Kent Downs AONB ELMS Tests & Trials: Viticulture

Viticulture impacts and opportunities for Public Goods in the protected landscapes of the South Downs National Park, Kent Downs AONB and Surrey Hills AONB.

By

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Executive summary

Over the last 15-years there has been a significant increase in vineyard area in the UK, >300% to over 700 vineyards covering circa 3500 hectares (ha). Now there are 51 vineyards in the South Downs National Park (SDNP) totalling 436 ha, 36 in the Kent Downs AONB (or in the setting) totalling 685 ha, and 10 in the Surrey Hills AONB totalling 122 ha (not include all 2020 plantings). This increase represents one of the most remarkable successes of land use diversification and rural enterprise in the UK in recent decades. Underpinned by climate change and supported by investment, training and recognition for high-quality wine production, the sector looks set for further expansion.

Beyond benefits to rural economies viticulture (grape-growing) and wine production offer opportunities for greater ecosystem services net gains. Vineyards have more potential for biodiversity than arable farming and in some instances pastoral farming, land uses they commonly replace, because the actual land area within a vineyard that is planted with vines is only circa 15–20% of the total area. However, vineyards also affect landscape character and the environment, and have potential for harm, within protected landscapes.

Scale and location is a major factor for the integration of vineyards, particularly in open Downland. Where contained by rolling topography, woodland blocks and field boundary hedgerows – all elements characteristic of much of the South Downs and AONBs – their integration is far more successful. The tipping point, in terms of scale and impact, remains unquantified and requires a landscape capacity assessment.

Opportunities for vineyards to enhance public goods through an increase in biodiversity (thriving wildlife and plants), mitigation and adaptation to climate change, and the delivery of beauty, heritage and engagement are significant. This short study assesses key Landscape Character Type impacts from viticulture and opportunities for mitigation, and it sets the context and background to evaluating where public goods could be enhanced.

1. Introduction

Cultural landscapes in the SDNP and Kent Downs and Surrey Hills AONBs are the result of thousands of years of human interaction with nature. The balance between people and nature is articulated through the definition of landscape and the terminology of Ecosystem Services; those that are regulatory services such as water and air; those that support this such as soil and nutrients; those that are cultural such as education, inspiration and renewal and those that are provisionary such as water, food and raw materials. Key pressures on these landscapes are as diverse as loss of habitat and biodiversity, tranquillity, water quality, and soil health. Agricultural intensification, climate change, tourism and recreation contribute to those pressures.

Protected landscape authorities have a responsibility to manage challenges and interventions and balance socio-economic wellbeing and change within these landscapes, to preserve and enhance them (Section 2).

Vineyards, wineries and associated infrastructure can have an impact on landscape character and ecosystem service provision, and they present both risks and opportunities. These are the focus of this short study.

This report provides a high-level landscape impact assessment for the different protected landscapes and sets out initial findings to inform a focus on areas of viticulture that could offer enhanced public goods. Ecosystem services delivered through viticulture can be as net gains from the land use they replace (arable or pasture), yet their benefit or harm is often relative to the landscapes (and associated pressures) in which they are established; how they are managed; their degree of socio-economic and landscape integration; and, their scale. Therefore, this assessment of impacts in the protected landscapes provides a roadmap to identifying opportunities for Natural Capital derived public goods.

2. Landscape characters within the protected landscapes

The landscape characters of the SDNP and AONBs are summarised as follows:

SDNP: What appears to have been consistent through the millennia following the initial clearances are: the openness and views from the high ground; the short grassland; the well-travelled and grazed pasture of the downland hills; the winds and exposure; the interaction between nature and agriculture; the rivers, wooded slopes; the interaction with both the sea to the south and with the Weald to the north; and, its historic trade and transport links and key views to and from the scarp slopes of the South Downs. A high proportion of the landscape is historically intact and has remained unchanged in use (often pasture) and pattern for several hundred years. What has of course changed are the scale and types of farming, the settlement scales, building styles and materials. Along with this, the nature of the ecosystem habitats, with change in woodland make-up and loss of chalk grassland, eroding soils and shorelines.

The geology of the South Downs underpins so much of what makes up the special qualities of the area: its diverse landscapes, land use, buildings and culture. While most people immediately think of chalk when they think of the South Downs, greensands and clays form the Western Weald. In this relatively small area a rich diversity of landscapes exist. Within these diverse landscapes you can discover hidden villages, thriving market towns, farms both large and small, and historic estates, connected by a network of paths and lanes, many of which are ancient.

Kent Downs AONB: The unique landscapes of the Kent Downs AONB create and contain a rich and distinctive biodiversity providing a home to many plants and wildlife including several species that are largely or wholly confined to the Kent Downs. Habitats found in the Kent Downs include chalk grassland, woodlands (ancient woodland, veteran trees and wood pasture), traditional orchards and cobnut plats, chalk cliffs and the foreshore, chalk rivers and wet pasture, ponds and heathland. Many of these habitats have become isolated making them vulnerable and some of the plants and wildlife found in the Kent Downs are scarce. A long-established tradition of mixed farming has helped create the natural beauty of the Kent Downs. The pastoral scenery is a particularly valued part of the landscape and farming covers around ~70% of the AONB. Expansive arable fields are generally on the lower slopes, valley bottoms and plateaux tops. Locally concentrated areas of orchards, cobnut plats (nut orchards), hop gardens and other horticultural production are also present in the Kent Downs. Livestock – particularly sheep – can often be seen grazing grassland across the Kent Downs.

As with the SDNP, a large proportion of the Kent Downs is based on chalk which leads to vibrant and colourful chalk grassland where orchids and other chalk-loving plants thrive. South-facing steep slopes (scarps) of chalk and greensand, hidden dry valleys, broad and steep-sided river valleys and of course the iconic white cliffs around the Dover coast are some of the dramatic landforms to be seen within the Kent Downs. Breath-taking, long-distance panoramas are offered across the Kent Downs. Man-made features such as quarries from the former cement making industry around the River Medway create distinctiveness at a local level.

Human activity across Kent for 1000s of years has created an outstanding heritage and 'time depth' to the Kent Downs. There are the remains of Neolithic megalithic monuments, Bronze Age barrows, Iron Age hill-forts, Roman villas and towns, medieval villages focused on their churches, post-medieval stately homes with their parks and gardens and historic defence structures from Norman times to the 20th century. Fields of varying shapes and sizes and ancient wood-banks and hedges set within networks of drove-ways and sunken lanes add to the historic look and feel of Kent's rural landscape. Distinctive architecture can be seen in villages and oast houses, churches, former farm buildings and country houses are a reminder of Kent's lengthy history. Tranquillity and vibrant communities are present in the Kent Downs AONB

Surrey Hills AONB: The Surrey Hills is now one of the most wooded of the nationally protected areas in the country. It has an intriguingly diverse landscape characterised by hills and valleys, traditional mixed farming, a patchwork of chalk grassland and heathland, sunken lanes, picturesque villages and market towns. The special landscape features that define the special character of the Surrey Hills are its views, woodland (40% of the AONB and 14% of which is ancient woodland), heathland and commons (18% of the AONB), tranquillity, country lanes, downland, historic buildings, dark skies, farmland and grassland (40% of the AONB is dedicated agricultural land), rivers, streams and aquifers, and parkland. 1% of the AONB is remnant chalk grassland.

Although geology, soils and climate have created the bones of the landscape, the appearance of the Surrey Hills has been shaped for centuries by the changing patterns of land use and settlement. Over much of the Surrey Hills the historic settlement pattern remains largely intact: small picturesque villages of Saxon and medieval origin in the valleys; isolated farmsteads on chalk slopes; valley bottoms and in clearings won from the woodland; large country houses with designed landscapes, including parkland; market towns; and remnants of seventeenth and eighteenth century industry.

3. Viticulture growth

Evidence points to the existence of vineyards in southern England during the Medieval Warm Period (Gladstones, 1992) and to their potential existence in Roman Britain (Selley, 2004). Over the last 15-years there has been a recent significant increase in vineyard area in the UK; >300% to over 700 vineyards covering circa 3500 ha (see Figure 1). Now there are 51 vineyards in the SDNP (Figure 2) totalling 436 ha, 36 in the Kent Downs AONB (or in the setting) totalling 685 ha (Figure 3), and 10 in the Surrey Hills AONB totalling 122 ha (Figure 4). This data does not include all 2020 plantings.

The presence of commercial vineyards in England and Wales today is mainly attributed to suitable climatic conditions, in particular, accompanying air temperatures which have increased with climate change.

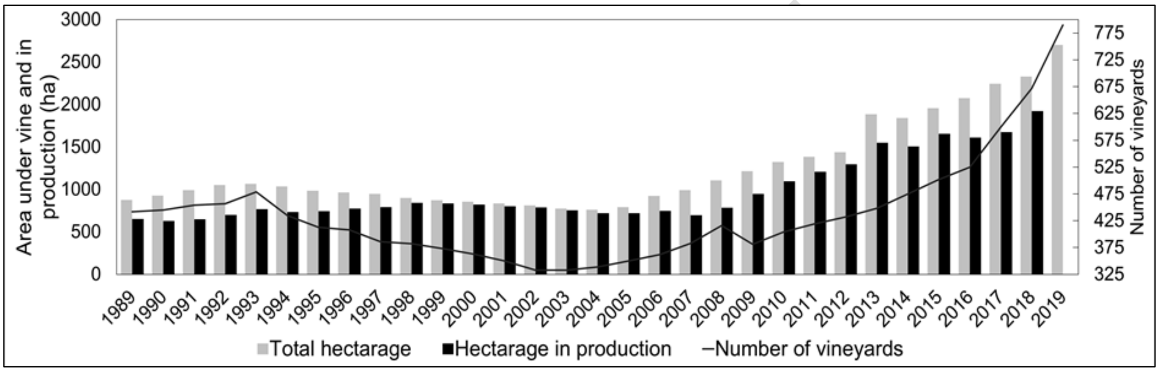

Figure 1. UK hectarage under vine and vineyard numbers (1989 – 2019). Data source: Food Standards Agency (FSA, 2019) and Vinescapes.

Recent vineyard plantings have predominantly occurred in southern England (50–52°N) with vineyards in south-east (East and West Sussex, Kent, and Surrey) and south-central (Berkshire, Hampshire, the Isle of Wight, and Wiltshire) England accounting for circa 70% of the UK total. Most large commercial vineyards are positioned within south-east and south-central England.

Data from the UK Vineyard Register (Wine Standards Board of the Food Standards, 2019) also shows that average vineyard size in the UK has risen from 1.98 ha in 1989 to 3.41 ha in 2018. Total UK vineyard area is greater than that of another emerging cool climate sparkling wine producing region: Tasmania (ca. 2000 ha) but significantly smaller than another closer producing region, Champagne in France, which is over 35,000 ha, growing predominantly the same varieties as the UK.

English Sparkling wine has received significant national and international acclaim for its quality. Whilst not all English Sparkling wine is of an exceptional standard, those that are have been heralded by wine critics, competition judges, the wine (and other) media and customers as prestigious. Indeed, increasing recognition for its quality and associated awards were contributing reasons cited by English wine producers (in a 2015 survey) as drivers for recent growth of the sector (Nesbitt, Kemp, Steele, Lovett, & Dorling, 2016)

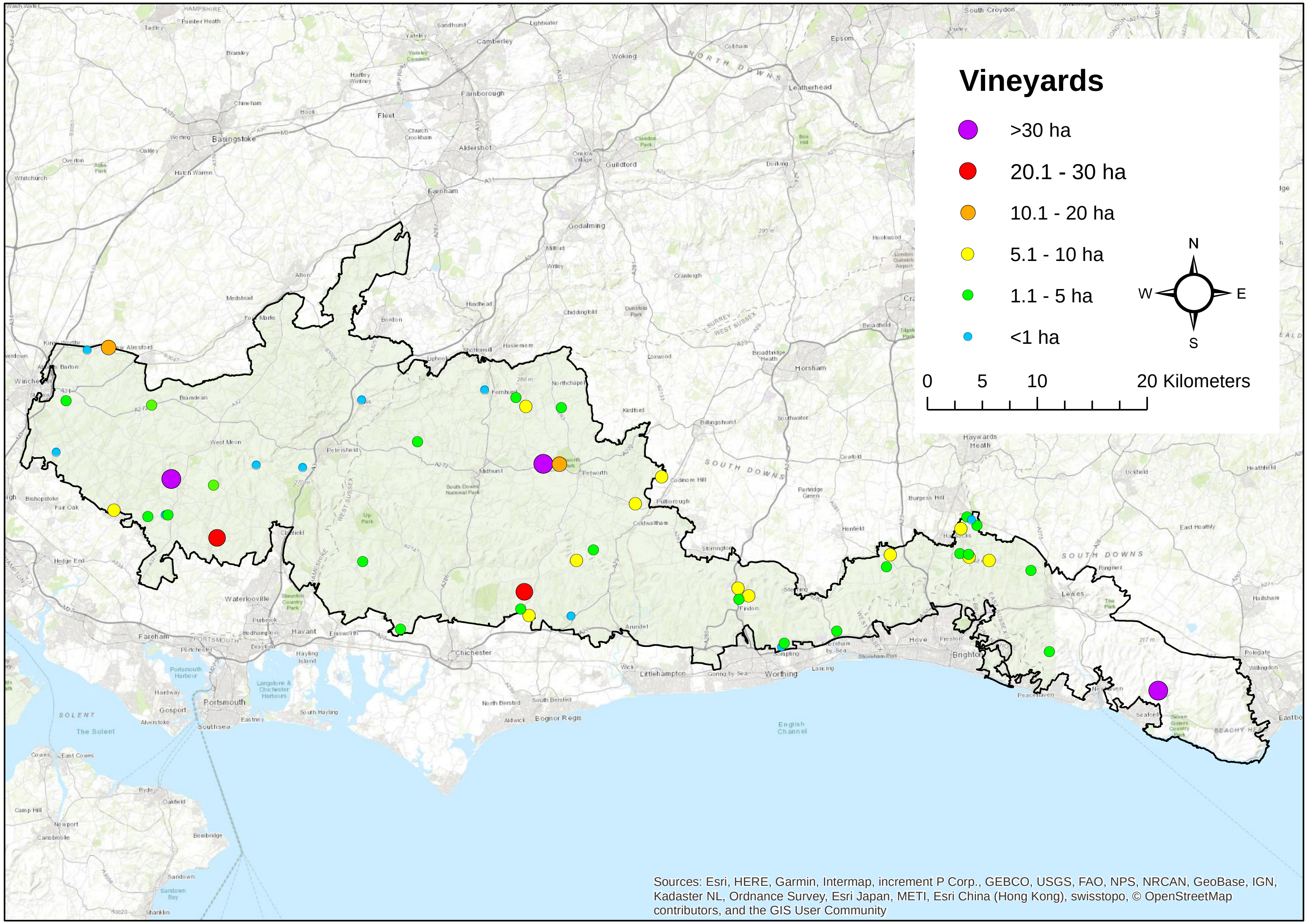

Figure 2. Vineyards within the SDNP (2020), classified by scale (ha).

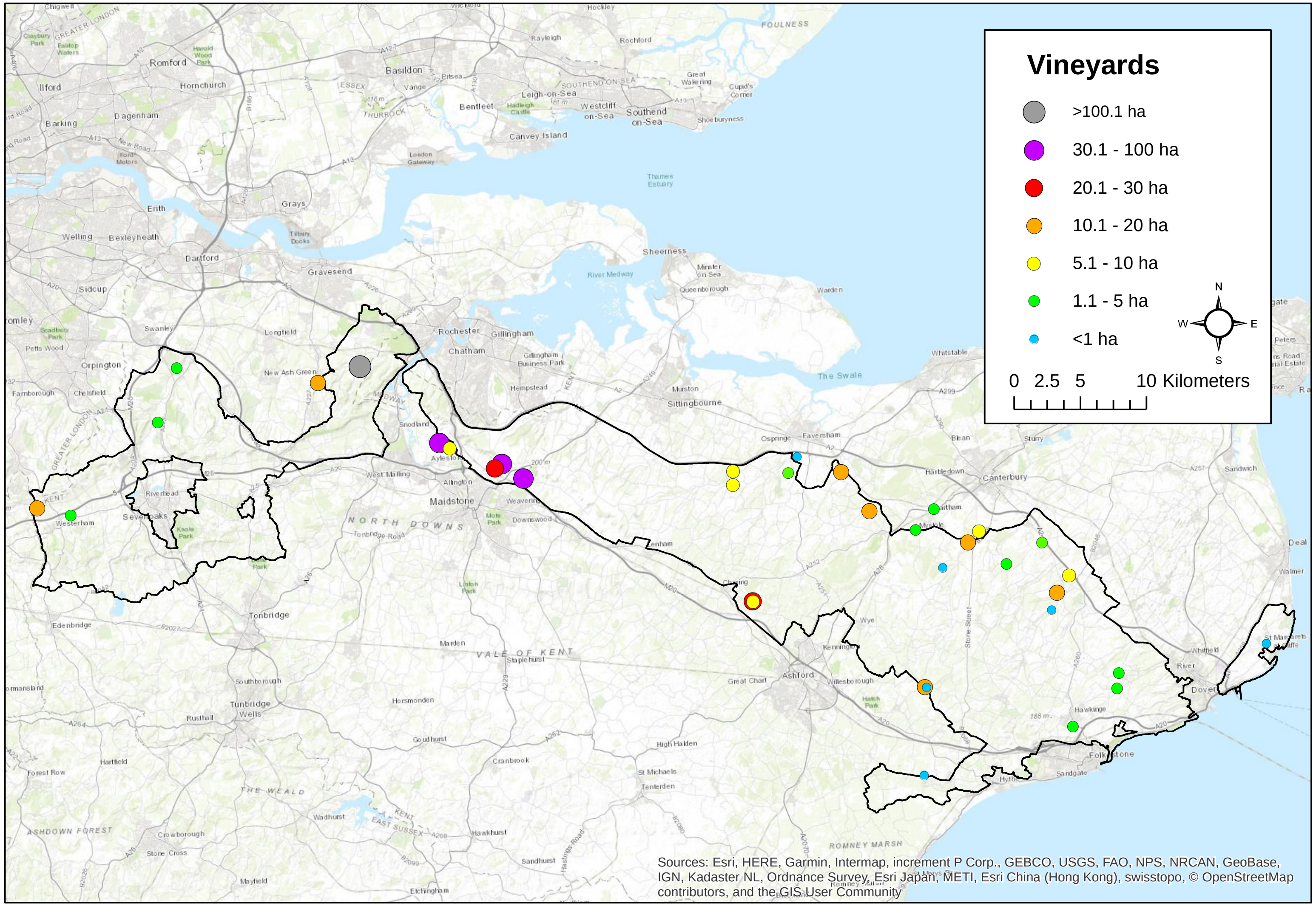

Figure 3. Vineyards within the Kent Downs AONB (2020), classified by scale (ha).

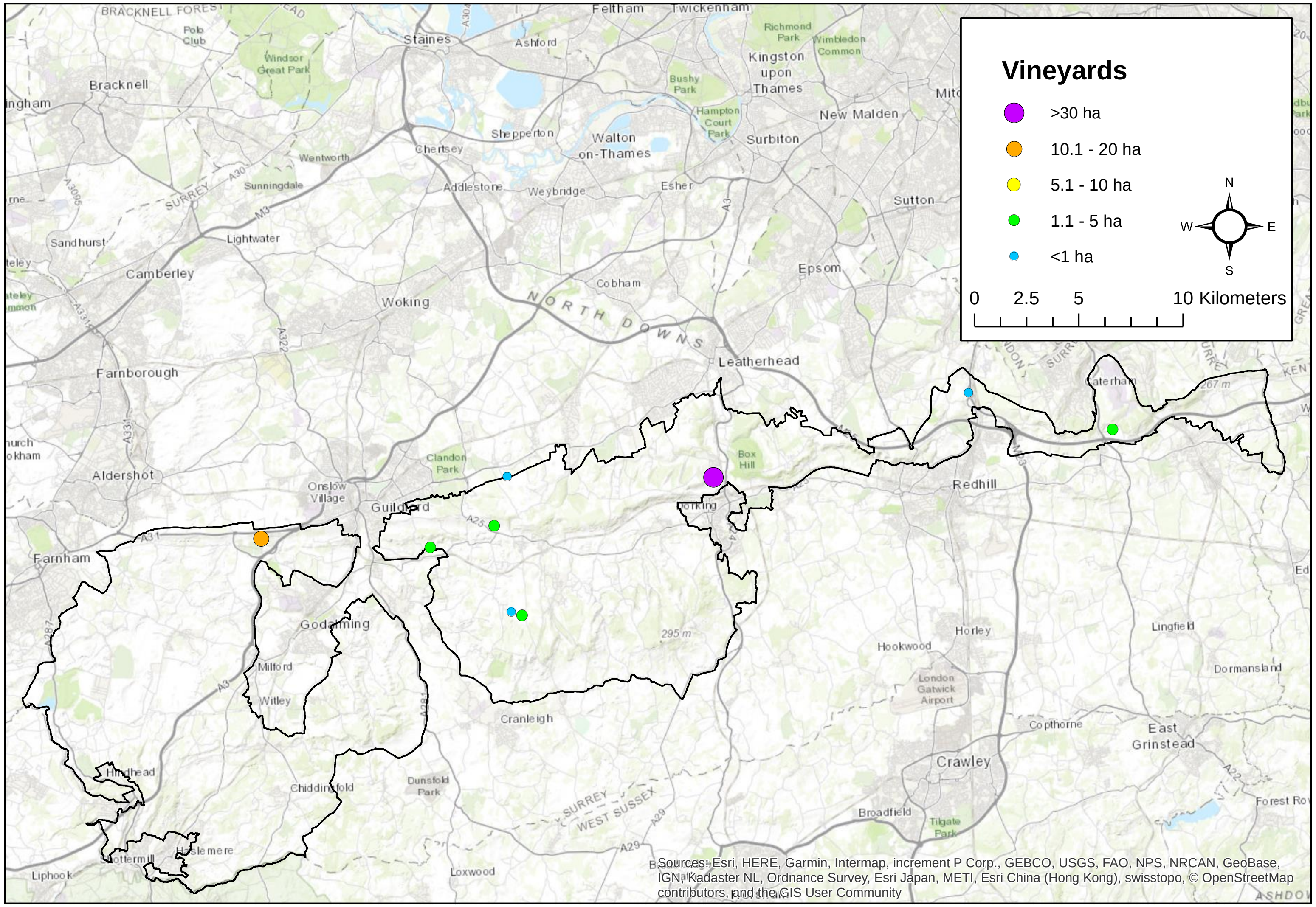

Figure 4. Vineyards within the Surrey Hills AONB (2020), classified by scale (ha)

Note: For the purpose of this study individual vineyards are classified as being physically separated when more than 100 m apart. Where 2 – 3 vineyards with different names, but belonging to the same business/owner, are within just a few metres of each other, these have been classified as one vineyard entity. Conversely where 2 – 3 vineyards have the same name and belong to the same business/owner, but are more than 100 m apart, they have been classified, in this study, as individual vineyards.

The recent rapid expansion of viticulture in England and Wales is predicted to continue with a potential 40 million bottles of English wine being produced annually by 2040, with a potential retail value of £1bn or more (Wine GB, 2018). WineGB's chairman has stated: '*English and Welsh wine is seeing growth far exceeding any industry forecasts and the sector is the bright light in UK agriculture with vineyards being planted across the breadth and depth of our island'* (Wine GB, 2019).

4. Suitability mapping

Vineyard land 'requirements' in relation to topography, soils, land cover, weather and climate (longer-term conditions; commonly measured over a 30-year period) are not uniformly the same for all vineyards. There are constants within those variables that hold true for a 'good site' (set out below), but required/desired variables will alter somewhat depending on the intended grape varieties, wine style, viticulture decisions and practices (including rootstocks, training systems, automation etcetera). Nonetheless site selection is critical to viticulture and to its likely success, profitability, resulting wine styles, marketing and overall sense of place – what is sometimes called 'terroir'. Notwithstanding the human element to this, and the history and heritage of the viticulture location or region, weather and climate conditions are critical as they play predominant roles in grapevine physiology and phenology and ultimately determine the commercial viability of viticulture.

To facilitate an analysis of landscape character impacts of viticulture in the SDNP and AONBs we (Vinescapes) modelled land and climatic suitability within the protected landscapes to elucidate the spatial distribution and scale of viticulture potential.

The spatial and varietal distribution of longer established wine producing regions of the world, often termed the 'old-world', largely results from centuries of trial and error, experience, learning and adaptation. For newer regions such as the SDNP decisions regarding terrestrial and climatic suitability cannot readily be established from empirical or regression-based predictions. Defined quantitative relationships between variables such as locality, topography, soil characteristics, seasonal weather profiles, inter-annual variability, grapevine yields and grape quality parameters for different varieties are not yet objectively established within the protected landscapes. Vineyard site selection remains on an ad-hoc case-by-case basis often lacking systematic spatial comparison and potentially exposed to value judgements around critical characteristics, their relative degrees of importance and the weightings that should be applied to them. However, to provide an objective high-resolution local – regional assessment of climatic and terrestrial (soil, topography, land use) suitability, modern Geographic Information Systems (GIS) for data integration and spatial analysis provide a rapid means of identifying land suitability for viticulture, thus bypassing the decades or even centuries of exploration. GIS tools have been employed here to deliver high-resolution (50 x 50 m) viticulture suitability maps which in-turn help impact assessments and policy relevant actions that may be forthcoming from this work.

4.1. Model development / methodology

Data sources and the methodology for suitability model development can be found in (Nesbitt et al, 2018) and are not repeated here. There are two key differences in this study: the climate data is derived from the latest UK Climate Projections 2018 (Met Office UK Climate Projections (UKCP18), 2020a); 5km resolution analysis tool, and this study does not use a Fuzzy Logic methodology to grade suitability, rather a Boolean approach is adopted within the variable constraints applied.

It should be noted that whilst these variables have been employed for modelling work within this study, this does not mean vineyards will not be established on land with variables that fall outside of these thresholds. Indeed, some within the National Park and AONBs could be described as 'sub-optimal' as they fall outside of these variable thresholds. In a similar vein, it may be somewhat surprising to note that, within the variable thresholds provided below, soils classified as slowly permeable, seasonally wet and with impeded drainage are listed. Whilst these are undesirable characteristics several well established vineyards within the SDNP and AONBs exist on them and in all likelihood with appropriate soil and ground management, rootstock selection, and viticulture practices the prima facie challenges of such soils may be overcome or mitigated.

Therefore, whilst this study includes an objective assessment of present land suitability it should be expected that vineyards exist, and may in future be planted, as outliers to this model.

4.2. Model variables

Model variables and their relationship to viticulture are explained further below:

Elevation: There is no stipulated 'ideal' elevation for vineyards in England and Wales but guidance suggests vineyards would be best sited below 100 and not above 150 m (Skelton, 2014). Elevation suitability is restricted by decreasing temperatures at higher altitudes and the greater potential for wind exposure.

Aspect: At higher latitudes south facing slopes (in the northern hemisphere) have greater direct solar radiation gain potential (Coombe & Dry, 2004); (Jackson, 2014) particularly during the ripening period when the sun is higher in the sky. They are also conducive to reducing the lag phase during which a site heats up and dries out after a cold night (Jackson, 2014). All else being equal such slope aspects are favourable to both yield and grape berry quality parameters.

Slope angle: Slope angle for viticulture (with conventional practices and equipment) is 1–15%. The potential for mechanical vineyard-management activity becomes increasingly limited on slopes greater than 10% (Jackson, 2014) and erosion risk increases. Below 1% there is an increased risk of cold air accumulation and potential frost damage (Jones, Snead & Nelson, 2004).

Land cover: Potentially suitable areas for viticulture are limited in this work to those classified as arable, horticulture or grassland in the Centre for Ecology and Hydrology's (CEH) Land Cover Map (LCM) (Centre for Ecology and Hydrology, 2007), because they were deemed most likely to exhibit viticulture suitability parameters and correspond to most existing vineyards previous landcover.

Soil: Soil texture, drainage, pH, fertility, nutrient and organic matter content are all important attributes in determining viticultural suitability. Their influences on vine nutrient and water availability, soil temperature and humidity, the solubility of metal ions and the supply of nutrient cations and anions, the number of beneficial microbes, and contributions to soil chemical, physical and biological properties all impact vine health, growth and productivity (Davenport & Stevens, 2006); (Field, Smith, Holzapfel, Hardie, & Emery, 2009); (Lanyon, Cass, & Hansen, 2004); (Riches, 2013). Although a range of desirable soil characteristics exist for viticulture, for example it is generally accepted that soil pH should be between 5.5–7.5 for optimum vine growth and soil microbial composition (Cass & Maschmedt, 1998) (Lanyon, Cass, & Hansen, 2004); (Riches, 2013), no one prescriptive 'ideal' set of soil properties exists. Rather a broad and generalised range is presented as being suitable under different environmental circumstances and for different rootstocks, clones, varieties, planting densities and training systems. It should also be noted that many soil characteristics, particularly nutrient availability, can be ameliorated via soil management activities to achieve desired traits. However, to best represent the range of soil characteristics deemed desirable for viticulture the Soilscapes data series was selected as it provides useful, concise, easily interpreted and applicable descriptions of the soils of England and Wales. Whilst not necessarily 100% representative of soil 'types' at individual field scale it was found by Nesbitt et al. (2018) to be more representative than other soil mapped data. 9 of the 27 Soilscapes soil descriptors / 'types' were selected for this study. Whilst accepting that 'Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils; Slowly permeable seasonally wet acid loamy and clayey soils; and, Slightly acid loamy and clayey soils with impeded drainage' are not theoretically ideal for viticulture they were included because several well established vineyards within the National Park and AONBs are established on such soils and presumably have employed appropriate vines and viticulture practices to grow on them.

Designated areas: It was assumed that where land areas had been awarded a special designated status, for example, Site of Special Scientific Interest, and were therefore 'protected', that they would not be available for viticulture.

Temperature and bioclimatic indices: Temperature plays a major role in viticulture viability, grapevine growth, and in modulating the final content of compounds in grape berries such as sugars, acids, phenolics, flavour compounds and proteins (Gladstones, 1992). In viticulture-climate research temperature is often presented through bioclimatic indices (BCIs), metrics which provide simplistic illustrations and assessments of present or future viticulture or varietal suitability (Anderson, Jones, & Tait, 2012); (Duchêne & Schneider, 2005).

These BCIs commonly place numerical or descriptive envelopes around summed or averaged daily or monthly growing-season temperatures to express varietal suitability ranges. They are applied in different regions, for different timescales, using different spatial resolutions, and driven by both observed and modelled climate data. Here the latter applies and it should be noted that modelled data does not necessarily resolve the range of climatic processes, intra-annual variability, or critical daily or hourly time-scale events which can impact productivity and quality and which are likely to influence sub-regional climate-viticulture relationships (Jones, Moriondo, Hall, & Duff, 2009); (White, Diffenbaugh, Jones, Pal, & Giorgi, 2006). However, the model (5 x 5km resolution) does provide a meso-scale assessment which indicates local viticulture suitability. Where temperature is applied to model BCI viticulture potential in the SDNP and AONBs it is used as an analogue with the assumption that larger bioclimatic values present increased opportunity when the bottom end of 'cool-climate' is being explored.

There is one temperature BCI employed in this modelling work: Growing Season Average Temperature (GST), calculated as the monthly mean (April–October in the Northern Hemisphere) summed (for the 7-months) and divided by 7. The classifications awarded to GSTs are shown in Figure 5.

Spring air frosts that injure developing buds and shoots are among the most common detrimental effects of minimum temperature extremes on *Vitis vinifera* L. grapevines. Without frost protection, they pose a significant economic risk to vineyards (Trought, Howell, & Cherry, 1999). Cool-climate wine producing regions are particularly exposed to the risk of early season frost events when the advancement of budburst occurs in response to increased spring air temperatures (Molitor, Junk, Evers, Hoffmann, & Beyer, 2014); (Mosedale, Wilson, & Maclean, 2015).

Rainfall: Wine grape quality and quantity are affected by precipitation and water availability (Makra, et al., 2009); (Moutinho-Pereira, et al., 2007). High levels of rainfall, usually accompanied by reduced sunlight, can negatively affect vine growth, berry quality and quantity through associated issues such as increased disease pressure, overstimulated vegetative growth, reduced flowering, millerandage (where grape bunches contain berries that differ greatly in size and maturity, sometimes referred to as 'chicken and hen'), coulure (flowers fail to set and are shed at or after flowering) and a sugar/acidity imbalance.

High rainfall during June, when grapevine flowering commonly occurs in the UK, has been previously shown to have a negative impact on flowering and subsequent grape yield (Nesbitt, Kemp, Steele, Lovett, & Dorling, 2016).

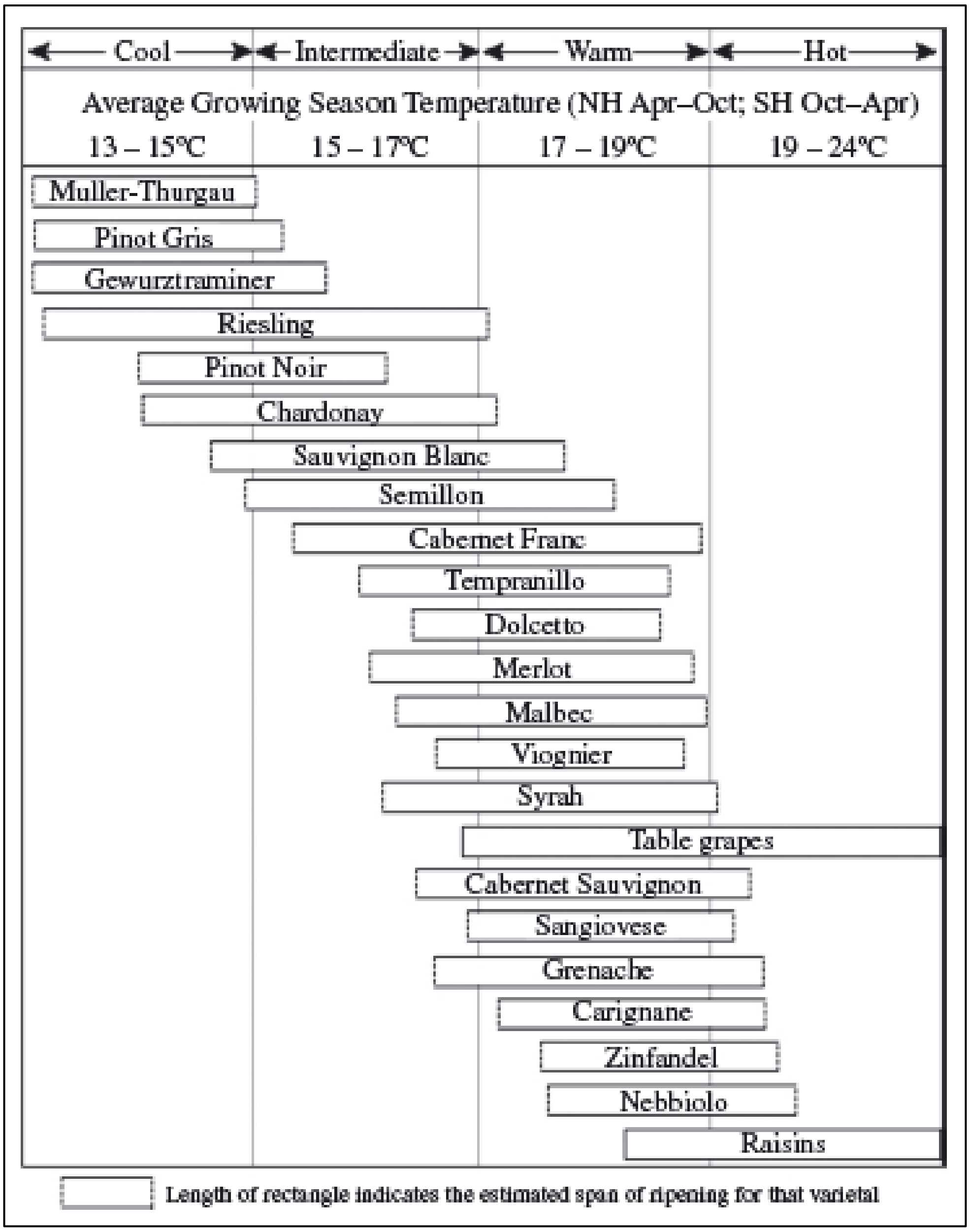

Figure 5. Climate – maturity thresholds for GSTs and varietals (Jones, 2006)

Wind: Wind speed and direction have not been included within this model as detailed near-surface wind speed data for the growing season within the SDNP and AONBs was unavailable. Wind, at vineyard level, is likely to be influenced by local topographical and geo-spatial factors. However, it can generally be expected that the prevailing wind through most of the National Park and AONBs is south-westerly. Wind mitigation is critical in vineyards as it can disrupt canopies and flowering. A breeze on the other hand is beneficial as it helps dry out a vineyard and keeps diseases at bay. The elevation restriction to 150 m within this model is in part due to more likely wind exposure at higher elevations, although there are vineyards within the National Park and AONBs at significantly lower elevations which are exposed and still challenged by wind.

Sunshine and solar radiation are also important with regards to ripening of wine grapes. Within such a relatively small area it has been assumed, for the purposes of this work, that the criteria of southerly facing slopes captures optimal land for sunlight exposure and solar radiation capture. Where this land is in valleys or ‘shaded’ by surrounding higher land the suitability of it for viticulture would require careful and individual site assessments.

5. Viticulture suitability modelling results

Figures 6–8 below show the combined viticulture suitability maps for the three protected landscapes. Before commenting further on this output, we must state that this map SHOULD NOT be used alone as the basis for viticulture investment decisions. All land considered for planting with vines will require a comprehensive viticulture site evaluation by experts.

The viticulture suitability model results indicate:

- ~39,700 ha of suitable land within the SDNP (Figure 6 and Table 1).
- ~7,160 ha of suitable land in the Kent Downs AONB (Figure 7 and Tables 1 & 2).
- ~5,620 ha of suitable land in the Surrey Hills AONB (Figure 8 and Table 1).

It is not possible to state with any degree of certainty how many wineries or what infrastructure would be required to accommodate the various scales of potential growth. This will be dependent on how the sector evolves for the purposes of production and marketing. For example, one large production facility (winery) and associated large storage warehouses could accommodate the production and storage of 10s of millions of bottles. Conversely, every vineyard could have its own small winery, but we know that is not the case currently. Or there could be a mix of small, medium and large wineries for a mix of individual producers or groups or co-operatives of such (as in more established wine producing regions).

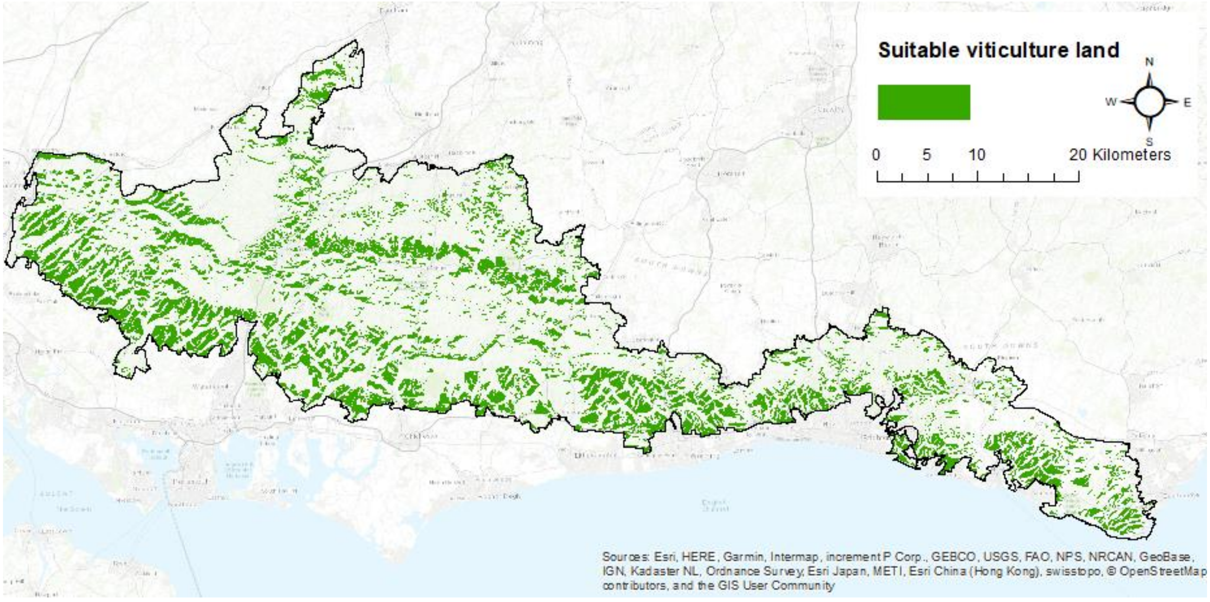

Figure 6. SDNP viticulture suitability areas

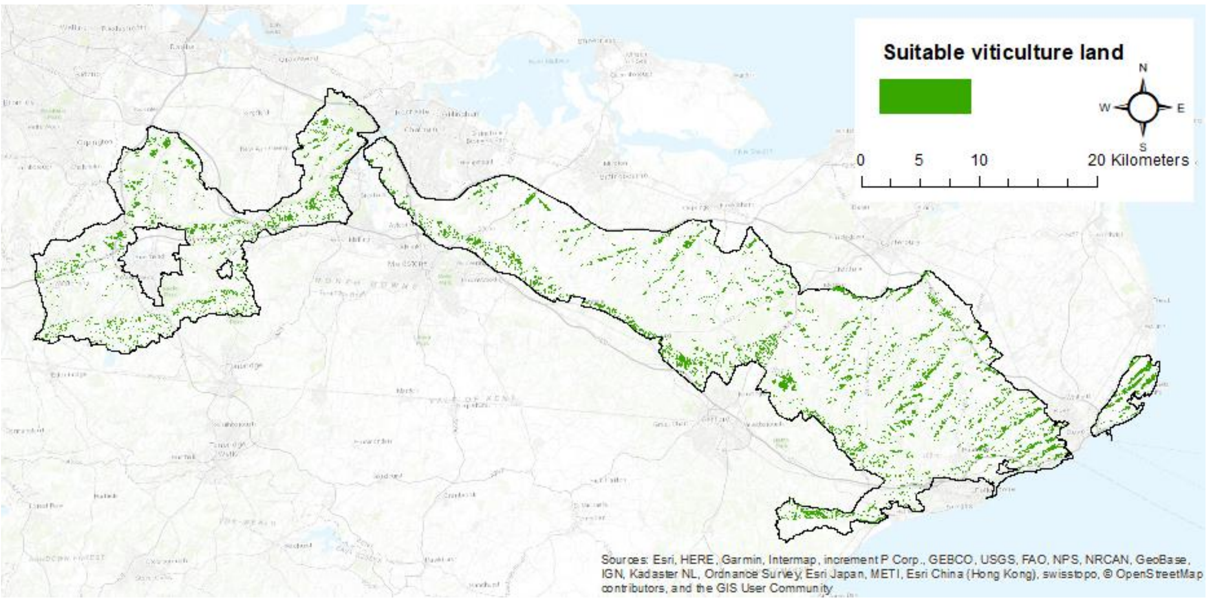

Figure 7. Kent Downs AONB viticulture suitability areas

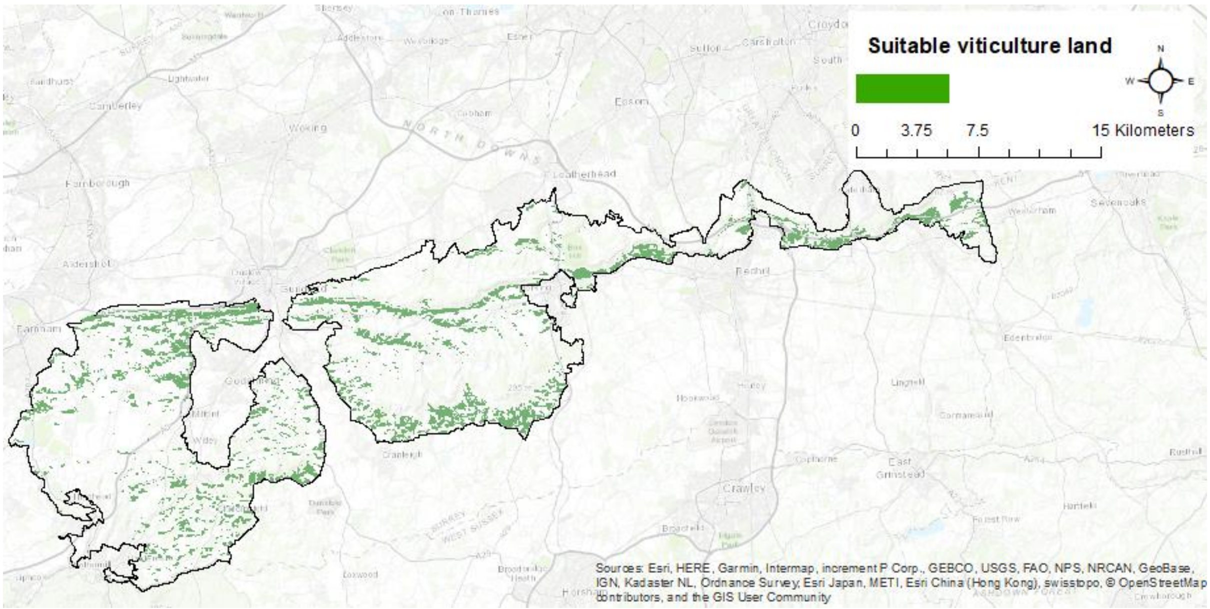

Figure 8. Surrey Hills AONB viticulture suitability areas

When overlain with identified landscape character areas it is possible to see which landscape types have greater or lesser area that is deemed suitable for viticulture (suitable purely from a viticulture perspective, not a landscape capacity perspective). The results of this exercise are shown in Figures 9–11 below. Note, for the Kent Downs AONB two maps are provided as landscapes are identified both by name and type (Figures 10a and 10b respectively).

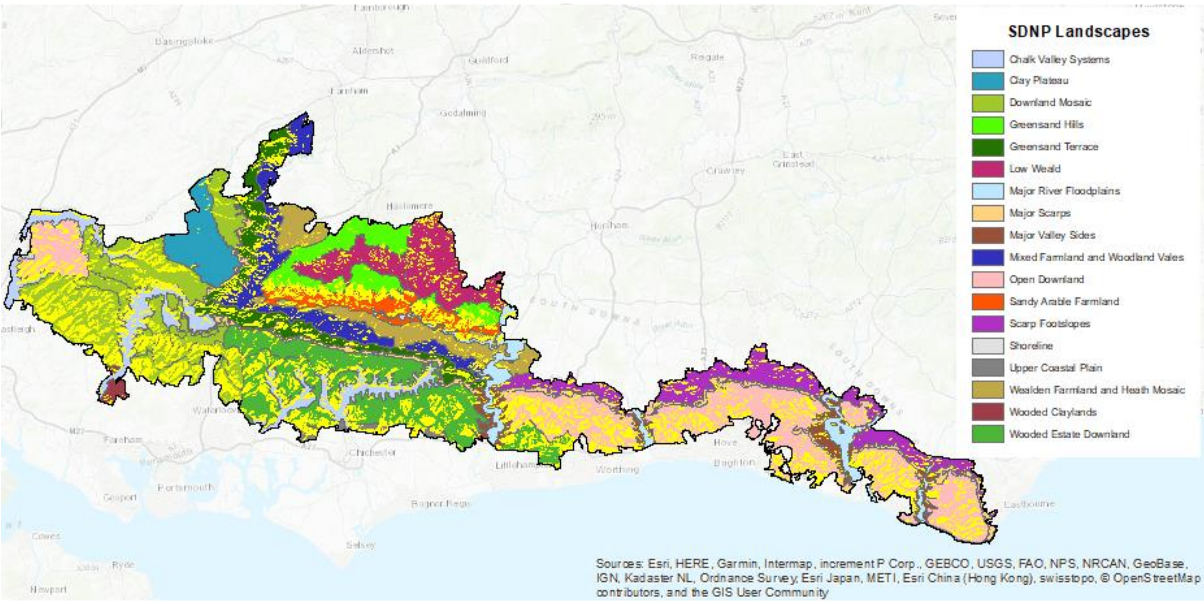

Figure 9. SDNP landscape characters overlain with suitable viticulture areas (yellow)

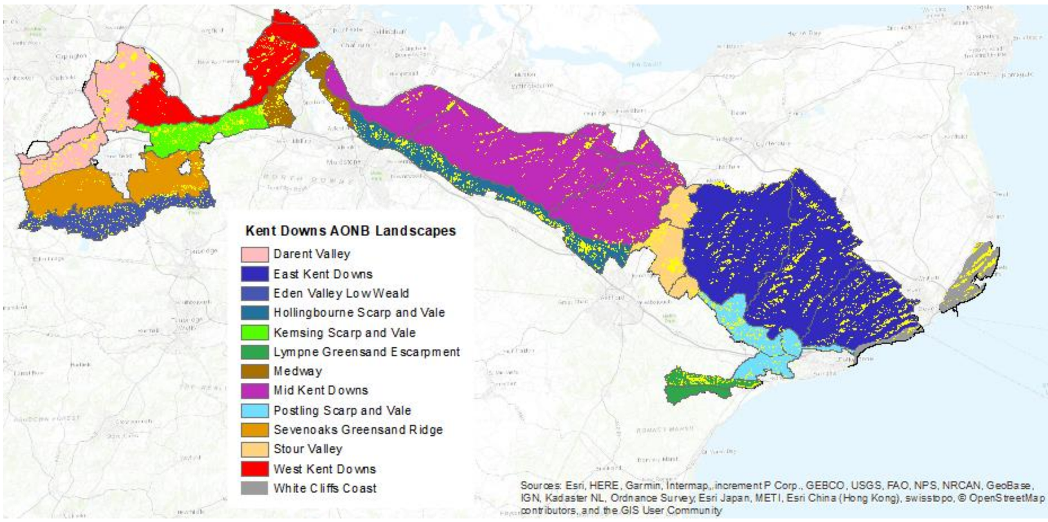

Figure 10a. Kent Downs AONB landscape names overlain with suitable viticulture areas (yellow)

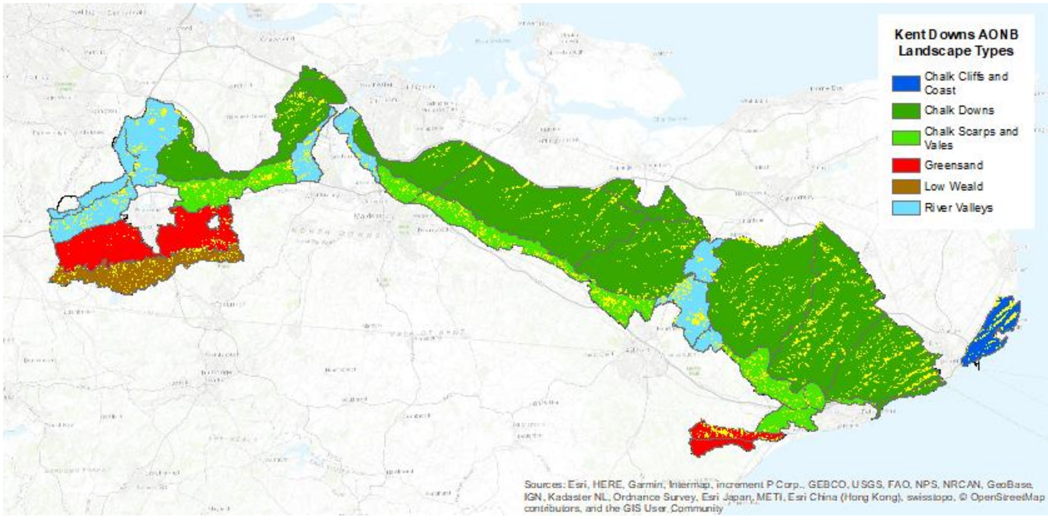

Figure 10b. Kent Downs AONB landscape character types overlain with suitable viticulture areas (yellow)

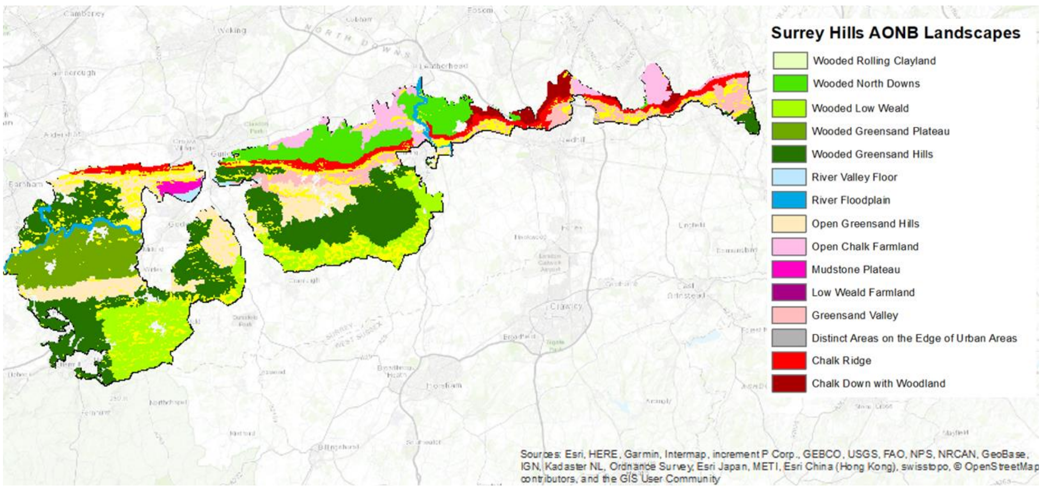

Figure 11. Surrey Hills AONB landscape characters overlain with suitable viticulture areas (yellow)

Subsequently, suitable viticulture land hectarage (ha), by landscape character type, are presented in Table 1 below, and additionally for the Kent Downs AONB for Landscape Character Areas (Table 2).

Table 1, SDNP, Kent Downs AONB and Surrey Hills AONB modelled suitable viticulture land (ha) by Landscape Character Types.

SDNP		**Kent Downs AONB**		**Surrey Hills AONB**	
Landscape Character Type	**hectarage (ha)**	**Landscape Character Type**	**hectarage (ha)**	**Landscape Character Type**	**hectarage (ha)**
Scarp Footslopes	1348	Chalk Downs	3316	River Floodplain	41
Major Valley Sides	712	River Valleys	1166	Wooded Greensand Hills	954
Open Downland	10074	Greensand	410	Greensand Valley	1112
Shoreline	2	Low Weald	389	Chalk Down with Woodland	12
Major River Floodplains	181	Chalk Scarps and Vales	1564	Open Chalk Farmland	135
Major Scarps	88	Chalk Cliffs and Coast	314	Wooded North Down	36
Wooded Estate Downland	5967			Open Greensand Hills	941
Upper Coastal Plain	602			Wooded Low Weald	1528
Wooded Claylands	67			Chalk Ridge	525
Chalk Valley Systems	2635			Wooded North Downs	0
Downland Mosaic	8301			River Valley Floor	0
Wealden Farmland and Heath Mosaic	707			Mudstone Plateau	37
Sandy Arable Farmland	2430			Wooded Greensand Plateau	106
Mixed Farmland and Woodland Vales	1623			Open Greensand Hills	188
Greensand Hills	1208			Distinct Areas on the Edge of Urban Areas	5
Greensand Terrace	2118				
Low Weald	1570				
Clay Plateau	71				
TOTALS	**39702 ha**		**7158 ha**		**5619 ha**

Table 2, Kent Downs AONB suitable viticulture land (ha) by Landscape Character Area.

Landscape Character Area	**hectarage (ha)**
West Kent Downs	276
Darent Valley	542
Sevenoaks Greensand Ridge	192
Eden Valley Low Weald	389
Kemsing Scarp and Vale	386
Stour Valley	402
Medway	222
Mid Kent Downs	861

Hollingbourne Scarp and Vale	809
East Kent Downs	2148
White Cliffs Coast	345
Postling Scarp and Vale	369
Lympne Greensand Escarpment	217
TOTAL	**7158**

It is out of scope for this report to detail specific potential impacts and mitigants for each landscape character type or area and to do so would also require a detailed landscape capacity assessment. But key findings show that within both the SDNP and Kent Downs AONB Downland (open, chalk, mosaic), Chalk Valleys and Vales, Sandy Arable Farmland and Greensand Terraces offer the largest scale of area for viticulture. Wooded Low Weald, Greensand Valleys and Hills, and Open Greensand Hills present most area in the Surrey Hills AONB.

The primary landscape that offers most scale of opportunity is chalk downland. Its dominant land use is arable agriculture, but there are also areas of parkland, orchards, vines, woodland and pasture. Field patterns are variable, but are generally larger on ridges than in valleys, reflecting historic processes of enclosure. It is composed of scattered historic buildings including churches, manors, country houses, farms and cottages often of brick and flint construction. A dense network of historic roads, tracks and sunken lanes (including Prehistoric routeways, Roman roads and medieval drove roads and Turnpikes) are characteristic. The downland is relatively tranquil with a strongly rural and somewhat timeless feel. The pattern of ridges and dry valleys gives the landscape a rhythmic feel where views are often linear and channelled by landform. There are long views from high ground, overlooking adjacent valleys. Typical landscape characters are illustrated in Figures 12–14 below.

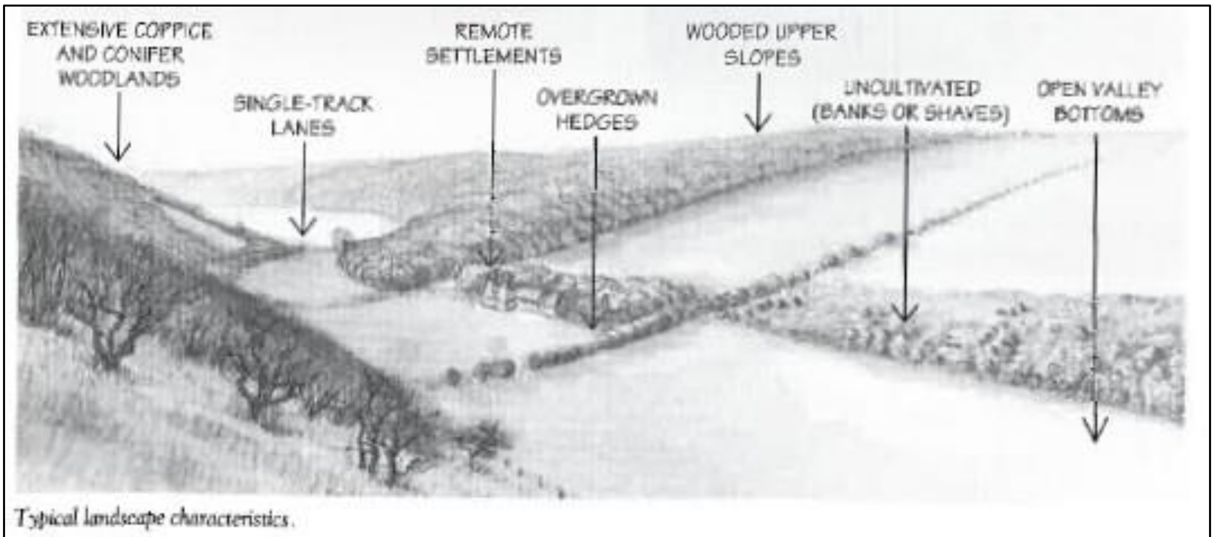

Figure 12. Typical downland landscape characteristics (Source: (Kent Downs AONB) Landscape Character Assessment Update - East Kent Downs Landscape Character Area 1C)

Figure 13. Typical downland landscape characteristics (Source: (Kent Downs AONB) ***Landscape Character Assessment Update - East Kent Downs Landscape Character Area 1C)***

Figure 14. Typical downland landscape characteristics (Source: (Kent Downs AONB) Landscape Character Assessment Update - East Kent Downs Landscape Character Area 1C)

The landscape is not static, and it is affected by changing practices in land management as well as development pressure. Some of the changes, such as the change in crop choice from orchards or arable to grape vines, the increasing use of land for equine management, and the introduction of suburban-style gates, boundaries and road junctions are incremental, but can add up to considerable landscape change across the area. The impact of vineyards within such landscapes will depend very much on their scale, how sensitively they are integrated (for example, whether they are surrounded by woodland or hedges, trellis material choice, ground cover choice) and how they are managed (i.e. effects on tranquillity, practices regarding pesticide application management, whether they are open to the public or require additional infrastructure).

ELMS offer opportunities to restore and reinforce valued characteristics of these landscapes whilst at the same time encouraging sensitive diversification through an ecosystems service approach to conserving and enhancing the landscape – where viticulture and wine production are concerned.

6. Viticulture - landscape impacts

Most vineyards contain:

- Linear rows of vines, circa 2m apart.
- End or row headlands (~10–15m) wide strips of grass.
- Trellising (wooden or metal posts, wires (fruiting and foliage wires), anchors and sundries such as tiebacks, clips and chains) up to 2m height.
- Tutors (thin metal, plastic or wooded tutors/stakes to train the vines; about 1m high).
- Grow tubes / rabbit guards for the first 3–4-years (come in a range of styles and colours).
- Ground cover (grass or plants) in between the rows.
- Cultivated or sprayed (herbicide) strips of ground (~60–80cm) under vines.
- Deer, rabbit and maybe badger fencing surrounding the vineyards, with access gates.
- Surrounding or/and internal hedges, trees and vegetation.
- Vineyard equipment movements (tractors with sprayers, mowers, cultivators, trimming equipment etcetera).
- People working in the vineyards.

Some vineyards also contain:

- Windbreaks (usually linear rows of trees but could also be plastic meshing).
- From mid-March to May some vineyards have frost protection equipment in them. These could be candles/bougies, mobile wind fans, cold air drains or heaters (static or towed).
- Access tracks (grass, hard core, gravel, concrete, tarmac) of varying lengths.
- Vineyard equipment storage facilities, workshop facilities, welfare facilities, offices, spray tank wash down areas, and maybe public areas – although these are often ore associated with winery buildings.

A range of images in Figure 15, below show typical English vineyards.

Figure 15. English vineyards

Cover crops (between vine rows and potentially under vines as well), wildflower mixes, native grasses, biodiversity areas and established windbreaks in vineyards actively support viticulture [and soil health] but also promote biodiversity and ecosystem services – where they are employed. These assets can be part of the vineyard landscape character. For centuries vineyards and wine producers have drawn on landscape character, soils, and a sense of place (terroir) to impart or explain the difference and uniqueness of their wines. Vineyards in the SDNP and AONBs are no exception.

However, a managed, regimented and controlled landscape may not enhance some areas of the SDNP or AONB landscapes and could even be associated with harm and loss of openness. As with other changes of land use and landscape installations receptiveness of them and opinions by residents, visitors and stakeholders is somewhat subjective and affected by many variables. There are also other activities/impacts that can be associated with vineyards such as events, tours and a higher presence of human interaction than was the case in previous land uses. These can have significant effects on landscape and visual qualities, including tranquillity, one of the key landscape character components of the SDNP and AONB areas. Scale and location is a major factor with integration of vineyards, particularly in open Downland. Where contained by rolling topography, woodland blocks and field boundary hedgerows – all elements characteristic of much of the South Downs and AONBs – their integration is far more successful. The tipping point, in terms of scale and impact, remains unquantified and requires a landscape capacity assessment. Additional infrastructure, for example access roads, storage facilities or wineries would be subject to planning permissions and suitability and impact determined on a case by case basis in accordance with planning policy.

7. Environmental and landscape risks

By way of summary, the recent SDNPA Viticulture Growth Impact assessment (SDNPA, 2020) identified that although the landscapes of the SDNP, Kent Downs AONB and Surrey Hills AONB are different in many ways, the environmental risks that viticulture poses do not change between them. This is because the environmental risks are mainly driven by viticulture practices and these practices remain constant across landscape areas, although they vary at a vineyard to vineyard level depending on the practices used. Table 3 below provides a list of annual vineyard operations and their associated risks, classified as essential, optional or alternative tasks.

Table 3. List of annual vineyard operations and their potential hazards

Time of year	Vineyard operation	Tasks	E, A or O?	Potential hazards to the natural environment
December – March	Winter pruning to manage the vine growth and structure to optimise grape yield and quality variables.	Cut/prune vine canes by hand	E	• Risk of soil compaction when walking in the vineyard
		Remove cut canes from trellis	E	• Risk of soil compaction when walking in the vineyard
		Attach canes to lower wire on trellis	E	• Risk of soil compaction when walking in the vineyard
		Mulch prunings in vineyard alleys	A	• Risk of soil compaction when driving a tractor in the vineyard
		Burn prunings on site	A	• Air pollution through burning of prunings • Reduction of soil carbon levels, as prunings are not returned to the soil

		Remove prunings from site	A	• Risk of soil compaction when driving or walking • Reduction of soil carbon levels, as prunings are not returned to the soil
February - March	Trellis repairs	Replace broken trellis posts and mend broken wires and end-assemblies	E	• Soil compaction and damage to alleys and headlands through use of tractor-driven machinery
March - November	Vineyard floor management to facilitate access, manage nutrient and water competition, improve soils and encourage biodiversity.	Maintain a grass cover in the vineyard and headlands through mowing	A	• High-frequency mowing will reduce floral biodiversity, habitats and sources of food for vineyard fauna
		Maintain a weed-free vineyard floor through cultivation	A	• Over-frequent cultivation will disrupt soil habitats and increase the rate of breakdown of soil organic matter, which can result in structural breakdown. • Cultivation on slopes will increase the risk of erosion
		Maintain a weed-free vineyard floor using herbicides	A	• Pollution of water sources (see inputs) • Reduction in floral diversity • Harm to soil organisms (see inputs)
March - November	Fertiliser applications	Application of fertilisers to the soil	E	• Pollution of water sources (see inputs) • Harm to soil organisms (see inputs)
		Application of foliar feeds	O	• Pollution of water sources (see inputs)
April – October	Plant protection from pests and diseases to optimise fruit quality and quantity. Methods vary.	Pesticide application (on the vast majority of vineyards)	O	• Pollution of water sources (see inputs) • Harm to natural fauna (see inputs)
		Deer, rabbit and possibly badger fencing	O	• Disruption to movement of larger animals
		Bird scaring and/or netting	0	• Seasonal disruption to bird populations
April - October	Summer trimming and canopy organisation to optimise vine growth, fruit quality and light inception.	Excess bud and shoot removal	E	• Risk of soil compaction when walking in the vineyard
		Tucking shoots into the trellis	E	• Risk of soil compaction when walking in the vineyard
		Trimming canopies	E	• Over-frequent trimming will generate soil compaction
		Leaf removal	O	• Risk of soil compaction
May - June	Vineyard establishment	Fertiliser application	E	• Pollution of water sources (see inputs) • Harm to soil organisms (see inputs)
		Soil cultivation	E	• Cultivation on slopes will increase erosion
		Vine planting	E	• Risk of soil compaction
		Trellis erection	E	• Risk of soil compaction
October	Grape harvesting	Hand harvesting	A	• Soil compaction due to heavy footfall
		Machine harvesting	A	• Soil compaction due to heavy machinery
		Transport of grapes to the winery	E	• Damage to headlands in wet weather

*(E = an essential task that is required for the effective management of the vineyard, O = an optional task, A = an alternative task)**.***

The main environmental risks are:

- Enhanced loss of soil through erosion.
- Degradation in soil health due to over-cultivation, loss of organic matter and compaction.
- Loss of soil biodiversity through pesticide and fertiliser application.
- Loss of surface biodiversity and native species through habitat destruction and pesticide applications (including spray drift).
- Pollution and eutrophication of water bodies.
- Greenhouse gas emissions.

Table 4 below offers a comparison of potential heightened risks within the three different protected landscapes, caused by viticulture in general, i.e. not just from those surveyed or interviewed.

Table 4. Comparison of key environmental features between the SDNP and AONBs

Area & scale (km^2)	Geology/principal soil types	Principal habitats/land use	Conservation projects	Unique features	Potential heightened risks
South Downs National Park 1600	Chalk downland: shallow lime-rich, freely draining loamy soils, poor in both minerals and nutrients, over chalk or limestone. Chalk eroded in places to reveal underlying lower & upper greensand and Gault clay, these soils are usually acid, nutrient poor and with impeded drainage. Underlying chalk acts as an aquifer.	Sheep-grazed grassland, lowland heath, woodland, coastal cliffs. Farming: sheep, arable, semi-natural grassland, vineyards. River Valleys: chalk streams, wetlands.	Planting disease-resistant elms for the white-letter hairstreak butterfly; 6 km of hedge planting in Woolbeding; Beelines appeal to restore habitat for pollinators; planting 5,000 trees in community spaces, along roads and walking routes.	Large estates (Goodwood, Cowdray, Petworth and Firle), and large areas of the eastern Downs owned by local authorities or the National Trust; South Downs Way National Trail; Well-conserved historical features. High population (110,000), with large market towns.	-Loss of soil through wind erosion - Degradation in soil health due to over-cultivation and loss of organic matter - Loss of soil biodiversity through pesticide and fertiliser application - Loss of surface biodiversity through habitat destruction and pesticide application.
Kent Downs AONB 879	Chalk downland: shallow, freely draining, lime-rich loamy soils over chalk or limestone, eroded to reveal underlying slightly acid loamy greensand and clayey soils with impeded drainage	Chalk grassland, deciduous woodlands (20%), chalk coastal cliffs, chalk rivers, wet pasture, ponds and heathland. Mixed farming: (64%) sheep, horses, arable, orchards, cobnut plats, hop gardens, vineyards	Darent Valley Landscape Partnership Scheme Green Pilgrimage Undergrounding power lines Community orchards	Many habitats have become isolated, so need to create corridors between them Remains of Neolithic megalithic monuments, Bronze Age barrows, Iron Age hillforts, Roman villas and towns, medieval villages & churches, post-medieval stately homes and historic defence structures.	- Loss of soil through wind erosion - Degradation in soil health due to over-cultivation and loss of organic matter - Loss of soil biodiversity through pesticide and fertiliser application - Loss of surface biodiversity through habitat destruction and pesticide application.
Surrey Hills AONB 422	Chalk downland: shallow lime-rich, freely draining loamy soils over chalk or limestone. Greensand hills, plateaux & valleys Some clay Weald areas, plus freely draining very	Woodland (40%), chalk downland, heathland. Agricultural land (40%).	Conservation work at Quarry Hangers. Safeguarding Farnham Heath Nature Reserve against fire damage.	One of the most wooded of the nationally protected areas in the country, an intriguingly diverse landscape characterised by hills and valleys,	- Loss of soil through wind erosion - Degradation in soil health due to over-cultivation and loss of organic matter - Loss of surface biodiversity through

	acid sandy and loamy soils.			traditional mixed farming, a patchwork of chalk grassland and heathland, sunken lanes, picturesque villages and market towns. A diverse landscape that is 40% woodland (of which 14% is ancient), 40% agricultural land and 18% heathland and commons. 1% remnant chalk grass land 25% of the AONB is open to the public, including Leith Hill, the highest point in SE England.	habitat destruction and pesticide application.

At a high level below are some considerations for viticulture impact/mitigants in these special areas:

- Where they are more wooded, this is likely to obfuscate any new vineyard plantings.
- Parts of the Kent Downs AONB, particularly around Faversham, have extensive fruit farms. Diversification to a vineyard in this limited area is not anticipated to impact landscape character, as the trellising systems are already used extensively.
- Scale of receiving landscape and the proposed business is important.
- Key viewpoints could be impacted by an increase in vineyard numbers or scale.

The loss of surface biodiversity through habitat destruction and pesticide application is of major concern to the grape growers interviewed for the SDNP Viticulture Growth Impact Assessment. Pesticide applications in vineyards are, according to Defra, higher/ha, than in arable/cereal farming. However, is should be noted that the lower application rates in arable production will mask the strength of applied products. Vineyards have much more opportunity to use bio-control agents such as Fytosave or Botector etcetera which, if used, will have a higher application rate than a conventional fungicide used on wheat. Further research is needed to facilitate a like for like comparison. What was clear from the vineyard survey and interview results was that the number of pesticide applications ranged between vineyards in the protected landscapes from 6 – 20 applications per year. Whilst pest/disease pressure and pesticide requirements vary between vineyards due to meso and micro scale climatic differences, varietal differences and vineyard management differences, and resulting fruit quality and quantity and therefore value will vary, it is clearly plausible that with improved training, skills and knowledge pesticide application rates could be usefully reduced.

This also points to an opportunity to develop a more integrated approach to plant protection; using a range of different pest management methods and using pesticides only when justified through monitoring the pest, host and environment, and using softer chemistry, such as biological control agents. A good illustration of the value of an IPM plan is the case of light brown apple moths in European vineyards, non-indigenous pests which have negatively affected many vineyards in southern England over recent years.

There is significant potential for vineyards to increase native flora and fauna in vineyard environments to boost biodiversity and ecosystem services, indeed such approaches have been adopted elsewhere and with some research could be more readily adopted in the UK.

It is therefore important to note, and not underestimate the desire from Vineyard Managers to learn and do more to be good custodians of the land in which they operate. It is also important to note that whilst different practices are employed in different vineyards the impact of those activities may affect yields and fruit quality, which in turn impact the economic productivity and viability of the vineyard ventures.

Viticulture has less compliance procedures in place and is less regulated than other forms of crop production, similar to other processing crops due to the lack of a requirement from the end customer of an audit scheme. Where good practice is employed, as in many of the vineyards in the SDNP and AONBs, the risks of soil loss, soil health degradation, loss of soil biodiversity, pollution and eutrophication of bodies of water, and the loss of surface biodiversity, are decreased. Table 5 below, summarises best practices as found in the SDNP and AONBs.

Table 5. Summary of best practice to mitigate environmental impact

Hazard	Best mitigation practice	Areas practiced*
Loss of soil through erosion	Minimal cultivation: only pre-planting Leaving strips of grass in cultivated areas	All
Degradation in soil health due to over-cultivation, loss of organic matter and compaction	Carry out regular soil analyses, including organic matter Return of organic matter from prunings to soil by mulching Addition of organic matter (e.g. PAS 100 compost) to soil Subsoiling in alleys to counter compaction No ploughing pre-planting Tractors with multiple implements to reduce passes	All All SD, KD SD, SH KD, SH KD
Loss of soil biodiversity through pesticide and fertiliser application	Controlled use of herbicides and pesticides, Absence of use of insecticides Use of qualified agronomist to organise plant protection programme Monitoring for vineyard pests Very infrequent use of soil-applied fertiliser	All SD, SH SD, KD All All
Pollution and eutrophication of bodies of water	Use of LERAP assessments Use of 'tunnel' shaped (recycling) and directional pesticide applicators	All SD, KD
Loss of surface biodiversity through habitat destruction and pesticide application.	conscious of the value of natural habitats in, or around their vineyard Workers discuss environmental conservation amongst themselves Significant part of estate is managed as naturally wild area Continuous grass cover in vineyard alleys, mowed infrequently Alternate alley mowing Cover crop trials to promote invertebrate biodiversity Alleys planted with naturally occurring plants Allowing plants in alleys and headlands to grow tall and flower Infrequent trimming of hedgerows Planting trees around and across the vineyard Significant habitats and conservation features mapped	SD, SH All SD All SD SD, SH SD, KD SD SD, SH SD All

	Habitat (e.g. pond) creation	SD
	Informal biodiversity monitoring	SD
	Working with local conservation group	SD
	Conservation of specific native species at risk	SD, SH
	Removal of invasive non-native species	SH

**SD = South Down National Park, KD = Kent Downs AONB, SH = Surrey Hills AONB.*

The discussions that occurred with vineyards in developing this Section of the report clearly indicated a very significant level of support for environmental conservation by vineyard enterprises, which could be further encouraged by developing education and training, particularly in the following aspects:

- Evaluation of erosion risk when preparing land for planting vineyards.
- The importance of organic matter in vineyard soils.
- Managing the vineyard floor to promote biodiversity.
- Minimising environmental and human risks generated by pesticide applications.
- Promoting biodiversity in the vineyard environment through habitat management.
- Integrated Pest Management (IPM) techniques for grapevine protection.
- Conserving native species and controlling non-native invasive species.
- Monitoring and reducing greenhouse gas emissions, and water, energy and carbon footprints.
- Mitigating against, and adapting to, climate change.

To put these ideas into practice, growers may find it more effective to take part in certified sustainability production schemes, such as Organic (Soil Association) or Biodynamic (Demeter) production. Indeed, speaking with Rangers (SDNP) and other stakeholders as part of the SDNPA study, the question has been raised as to why more vineyards are not managed under such certified schemes. It is not a question put to producers as part of the SDNPA study but the authors hypothesise that this may be because they are (or are perceived to be) onerous in terms of time and finance (both production costs and accreditation costs). Anecdotal evidence suggests that yields in Organic and Biodynamic vineyards in south-east England are significantly lower and for some sites such a detriment may make viticulture unviable. Producers are also concerned about potential impact on grape quality, are unfamiliar with the practices and regulations of such schemes, view them (not necessarily correctly) as presenting little marketing advantage, or regard them as not being specific enough to address the circumstances of perennial plants like grapevines (which are almost always the sole commercial crop produced in a vineyard enterprise).

However, there are a couple of important observations to make in relation to this point. Firstly, that the majority of UK trained (normally at Plumpton College, nr. Lewes) and internationally trained Vineyard Managers and operatives are highly likely to have had some education in sustainable production as these become integrated into core syllabuses of viticulture education in response to increasing awareness of environmental degradation and climate change, and as was noted earlier on, that customers are also increasingly aware of such. Secondly that during the lifespan of this study WineGB, the national industry association for English and Welsh wines, has started to address the subject of environmental conservation in UK vineyards and wineries through the Sustainable Wines of Great Britain (SWGB)

Accreditation Scheme. This ‘grass routes’, ‘bottom-up’ approach to addressing risks and promoting opportunities where they exist may be somewhat in contrast to other farming regulations and subsidy incentives, but it will provide a platform for engagement with and development of further sustainable practice. As the ‘scheme’ builds more subject areas, training and greater rigour in practice and assessments will undoubtedly follow.

8. Conclusion – Public good opportunities

An increasing number of vineyards in the Kent Downs and Surrey Hills AONBs and the SDNP are being predominantly established on previously arable or pastoral land. For the latter conversion to viticulture will likely result in a further loss of indigenous biodiversity – plants, habitats, and wildlife. Where vineyards replace arable farmland there is significant opportunity for an increase in biodiversity, greater in volume and ‘type’ than would have been the case before conversion. Biodiversity is a defining element of the areas’ sense of place, something that is also defined in viticulture and wine terms through the concept of ‘terroir’. In short, targeting both pesticide reduction and increased biodiversity as an enhanced public good is not commonly adopted.

The general desire to protect species and heritage within the AONBs and SDNP requires that landowners and Vineyard Managers are empowered with information and incentives to assist in this vital task. Consequently, there is a groundswell, expressed most recently by SDNP Vineyard Managers to do more to protect and enhance biodiversity and the environment in which they operate. Furthermore, there is a commercial opportunity to project a clean, green image for AONB and SDNP wine producers to satisfy the demand for quality and sustainability from an increasingly discerning market – quality in the bottle and in the vineyard**.**

There is a potential win-win situation where research into ecosystem services and enhanced biodiversity in vineyards provides added value through biocontrol and other environmentally-friendly practices, including reduced reliance on herbicides and pesticides. These practices have been shown to enhance the natural character and resilience of the special areas to climate change and conversion, in work in New Zealand and Australia. Shelter belts, entranceways, stream and pond edges, vineyard borders, and the inter-vine rows and under-vine rows themselves (Figure 16) could all receive an ecological makeover – with research and co-developed (with producers and ecology experts) knowledge about what could be done and what may work.

In addition, introducing more and different plants/species into a vineyard will also soften the visual impact of trellising (lowering it) and potentially providing a taller winter cover, again to an extent reducing the impact of bare trellising in the landscape and improving their aesthetic appeal. What some may call re-wilding could also provide opportunity for education, and an added attraction for visitors – all whilst linking the older established landscape with newer viticulture, whilst providing opportunity to market improved environmental credential and ‘terroir’ appeal.

Figure 16: cover crop examples and under-vine cover

Further 'local' research in this area, to inform the ELMs Tests & Trials work could:

- Identify native species that could be re-introduced as beneficial to vineyard biodiversity and wider ecosystem services and natural capital in specific landscape types, and which would help vineyards meet the Environmental Land Management's (ELMs) public goods tests of:
    - Ensuring clean and plentiful water: by reducing spray applications and pesticide loss to ground and buffering against any future irrigation requirements.
    - Clean air: by reducing spray applications and tractor movements as less mowing would also be required.
    - Mitigation and adaption to climate change: by encouraging biodiversity and carbon sink potential within an adaptation setting, also offering shade in extreme conditions and reducing evapotranspiration.
    - Protection from and mitigation of environmental hazards: by reducing pesticide use and promoting biodiversity, also by reducing soil erosion through established ground cover.
    - Thriving plants and wildlife: by encouraging biodiversity and re-introducing native species through vineyard greening which in turn attract birds and insects, natural pest predators and may offer wildlife corridors.
    - Beauty, heritage and engagement: by improving vineyards aesthetic appeal in sensitive landscapes, re-introducing native beneficial species, providing opportunity for a unique story of environmental land management in vineyards which should in turn attract visitors and wider engagement and interest in the work.

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