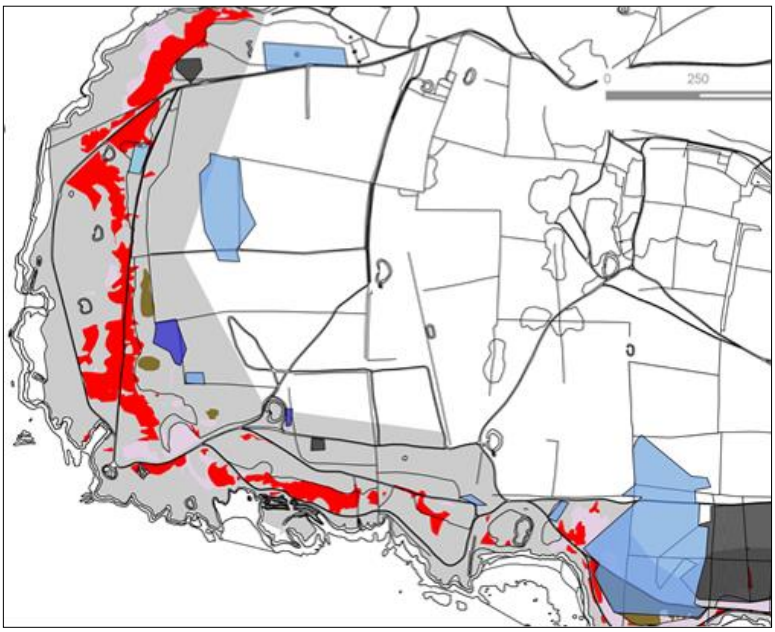
There are some large expanses of bare ground, often with scattered small patches of heath. One area on Linney Down, which lies adjacent to large GC patches with a high concentration of *Succisa* and larval webs, has very little *Succisa.* Others have sparse *Succisa* on some of the patchy heather tufts (Figure 13). The large bare patch on Trevallen Down is also near large GC patches, and appears to have been further maintained by rabbit activity. It is not known whether these have been agreed as military activity zones because they were judged as less important for conservation.

Figure 13. Bare ground with tufts of heather and occasional *Succisa pratensis* Linney Down Valley.

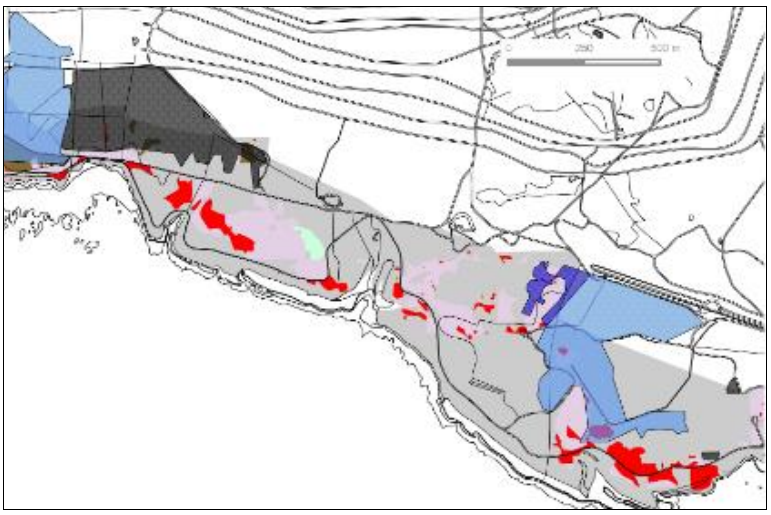
Maps 20, 21 and 22 (below) show the areas of recent burns overlying marsh fritillary habitat (copied from maps provided by L. Houlston). While nearly all have avoided areas of Good Condition habitat, a number have damaged Suitable Sparse habitats on Range West, particularly on Pen-y-Holt, Bulliber and Flimston Downs, as well as on Crickmail Down on Range East. A large patch of PR on Bulliber has also been burned.

Burn year	
2015	
2014	
2013	
2012	

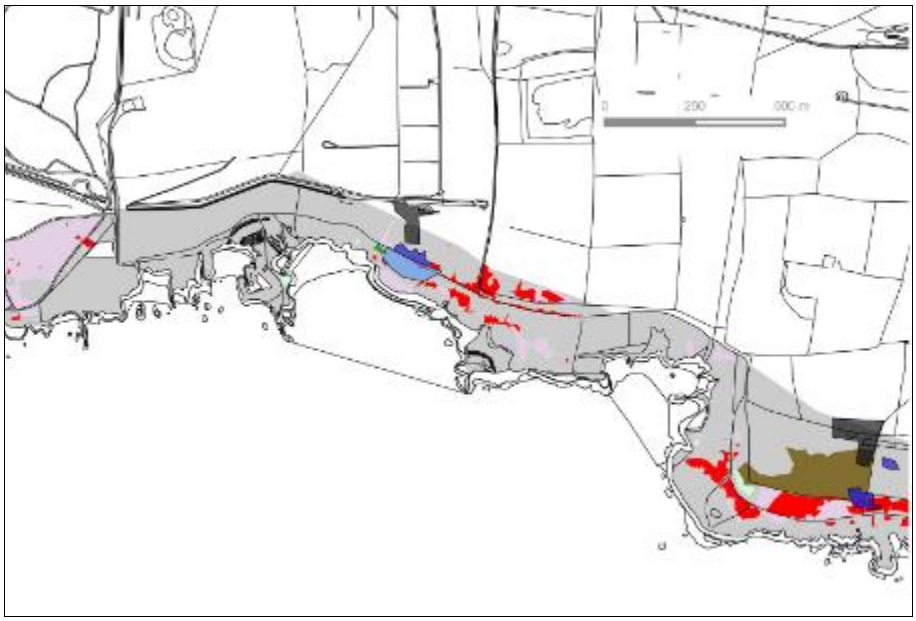
Figure 14. Key for burns maps, below.



Map 20. Castlemartin burns 2012-2015 - Linney to Bulliber Downs.



Map 21. Castlemartin burns 2012-2015 – Mt. Sion to Flimston Downs.

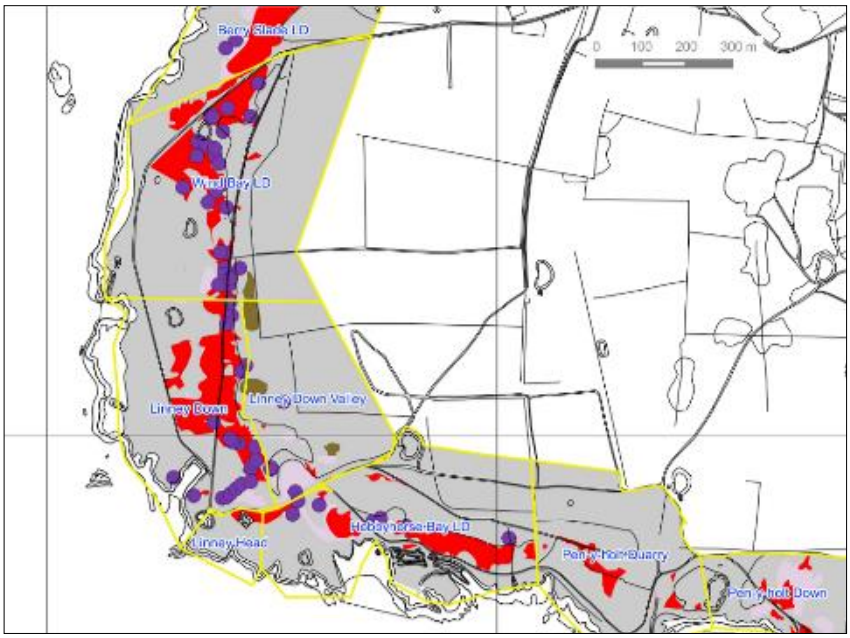


Map 22. Castlemartin Mount burns 2012-2015 - Longstone to Crickmail Downs.

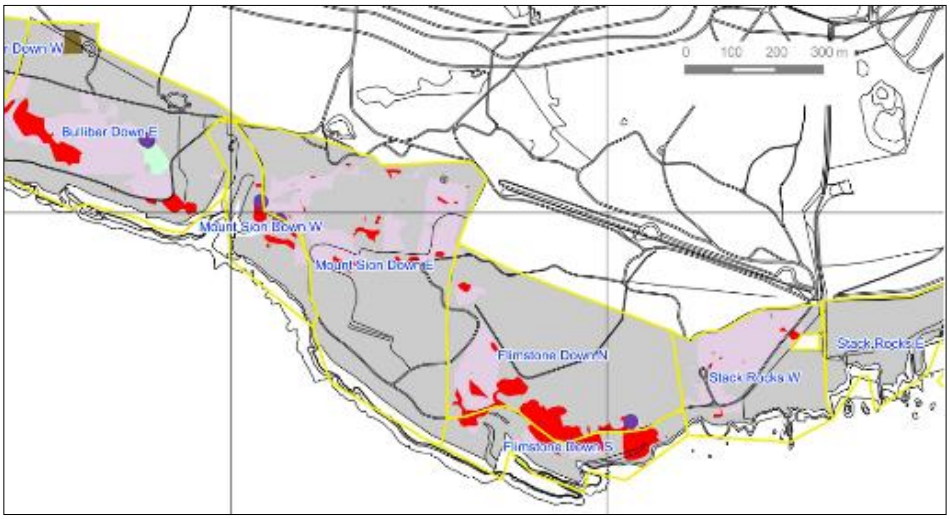
5.5 Marsh fritillary larval webs

The short turf on Castlemartin Range makes it easy to spot larval webs. Two-hundred and twenty-five webs were counted in the course of the habitat survey (Maps 23 and 24). Nearly all of these were in the far west, on Linney Down, Linney Head and Hobbyhorse Bay, with only nine further east (on Bulliber, Mount Sion and Flimston Downs). No webs were seen on Range East or Brownslade Burrows East. While this may be a reflection of the survey dates on these different sites, webs were found on Linney Down as late as the 4th of October, when other areas had been surveyed from as early as the 29th of August, with no or very few webs evident.

Figure 15. Larval web on Linney Down.
Note: different instar larvae in same web.



Map 23. Marsh fritillary larval webs 2015, Linney Down to Pen-y-holt Quarry (purple circles).



Map 24. Marsh fritillary larval webs 2015, Bulliber to Flimston Down (purple circles).

6. Discussion

6.1 Habitat Condition

This survey shows that Castlemartin Range provides a large extent of Good Condition and Suitable habitat for the marsh fritillary metapopulation. Additionally, many of the patches are large and most are well connected. This is crucial, since fragmentation is one of the greatest threats to the survival of the marsh fritillary across Britain and Europe. Castlemartin is surely the largest site with the most *Succisa pratensis* and the largest and most connected habitat in all of Wales.

Modelling has suggested that marsh fritillary metapopulations may require between 76 and 104ha of suitable habitat for their long-term survival (Bulman *etal*. 2007). Fowles (2004) regards 50ha of Good and Suitable Condition habitat within 2km of a protected site featuring marsh fritillary as an appropriate target to represent Favourable Condition Status (FCS). Castlemartin's 72.9ha of Good and Suitable habitat easily exceeds this target. Range West alone meets the criteria, with 49.4ha. Range East has 23.5ha.

However, the Castlemartin SAC core management plan (CCW 2008) sets a minimum limit for marsh fritillary FCS on Castlemartin Range SSSI of at least 100ha of suitable habitat, with a minimum of 50ha of GC habitat. The conservation objective defines GC as *Succisa*-rich habitat between 7 and 20cm tall in at least 70% of sampling points, which differs from Fowles 2005 and the definition used in this current study. This FCS target unrealistically exceeds the total amount of habitat with *Succisa pratensis* found at Castlemartin, by an extra 20ha. It is suggested that this FCS target be amended.

6.2 Grazing

The current grazing regime appears to be working, since the marsh fritillary metapopulation is robust. Plans to increase grazing numbers in the future (S. Philipps-Harries, pers. comm.) should be considered carefully by the MOD and NRW. At the very least, they should be concentrated in the areas with the least or no marsh fritillary habitat, since many of the suitable habitat patches are approaching the minimum sward height already. They are unlikely to be suitable if they are grazed any harder. However, the large grazing compartments make 'micro-management' difficult. NRW will need to balance the needs of marsh fritillaries with the other short-turf and open habitat-specialist key species protected at Castlemartin, along with the MOD's requirements.

Brownslade Burrows East was heavily grazed and poached in some areas in 2015, to benefit invertebrates and lower plants. The areas of devil's-bit scabious and *Molinia* are probably grazed too short for the marsh fritillary - without seeing webs on this type of vegetated dune habitat, it cannot be stated whether Castlemartin marsh fritillaries are able to survive in this shorter, sparser habitat. Larvae were recorded here in 2011 – it would be interesting to know if the grazing that year was at the same intensity as it was in 2015.

Sheep are normally not recommended for marsh fritillary sites, since they can preferentially select *Succisa pratensis* and other herbs. Sheep grazing has led to the decline and disappearance of devil's-bit scabious from many rhos pasture sites. Judging from the great abundance of *Succisa* at Castlemartin, the winter sheep grazing does not appear to be having a detrimental effect here, since most of the seeds will have ripened and fallen before the sheep arrive in November. However, there is no systematic monitoring, which would be very helpful in identifying any trends in *Succisa* abundance.

There are large dense patches of *Succisa* with few or no flowers (Figure 16). The reason for this is unknown, but it could result from sheep grazing. The plant flowers after the flight period and so does not affect marsh fritillaries' nectar resource. However, lack of flowering may have a future effect on *Succisa* recruitment and

colonisation. There is such a large extent of the plant at Castlemartin that this is not an immediate concern. However, devil's-bit scabious flowers provide an extremely important nectar source for late summer/autumn pollinating insects, such as shrill carder bee, as it flowers late in the season when most other wildflowers have gone to seed.

Figure 16. Dense non-flowering *Succisa pratensis* in short turf.

The harsh coastal environmental conditions also play a major role in 'managing' Castlemartin's habitats. Along with the impact of rabbit populations, this must be factored in when considering any future changes to the grazing regime.

The impact of military activities can be marked, but overall the MOD's management of this prime conservation site in consultation with NRW appears effective.

6.3 Burning

Uncontrolled fires can have major localised impacts, but they help control bracken and scrub, and maintain open habitat. The large burn of Potential Rank habitat (dense gorse) on Bulliber Down has helped to open up the habitat and allowed light to reach the sparse amount of devil's-bit scabious here.

However, several large burnt patches of Suitable Sparse on Range West (Pen-y-Holt, Bulliber and Flimston Down) and Range East (Crickmail Downs) are of concern. NRW should work with MOD Castlemartin Range to develop future management plans that avoid firing in these areas, if possible, and concentrate on NS patches instead.

6.4 The Castlemartin Range marsh fritillary and future surveys

This study has mapped the generous amount of *Succisa pratensis* in Good and Suitable condition habitat on Castlemartin Range. Many of these habitat patches are large and most are well connected, especially on Range West. Furthermore, there is likely to be a large nectar resource for the adults during their spring flight period. Hence, it is no wonder that the Range supports what must be the largest marsh fritillary metapopulation in Wales, and one of the largest in the UK.

The Brownslade Burrows East habitat (nearly 4ha of SO) is roughly 1.8km from the nearest site occupied by the marsh fritillary on the Range (at Berry Slade). This is not too far to exchange occasional individuals, meeting the definition of a metapopulation. Colonisation from the core metapopulation is especially possible in a 'good year' when adult numbers boom, and may occur more frequently here, since the main Castlemartin Range metapopulation is so large. Thus, any marsh fritillaries occupying Brownslade Burrows East can be considered to be part of the main Range metapopulation. Small numbers of marsh fritillary are recorded to the north of Castlemartin Range, at Somerton Farm and Bee Hall, with occasional records at Stackpole to the east and old records of other sites to the north. One or more other nearby sites with habitat potential may have been destroyed in recent times (B. Haycock, pers. comm.). Brownslade Burrows East may serve as a link or stepping-stone between the Range metapopulation and these scattered colonies. The smaller and more isolated a colony, the less likely it is to survive, so the future survival of these small colonies is uncertain. A survey of the surrounding landscape would illustrate whether the metapopulation and its habitat does extend beyond Castlemartin Range's boundaries.

A tiny amount of GC habitat was seen on Brownslade Burrows West. It would be worth surveying suitable swards between Brownslade Burrows West and the cliffs for more habitat.

It appears that a range of survey methods have been used to survey/monitor Castlemartin Range's remarkable marsh fritillary metapopulation since 2003, and so it is difficult to judge trends in population numbers and use of breeding sites over time.

There are no immediate threats, but it is vital that the habitat is maintained in the best possible condition to support this significant population. It is important that the metapopulation and its habitat are regularly and systematically monitored to ensure this continues. Perhaps the known core habitat could be monitored regularly, along with a rolling programme to survey sections of suitable habitat in turn across the rest of Range West and East as well as Brownslade Burrows East. This is a large task, due to the great amount of suitable habitat across both ranges. It is recommended that Butterfly Conservation Wales' monitoring methods be used, to ensure that the data can be comparable over time, and that it contributes to the Wales-wide monitoring programme. Any measures to encourage *Succisa* colonisation, such as allowing it to colonise bare areas, could help ensure the long-term survival of the marsh fritillary in the face of unknown future threats associated with climate change. New areas of bare ground could be created in adjacent areas lacking *Succisa,* to provide habitat for bare-ground specialists.

It appears that marsh fritillaries chiefly breed on Range West, with only occasional records from Crickmail and Trevallen Downs on Range East (although it is not clear if this is an artefact of survey effort, which concentrates on Range West). This study has shown that there is less GC and Suitable habitat on Range East, and it is less well connected. Nevertheless, there are large habitat blocks on Crickmail and Newton Downs (to the west of Hangman's Leap), the area west of St. Govan's Chapel and on Trevallen Downs. While these Range East patches are separated from each other, and from Range West, by stretches of Not Suitable habitat, they are

still close enough to be considered to lie well within the metapopulation's range. There is more extremely short Suitable Overgrazed habitat with no structure at all on Range East, which could be a factor behind the low butterfly numbers here. This area, especially Crickmail Down, appears to have been targeted for intensive grazing to meet the needs of other key species on the Range. This survey's results could be used to revise priorities, in order to avoid overgrazing areas on Range East with plentiful *Succisa* and target *Succisa*-free stretches instead.

It is also possible that visitor pressure reduces the suitability of habitat for the butterfly on Range East, especially on Trevallen Down and St. Govan's Head. Although public access is limited to weekends and the month of August, any webs in the short turf would be vulnerable to trampling by walkers and cyclists.

Military use has a localised impact, especially from uncontrolled fires. However, this does not appear to have had any long-term impact on the metapopulation, and is compensated for by the appropriate management of the Range as a whole.

There is speculation that the metapopulation is moving westwards on Castlemartin Range, possibly due to changes or variation in water table level and/or soil type (B. Haycock, pers. comm.). In 2009, the largest populations were recorded on Pen-y-holt, Bulliber and Mount Sion Downs, with few on Linney Down at the western end of the Range. Now the largest colonies are found on Linney Down. However, this impression may merely be due to variation in survey effort in different parts of the Range, with less survey effort on Linney in the early years.

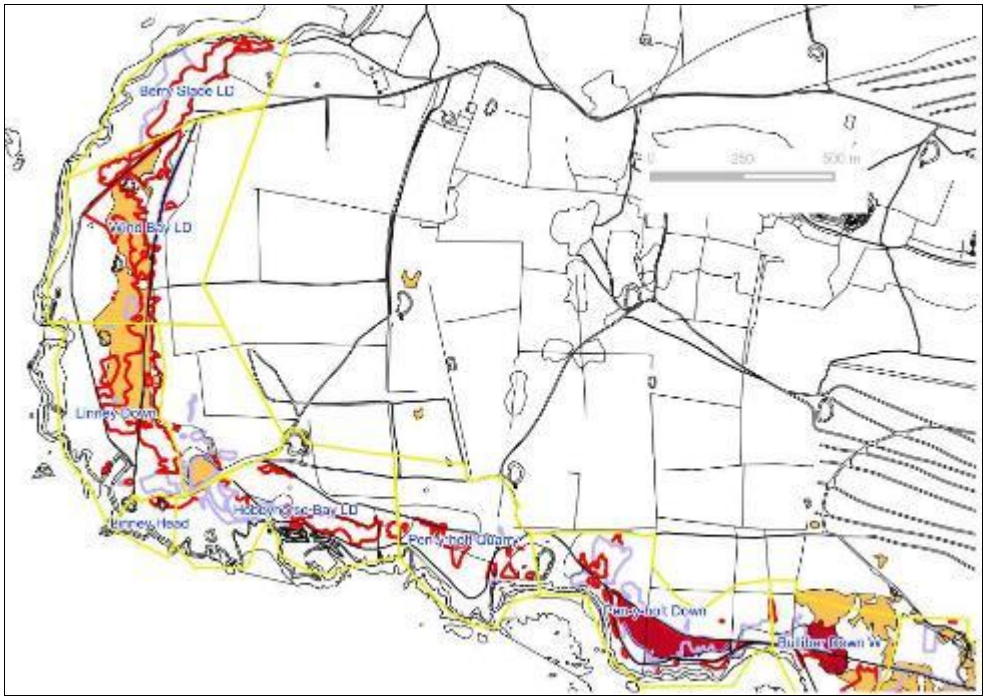
Maps 25-28 (below) show that Good Condition habitats do seem to occur more often on peaty heathland soils (NVC categories H7 *Calluna vulgaris – Scilla verna* (maritime) and H8 *Calluna vulgaris – Ulex gallii (*acid to neutral soils)) than on maritime or dry calcareous grasslands (Maps 29-32). This could provide another clue as to the low numbers of marsh fritillaries recorded on Range East in particular, where much of the GC and Suitable habitat lies on calcareous soils.

A larval web survey comparing occupation of these two habitat types on Range West would be valuable. If the butterflies do preferentially select these damper habitats, it would show that Castlemartin Range's marsh fritillary habitat does not differ quite as much as previously thought from typical Welsh damp rhos pasture (albeit in a shorter and less tussocky sward). Coastal climate and soil type are also important factors here, allowing the marsh fritillaries to occupy shorter swards than elsewhere. Interestingly, it is thought that marsh fritillaries only colonised calcareous (chalk) grasslands in southern England in the early 20th century, with the decline of intensive sheep and rabbit grazing; here they occur in 5-15cm swards, usually on south or west-facing slopes (Thomas and Lewington, 2010).

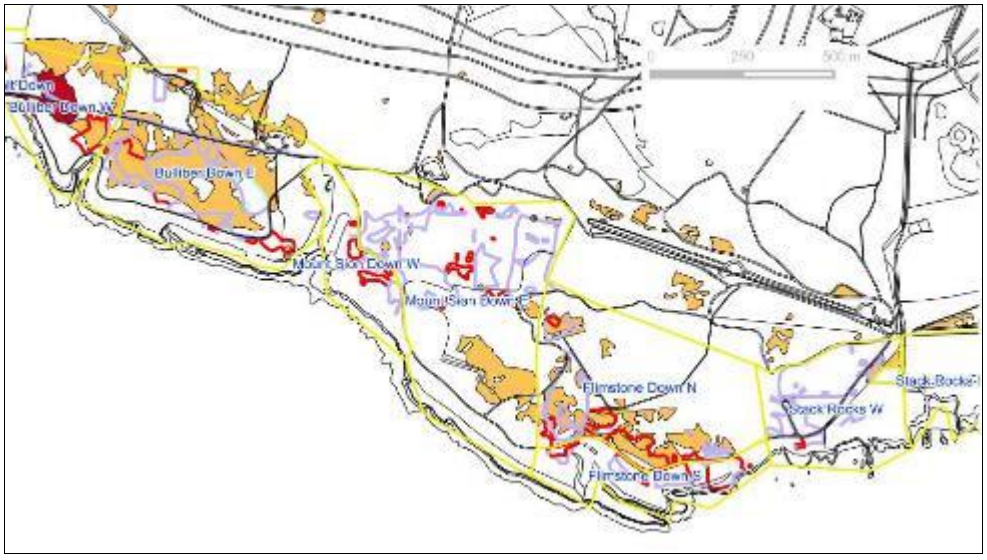
Castlemartin's heath habitat does resemble coastal sites occupied by Scottish marsh fritillaries nearly 350km north of Castlemartin, on the west coast of Islay – short, wind and salt-stunted heath forming a uniform sward in which the larvae successfully hibernate. Additionally, like Castlemartin, much of the *Succisa* is small but very abundant. The one difference occurs in the Islay topography, which is more varied and may provide more shelter than that provided by Castlemartin’s fairly flat landscape (T. Prescott, pers. comm.).

GC habitat outline	
SS habitat outline	
SS habitat outline	
Heathland	
Ulex heath	

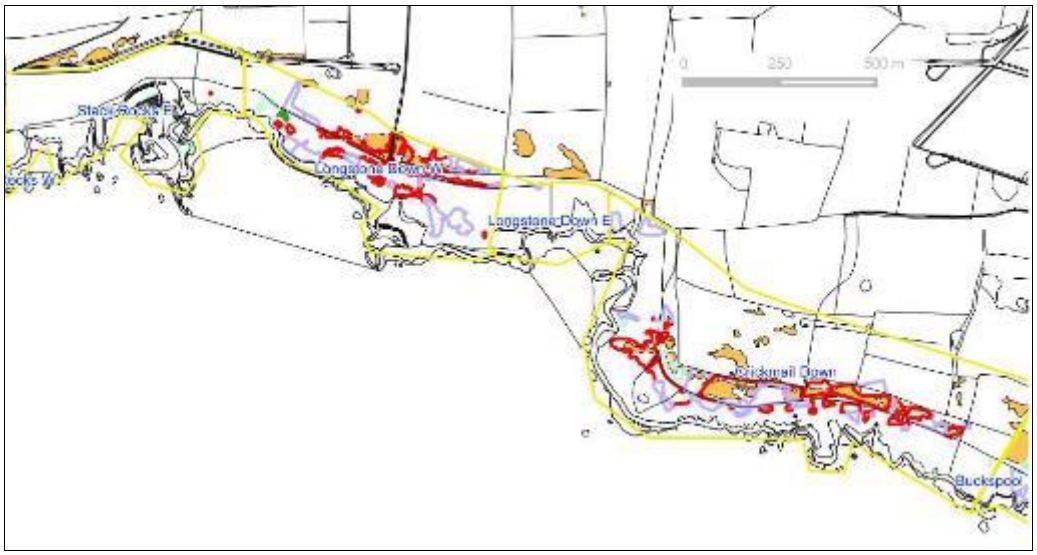
Figure 17. Key: Marsh fritillary and heathland.



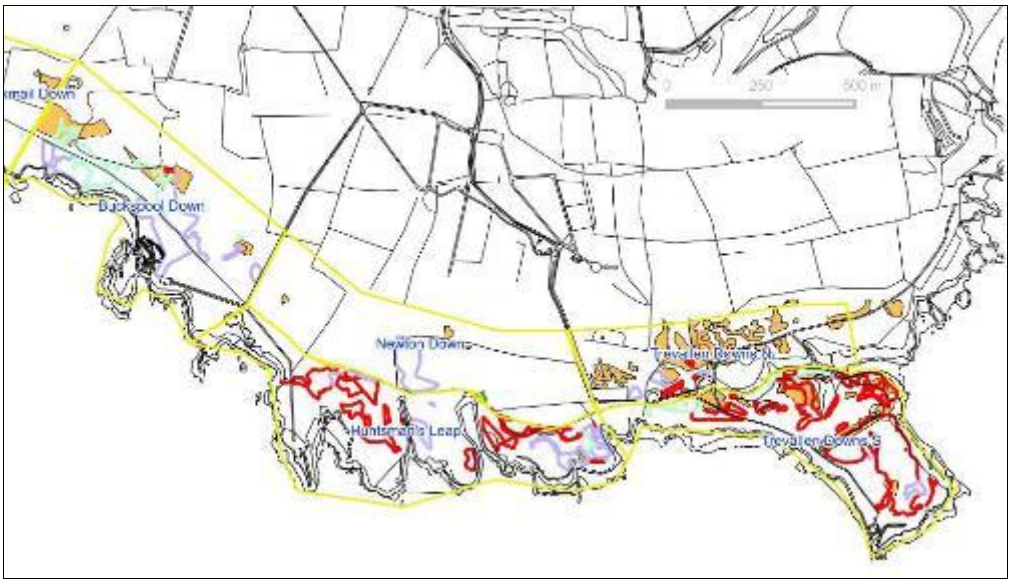
Map 25. Marsh fritillary habitat on heathland: Range West 1.



Map 26. Marsh fritillary habitat on heathland: Range West 2.



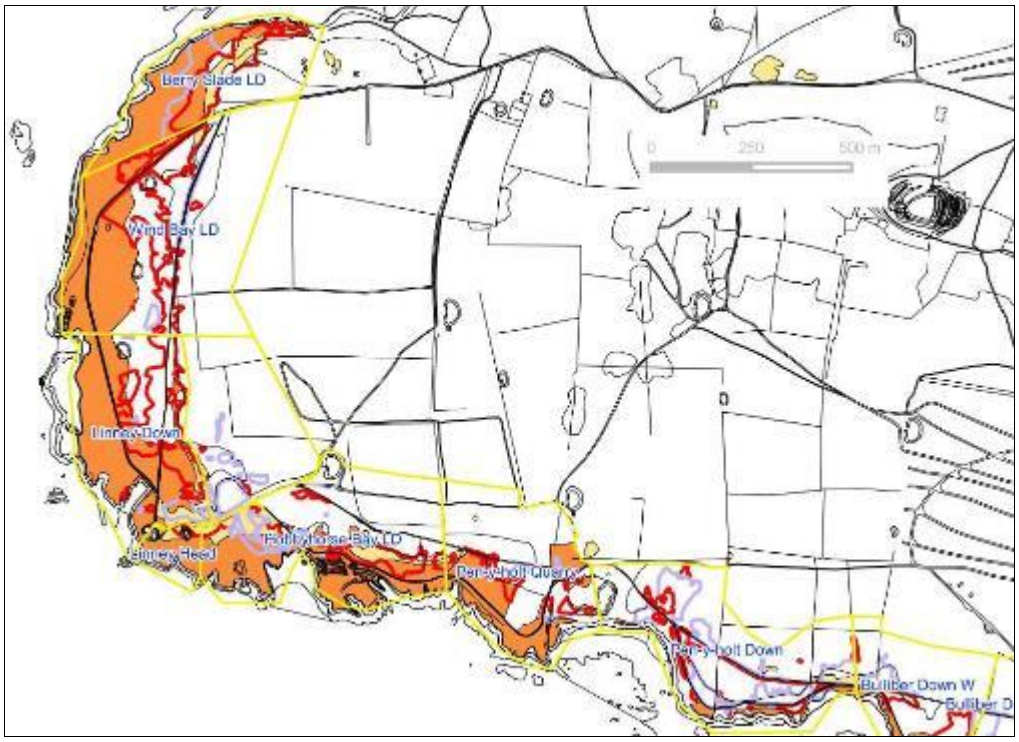
Map 27. Marsh fritillary habitat on heathland: Range East 1.



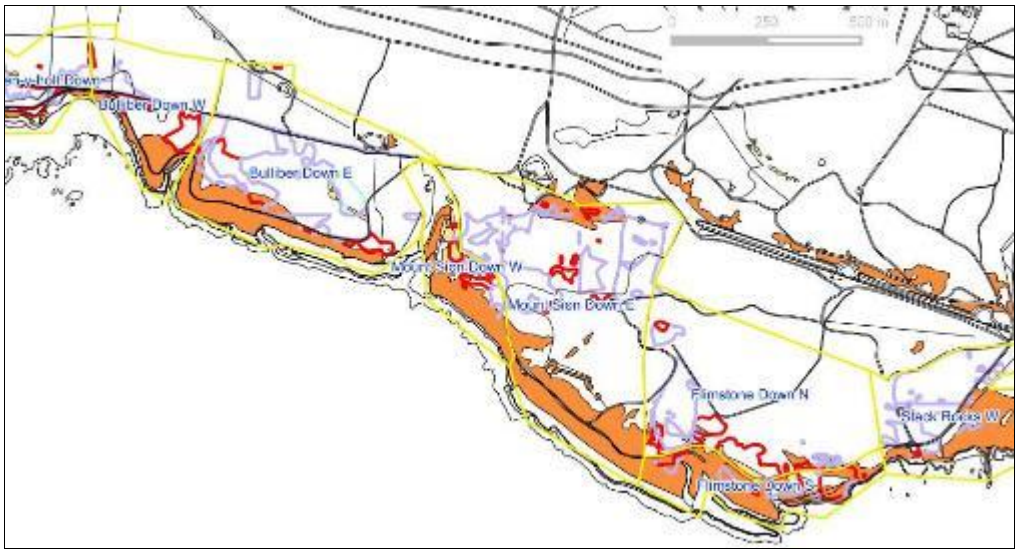
Map 28. Marsh fritillary habitat on heathland: Range East 2.

GC habitat outline	
SS habitat outline	
SS habitat outline	
Maritime and dry calcareous habitats	

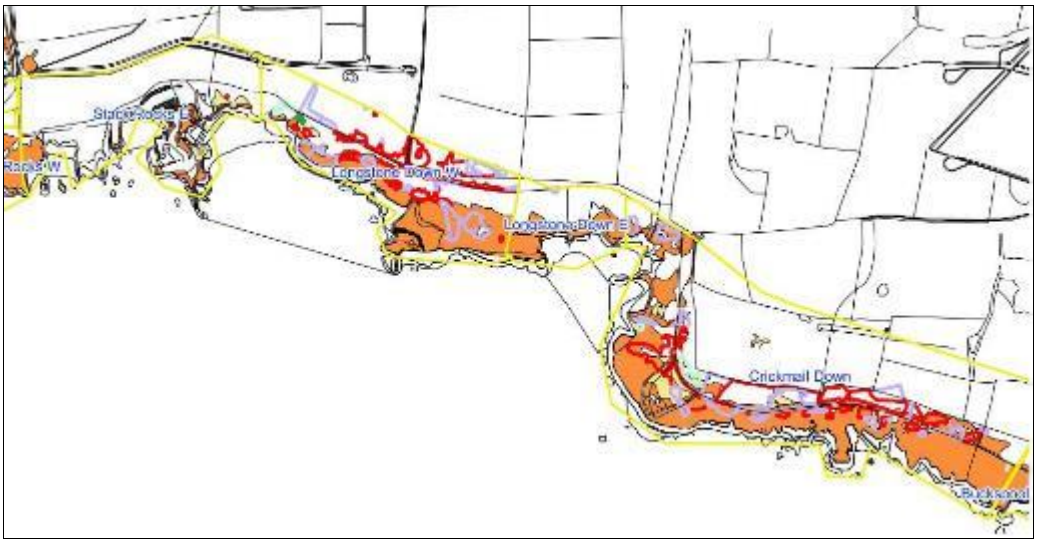
Figure 18. Key: Marsh fritillary and calcareous habitats.



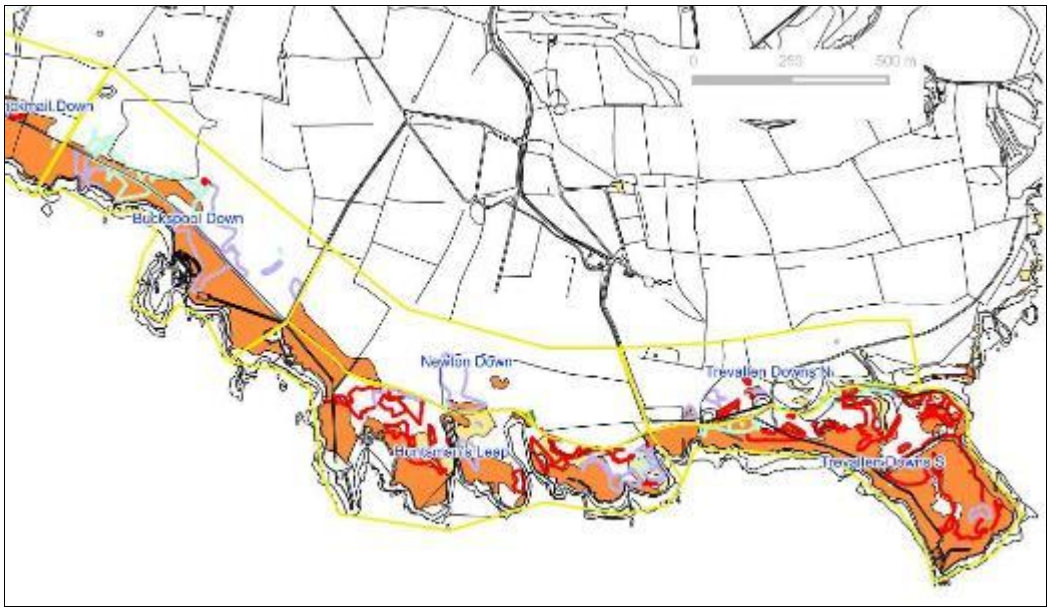
Map 29. Marsh fritillary habitat on maritime and dry calcareous grassland – Range West 1.



Map 30. Marsh fritillary habitat on maritime and dry calcareous grassland – Range West 2.



Map 31. Marsh fritillary habitat on maritime and dry calcareous grassland – Range East 1.



Map 32. Marsh fritillary habitat on maritime and dry calcareous grassland – Range East 2.

It is unknown whether an overlooked marsh fritillary population was present for some time prior to the butterfly's discovery on Castlemartin Range in 2003. They may have colonised from small sites to the north of the Range, and there are theories that they colonised from the south (south-west England or the Gower Peninsula), possibly along with influxes of painted lady butterfly *Vanessa cardui* and other immigrants. A genetic study of the Castlemartin Range marsh fritillaries and potential source populations would be enlightening.

The first NRW sighting of the butterfly in 2003 coincided with the start of the Iraq War, when military activity on the Range was increased, and grazing levels decreased (S. Phillips-Harries, pers. comm.). It is possible that the previous grazing regime

produced a widespread short (Suitable Overgrazed) sward across much of the Range, limiting the suitability for the marsh fritillary.

The MOD carried out a transect survey of *Succisa* and habitat condition in 2003 and 2004. As there was insufficient time to repeat this survey along with the contracted work in 2015, a repeat survey would give an indication of the impact of the changes in grazing pressure. This could inform future decisions about increased stock levels on the Range.

It has been speculated that the large population survives because it has not yet been 'found' by the specialist marsh fritillary parasitoid wasp *Cotesia bignellii.* This wasp inserts its egg into the marsh fritillary larva, and leaves tell-tale small cocoons on parasitised larval webs. To date, there have been no records of the wasp on the Range.

7. Conclusions & Recommendations

A substantial amount of Good and Suitable Condition habitat sustains Castlemartin's robust marsh fritillary population. The 72.9ha of Good and Suitable habitat, with 33ha of that in Good Condition, exceeds Fowles' (2004) definition of Favourable Condition Status as 50ha of Good and Suitable Condition habitat within 2km of a SSSI featuring marsh fritillary, at least 10ha of which should be in Good Condition. Furthermore, much of Castlemartin Range's habitat occurs in very large and well-connected patches, vital for the long-term survival of the metapopulation.

Castlemartin Range's habitat resource meets the target derived from metapopulation modelling, which suggested that marsh fritillary metapopulations may require between 76 and 104ha of suitable habitat for their long-term survival (Bulman *etal*. 2007). It falls short of the Limestone Coast of South West Wales Special Area of Conservation Core Management Plan (CMP) target of at least 100ha of suitable habitat, with a minimum of 50ha of GC habitat. As with most surveys, especially on large sites such as Castlemartin Range, this one was necessarily a sample, rather than a census, of all *Succisa pratensis*. Some small patches will have been missed, but these will have added up to a minimal area, far less than the additional 20ha targeted in the SAC Plan. Thus, it is recommended that the CMP target be adjusted to reflect the values recorded in 2015.

The current management by the MOD and Landmarc Support Services in consultation with NRW has maintained a healthy marsh fritillary metapopulation since its discovery in 2003. The management task is large, balancing the needs of the many key species and habitats on the Range, as well as the MOD's own requirements. There are small issues, such as accidental burns and scrapes in *Succisa*-rich patches, which can be easily resolved. Any future increase in stock numbers should be considered carefully, to ensure that grazing does not intensify on marsh fritillary breeding areas, and sheep grazing should continue to be restricted to winter. This would be tricky to control within the large grazing compartments. A relaxation of grazing in areas of Range East supporting good stands of *Succisa pratensis* may help boost numbers of the marsh fritillary here. The needs of other key

species requiring very short turf could be accommodated in the areas shown to have little or no marsh fritillary habitat.

Future monitoring is vital to ensure the survival of this internationally significant marsh fritillary metapopulation. Due to the substantial extent of habitat across this large site, a monitoring plan should be developed to ensure that different parts of the Range are regularly audited. It will require a large commitment by volunteers, Butterfly Conservation Wales and/or contractors to ensure that it can be repeated on a regular basis. The additional surveys suggested in the Discussion above (Section 6) would throw further light on the status and survival of this remarkable marsh fritillary metapopulation and its habitat. A survey of potential habitat outside of the Range, particularly to the north, would further add to our knowledge of this SSSI key feature metapopulation. All of these measures would increase our understanding of marsh fritillary metapopulation dynamics, habitat condition and management on sites across Wales.

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All photographs by Deborah Sazer or John Anderton.

9. References

Bulman, C.R., Wilson, R.J., Holt, A.R., Galvez Bravo, L., Early, R.I., Warren, M.S., Thomas, C.D. 2007. *Minimum viable metapopulation size, extinction debt and the conservation of a declining species.* Ecological Applications. 17(5): 1460-1473. Ecological Society of America.

Countryside Council for Wales. Undated a. *SR 99/1 Castlemartin Ranges (part SSSI): site description.*

Countryside Council for Wales. Undated b. *Site of Special Scientific Interest Citation Castlemartin Range.* SSSI 0140 Citation EN001

Countryside Council for Wales. Undated c. *Castlemartin Range SSSI Your Special Site and its Future.*

Countryside Council for Wales. 2008. *Core Management Plan including conservation objectives for Limestone Coast of South West Wales / Arfordir Calchfaen De Orllewin Cyrmu SAC.* Countryside Council for Wales.

Countryside Council for Wales. 2011. *Castlemartin Range SSSI – Consenting Protocol 2011-2016.* Countryside Council for Wales.

Fowles, A.P. 2004. *Conservation objective for marsh fritillary populations on marshy grassland.* Unpublished file note. Countryside Council for Wales.

Fowles, A.P. 2005. *Habitat quality mapping for marsh fritillary populations.* Staff Science Report 05/5/1. Countryside Council for Wales.

Hawkeswood, N. 2011. *Integrated Rural Management Plan, Defence Infrastructure Organisation Service Delivery Wales and West, Castlemartin Range, Volume 2 – Part C: Natural Environment*. Defence Infrastructure Organisation.

Haycock, B. 2005. *Marsh Fritillary recording in Castlemartin Range West 2004* Report to SPRRAG, unpublished CCW report.

Haycock, B. 2010. *Marsh Fritillary recording on the Castlemartin Peninsula – 2009*. unpublished CCW report.

Knight, G. 2008. *Invertebrate survey of the mesotrophic and calcicolous grasslands of Castlemartin MoD Range, Pembrokeshire 2007-2008.* Unpublished report by National Museums Liverpool for Landmarc.

Pembrokeshire Marsh Fritillary Recording Group. 2013. *Pembrokeshire Marsh Fritillary Survey 2013.*

Thomas, J. and Lewington, R. 2010. *The Butterflies of Britain and Ireland.* British Wildlife Publishing.

10. Appendices

10.1. Appendix 1: Marsh fritillary larval web records.

Exact grid reference				
Date	Grid square	Easting	Northing	Number
28/08/15	SR	8833	9662	1
28/08/15	SR	8833	9666	2
28/08/15	SR	8833	9665	1
28/08/15	SR	8834	9666	1
28/08/15	SR	8836	9671	1
28/08/15	SR	8836	9672	1
28/08/15	SR	8836	9671	1
28/08/15	SR	8838	9586	1
28/08/15	SR	8839	9687	1
28/08/15	SR	8839	9586	2
28/08/15	SR	8840	9587	1
28/08/15	SR	8840	9599	1
28/08/15	SR	8841	9598	1
28/08/15	SR	8841	9598	2
28/08/15	SR	8842	9588	1
28/08/15	SR	8842	9689	2
28/08/15	SR	8842	9598	1
28/08/15	SR	8843	9589	1
28/08/15	SR	8845	9592	1
28/08/15	SR	8845	9589	1
28/08/15	SR	8845	9592	2
28/08/15	SR	8845	9594	4
28/08/15	SR	8846	9594	1
28/08/15	SR	8849	9592	3
28/08/15	SR	8849	9592	1
28/08/15	SR	8849	9592	1
28/08/15	SR	8872	9580	1
28/08/15	SR	8874	9581	1
31/08/15	SR	8835	9665	1
31/08/15	SR	8837	9664	1
31/08/15	SR	8839	9641	1
18/09/15	SR	8828	9590	2
18/09/15	SR	8832	9586	1
19/09/15	SR	9077	9519	1
19/09/15	SR	9077	9519	1
19/09/15	SR	9108	9502	5
19/09/15	SR	9113	9497	1
19/09/15	SR	9206	9444	1
20/09/15	SR	8854	9582	1
20/09/15	SR	8855	9585	1
20/09/15	SR	8860	9584	1
20/09/15	SR	8879	9579	1

20/09/15	SR	8902	9577	3
04/10/15	SR	8837	9603	1
04/10/15	SR	8839	9668	2
04/10/15	SR	8839	9636	1
04/10/15	SR	8840	9630	2
04/10/15	SR	8840	9635	1
04/10/15	SR	8842	9637	3
04/10/15	SR	8843	9614	1
04/10/15	SR	8844	9615	1
04/10/15	SR	8852	9607	2
04/10/15	SR	8855	9587	1

	Central grid reference			
Date	Grid square	Easting	Northing	Number
31/08/15	SR	8838	9641	1
31/08/15	SR	8844	9671	2
31/08/15	SR	8841	9627	2
31/08/15	SR	8838	9634	2
31/08/15	SR	8835	9652	3
31/08/15	SR	8840	9673	5
31/08/15	SR	8840	9633	5
31/08/15	SR	8839	9625	6
31/08/15	SR	8838	9661	7
31/08/15	SR	8839	9651	7
31/08/15	SR	8839	9637	7
31/08/15	SR	8838	9662	10
31/08/15	SR	8838	9656	10
31/08/15	SR	8830	9655	10
31/08/15	SR	8847	9677	15
31/08/15	SR	8837	9655	20
28/08/15	SR	8846	9597	38

10.2. Data Archive Appendix

The data archive contains:

[A] The final report in Microsoft Word and Adobe PDF formats.

[B] Species records, which are held on the NRW Recorder 6 database.

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue http://libcat.naturalresources.wales or http://catllyfr.cyfoethnaturiol.cymru by searching 'Dataset Titles'. The metadata is held as record no 116492.

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