LANDSCAPE-SCALE CONSERVATION IN KENT

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Geese flying over snowy beach
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Nature pond © Chris Gomersall 2020Vision

MAKING SPACE FOR NATURE: MORE

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Introduction

It is increasingly well recognised that coordinated landscape-scale conservation is required to slow and reverse species declines across Great Britain. This thinking is underpinned by Professor Sir John Lawton's 2010 report, 'Making Space for Nature' (Lawton, 2010), which called for "more, bigger, better, joined" wildlife sites. Crucially, conservationists are now thinking beyond isolated targeted conservation on reserves, and looking at the bigger picture at the landscape-scale, in order to reduce habitat fragmentation, create corridors and connect existing wildlife sites. A number of forward-thinking organisations are going one step further and striving to restore wilderness landscapes with minimal human intervention through rewilding approaches, with the aim of restoring self-sustaining ecological functions and services. Landscape-scale conservation holds potential to restore biodiversity and ecological processes in the UK, and contribute more substantially to tackling the global climate and biodiversity crises. However, there are few established methods and approaches to guide practitioners in the monitoring of landscape-scale conservation outcomes in Great Britain.

KWT's Nature's Sure Connected (NSC) project developed a practical framework and guidance for evidencing landscape-scale outcomes of landscape-scale conservation (Tinsley-Marshall *et al*., 2021), in collaboration with 59 local and national stakeholders. A key priority for evidencing outcomes of landscape-scale conservation highlighted by stakeholders was to monitor whether and how the number of sites and area of land managed for wildlife is changing. In response, the NSC project developed a collaborative web-based tool to monitor the extent and quality of conservation management at county-scale. Measuring both the surface area and quality of management was considered a far more useful metric than simply monitoring changes in the number of sites. For example, one large site may be bigger than 10 small ones and of significantly greater value. The NSC project developed new functionality within the existing online platform 'Kent's Conservation Landscape Tool', enabling stakeholders in the delivery of conservation to input spatial data (polygons) to the tool, with attributes detailing information about the site and prevailing management actions. A three-tiered system of ranking the quality and certainty of conservation management was developed as a standardised assessment of management action. By repeating the data collection and analysis annually, it will be possible to monitor how the area managed for wildlife in Kent changes over time.

Quantifying land managed for wildlife in Kent

A comprehensive list of 70 stakeholder organisations was compiled and a one-page information document with instructions on using the tool distributed to all. Contributors could submit two types of data: 'broad project areas' and 'conservation management parcels'. This enabled contributors to delineate both the land within a broad project boundary, and the land under active conservation management. These differences were recognised to avoid broad and potentially overlapping project areas passing as land under management, and thus overestimating the area actively managed. The original aim of the tool was to enable the conservation community to view and collaborate across broad project areas; however, new functionality to enable recording of discrete 'conservation management parcels' was critical to accurately quantifying the area in positive management.

Attribute tables were created for the recorded features, with either drop-down or yes/no fields, to ensure the data was captured in a standardised format to improve comparability and ease of analysis. Although not possible in the initial version of the tool, mandatory fields would ensure essential data was always collected. Fields for contact details enabled users to identify and contact potential partners for any new geographically- or theme-based projects and meant data issues could be followed up. Overlaps in digitised intervention areas were permitted to gather data on multiple actions taking place on one site and resolved in post-processing to prevent double counting.

To monitor change in the area of land managed for conservation in Kent, the data gathered through the KCLT was supplemented with 12 protected areas datasets, stewardship scheme agreement areas, and KWT's own land-influenced data. As 2020 was the first year that the tool was used, a comparison was made with data acquired for the Kent Biodiversity Strategy mapping exercise, conducted by KWT in 2016. The datasets and availability by year are shown in Table 1.

Table 1 The datasets used in an analysis of the number of sites and area of land managed for wildlife in Kent, showing their source and year of acquisition.

Type	Data	Source	Year acquired
Statutory designations	Local Nature Reserves	Natural England	2016 and 2020
	National Nature Reserves	Natural England	2016 and 2020
	Special Areas of Conservation	Natural England	2016 and 2020
	Special Protection Areas	Natural England	2016 and 2020
	Sites of Special Scientific Interest	Natural England	2016 and 2020
	Marine Conservation Zones	Natural England	2016 and 2020
Non-statutory designations	Local Wildlife Sites	Kent Wildlife Trust	2016 and 2020
	Roadside Nature Reserves	Kent Wildlife Trust	2016 and 2020
Private reserves	Kent Wildlife Trust reserves	Kent Wildlife Trust	2016 and 2020
	Plantlife reserves	Plantlife	2016 and 2020
	RSPB reserves	RSPB	2016 and 2020
	Woodland Trust reserves	Woodland Trust	2016 and 2020
Stewardship schemes	Environmental Stewardship Scheme	Natural England	2016 and 2020
	Countryside Stewardship scheme	Natural England	2016 and 2020
	English Woodland Grant scheme	Natural England	2016 only
Recorded advice or management	Kent Wildlife Trust land-influenced data	Kent Wildlife Trust	2016 and 2020
Other	Kent's Conservation Landscape Tool	Stakeholder organisations	2020 only

Management quality ratings (Table 2) were assigned to each polygon based on the management data provided and/or submitted by stakeholders and using conditional field queries in GIS software. Some areas from the KCLT lacked management data and could not be assigned management quality ratings. A comparison between both the number of sites and the total area of sites in 2016 and 2020 was conducted.

Calculating the number of sites presents several challenges due to the difficulty of defining what a site is and due to inconsistencies between datasets. For instance, dissolving (i.e. to consider as one site) areas based on site names is difficult as areas have different names under different designation types, while merging (partially) overlapping or neighbouring areas would lead to an underestimation of the total number of sites. Consequently, it was decided that post-processing should be kept to a minimum to limit the chance of inconsistencies and to ensure comparability between datasets from different years. Therefore, the number of sites was calculated simply as the count of features in all datasets. It should be noted that this method could still lead to an overestimation of the number of sites, if sites consisting of separate land parcels have been included as single-part features in the original datasets.

To evaluate the area of sites, the 'spaghetti and meatballs' approach (Raper and Maguire, 1992) was applied to the data, to split overlapping polygons, flatten the data, and retain the highest quality rating. This technique was applied to both the 2016 and 2020 datasets. Areas of loss, gain and no change from 2016 to 2020 were mapped, and results pertaining to changes in management quality ratings presented.

Nature Volunteers in Kent

Table 2 The quality ratings assigned to types of conservation management included with land areas submitted to the Kent's Conservation Landscape Tool.

Management/Advice category	Quality rating	Rank
Site protected; no intervention necessary (i.e. a nature reserve not requiring annual management action)	Beneficial	1
Practical work	Beneficial	1
Conservation grazing	Beneficial	1
Management plan in place	Beneficial	1
Environmental Stewardship:		
Higher Level	Beneficial	1
Entry Level	Useful	2
Entry Level plus Higher Level Stewardship	Useful	2
Organic Entry Level plus Higher Level Stewardship	Useful	2
Organic Entry Level Stewardship	Useful	2
Countryside Stewardship:		
Higher tier	Beneficial	1
Mid tier	Useful	2
Woodland Grant Scheme (2020 only)	Useful	2
English Woodland Grant scheme (2016 only)	Useful	2
Written advice	Useful	2
Visit and verbal advice	Useful	2
Stewardship scheme application	Uncertain	3
Telephone advice	Uncertain	3

Change in number of sites managed for wildlife

The results show that the number of sites in Kent (both land and sea) under conservation management decreased from 2,766 in 2016 to 2,361 in 2020 (Figure 1). This is partly due to decreases in the number of active environmental stewardship scheme agreements (580 sites in 2016 and 264 sites in 2020).

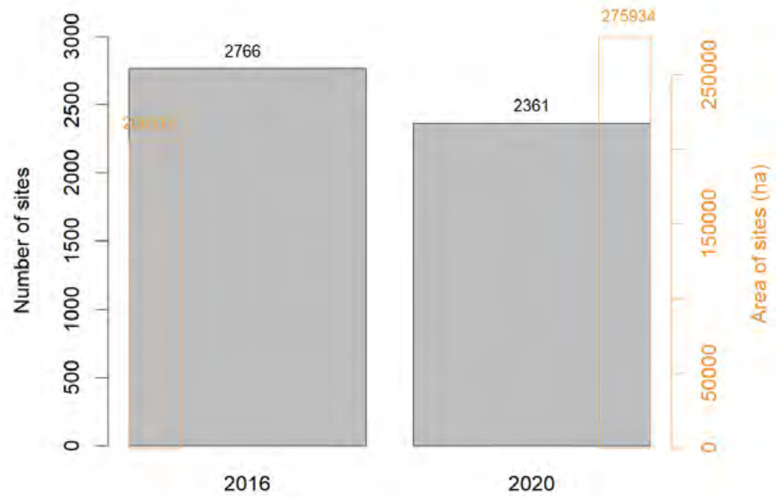

Figure 1 Bar plot showing number and area of sites managed for wildlife in Kent (land and sea) in 2016 and 2020.

Change in area of land managed for wildlife

The reported land area under conservation management in Kent in 2016 was 129,958 ha (34.8% of Kent's land surface (373,867 ha)) and the reported sea area under conservation management in Kent in 2016 was 76,220 ha (18.7% of Kent's seas to the meridian line (407,285 ha)). The reported land area under conservation management in Kent in 2020 was 115,883 ha (31.0% of Kent's land surface) and the reported sea area under conservation management in Kent in 2020 was 160,051 ha (39.3% of Kent's seas to the meridian line).

The results of a comparative analysis (Figure 2) show losses of terrestrial surface area under management, while significant gains are observed in the marine environment. Losses on land are mainly due to the expiration of entry level environmental stewardship schemes between 2016 and 2020. Areas under countryside stewardship scheme agreements, which were revised in 2016, do not appear to recoup these losses. The expiration of environmental stewardship schemes accounts for a substantial portion of the loss of area under quality rating of 2, which results in an overall net loss of land area under positive conservation management. However, the data shows a net increase in areas under a management quality rating of 1, due to both new sites and changes in quality ratings, and due to little loss of areas under quality rating 1. Furthermore, a substantial area (43%) in the study experienced no change from its existing status with a quality rating of 1 (Table 3). Gains in area under positive management in the marine environment are chiefly due to the designations of the new Foreland MCZ, Goodwin Sands MCZ, the Inner Bank Marine Conservation Zone and the Dungeness, Romney Marsh and Rye Bay Special Protection Area. These marine designations give the result of an overall net gain of area under positive conservation management in Kent.

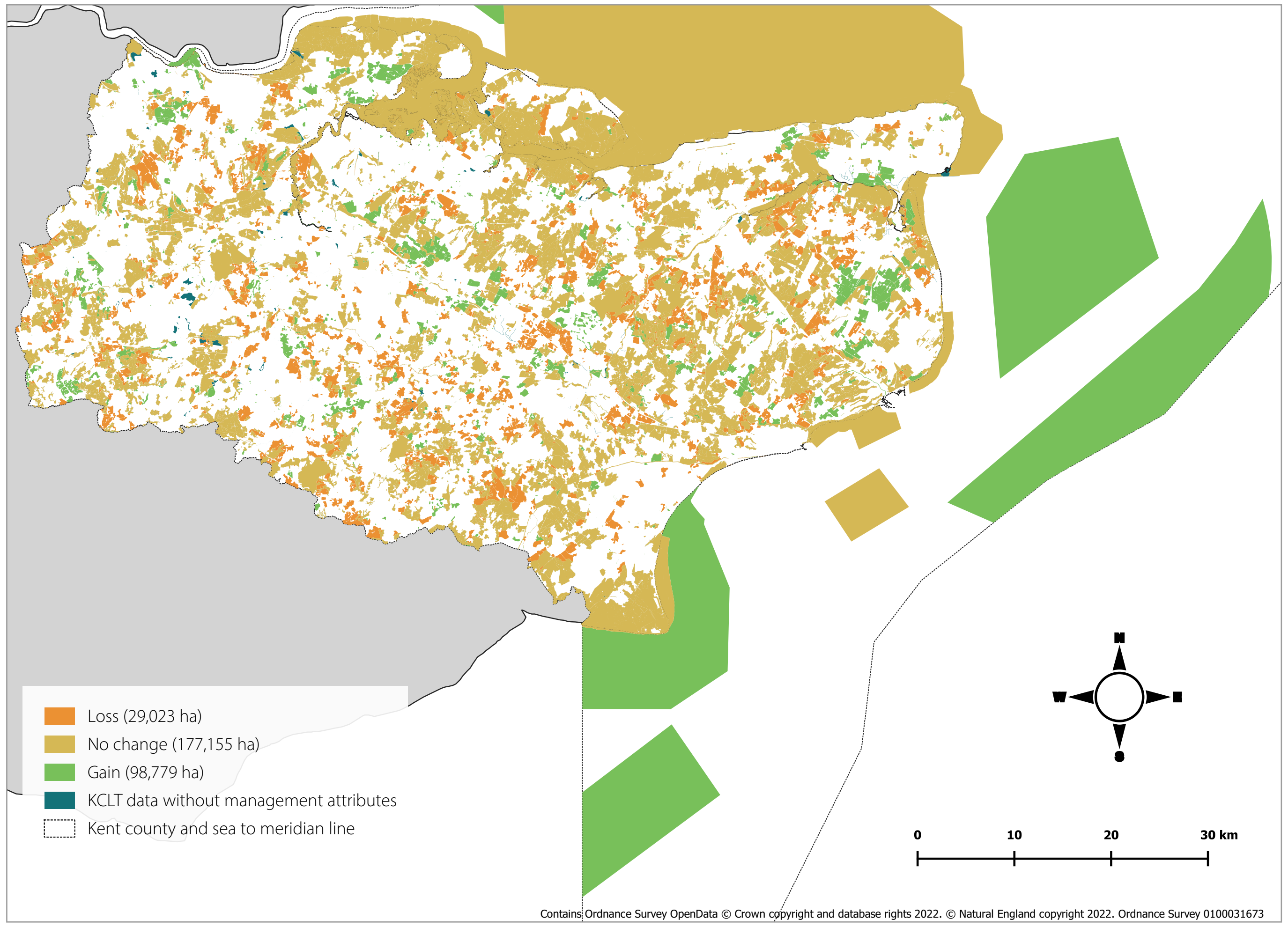

Figure 2 Map showing loss, gain or no change in land and sea area under positive management in Kent between 2016 and 2020.

Table 3 Changes in land and sea area under management between 2016 and 2020 based on quality ratings.

Scenario	Land area (ha)	Sea area (ha)	Total area (ha)
Loss of area under management quality 1	368	14	382
Loss of area under management quality 2	28,641	0	28,641
No change in areas under management quality 1	55,313	76,206	131,519
No change in areas under management quality 2	37,305	0	37,305
Change from management quality 1 to 2	129	0	129
Change from management quality 2 to 1	8,202	0	8,202
New area under management quality 1	7,856	83,845	91,701
New area under management quality 2	7,078	0	7,078
Total area of management data analysed	144,892	160,065	304,957

Limitations

One of the major limitations encountered in the application of the tool was the low engagement by stakeholders in the process of data contribution. Of the 70 organisations approached, 38 (54%) provided data in some form. This low contribution rate was likely due to several factors, in addition to constraints arising from the global Covid 19 pandemic. Firstly, organisations may not record management data in the first place, let alone in a spatial format, which means data may not be readily available. This provided part of the rationale for developing the tool, which now provides a practical solution. Secondly, data requests may not always have reached the appropriate contact in the organisation. There is also the limitation that each organisation may not have an internal system whereby those doing management on the ground are communicating to their GIS/office based team, to then add data to the tool. Thirdly, fewer and simpler data fields are needed to balance data requirements with ease/speed-of-use for end user. The aim for the KCLT is that data submission becomes a routine annual process for all conservation and land-owning organisations in Kent.

Given the limitations, it is likely that the results substantially underestimate the area of land influenced for conservation in Kent. To effectively monitor conservation management action in Kent, high engagement by stakeholders is required on an annual basis. Stakeholders who recognise that data for land they manage is not captured here are strongly encouraged to contact KWT to facilitate their engagement in subsequent data submission rounds. Whilst engagement with the tool was lower than expected, there was high availability of GIS layers of land with statutory designation from various organisations. During the stakeholder consultations, concerns were raised over recording sensitive or confidential management work or advice. Protocols allowed for sensitive data to be submitted directly to KMBRC, rather than inputting the data in the online tool.

Wye National Nature Reserve © Explore Kent

Next steps and recommendations

It is anticipated that data collection and analysis will be repeated annually to monitor how the area managed for wildlife changes over time. Conservation organisations will be encouraged to input data regularly, so data is gathered across the county on an annual basis for monitoring. Ongoing work by KWT is addressing this. Others will be encouraged to adopt this approach, build tools, and align reporting of areas managed using a common approach across counties to gain comparable statistics. Continual development of the tool itself by improving functionality and user-friendliness will create greater efficiencies, and although not possible to implement in the initial version of the tool, mandatory fields will ensure

Chalk mound early summer © Celia Davies

essential data is always collected. The automated GIS geoprocessing model will continue to develop to enable rapid standardised analysis of the data. Furthermore, consensus needs to be reached around the point at which management advice or practical work times out. For Single Data List 160 reporting, it is five years after one-off advice was provided or after a management plan or grant scheme ends.

There is additional scope to collect conservation management data using the same or a similar tool from a broader demographic. This could include land managed by schools, individuals, farmers or other landowners, which is crucially important in delivering landscape-scale conservation outcomes. An approach to this is being investigated by KWT.

The KCLT will also enable selections of the data applicable for Single Data List 160 reporting to be made simply, according to its eligibility guidelines for the land management advice included. If conservation organisations working in Kent contribute data to the KCLT, they will then not have to additionally tell KWT about their work on Local Wildlife Sites for it to be included in this reporting, saving time and effort on reporting.

As a Local Nature Recovery Strategy for Kent is developed, so too will the need for a reporting tool to monitor progress against targets for area of land managed, alongside reporting against the aims of the Kent Biodiversity Strategy. If comprehensive data contribution by the stakeholder community can be encouraged and facilitated, the KCLT tool offers a monitoring solution that will allow a key component of nature's recovery to be evidenced for Kent.

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Serene Kent river scene © Terry Whittaker 2020Vision

MAKING SPACE FOR NATURE: BETTER

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Introduction

The Government's 25 Year Environment Plan's biodiversity ambitions build on the 2010 *Making Space for Nature: The Lawton Report*. The Environment Act 2020 lays the foundation for the NRN. It establishes spatial mapping and planning tools to help inform nature's recovery, and introduces provisions requiring the development of LNRS across England. These will include a map of existing natural assets, including protected sites and wildlife-rich habitats, and key opportunities for enhancement.

One of the flagship goals of the Government's 25 Year Environment Plan is the development of a NRN to deliver on the recommendations from Professor Sir John Lawton, providing 500,000 hectares of additional wildlife habitat to help wildlife thrive, as well as delivering a wide range of additional benefits. The NRN will be implemented through LNRS. These will be the key mechanism for planning and mapping local delivery of the NRN.

Recovering wildlife will require more habitat, in better condition, in bigger patches that are more connected. The development of several of the Government's 25 Year Environment Plan's indicators include quantity, quality, and connectivity of habitats, and the target is to begin in 2024. The Habitat Indicator (known as D1), also needs to link with the development of a number of the other indicators, chiefly:

- Natural functioning of waters and wetlands (B6).
- Extent and condition of protected sites (D2).
- Healthy soils (E7).
- Area of sensitive habitats exposed to damaging levels of ammonia in atmosphere (A7).

National-scale habitat quality

For habitat quantity, accurate mapping of the extent of habitats with complete national (England-wide) coverage is required, along with a statistically robust method for detecting change in extent. Broad habitats (such as can be detected by satellite mapping products like Living England) are considered sufficient for this purpose. The method for assessing changes in extent of habitats for habitat quantity will need to be updated regularly enough to enable reporting on a five to six year cycle.

For habitat connectivity in a *structural* sense, there are a number of different components (e.g. patch size, number, clustering and proximity) that apply at a range of scales, but habitat extent mapping also forms the evidence base for this. A range of methods and models for calculating *potential* connectivity are available, however, their value is constrained by the quality of the input data. The models need data for the dispersal distance of a given species, the arrangement of habitat patches and other land cover across the landscape, and some need the permeability of different land covers to species movements. However, knowledge and data availability are limited. The connectivity aspect of the indicator will be dependent on the accuracy and frequency of updates of the habitat extent data on which the outputs of habitat connectivity calculations and modelling are based. In Kent, attempts have been made to develop an approach to detected *functional* connectivity – evidence of species permitting a connected landscape – and are detailed in the 'Joined' section of this chapter.

Habitat quality refers to how good or bad something is in relation to a reference. For habitat quality to be better compared, data collection and management needs to be on similar or adaptable platforms that can give comparable results and demonstrate nature recovery or the lack of progress in a joined-up manner. The first stage is to decide which habitat attributes to set targets for and to measure. The requirements of natural functioning of waters and wetlands also need to be considered, as this forms a freshwater component of the Habitat Indicator. A draft framework is being developed for this purpose by the UKCEH under the Defra/NE/UKCEH Memorandum of Agreement. This framework considers attributes used in Common Standards Monitoring, defining *Favourable Conservation Status*, and *Natural Capital Indicators*.

The main source of habitat quality data at present is the UKCEH Countryside Survey. There are, however, issues with this data, including very small sample sizes for some habitats, plus a dominant number of large sample sizes for arable and improved grassland. In addition, there has not been a complete survey since 2007, and the current five-year rolling programme – which started in 2019 – has a reduced sampling intensity with a number of aspects no longer recorded.

Habitat distribution (quantity and location), as well as information on habitat quality, are the key habitat evidence requirements. Quality encompasses a wide range of factors and functions, such as hydrology, soil processes and cultural value, as well as the condition of vegetation. The geographical resolution required depends on the ecosystem service or natural capital benefit being evaluated, e.g. the climate change mitigation benefits of a habitat may not be location-specific, but the flood alleviation benefits are highly location-dependent. The national atlas has a resolution of 25 km^2 and the county and city-scale atlases have a finer resolution of 5 km^2. Natural capital accounting figures need to add up to 100%, so a habitat map layer with full coverage is needed.

For habitat extent and location, a combination of PHI and UKCEH's LCM are used, as the LCM gives full national coverage, and the PHI provides a greater level of habitat detail. The aspiration is to replace LCM with Living England mapping once this is of sufficient accuracy. Other inventory datasets are used for specific habitats, e.g. the National Forest Inventory, EA saltmarsh dataset, and marine data layers. For habitat quality, SSSI condition assessments are a key source of evidence, along with the Integrated Biodiversity Advice. Other predominantly open access GIS layers are used where available for information on soils, hydrology, and cultural services etc. Where a dataset is not open access, copyright and licensing approval has been obtained for use in the atlases. The Environment Agency has considerable data available at the field parcel level where water quality standards are exceeding levels of pollution and affecting habitat quality. In addition, the water companies monitor regular levels of pesticide and nutrients for drinking water purposes, which can be useful when considering habitat quality in wetland habitats.

While the UK Peat Strategy has little relevance in Kent, the new England Tree Strategy will set out policy priorities to deliver the England Tree Planting Programme, with a target to plant 30,000 ha of new trees by 2025. It will focus on expanding, protecting and improving woodlands, in addition to educating society on how trees and woodlands can connect people to nature, support the economy, combat climate change, and recover biodiversity. Good habitat evidence will be required to enable the correct decisions to be made about where trees should be located. The work is linked to the Nature Recovery, but not all tree planting proposals will come through NRN, so the habitat evidence that underpins it is key, and areas classified by the Forestry Commission GIS layer as low risk for planting may have greater nature conservation value than currently realised.

The main source of evidence for tree planting is the PHI and other habitat inventories, but these are known to have gaps and issues with accuracy. Plugging these gaps is the highest priority, and one method for doing this might be the use of botanical coincidence mapping, using species records from BSBI to indicate likely areas of unmapped ecologically important habitat. Some known evidence gaps for


Cobham Wood © Kent Downs AONB

habitats sensitive to tree planting are around waxcap grasslands and habitat for breeding waders. BSBI botanical species data is generally good, but other species less so. Natural England is working with BSBI and the Woodland Trust on a pilot or proof of concept to demonstrate the additionality of species data compared to current inventories. The FC is also interested in incorporating this into its screening process. Species data could also be used to develop a 'survey effort index' to understand where there are gaps in the data (either by habitat type or geography), rather than a genuine absence of priority habitats. Areas of low survey coverage can then be targeted for additional fieldwork, and the information would also be useful in validating Living England.

Some known gaps around habitats particularly sensitive to tree planting are waxcap grasslands and breeding wader habitat. Better peatland mapping will also be critical. It is sometimes unclear whether apparent gaps are due to absence of priority habitat or lack of survey effort. Botanical species data, such as that held by BSBI, might indicate areas of likely priority habitat and/or low survey effort where fieldwork should be targeted, and could therefore help plug gaps. This is currently being tested, but if it proves valuable, there are data licensing issues to be overcome.

The marine designations are so new and marine conservation is not well understood, such that there is still limited understanding of how the ecosystem functions and that of individual species conservation requirements. Marine habitat mapping has so far been driven by the need for data to help with the designation of MCZs. A large programme of evidence

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gathering was commissioned for this purpose and methods and standards had to be discussed up front. Some data comes from collaboration with partnership organisations, for example the saltmarsh data layer from the Environment Agency. A consistent set of standards are in place throughout the marine mapping industry and these are promoted to those who wish to contribute data, such as NGOs and partner organisations. Habitat maps showing all the available evidence are now available for all English waters, though there are gaps in the coverage, especially outside of Marine Protected Areas.

In 2021, a national programme including Kent marine sites, investigated the status of a number species found in our Marine Conservation Zones (MCZ). The challenge of assessing the Thames and Medway Estuaries as to the state of the habitat quality is something that can only be done by a co-ordinated approach from many organisations.

What is exciting about the future is combining the best of traditional surveys and naturalists' skills with new technology. The Habitat Indicator (D1) applies to all terrestrial and freshwater habitats (priority habitats as well as habitats less rich in wildlife), which contribute to an environmental system providing wider benefits. This indicator will measure changes in extent, condition, connectivity and function of terrestrial and freshwater habitats in England. Currently, data is available to measure some aspects, such as extent and condition of some habitats, but further work is required to assess habitats beyond protected sites, and reliable methods for measuring ecological connectivity need to be further tested. Some of this indicator development work is being carried out by UKCEH under the Defra/NE/UKCEH Memorandum of Agreement, including the development of a draft framework for measuring habitat quality, and the testing and assessment of three potential methods for measuring habitat connectivity.

County-scale habitat quality

As described in the previous paragraphs, much of the data for habitat quality is based on geographic and habitat features, and county boundaries do not always coincide with marine habitats or river catchments. Nevertheless, there are a number of factors that play a particular role in habitat quality in Kent.

In recent years the issues of human disturbance have grown and become more diverse, and play an important role in defining habitat quality and whether it can meet species needs. The Kent coast and its nature reserves became particularly important for social activities in the pandemic year of 2020, which increased human disturbance in the area. This means defining habitat quality is based on human activity, yet the measures of addressing it are still being developed, and success has yet to be scrutinised. The Birdwise projects in North and East Kent, plus the Medway Estuary Partnership and the management of the Dungeness habitats, have an important role in tackling issues, but whether they are sufficiently effective or resourced will require a partnership approach with many organisations.

The issue of water quality is also particularly important when evaluating habitat quality in Kent's wetland environments. The contribution from drainage systems and the many pollution incidents highlight the difficulty in evaluating habitat quality. At a SSSI level, the concept of nutrient neutrality was adopted as a concept for the River Stour in 2021, with particular relevance for Stodmarsh SSSI. For SSSI monitoring, water quality data is needed, and as evidence emerges, standards vary depending on the legislation, whether it is in the sea, intertidal or freshwater. Currently, there are no standards for pesticides, harmful chemicals or discarded waste for SSSIs, and the reliance is upon other organisations, such as the Environment Agency, Water Companies and Local Authorities, to meet different environmental standards.

Strategic solutions for housing allocations exist in North and East Kent to address bird disturbance on internationally important coastal sites, ensuring that the project Birdwise is in place and that these projects can be expanded to assist nature recovery. On the Kent County border, Ashdown Forest in East Sussex has a strategy for addressing future impacts on ground nesting birds (from the residents of new housing) by providing alternative natural green spaces in Kent and East Sussex. All three strategic solutions result in a nature adviser being employed to educate residents and visitors alike about the wildlife of Kent and provide a network of greenspaces with nature and people in mind. The surveys and management of mitigated sites does not yet follow a standard that could easily be modified to demonstrate habitat or quality or contribution to the habitat network unless the land is put into a stewardship scheme or mapped onto the DEFRA Magic Map application as priority habitat. Pressures from human activity are growing particularly on coastal sites and fragmented woodlands (those woods not owned by Conservation Organisations).

As Kent becomes increasingly urban, green infrastructure will become ever more important to include with habitat connectivity and quality, however, the recognised mechanisms such as tree planting, green roofs, green walls, rain gardens and accessible green spaces, will need the monitoring and scientific evidence to demonstrate that they are of a sufficient habitat quality to qualify for wider biodiversity protection.

What habitat quality data is available and where could efforts be best made in Kent to collect data?

Many conservation organisations, including Natural England, have moved to the CMSi platform for both the SSSIs and the National Nature Reserves to assist project management and share progress. This is either within Natural England (for National Nature Reserves) or by making the information publicly available as in the designated sites website (for SSSIs). This system provides a way to report progress on monitoring and evaluating the SSSIs. The current structure is based on geographical units with features of interest that make up the special interest of the SSSI.

The system of monitoring SSSIs is changing, as increased understanding of species and habitats means changing priorities and adapting advice. The SSSI monitoring tables *(Favourable Condition Tables)* are publicly available on the SSSI designated sites website and increasingly Natural England has encouraged partner organisations to monitor and report the successes and challenges on SSSIs, with direct input from the MoD and RSPB. This approach of shared knowledge is likely to expand and adapt, as both traditional surveys (such as WeBS, BBS, and butterfly transects, which are used for evaluating SSSI condition and habitat quality) are undertaken and complemented by new techniques, such as remote sensing, improved satellite imagery, and eDNA testing to help define nature recovery.

For Kent's contribution to national nature recovery, the concept of FCS for species and habitats has been developed. The FCS is based on international wildlife conservation and is about interpreting the concept of FCS in the context of the EU Habitats Directive. Kent Nature Partnership would be able to highlight successes and challenges for biodiversity recovery by contributing to that favourable condition.

The FCS has published statements that are relevant to Kent. These include hedgerows, lowland dry acid grassland, Purple Moor Grass and rush pastures, Duke of Burgundy, Harbour Porpoise, Hazel Dormouse, Little Tern, Peregrine Falcon, Dartford Warbler, coastal dunes and White-clawed Crayfish. These statements build on the S41 species and habitats (the current basis for the Biodiversity Action Plans).

Kent County Council and partners have undertaken National Vegetation Classification surveys over the decades. These datasets provide a more comprehensive baseline than exists for many other counties. In addition, the presence of the Kent Downs AONB and High Weald AONB means there is a long history of knowledge where habitat and landscape are intertwined with the concept of natural beauty. The large scale of the SSSIs in North Kent (Thames Estuary, Medway Estuaries and Marshes, and The Swale), East Kent Coast and Dungeness, also mean that a substantial proportion of the county's habitat quality can be evaluated and change can be predicted.

The agri-environment schemes cover many parts of the county and agricultural land-use is mapped by the government on the Magic Map application. The website includes the SSSI areas and their condition, as well as the types of habitat management in place. The data that comes from the agri-environment scheme is used to quantify the amount of habitat that exists and contributes to the national discourse regarding quantities of habitat. Where land is in stewardship, specific payments are made for management to ensure good habitat management and that the habitat is maintained in good quality. The national bird surveys co-ordinated by the British Trust for Ornithology and funded through the government, provide a strong basis for evaluating habitat quality. In addition, the RSPB reports record breeding success annually from its major reserves. Breeding success at its wetland sites is a particularly good indicator of habitat quality. In the Blean woodlands, the woodland breeding bird assemblage and butterfly assemblage also gives a good indication as to the quality of the management of the woodland habitat. The network of bird breeding recording in Kent has been crucial for the designation of Lodge Hill, Chattenden Woods SSSI and Swanscombe Peninsula SSSI.

A key challenge at the county-scale is to have confidence in the habitat quality, particularly for those that are small and fragmented, such as wax cap grasslands and vegetated shingle.

Sites of Special Scientific Interest: defining special interest

Most SSSI were notified or re-notified in the 1980s with an SSSI citation document that described in various levels of detail the 'special interest'. The maps produced for SSSI designation usually only include the site boundary with little or no habitat information. Phase 1 habitat maps were sometimes produced at the time of notification, but are often not detailed enough for the extent of notified features to be clearly identified. They are not incorporated into Natural England's current mapping systems or the PHI. PHI data helps in producing a base map, but is not resolved in sufficient detail to show National Vegetation Classifications (the basis on most habitat assessments) and is based on land parcel polygons rather than habitat boundaries. The PHI data represents a point in time which usually doesn't coincide with the date of site notification.


Hollingbourne Downs SSSI © Kiddle

The purpose of SSSIs is to designate a representative sample of key habitats or viable populations of a rare and/or declining species. The SSSI priorities are published and specific criteria for selection must be published with commitments to review and re-publish as understanding grows. However, key features missing from protection are the ecotone between habitats, especially scrub and natural tree regeneration in the terrestrial environment, and natural dynamic processes along Kent coastlines, estuaries and river network.

Natural England has published documents that seek to address the issue of understanding the importance of designated SSSIs and that change in appreciation of what made a site special. The 1990s had a programme of Site Management Statements between SSSI owners and Natural England. Following the CROW Act of 2000, Natural England produced VAMs that were publicly available, and *Favourable Condition Tables* for every SSSI site, which informed SSSI owners and interested parties what is needed to reach favourable condition and how SSSIs are monitored. In addition, many of the bigger SSSIs are SAC and SPA under the European legislation. Through the 2000s, Site Improvement Plans and Conservation Objectives further described the special interest on SSSIs and are published by the JNCC.

Between 2010 and 2020, many of the marine SPAs had detailed supplementary advice documents (known as SACOs); these addressed many of the special interest features found on SSSIs that used both terrestrial and marine habitats. Furthermore, where strategic solutions are in place for specific human activities addressing impacts on designated features (of the SSSI and SPA), further detail is available on local authority websites in how addressing disturbance to overwintering birds is being addressed (see Birdwise North Kent and East Kent).

Several SSSIs are managed by Kent County Council, and management plans are published online in order to receive Green Flag status. These management plans report on the progress and challenges of managing these SSSIs on a regular basis. KWT, The National Trust, RSPB, Woodland Trust and Plantlife all have management plans for their nature reserves, in addition to management prescriptions for stewardship agreements. Many of the SSSIs in agri-environment schemes produced specialist plans to help define habitat management and indicators of a successful scheme.

The state of habitat condition in Kent: SSSIs

Over the last 20 years, Natural England has notified Dungeness, Romney Marsh and Rye Bay SSSIs (2006), Chattenden Woods and Lodge Hill SSSI (2013), and Swanscombe Peninsula (2021) as representative examples of good quality habitat and sometimes with the potential for improvement or nature gain. Arguably, these additional designations make the KBS target of 75% of SSSIs in favourable condition more challenging to achieve.

Natural England assesses and reports on the condition of SSSIs at a national level using Common Standards Monitoring, developed by the JNCC (JNCC, 2019) for the whole of the UK. Table 1 provides a breakdown of the SSSI units assessed across Kent's 99 SSSI sites. Currently, just under 69% of the area designated as SSSIs in Kent are in *favourable condition*, which means that the features of special interest are being conserved and meet all the monitoring targets; 21% of the area are in *unfavourable recovering* condition, which means that although all the features are not being adequately conserved, all the necessary management mechanisms are in place; 2% are in *unfavourable condition: no change* which means that the features are not being conserved and that changes in management are needed; and finally, 7% are in *unfavourable declining* condition, which means that the features are not being adequately conserved and it is getting progressively worse. The area of SSSI land contributing to these percentages is provided in Table 2 and a proportional visualisation in Figure 1.

Table 1 Number of sites and area assessed for condition status in Kent

	Sites	Units	Units assessed
Total number	99	920	897
Total area (ha)	39,114.58	34,628.52	34,364.43

Oare Marshes © Saffy H

Table 2 Area and percentage breakdown of Kent's SSSIs assessed in categories of condition status

	Percentage meeting area of favourable or unfavourable recovering	Favourable	Unfavourable – Recovering	Unfavourable – No change	Unfavourable – Declining	Partially destroyed	Destroyed
Area (ha)	31,008.13	23,739.69	7,268.44	777.30	2,560.20	0.00	22.56
Percentage	89.55%	68.56%	20.99%	2.24%	7.39%	0.00%	0.07%

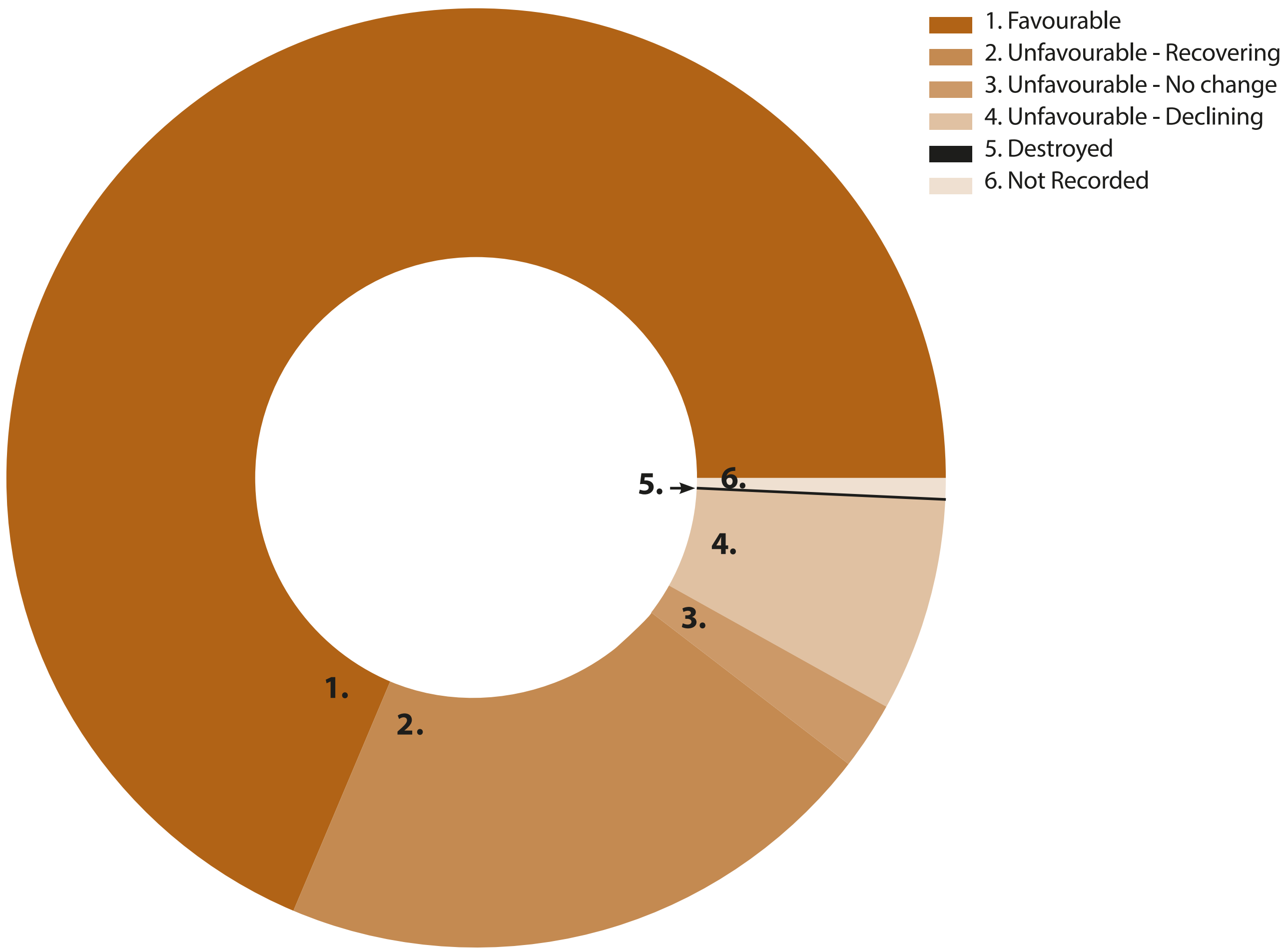

Figure 1 Proportional visualisation of Kent's SSSIs assessed in categories of condition status

In the past 10 years, more than 1,700 ha of SSSI land has improved in condition, primarily from *unfavourable recovering* to *favourable* condition. However, during the same period, 5,453 ha of land has declined in condition, with the largest area of decline being within Medway Estuary and Marshes SSSI, where algal blooms have been detected, smothering the mudflats and impacting on food availability for the bird assemblage. Other significant areas of decline have been due to decreasing wintering and breeding bird numbers. In many cases, it is judged that the correct management is in place on the site to maintain the habitat required to support the birds through stewardship schemes, ditch management, the consenting process, and the Local Development Framework process, however, the feature is still in unfavourable condition. As it is currently unclear as to why bird declines are occurring, a number of reasons are being investigated, including disturbance, and bird movements within the region and internationally.

In recent years, more collaboration between conservation organisations has resulted in the National Trust, RSPB and MoD having monitored SSSIs under their management. This means there is a better understanding of shared outcomes and defining habitat quality or species favourable conservation status.

The state of habitat condition in Kent: other sites

Natural England's SSSI condition monitoring data provides some of the best available and most accessible data on habitat quality, though many other organisations in the county assess the condition of habitats on their sites and in the wider landscape. Drawing this information together across a suite of organisations and from a variety of approaches was beyond the scope of this report. Further iterations of the State of Nature in Kent would benefit from the resource and capacity to do so. Here, an example of how KWT is monitoring habitat condition on its estate is provided.

The JNCC common standards monitoring approach and similar approaches, often known as 'rapid assessment', are popular among site managers assessing and reporting on reserves at a site-scale. However, the method, which involves pseudo-random sampling along a structured walk to describe botanical and structural attributes of habitat quality, often lacks the power to quantify the primary target of site managers, which often is to maintain or improve the distribution of key plant species and habitat attributes. An inherent issue with monitoring of habitat quality is that it is impossible to be certain what change will occur and where, yet the purpose of monitoring is to detect it. Monitoring at site-scale for the purpose of assessing targets and informing management must both *detect* and *quantify* change that may happen at any location within the whole of that site. The application of condition assessment methods is not always inherently quantitative, and often does not systematically sample the whole of a site. It therefore cannot tell us how much of a site meets a given criteria, and neither can it detect change everywhere it occurs. If coverage of the whole site is not achieved, it is impossible to know if 'good' areas are always in the same place, or if they move within a site.

To address these challenges, KWT has adopted the 'grid square approach' (Meakin, K. & O'Connel, M., 2017) for habitat condition monitoring on its estate of approximately 80 sites. It is founded on the realisation that in order to answer key questions about habitat quality (i.e. what species are present and where do they occur, where and why is change occurring) requires the data to be spatially referenced. The most meaningful, achievable and affordable indicator of change in response to management that can be quantified by monitoring is the spatial distribution and configuration of species on a site. In recent years, the development of open source GIS software places the appropriate tool to collect, visualise and analyse spatially referenced data within reach of resource-limited organisations, allowing the production of site-scale distribution maps based on grid-squares. The resulting maps are intuitively interpretable, free of technical jargon, easily assimilated by time-pressured practitioners, and are accessible to a wide non-specialist audience. They provide an easy method of understanding the ecology of species on a site, quantifying change and of planning management.

Using GIS, grid squares of differing sizes (e.g. 25 m, 50 m, 100 m, 250 m, 500 m) are generated based on the BNG. These squares are essentially fixed sample locations; the knowledge that a site is monitored using a 25 m grid based on the BNG defines these sampling locations unequivocally in perpetuity, facilitating repeat sampling of discrete spatial locations. The grid squares are 'clipped' to site boundaries and assigned unique identification codes, a process fundamental in allowing successive annual survey data to be linked to spatial locations on a site over time. The data collected is the same as that collected in Common Standards Monitoring, differing in the relative quantity and distribution of where they are collected within a site. The grid squares are used to stratify random sampling such that samples are taken in each square encompassed by the site boundary (or boundary of target habitat within a site). Each square is sampled for key attributes by a walkover survey. This means that every sample location within a site has an equal chance of selection (i.e. is truly random), a vitally important consideration in any programme of data sampling and statistical analysis.

For every habitat classified in the NVC, a list of key positive indicators is defined in Common Standards Monitoring. These lists of species set a relatively high threshold for assessment, suitable for sites of SSSI quality. When used to assess sites of lower value, such as sites undergoing restoration, or where new habitat is being created, these lists set rather a high bar and offer a low degree of sensitivity to change, such that new and restored sites may take considerable time to show improvement; chalk grassland creation, for example, can take 60 years or more. In order to provide a greater sensitivity to lower value improvement on a site, these lists are augmented with additional positive indicator species developed for LWS in Kent. This longer list also allows for a greater degree of distinction between the status of high quality sites. Other standard assessment criteria include, for example, habitat extent, undesirable species (those requiring active management to control), sward height, bare ground, flowering plant cover and litter cover, and the structure of characteristic vegetation components, such as dwarf shrubs or tree age classes.

Collecting data following this approach allows the production of grid square maps of a site, where each square is colour-coded according to the value of each attribute. This is depicted using a 'heat map'. Squares are coloured using a temperature scale (pale yellow – cold, orange – tepid, red – hot). The map will get 'hotter' as the number of 'hot' squares increases. The maps clearly demonstrate that if a habitat condition attribute is improving, the number of defining grid squares increases. It also demonstrates exactly where these areas are, and importantly allows each attribute to be quantified as a proportion of the site or target habitat. This will allow management targets to be set and assessed on a site by site basis.

Example data for Hothfield Heathlands, summarised for a four-year baseline survey period, are shown in Table x, Figure y and Figure z. Approximately one third of the KWT estate has now been surveyed following this approach. In time, it is anticipated that futured iterations of this report will summarise the state of habitat quality for a much greater proportion of key sites in Kent.

Table 3 Summary statistics for attributes of habitat condition for lowland heathland assessed at Hothfield Heathlands over a baseline survey period from 2017 to 2020.

Attribute	Target	Proportion of site meeting target
Extent	No net loss	100%
Positive indicator species	100% of samples in which >2 positive indicator species present	97%
Bare ground	100% of samples with between 1-10% cover	69%
Vegetation structure: growth phase composition of ericaceous cover	% of samples in which each growth phase dominant falls with target range for each phase	
	Pioneer (10-40%)	45%
	Building & mature (20-80%)	55%
	Degenerate (<30%)	100%
	Dead (<10%)	100%
Vegetation structure: % cover of dwarf shrubs	100% of samples in which dwarf shrub cover >25%	40%
Vegetation composition: desirable grasses	100% of samples with at least 26% (frequent) cover	77%
Vegetation composition: desirable herbs	100% of samples in which herb cover >11%	66%
Negative indicator species: herbs	100% of samples with <1% cover	93%
Negative indicator species: coarse grasses/ rushes/sedges	100% of samples with <1% cover	70%
Negative indicator species: bracken	100% of samples with <15% cover	13%
Negative indicator species: scrub/woody species	100% of samples with <15% cover	26%
Negative indicators: signs of disturbance	100% samples with <1% heavy erosion	98%
Vegetation structure: % cover of gorse sp.	100% of samples in which gorse <25% cover	97%

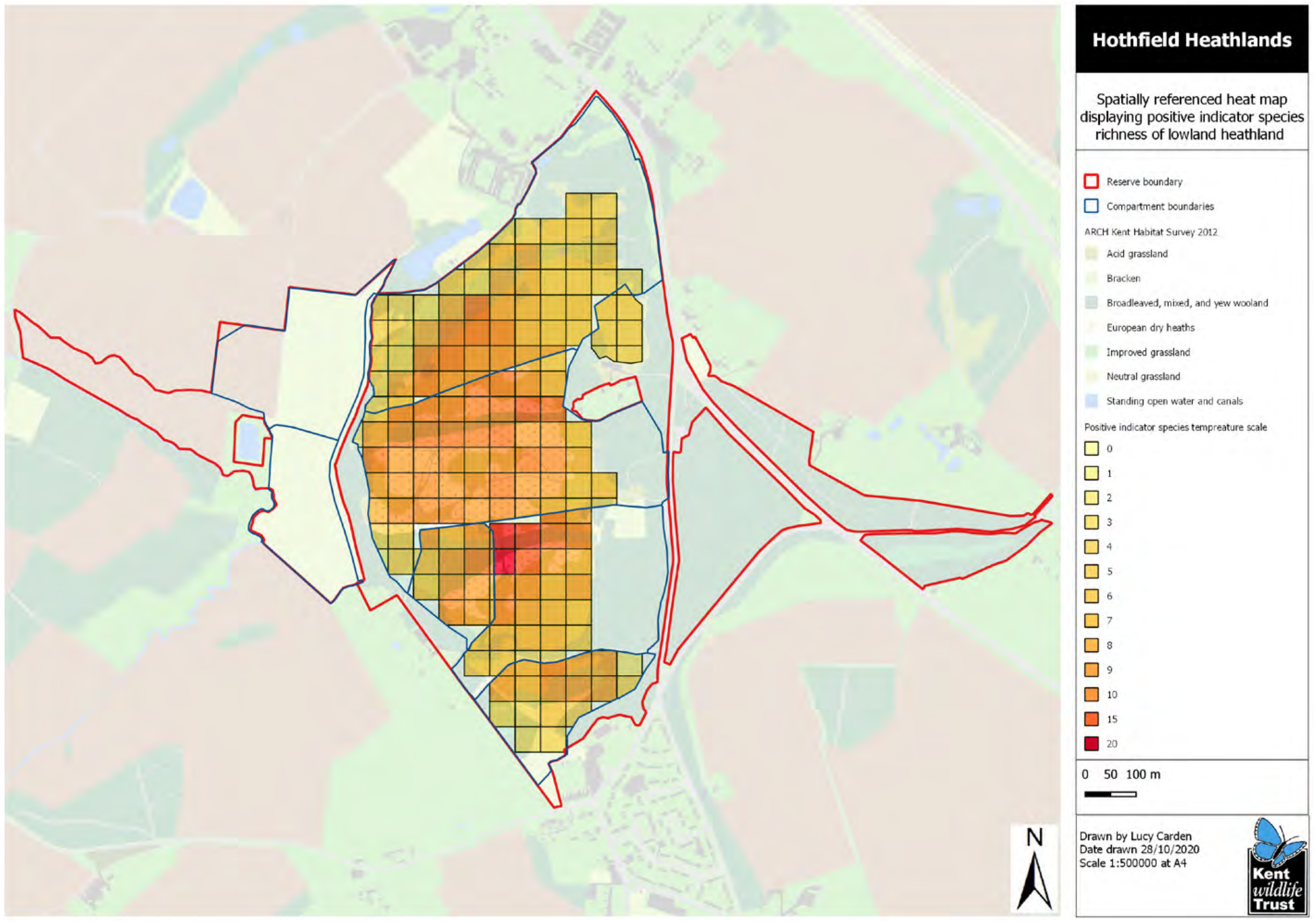

Figure 2 Spatially referenced heat map displaying the average richness of heathland positive indicator species at Hothfield Heathlands over a four-year baseline survey period (2017-2020).

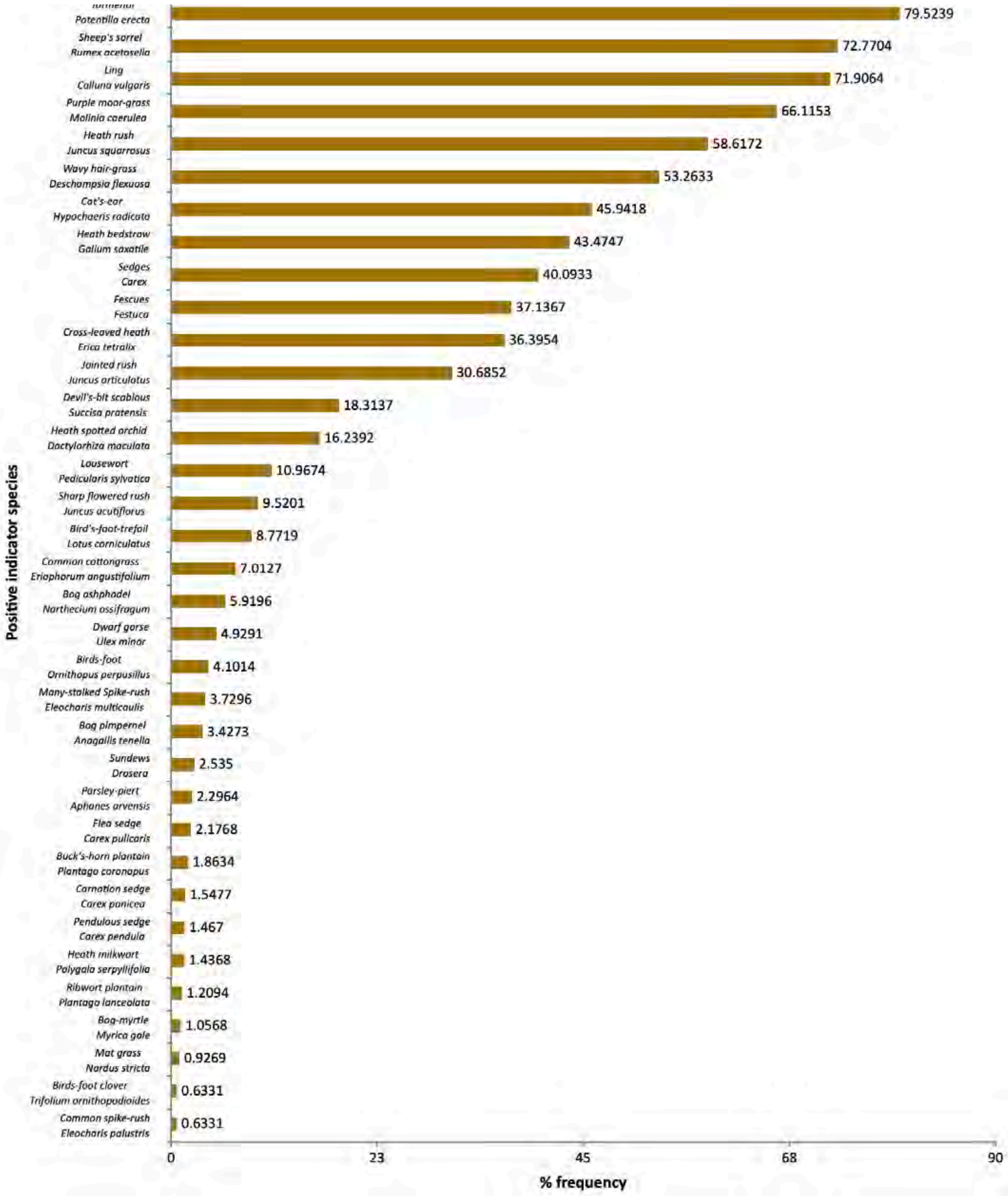

Figure 3 Frequency bar chart of lowland heathland positive indicator species at Hothfield Heathlands, expressed as the average percentage of the number of sampled grid squares in which they occurred over the baseline survey period (2017-2020). The bar chart displays the average frequency of all of the positive habitat indicator species recorded by the survey over the baseline survey period 2017-2020. The data are displayed as a percentage of the number of samples taken, meaning bar charts are comparable between sites and years. If a species was recorded in one year but not another it is always included in the chart. The larger the bar the more frequently a species was recorded in the survey, up to 100%, indicating a species was recorded in every sample.

The state of habitat condition in Kent: landscape-scale

Landscape-scale conservation is the combined contribution of multiple actions, on multiple sites, and by multiple stakeholders, to the resilience of ecological networks. This results in a complex matrix of interventions and policies in space and time. Monitoring the outcomes of landscape-scale conservation therefore presents significant challenges to the individuals and organisations involved in its delivery. Monitoring of site-scale outcomes is well-established and best practice is available and adopted. Landscape-scale monitoring is in its infancy by comparison. The absence of common standards and approaches reflects both the infancy of landscape-scale conservation and the scale and complexity of the challenge.

The Nature's Sure Connected project led by KWT from 2018-21 sought to address some of these challenges by consulting widely with a community of conservation practitioners to gather expertise and information on their needs from landscape-scale monitoring. The project reviewed and analysed existing landscape-scale monitoring approaches, generated consensus on priorities and principles, and developed partnerships to design and test sustainable monitoring approaches. This informed the development and testing of a monitoring framework and practical approaches to landscape-scale monitoring. The project developed a practical framework structured around a series of logical steps to inform the creation of monitoring objectives and programmes. The input of stakeholders fed into the development of each approach.

One of five key themes prioritised by stakeholders for the project to address was better land management and habitat quality. The practical framework details the steps taken by the project to develop drone-based remote sensing capabilities within KWT to facilitate a cost-to-scale effective approach to monitoring attributes of habitat quality at landscape-scale. A set of outputs provide practical guidance to help others to develop these capabilities.

A key attribute of habitat quality is the structure and variation in vegetation, for example the variation in size of trees in different size classes. A common woodland management objective is to increase structural variation (i.e. the variety of sizes classes of trees) and promote natural regeneration, which can be quantified by monitoring abundance and canopy area of trees within size classes, assessing change against baseline data. The gathering of aerial imagery was piloted at West Blean and Thorden Woods. Images were used to create digital surface models which show the relative height and structure of above ground features such as vegetation. From the model, individual trees were identified and canopy areas calculated. This resulted in the vegetation structure detailed in Figure 4. This shows that the smallest trees, measured by width, have the greatest variation in canopy area and are most abundant. The largest trees have far less variation in canopy area and they are the least abundant size class. Repeat survey and analysis will demonstrate any change in the abundance of trees in each size class, and any change in canopy area, allowing a structural variation component of woodland habitat quality to be monitored. This work is a significant advance in capability to monitor habitat quality at scale, and further work is now underway to enhance the scale and scope of its application.

Blean Woods Vegetation © Donovan Wright

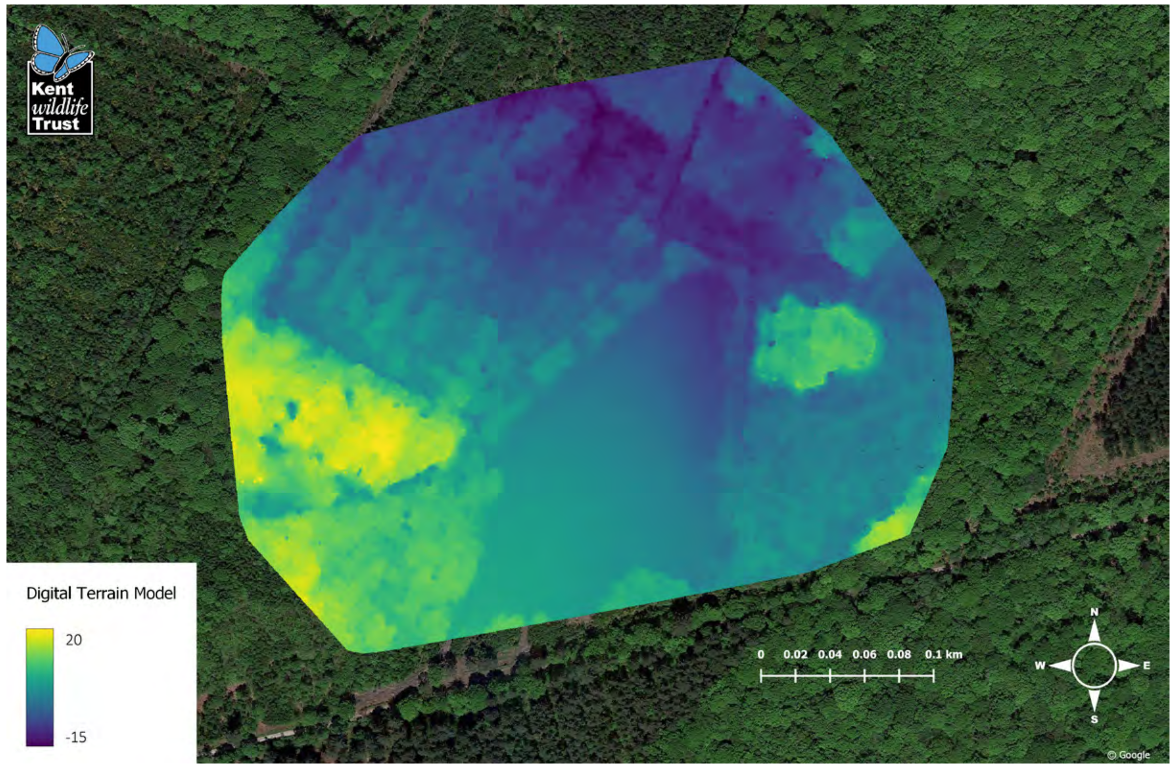

Figure 4 Digital Surface Model created using OpenDroneMap, showing the heights of the vegetation relative to the take off point, West Blean Woods, Canterbury, Kent.

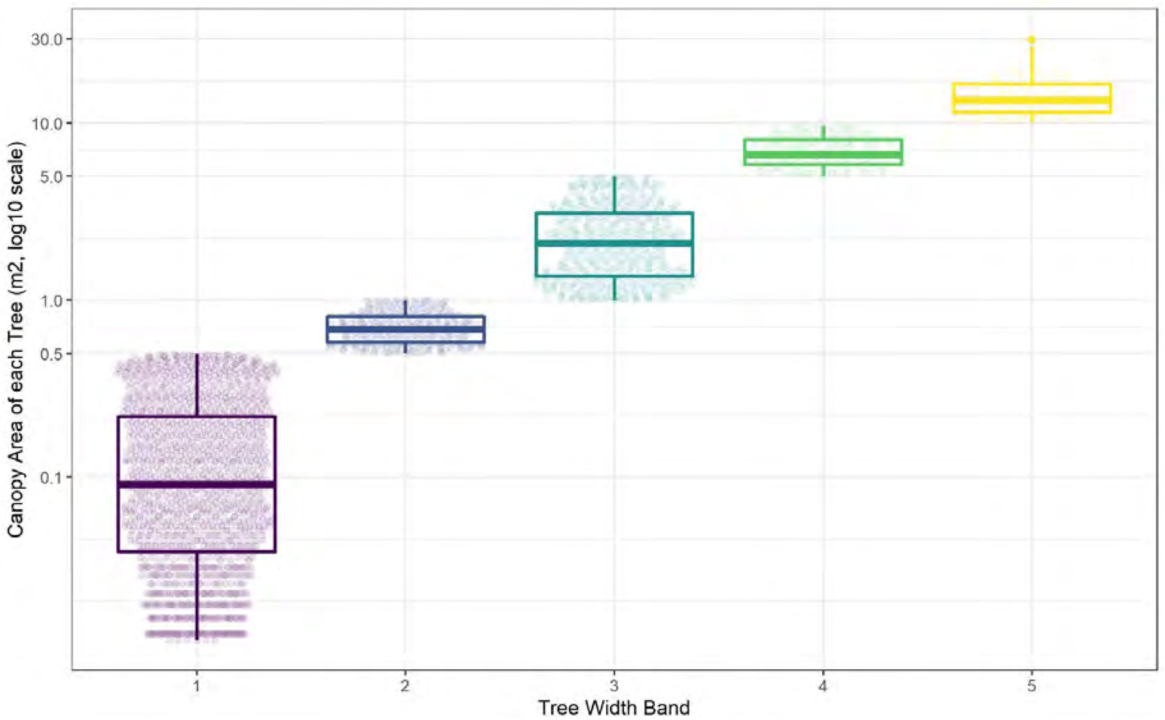

Figure 5 Boxplot showing tree areas in a sub-sample of aerial imagery from West Blean and Thornden Woods, in each of five width bands, (1 = 0-0.5 m², 2 = 0.5-1 m², 3 = 1-5 m², 4 = 5-10 m², 5 = >10 m²). The vertical lines show the full range of tree areas in each class and extend to the smallest and largest areas. Boxes show the interquartile range with the median shown as a bold line. Whiskers extend to the smallest and largest observations or 1.5 times the interquartile range, whichever is smaller, with outliers shown by filled circles. Points show raw data, arranged in a "beeswarm" plot, which plots points of the same value adjacent to each other, allowing for both distribution and frequency to be seen.

Introduction | Headlines | Drivers | Conservation | Kent's Species | **Landscape-scale** | Case Studies | Conclusion
More | **Better** | Joined

Conclusion

Due to the varied approaches of a large number of land managing organisations in Kent to monitoring habitat quality across a wide range of other sites, the challenge of drawing this data together was out of scope of this report. The Kent Biodiversity strategy sets a target of 75% of SSSI restored to favourable condition, securing their wildlife value for the long term. Data gathered by Natural England demonstrate that just under 69% of the area designated as SSSIs in Kent are in favourable condition; while this is an encouraging figure, there is progress to be made towards meeting this target over the next 10 years and beyond. The opportunity to develop an appropriate monitoring framework within the context of the LNRS will provide a catalyst to coalesce and align around consistent and standardised approaches that will enable more comprehensive reporting against both Kent Biodiversity Strategy targets and objectives of the LNRS. This opportunity should be fully exploited, and it is vital that sufficient resource is directed at evidencing conservation outcomes if accurate monitoring of progress towards habitat quality goals is to be achieved. Advances in methodological approaches to gathering both to field and remote sensed data must be taken advantage of. Rapidly developing remote sensing technologies, the increasing availability and accessibility of open source, high resolution geospatial datasets, and the decreasing requirements for computational power necessary to analyse them, present significant opportunities to ensure habitat quality goals can be effectively measured and therefore outcomes maximised. We must rise to the challenges of delivering and evidencing better habitat quality over the complex matrix of habitats, interventions and custodianship of land management in the county.

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Kent coastline and white cliffs © Becky Hitchin

MAKING SPACE FOR NATURE: JOINED

ROBBIE STILL AND PAUL TINSLEY-MARSHALL, KENT WILDLIFE TRUST

Introduction

One of the key principles in 'Making space for Nature' (Lawton *et al.*, 2010) is summarised in the mantra 'joined'. The key approaches put forward by Lawton, and adopted by the conservation community to restore landscape connectivity, are to "Enhance connections between, or join up, sites, either through physical corridors, or through *stepping stones*." Habitat loss and fragmentation are ubiquitous in both natural and human modified landscapes, resulting in detrimental consequences for biodiversity and functional processes. Development pressure is particularly high in Kent, with more than 5,000 new dwellings added on average each year (Strategic Commissioning – Analytics Kent County Council, 2020), and 44% of these were built on previously undeveloped land (Strategic Commissioning – Analytics Kent County Council, 2019). Patterns of biodiversity and ecosystem function are changing as a result of this, resulting in a loss of connectivity and ecological integrity in ecological networks. This can influence individuals, populations and communities through intra- and inter-species, and inter-ecosystem interactions. These interactions affect ecological processes such as nutrient and energy flows, predator-prey relationships, pollination, seed dispersal, demographic rescue, inbreeding avoidance, colonisation of unoccupied habitat, and alter species interactions and disease transmission. Landscape connectivity facilitates the movement of biotic processes such as animal movement, plant propagation, and genetic exchange, as well as abiotic processes such as water, energy, and material movement within and between ecosystems.

The Kent Biodiversity Strategy states the goal that "by 2045, Kent has a rich and growing terrestrial biodiversity, underpinned by more resilient and coherent ecological networks and healthy, well-functioning ecosystems". Connectivity is a key element of this, and some of the best available data on the state of connectivity in Kent is shared in this report.

Landscape connectivity

The degree to which regional landscapes that encompass a variety of natural, semi-natural, and developed land cover types, impede or facilitate wildlife movement and ecological processes.

Assessing connectivity

Although an intuitive concept, there is no single consistently used metric of connectivity. Generally, connectivity metrics fall into three categories:

1. ***Structural*** connectivity metrics are based on physical properties of landscapes, which includes the concepts of patches (size, number of patches and distance between them) and relative disturbance (human structures and land use, fragmentation, human population) but not ecological processes (Wu, 2013).

2. ***Potential*** connectivity metrics are based on the landscape structure, as well as some basic information about the study organism's dispersal ability.

3. ***Functional*** connectivity metrics are measured based on the actual movements of individuals along and across contours of connectivity, including among patches (where these exist). This can take into account life cycles, as well as simply presence.

Connectivity modelling approaches are popular and widely used in conservation to quantify structural and potential connectivity. Conservation organisations are growing in knowledge, expertise and application of these techniques, however quantifying functional connectivity remains a challenge, and demonstrating this might be considered a gold standard in evidencing landscape-scale outcomes of landscape-scale conservation. The need to validate modelling approaches is widely recognised, though many existing field survey methods lack a strategic approach to survey design that can detect functional connectivity.


Walking Trail
© bobofthedead84 @pixabay

The state of connectivity in Kent

Three connectivity studies conducted in Kent are reviewed here: two of these focus on modelling *structural* and/or potential connectivity, while the third adopts a two-stage approach. This approach first quantified potential connectivity for defined species, and then attempted to validate model outputs using a novel field survey approach to quantify *functional* connectivity.

B-lines

B-lines, a partnership project led by BugLife[1], aimed to address pollinator declines by restoring and creating large areas of wildflower rich habitat within a prioritised and connected network, otherwise known as B-lines. Over time, these will develop into a series of linear pathways of species-rich habitat, linking existing core wildlife areas to create a coherent network. They will therefore play a core role both in increasing habitat area and connectivity, and in improving the permeability of the wider landscape.

Connectivity modelling was carried out in 2015; to aid B-Line identification, potential connectivity was modelled across the target counties, including Kent, using 'Condatis' (The Condatis Project, 2021). This provided a snapshot of connectivity of one specific habitat type, wildflower meadow, across the counties, and was used to inform the location of B-lines. This is an example of the value of connectivity modelling in informing action to improve connectivity, though does not provide the comparative analysis of changes in connectivity that will allow change in the status of connectivity to be determined. It does, however, provide an opportunity to repeat modelling post establishment of B-Lines, that would allow resulting improvements in connectivity to be quantified.

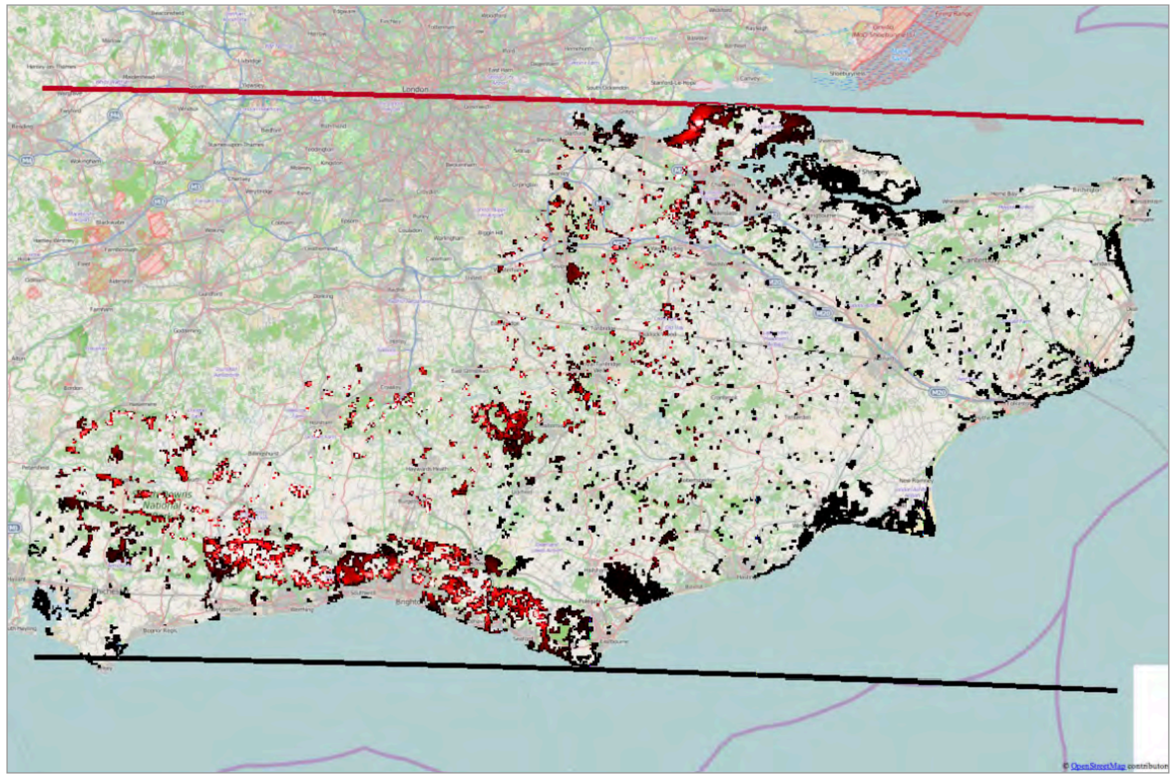

Figure 1 Results from Condatis connectivity modelling for wildflower meadow habitat across Kent, Sussex and Hampshire in 2015. The model investigated routes from the southern extent to the north, and red squares show higher connectivity values and therefore the most strategically promising routes for B-line creation. Making a Buzz for the Coast

[1] With Natural England, Kent Wildlife Trust, Sussex Wildlife Trust, South Downs National Park, University of Liverpool, Brighton and Lewes Downs Biosphere, Kent and Medway Biodiversity Records Centre and the Sussex Biodiversity Records Centre

Making a Buzz for the Coast

As part of the 'Making a Buzz for the Coast' project, the Bumblebee Conservation Trust[2] and Kent and Medway Biological Records Centre modelled connectivity for foraging worker and dispersing queen bumblebees. The study modelled connectivity for a generalist and a specialist species, and found that the majority of 'least cost' pathways across the landscape followed main roads, with existing Roadside Nature Reserves highlighted as key areas which have existing management plans. This mapping enabled the project officers to prioritise their actions to maximise the benefit for bumblebee conservation, and brought the project into alignment with the B-lines, facilitating the creation of 'Bee Roads' – 13 new Roadside Nature Reserves covering an area of 12.1 ha across the Swale.

This study took place in 2017, using habitat data from the 2012 Kent ARCH Habitats survey. Similarly to the B-lines, this project modelled connectivity in order to inform conservation rather than to assess connectivity outcomes across the north Kent coast. As such, further connectivity assessment would be highly beneficial following the Bee Road creation to analyse the effectiveness of the project and give an indication of status and trends in connectivity in the region.

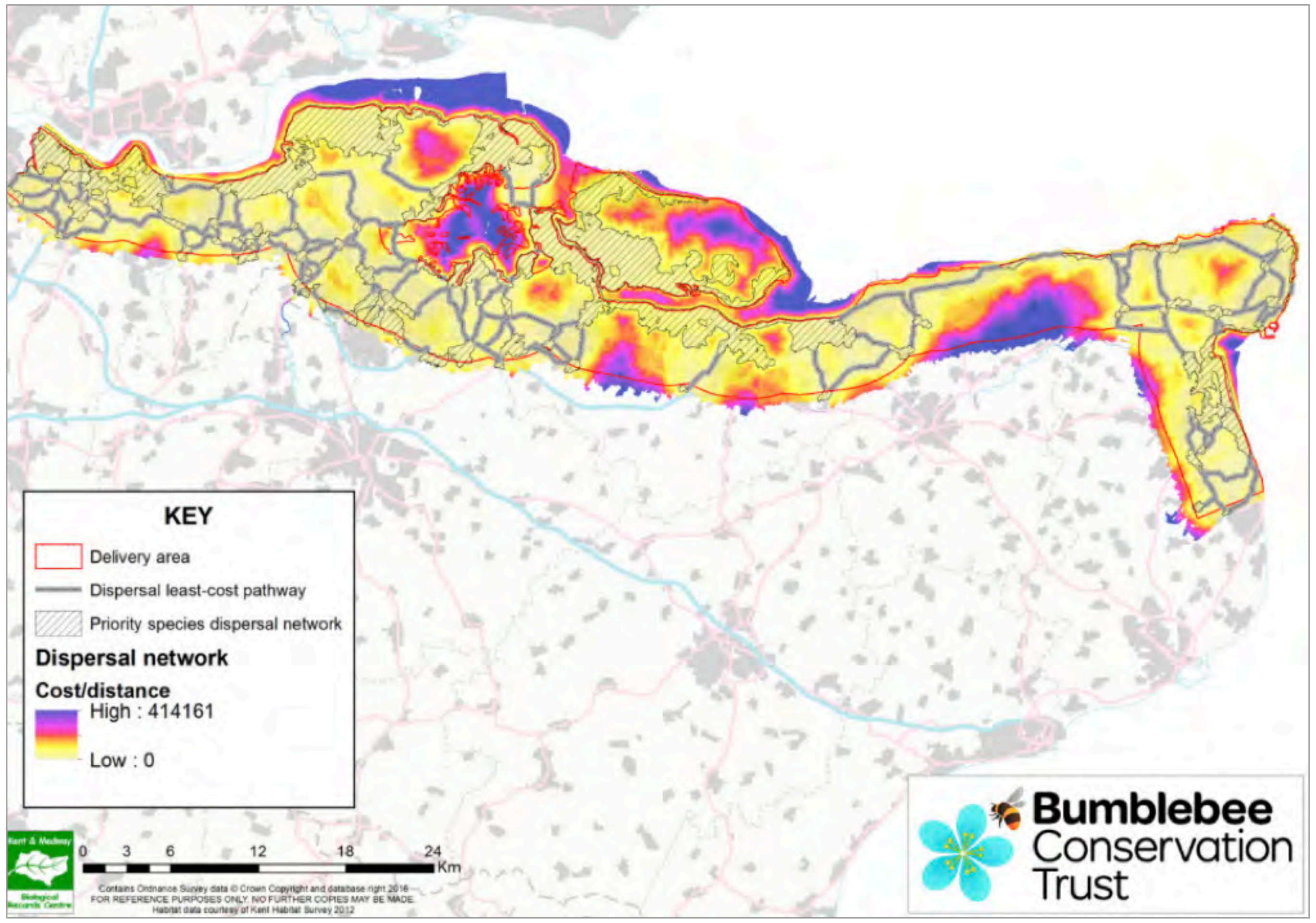

Figure 2 Results of connectivity modelling for the Making a Buzz for the Coast project along the North Kent coast. High values are associated with extensive hostile habitat for both generalist and priority species. Least cost pathways between priority species dispersal networks have been calculated, which will be used to establish Bee Roads.

[2] In partnership with the RSPB, Thanet District Council, Thames Water and Kent Wildlife Trust

Nature's Sure Connected

As part of KWT's Nature's Sure Connected project (Tinsley-Marshall *et al.*, 2021), KWT used Circuitscape to perform least cost path analysis of two indicator species to assess the change in functional connectivity of a key habitat: chalk grassland within the North Kent Downs. Chalk grassland is characteristic of Kent and is internationally important; due to the loss of 97 % of wildflower meadows in the UK since 1945 (Barkham, 2015) it is a key focus of conservation action across the county. The project identified an important opportunity to monitor connectivity change using the Kent ARCH habitat survey data for 2003 and 2012. Two indicator species were chosen for this habitat based on criteria for selecting landscape scale indicators developed by the project (Tinsley-Marshall *et al.*, 2021). The European Adder *Vipera berus* and Adonis Blue Butterfly *Polyommatus bellargus* were chosen for the study, as characteristic species of, and ecologically associated with, chalk grassland in Kent. The choice also reflected temporal variability in dispersal due to contrasting life cycle duration, the number of generations per year, and dispersal ecology. Least cost path analysis assigns a permeability value to cells (i.e. mapped habitat polygons), and models the permeability of the landscape between core populations according to the permeability of habitat polygons to each species. Local experts from BC and KRAG provided technical advice to parametrise the models.

Model output maps can be difficult to interpret; numerical values for change in connectivity were therefore derived following Siggery et al., (2019). Values appear to demonstrate a decrease in connectivity from 2003 to 2012 (Table 1), thereby revealing a limitation of the approach inherent in the mapped habitat data. The 2003 habitat data was digitised at a coarser resolution than in 2012. In 2003, habitat polygons were manually digitised, whereas the 2012 survey populated more accurate Ordnance Survey MasterMap polygons. This means, for example, that smaller greenspaces within urban areas are resolved in 2012, while in 2003 whole towns were categorised as built environment even if green space was present. This means that areas that may have been impermeable to indicator species in 2003 were not modelled as such, and vice versa. Therefore, apparent change in connectivity may not be genuine change, rather just an artefact of the detail of the resolution of habitat data inputs. Interestingly, it does demonstrate how increases in urban green space influence permeability.

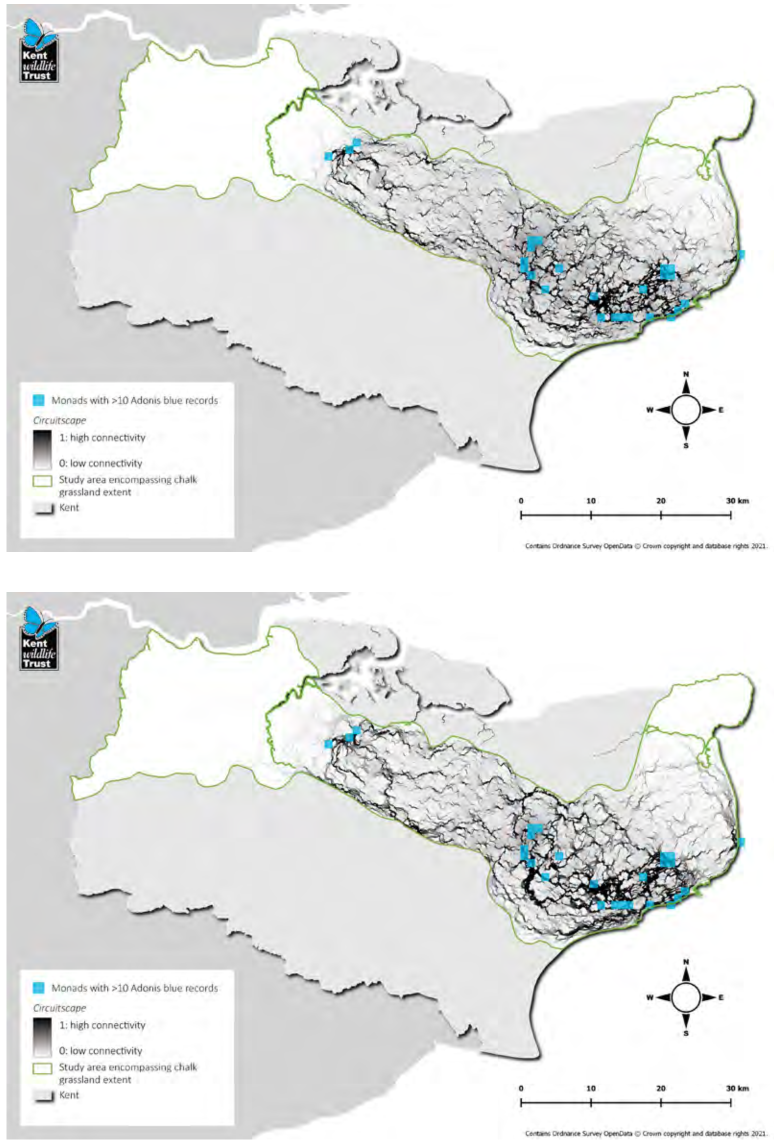

Figure 3 Circuitscape output maps for 2003 (top) and 2012 (bottom) ARCH Kent Habitat Survey data based on population cores (pale blue) created from monads with records of more than 10 Adonis Blue in one record.

Table 1 Connectivity values derived using Circuitscape modelling of landscape connectivity for Adder and Adonis Blue in the North Kent Downs in 2003 and 2012, using mapped habitat data.

Species population cores modelled	2003	2012
Adder Cores were monads containing at least one record with more than four Adders in one sighting	1.706	1.618
Adonis Blue Cores were monads containing at least one record with more than 10 Adonis Blue in one sighting	1.869 (Figure 3)	1.789 (Figure 3)

Note: Connectivity results were derived following Siggery et al (2019), criteria for population cores advised by BC/KRAG.

Dark green fritillary *Argynnis aglaja* © Wildlife Trusts

In addition to the modelling element, KWT also developed a novel field survey approach in an attempt to validate model outputs and quantify functional connectivity. An equation to define locations in which recording a focal indicator species will demonstrate functional connectivity was created:

Target survey locations = (potential range - known range) + known absence + spacial dispersal potential + temporal dispersal potential

The equation provides a simple way of defining appropriate locations in which recording the focal indicator species would provide an indication that connectivity has facilitated its colonisation of locations in which its prior absence over a specified timeframe can be assumed, as far as reasonably practical.

Surveys for each indicator species were carried out at the target locations, using the UK Butterfly Monitoring Scheme timed count method (UK Butterfly Monitoring Scheme, 2021) for Adonis Blue and direct observation and refugia ('tinning') survey methods (Froglife, 1999; Gent *et al.*, 2003) for the European Adder. A total of 26 target survey locations were surveyed for Adonis Blue, and 11 for Adder. Adonis Blue was recorded in 17 locations in which the Survey Site Equation had established reasonable confidence in absence in the 10 years prior to survey. Records for three of these locations were accepted, and 14 failed verification by the county recorder. No Adders were found in any of the target survey locations. By selecting species that fit the "criteria for selecting landscape-scale indicators" and applying the Survey Site Selection Equation, the survey carried out by the project detected occupation of new habitat patches by Adonis Blue that were of suitable habitat type for the species, for which a degree of confidence in prior absence had been established using current distribution and survey effort data, and within the anticipated dispersal distance from occupied patches. Having reached previously unoccupied patches it can be inferred that habitat connectivity exists for Adonis Blue. Although not all Adonis Blue records were accepted, in part due to the species never having been recorded in these locations, the survey was able to identify locations in which further surveillance might enable the detection of functional connectivity. While no new patches occupied by Adder were found, this was anticipated to a certain extent on the basis of the slow dispersal rate of this species. Surveys have established greater confidence in the baseline absence data for Adder at these sites however, and have again identified areas that warrant future surveillance and the potential to detect functional connectivity in future.

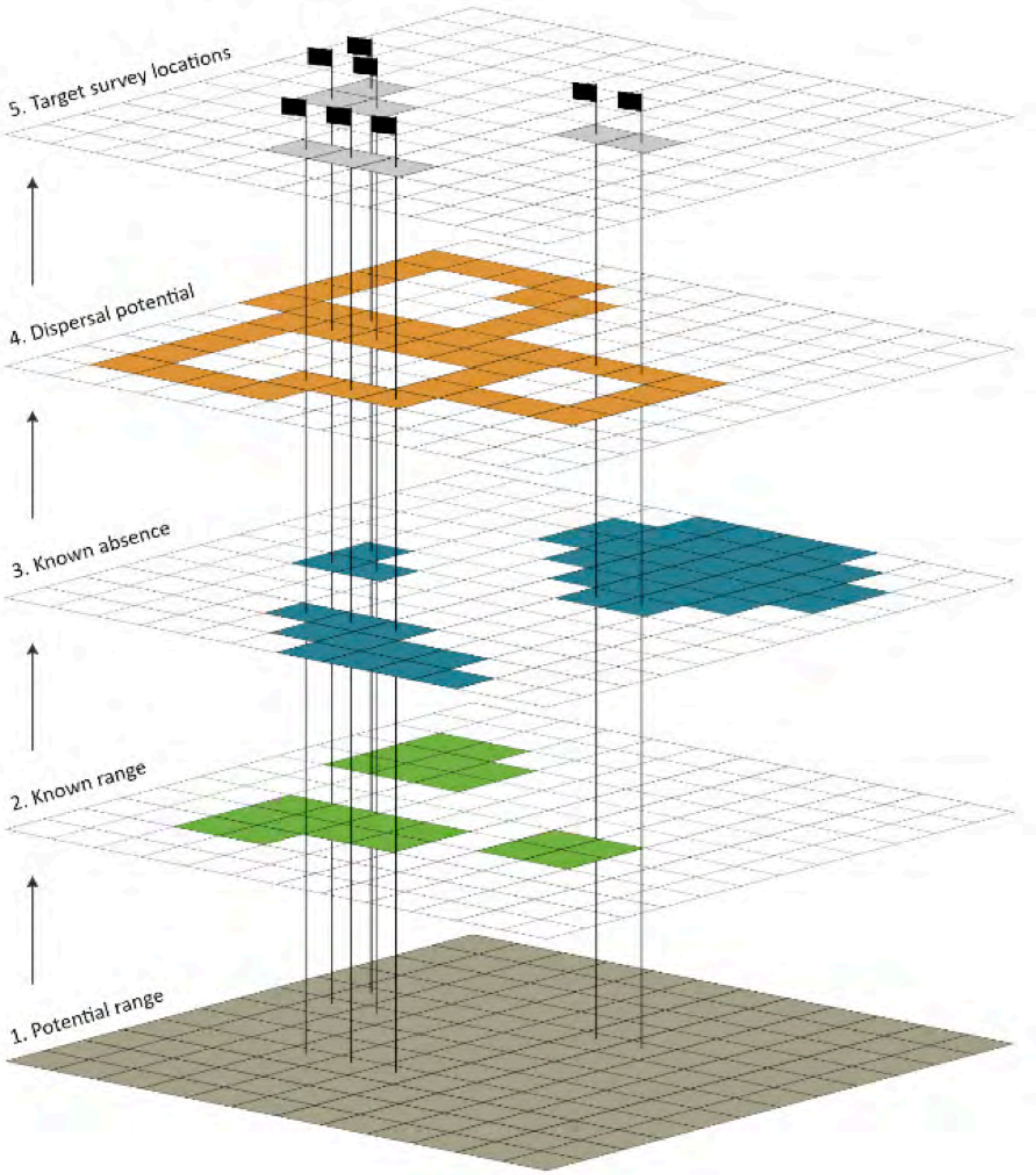

Figure 4 A conceptual diagram of the Survey Site Selection Equation. Potential range is the extent of suitable habitat in the study landscape with sufficient patch size to support the target indicator species. Known range is determined from all available species records. Known absence is determined using survey data for the relevant group to define locations in which the relevant taxa has been surveyed within a specified timeframe (10 years in this example) and in which the target indicator has not been recorded, to provide confidence in prior absence as far as reasonably practical. Dispersal potential was determined through consultation with local experts (KRAG and BC), and by buffering the existing range by this dispersal distance. Target locations are identified as areas within potential range, within dispersal potential of known range, and in which prior absence of the target indicator species can be assumed within the specified timeframe.

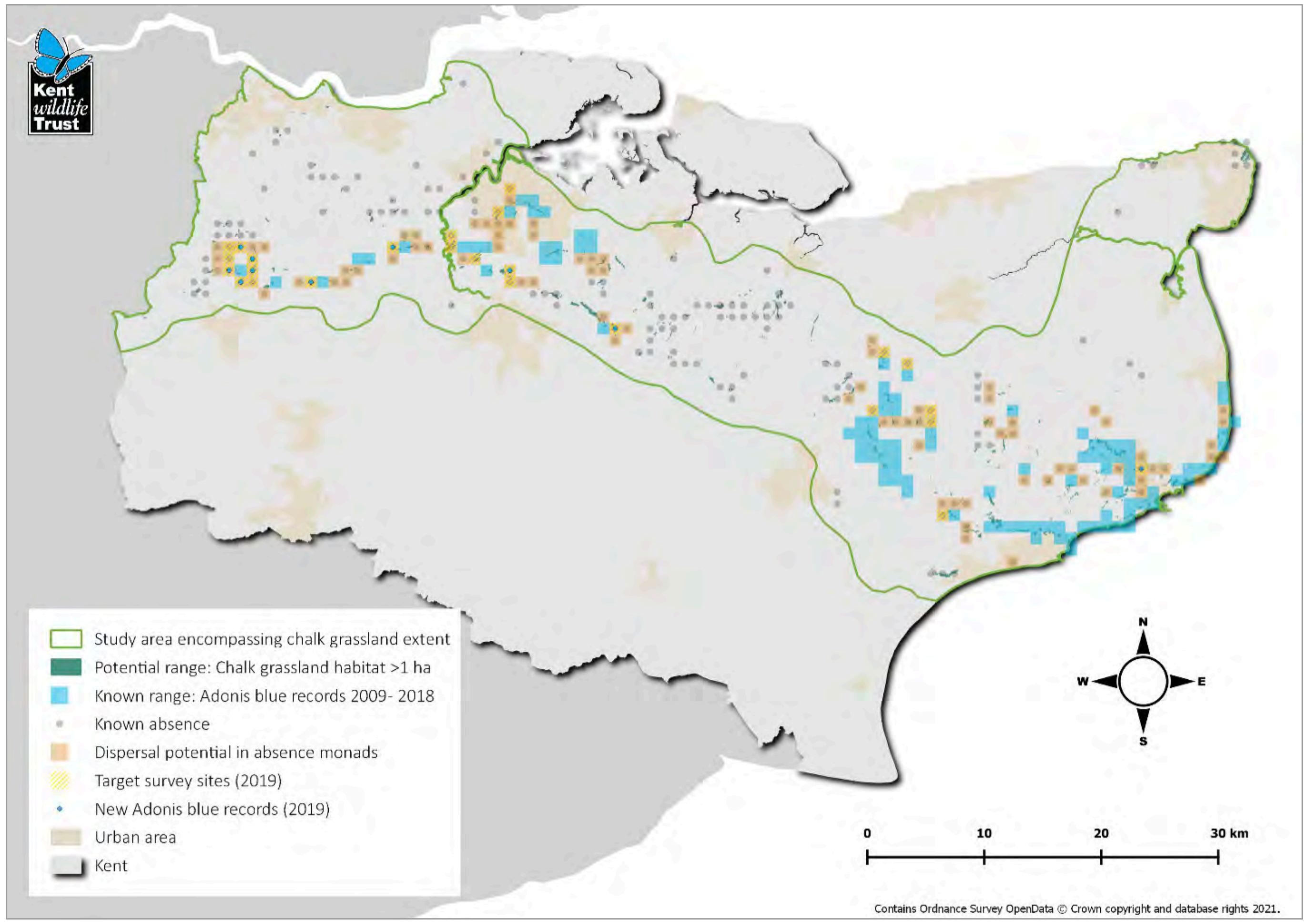

Figure 5 Map showing the results of a field survey approach to detecting functional landscape connectivity for Adonis blue in Kent, including the components of the survey site selection equation.

Conclusion

Primarily connectivity in Kent has been assessed in order to inform conservation actions, rather than to measure changes in connectivity. There is not a great deal of understanding of the state of connectivity, or how it has changed over time and in response to conservation action. Additionally, the diversity of coverage across different habitats and taxa is low; both the B-Lines and Bee Roads initiatives focus on wildflower verges for pollinators, and Nature's Sure Connected trialled a novel methodology on chalk grassland indicator species. To our knowledge, there have been no assessments of connectivity across other habitats in Kent, such as woodland. Furthermore, the impact of modelling parameters means that a single connectivity model without validation with ground truthing is fairly difficult to draw conclusions from. The novel field survey method to monitor functional connectivity developed by KWT appears to provide a promising approach to validating connectivity models and generating empirical field data to detect functional connectivity, though further testing and application of the approach will be needed to refine and build confidence in robustness.

Connectivity studies in Kent are further limited by the lack of an up-to-date habitat coverage dataset. The Kent ARCH habitat survey is now nine years old, and therefore even though the modelling for Nature's Sure Connected and Making a Buzz for the Coast was completed in 2019 and 2017 respectively, they are based on data accurate only to 2012. This restricts the ability to model trends in connectivity over time, which would require an updated full county habitat survey to assess the impact of a conservation action to improve connectivity. Recently, the UKCEH has released the UKCEH Land Cover Maps (UK Centre for Ecology and Hydrology, 2019) which uses consistent mapping resolution across years, and which may provide an opportunity for this in the future. Alternatively, advances in remote sensing from satellite imagery and targeted habitat surveys may be required.

The Nature Recovery Network will see the creation of a Local Nature Recovery Strategy (LRNS) for Kent. Connectivity will be a key element of the LNRS, and a combination of the methods described here, drawing and building on previous studies and the knowledge

and skills developed within the conservation community in Kent, will allow goals for connectivity to inform the strategy for nature's recovery in Kent. The LNRS will require stringent monitoring to ensure that the strategy is having the desired impact, therefore consistent and repeatable connectivity monitoring will be a vital component of the evidence base in the coming decade as the Kent Nature Partnership works to delivery both the Kent Biodiversity Strategy and the Local Nature Recovery Strategy.

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