THE STATE OF KENT'S SPECIES

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European beaver © Nick Upton

Shaggy Pholiota *Pholiota squarrosa*
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KENT'S FUNGI

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Summary

- Kent has a rich assemblage of fungi with 859 species known in the database held by Kent & Medway Biological Record Centre (KMBRC).
- Four Kentish species are protected by the Wildlife and Countryside Act 1981, and a further eight Boletes are on the UK Red Data List. In addition, there are 43 species on the Red Data List for Kent. The Kent Biodiversity Action Plan lists 32 species, with some overlap between lists.
- Many common species are widespread across the county, with the rare or endangered species restricted to the county's unimproved chalk grasslands, meadows, ancient woodlands, traditional orchards, parkland with veteran trees, churchyards, and sand dunes.
- Acute pressures for built development threaten many key habitats for fungi.
- Changes in rainfall patterns and hotter drier summers have an impact on soil moisture content which impacts on fungal growth.
- Increasing levels of toxic fumes from car exhausts, heavy metal loss from tyres and vehicle brakes and degradation of microplastics have an impact on fungal communities.
- Maintaining appropriate habitat management is vital for the survival of some species. Ensuring protection of soils from damage by compaction will encourage the development of healthy soils containing the vital fungal communities which support healthy plant growth and increased carbon sequestration.
- Several introduced pathogenic species have been recorded in Kent including *Phytophthora ramorum*, *Hymenoscyphus fraxineus*, which causes Ash Dieback and more recently *Cryphonectria parastica*, which causes Sweet Chestnut Blight.
- There is an increased interest in foraging mainly for small scale consumption, but if such sites become better known then commercial collecting may become an issue.
- Systematic recording for different habitats would be welcomed, but there is a serious lack of suitably skilled observers to quantify any changes in distribution.

Fungi fauna of Kent

In well vegetated areas, the number of fungi present outstrips the number of species of vascular plants. In 2019 botanists registered 1,942 newly named species of vascular plants on the International Plant Names Index and mycologists recorded 1,886 novel fungi. Only a small fraction of a potential one million species of fungi have been named, but unlike plants, fungi have a single DNA marker known as the 'internal transcribed spacer' which is often able to distinguish a specimen fungus to species level. This new technique can be used to discover many species new to science from environmental samples, such as soils. However, this can present identification issues if the DNA sample cannot be matched to a recognised specimen which can be retained in a fungarium.

The database maintained by KMBRC holds records of 859 recently recorded species. Records have been accumulated by the diligent efforts of local naturalists, Kent Wildlife Trust, and a few dedicated mycologists who lead public forays or by individuals submitting records of their own observations. Additional information about certain species has been garnered through *The Lost and Found Fungi Project* (Brian Douglas, pers. comm.). Digital photographs have largely replaced the earlier mania for collecting, but individual specimens may require collection for further study to produce a spore print as well as microscopic or chemical examination to verify identification. The potential number of fungal species in the UK is about 15,000. The majority have been recorded by observation of their fruiting bodies by members of the British Mycological Society, members of the Fungus Conservation Trust, other recording groups and individuals.

Fungi play a crucial role in the functioning of all Kent's ecosystems as decomposers and recyclers. Their combined activities underpin and shape the nature of habitats occupied by other organisms. As decomposers, different species utilise the various substrates found in fallen branches, leaves, fruit, or dung, breaking down complex molecules by enzyme action and releasing nutrients which are then available for reuse by plants or other organisms including soil bacteria. Vast numbers of fungal species are present in the upper portion of the soil, many as yet unidentified. The physical structure of the microscopical threads or hyphae help to retain moisture and reduce erosion by binding the mineral particles together reducing erosion. They also ensure that soils retain carbon.

Many of these soil fungi have a symbiotic relationship with plants ensuring that they thrive. Some specialist fungi are associated with rotting wood within standing trees and may be restricted to individual specimens recorded from a certain tree. A number of these are

parasitic on plants, some causing economic loss of crops. Most species are predated by a variety of animals; there are at least 1,000 insects which are associated with fungi, some are very specific only feeding on one species of fungus.

Status and trends

Along with all other life forms on the planet, fungi are under threat. A mere 285 of 148,000 described species are assessed on the Global Red List, equating to 0.2% (Antonelli, et al. 2020). The compilation of a Red List for UK fungi commenced over two decades ago and saw the publication of *A Provisional Red Data List of British Fungi* (Ing, 1992). Since then, further work has resulted in the preparation of five Red Data Lists covering the more frequently recorded species available at http://abfg.org.

The vast number of species, relative paucity of recording effort for fungi, and lack of structured, methodological survey schemes mean that assessing trends in the abundance of fungi is highly challenging. For some their ephemeral nature means they are easily missed. A delicate Ink Cap may only last a few hours or be eaten by a hungry slug or deer. There is no standardised methodology for assessing fungal bio-abundance, but some records do include a count of fruiting bodies which can help to monitor some trends linked to changes in pollution levels or damage from recreational pressures.

The combination of the lists of historical records held in an earlier version of the Fungal Records Database of Britain and Ireland (FRDBI) for the Vice Counties East and West Kent produced a total of 3,309 species for the county. Although, it should be noted that a significant number of these early records include micro-fungi which tend to be under-represented in more recent records. As ancient woodlands support a large of number of fungi, counties with a higher proportion of this habitat usually have a high score; Kent has the largest amount of ancient woodland in England. In fact, mixed coniferous and broadleaved woodlands provide greater variety of habitats for different fungal species as they have a wider range of tree species and often include ancient trees, standing or fallen dead wood, unimproved grassland, streams, or pools and dung from grazing animals. A small copse can support a unique assemblage of fungi, but larger sites will have a richer mycota (Spooner and Roberts, 2005).


Burgundydrop Bonnet *Mycena haematopus*
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Table 1 Numbers of fungi species known from Kent and surrounding counties from the Fungal Records Database of Britain and Ireland

Vice County Records	No of historic fungal species up to 2015
Hertfordshire	2206
East Kent	1926
West Kent	2925
Middlesex	1750
South Essex	1341
Surrey*	5569
East Sussex	1681
West Sussex	2793

* Includes records for the intensively studied sites at Esher Common and Kew Gardens.


Scarlet Elf Cup
Sarcoscypha austriaca
© Tricia Moxey

Only four species of fungi are protected under the Wildlife and Countryside Act of 1981. Incredibly rare, with only a few fruiting bodies, all have been recently recorded in their protected sites. They are Sandy Stilt Puffball *Battarrea phalloides*, Royal Bolete *Boletus regius*, Bearded Tooth *Hericium erinaceus* (designated as *Hericium erinaceum*), Oak polypore *Piptoporus quercinus* (designated as *Buglossoporus pulvinus)*.


Golden Jelly Fungus
Tremella mesenterica
© John Skerry

Eight Red List Boletae have recently been recorded within the county as have 43 other species on the Red List for the county, most as a single specimen. Those of note include species of the rare Stalked Tooth (Stipitate Hydnoid) fungal community (Marren, 2000). Such fungi are largely confined to specific habitats with rotting wood which has been decaying for many years. Careful habitat management and subsequent monitoring ensures that specimens of Zoned Tooth *Hydnellum concrescens*, Mealy Tooth *Hydnellum ferrugineum*, Velvet Tooth *Hydnellum spongiosipes*, Fused Tooth *Phellodon confluens,* Grey Tooth *Phellodon melaleucus*, Black Tooth *Phellodon niger*, Bitter Tooth *Sarcodon scabrosus* and Scaly Tooth *Sarcodon squamosus* have been observed in recent years.

While the status of such target species needs to be assessed on a regular basis, it is the continued monitoring of sites within priority habitats noted for their species richness and abundance of fungi which is important to obtain a clear picture of the biological health of such habitats. Earlier records gathered by Kent mycologists concentrated on specific sites and their information helped to produce the report which led to the listing of the Important Fungus Areas within the UK in 2014, (Evans, Marren and Harper, 2014a). This used strict criteria to reflect on the mycological interest of a particular site. Building up such a comprehensive species list for any site is time consuming as fruiting is influenced by temperature as well as wet or dry seasons. 520 sites across the UK were selected using these criteria. That Kent has the highest score in the whole of the country is an indication of both the richness of its sites and the dedication of the county's recorders. The top scoring site is Bedgebury Pinetum with over 900 species and Lullingstone Country Park a close second with over 700 (Evans, Marren and Harper, 2014a). The Natural England SSSI citation for Lullingstone Country Park mentions its old pollard trees and woodland. With 202 significant trees including one of the most notable oaks in the country with an assessed age of 1,014 years, all are likely hosts to some very special fungi (Bell, 2019).

The penultimate column in Table 2 indicates a 'wish list' of 37 potentially additional interesting sites in Kent for which additional survey work is likely to find some of the more unusual or rare species. These sites include additional woods, parklands, commons, and churchyards which are worthy of further investigation.

Table 2 Comparison of the number of Important Fungal Areas in south-eastern counties of the UK

	A	A, B	A, B, C	A, C	B	B, C	C	D	Total Score
Essex	1	1	0	0	1	0	2	1	5
Herts	2	4	0	1	10	3	3	17	40
Kent	1	4	1	1	3	0	1	37	49
Middlesex	0	0	0	0	2	0	0	1	3
Surrey	1	4	2	0	0	1	1	3	14
Sussex	3	0	2	0	0	0	1	6	12

Note: A: site with 5 or more species of Conservation Concern. B: site well recorded 700+ species C: site of habitat value D: sites suggested for further recording

During the past decade it is pleasing to note that several interesting species of fungi have been discovered in Kent, including the deadly poisonous False Morel *Gyromitra esculenta* (on dry sand soil beneath pines), and the striking grey and black shaggy scaly cap of Old Man of the Woods *Strobilomyces stobilurus*. Notably, the intriguing species *Amanita inopinata*, which is new to science and has yet to be described and officially named, a specimen of the golden capped Sunny Brittle Gill *Russula solaris* found at a second location within the county, and *Hygrocybe ingrate,* a species more usually found in the southwest of British Isles. *Laxitextum bicolor* (a Kent Red Data List species) is an uncommon species. It was located on dead oaks at three sites.

With the enthusiasm for using woodchips as a mulch, a couple of new additions to the UK list have been observed, these include the Magenta Rust Gill *Gymnopilus dilepis* found in large numbers on damp Sweet Chestnut chippings. This is a native of South East Asia but it has spread to other parts of the world. *Agrocybe rivulosa* which was recorded as a new species in Holland in 2003 and first noted in the UK in 2004 has appeared on wood chip mulch of flowerbeds. Large colonies of the cup fungus, *Peziza vesiculosa* have turned up on rotting heaps of late mown grass on roadside verges.

Several records were accumulated through the activities of participants in the *Lost and Found Fungus Project* which ran from 2014-2019 organised by

the Royal Botanic Gardens at Kew, which set out to rediscover 100 rare species that had not been observed for over 50 years. Mycologists searching in Kent were delighted to find specimens of Wood Candelabra Coral *Artomyces pyxidatus* which grows on rotting wood. *Hohenbuehelia bonii*, a yellow brown oyster mushroom was located at the base of dead Marram Grass. The vivid blue, Big Blue Pink Gill *Entoloma bloxamii* was found in calcareous grassland. The several brackets of the Oak Poloypore *Buglossoporus quercinus* were discovered on separate old parkland Oaks and *Volvariella aethiops* was found at one location. The rust, *Puccinia cladii*, was noted on the leaves of *Cladium mariscus* at a coastal site. The striking Zoned Rosette *Podoscypha multizonata* was found at the base of a couple of trees in different locations. Another interesting find was *Sarcodon joeides*, a rare-toothed fungus known from only a few sites in England. Growths of the yellow *Sarcodontia crocea* were found on a couple of apple trees in old orchards in East Kent (pers. comm., Brian Douglas).

Non-native and invasive species

There are several pathogenic fungi which are widespread across the county where their impact on trees has a wide impact on the landscape. Dutch elm disease is caused by the fungus *Ophisostoma novo-ulmi* which destroyed many elm trees especially those in hedgerows. This fungus was spread by the bark beetle *Scolytus scolytus* and *S. multistriatus*. The fungus blocks the water conducting tubes or xylem vessels in the trunk and branches, so the tree dies. Most mature elm trees died, although a few isolated ones can still be located. However, the impact of this fungus lingers on within surviving elms within many old hedgerows as their fungus riddled roots send up fresh shoots which can grow for about 15 years before dying off. The dead trunks fall over and are replaced in subsequent seasons by fresh growth.

Oak Mildew *Erisyphe alphitoides* is a fungus which forms a white coating on the leaves of oak trees. It is widespread across the county where sapling oaks are found (Lonsdale, 2016). The fungus causes distortion of the leaves and reducing its ability to photosynthesise as well increasing water loss from the whole infected shoot. In recent years this fungus has become more common on the leaves of established trees, especially those which are managed as pollards and can be a contributory factor in the death of such trees.

Ash Dieback (Chalara) is caused by the fungus *Hymenoscyphus fraxineus*. This is another invasive tree disease recorded in the UK on imported saplings during 2012. Ash is the most widespread tree species found in Kent, with records from 930 of the county's 1,043 tetrads. It is a tree which directly supports 112 invertebrate species, and its alkaline bark provides the right niche for 255 species of lichen. Ash trees grow in woodlands and hedgerows and are also a prominent feature of the urban landscape, as street trees, in many parks and gardens and alongside railway lines. Woodland managers have noticed well established infections in Ash trees in East Kent but the fungus is spreading westwards. Natural regeneration in heavily infected woodlands is compromised and mature trees are susceptible to secondary infections including Honey Fungus.

Phytophthora ramorum can infect at least 150 species of tree. Originally detected on larch it is of concern to all those who manage woodlands within the county and the Forestry Commission is monitoring its spread, see www.forestry.gov.uk for more information.

Key habitats and their protection

The association of certain fungi with specific trees has been known for a number of years, such as the Fly Agaric with birch, but the breakthrough discovery was made by Suzanne Simard whose research work in the late 1990's led to the discovery that forest trees share and trade food via the fungal networks that connect their roots. The term the 'wood wide web' has now become widely accepted, (Simard, 2021). The host plant supplies synthesised food materials to its

Porcelain Fungus *Oudemansiella mucida*
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Table 3 Priority habitats for fungi in Kent

Priority Habitats for Fungi	Comments about fungal assemblages
Lowland beech and yew woodland	Some very well recorded sites with varied habitats adding to a diversity potential of 700 + species of macrofungi. These assemblages have been undisturbed for centuries. Red Data species recorded.
Lowland mixed broadleaved woodland	Some very well recorded sites with varied habitats adding to a diversity potential of 700 + species of macrofungi. These assemblages have been undisturbed for centuries. Red Data species recorded.
Long established parkland	Contain ancient trees which support saproxylic specialists Red Data Species recorded.
Chalk grassland	Support waxcaps and other grassland specialists, many sites have remained unimproved for decades. Red Data Species recorded.
Lowland meadow	Limited range of fungal species.
Lowland dry acid grassland / lowland heathland	Support some specialist species restricted to this habitat. These assemblages have been undisturbed for centuries. Red Data Species Recorded.
Urban parks, gardens, golf courses	Potential for wide range of species if managed appropriately.
Roadside verges/hedgerows	Some Local Wildlife Sites are floristically rich – fungi under recorded but possible habitats for some species.
Traditional orchards	Some unimproved grassland species, plus fungi on old fruit trees.
Churchyards and cemeteries	Some unimproved grassland species. May support Red Data Species.
Brownfield sites	Data deficient as many are rather arid and contaminated sites.
Vegetated shingle and dunes	Support some specialist species – under recorded.

associated fungi in exchange for water and minerals. As 80% of plant species have this beneficial or symbiotic association with one or more fungal species this is the hidden value of fungi within all ecosystems. Some of the fungi involved do not produce a recognisable above ground fruiting body so are difficult to detect other than by DNA profiling. Tree diversity influences ectomycorrhizal (ECM) richness woodlands with differences between ancient woodlands and more recent plantations. In addition, very little is known about what constitutes
a viable population or the longevity of species in most substrates. Some answers may be provided by the increasing use of DNA studies, which is being used to reveal the existence of several genetically distinct entities that look morphologically identical
as is the case of Morel *Morchella esculenta* which is under investigation as are several samples of *Cortinarius* species from sites on chalky soils (Joyce Pitt, pers. comm.).

Several calcareous grasslands support specialised grassland fungi. A straightforward scoring system can be used to assess the conservation importance

Fly agaric *Amanita muscaria* and
Common Yellow Russula *Russula ochroleuca*
© Susan Warnerlgentur aut omni berum

Table 4 Special Areas of Conservation in Kent containing important fungal assemblages

Special Area of Conservation	Size	Main Habitats	Comments
Blean Complex Special Area of Conservation	524 ha	H9160 Sub-Atlantic and medio-European oak or oak-hornbeam forests.	The site comprises the largest ancient broadleaved woodland in southern Britain, situated on London Clay. These woods support a wide range of fungi and active recording must continue to monitor changes.
Dungeness Special Area of Conservation	3224 ha	H1210 Annual vegetation of drift lines H1220 Perennial vegetation of stony banks.	One of two south coast sites noted for annual vegetation of drift lines. Covering 1,600 ha Dungeness is the UK's largest shingle structure. It is a data deficient site for fungi.
Folkestone to Etchinghill Escarpment SAC	182 ha	H6120 Semi-natural dry grasslands and scrubland facies: on calcareous substrates – rich orchid site – some national rarities.	Orchid rich calcareous grassland sites support a range of specialist grassland fungi. Monitoring of these sites should continue.
Lydden & Temple Ewell Downs	63 ha	H6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates.	One of the richest sites in Kent for orchid and invertebrates. Should also be excellent for rare grassland fungi – data deficient.
North Downs Woodlands	287 ha	H9130 Asperulo-Fagetum beech forests H6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (with important orchid sites) H91J0 Taxus baccata woods of the British Isles.	The area is considered one of the best areas for beech and yew woodlands in the UK. Calcareous sites supporting a range of orchids are also known to be rich in species of grassland fungi. This SAC includes several sites with significant fungal records and active recording must continue to monitor changes.
Queendown Warren	14 ha	H6120 Semi-natural dry grasslands and scrubland facies on calcareous substrates (important orchid sites); Dry grasslands and scrublands on chalk or limestone (important orchid sites).	

of these sites based on the emergence of fruiting bodies of wax caps and other grassland species such as pinkgills, fairy clubs and earth tongues (Evans, Marren and Harper, 2014b). In Kent there are several locations where records of wax caps are in double figures, so these sites are important for their wax cap populations alone. Important sites for fungi in Kent are not restricted to the chalk bedrock; however, Table 3 provides details of priority habitats for fungi in Kent, which include specific assemblages of fungi which will be unique to each location within these habitats.

With increasing pressure from built development within the countryside, it is important to emphasise the value of the SAC designation where appropriate in raising objections to planning applications. Currently apart from those species protected under the Wildlife and Countryside Act 1981, fungi receive no recognition in relation to planning activities. Planners and developers should be aware that any biodiversity offsetting proposals should include consideration of potential loss of specialised fungal assemblages as these cannot be easily replicated. This is especially true of the saproxylic communities within ancient trees, or the mycorrhizal habitats in ancient woodlands or unimproved calcareous grasslands which have developed and stabilised over many decades. The original SAC designations do not include fungi, but since then the importance of the role of fungi in underpinning ecological services in maintaining healthy vegetation has become more widely understood. Soil fungi also help the soil to absorb carbon, thus assisting in climate change mitigation. Table 4 provides details of SACs in Kent with important fungal assemblages.

Drivers of Change

Changes in land management

The 20th century saw major changes to woodland management and the loss of swathes of unimproved grassland and rough common land. Motorways, road improvements and high-speed rail links were driven through the countryside, fragmenting habitats, and providing corridors along which new pests could be dispersed. Urban development meant more habitat loss too. The Kent Habitat Survey lists the changes in the areas of the various habitats and stresses the value of the habitats of significance for their vegetation types. Each one of these will have its own set of fungal species too, so landuse changes in area impact on fungi too. Coniferous woodlands support species which are unique to them and the loss of 72.1 ha with the extraction of coniferous timber will over time alter the balance of species within these sites. ECN fungi can take several years to become established in newly planted woodlands, especially those on former arable land.

Introduction | Headlines | Drivers | Conservation | Kent's Species | Landscape-scale | Case Studies | Conclusion
Fungi | Plants | Spiders | Dragonflies & Damselflies | Flies | Ants, Bees & Wasps | Beetles | Grasshoppers & Crickets | Butterflies | Moths | Amphibians | Reptiles | Birds | Mammals | Bats | Marine | Seaweed

The 21st century ushered in a more enlightened approach to conservation management in woodlands such as renewed traditional coppice management and pollarding of ancient trees, creating woodpiles, and leaving standing and fallen dead wood. All of these will enhance the potential for good fungal assemblages (Buckley and Blakesley, 2010; Woodland in the Kent Downs Landscape).

Some relict patches of unimproved chalk grassland and heathland have been protected and managed to provide opportunities for improved monitoring of emergence of fruiting bodies, but such conservation measures have to be ongoing, with mowing at the right time to avoid accidental damage to fruiting bodies (Griffith, 2011).

Soils are a non-renewable natural resource. They develop over centuries and as a living ecosystem act as the lynchpin for all ecological services. Every year England and Wales loses 3.9 million tons of topsoil to erosion with an annual cost of about £177 million a year. In recent years, the importance of protecting soils from erosion and from compaction is better understood (EA, 2019). The 25 Year Environment Plan recognises that soils health is the foundation for productive farming and forestry. This will encourage the development of healthy soils containing the vital fungal communities which support healthy plant growth and increased carbon sequestration. No-till practices are becoming more common as are appropriate management strategies for sites used for a range of recreational activities (Willis, 2018).

Climate change

Climate change is impacting the natural world with changes in rainfall patterns and higher summer temperatures. With so many different fungal species, it will be difficult to assess any changes as some may thrive in warmer, wetter conditions and others may struggle to survive. Some are already producing sporophores over a longer season. Thermophilic species could become more common and species which flourish in the near continent may arrive here in the UK. Hotter drier summers will reduce soil moisture content which impacts on fungal growth.

Pollutants

Since the 1940s the increased use of nitrogenous fertilisers on agricultural land, fungicides and the combustion of fossil fuels have added chemicals to the air, to land surfaces and to water courses. The UK's National Ecosystem Assessment in 2011 and the 2016 State of Nature Report flagged that atmospheric nitrogen deposition was one of the top two drivers of change in plant diversity. This in turn impacts fungal diversity. In 2014, 90% of land in SACs received excessive levels of nitrogen (RoTAP, 2012).

In the publication *We Need to Talk about Nitrogen*, the authors discuss this problem (Plantlife, 2014). Sulphur and nitrogen deposition can change soil pH and alter the chemical balance of nitrogen and carbon within the soil. The fungal composition of woodlands which receive excessive input of nitrogen is altered with beneficial ECM species being outcompeted by those more tolerant of pollution (EA, 2019). Research indicates that soils are tending to become slightly less acidic too, with more increase in woodland soils formed from calcareous substrates (RoTAP, 2012). The changes in species composition may include a higher incidence of more aggressive pathogenic species as a good range of ectomycorrhizal species within soils tend to suppress the growth of some pathogens (Quine et al, 2019).

Dog walking is a popular recreational use of many sensitive sites which results in increased nitrogen input from urine and faeces along many routes. Entry points to recreational sites receive higher concentrations. This will impact on the soil microbiome on either side of the well visited tacks and will be especially detrimental to the microbiomes of chalk grassland sites, heathlands, and popular woodlands.

As the total species richness below ground greatly exceeds the diversity of plants above, there is more focussed research about the impact of pollutants on the soil microbiome too (Environment Agency, 2019). Natural England is working alongside the Forestry Commission, the National Trust, and the farming community to make recommendations about limiting the impact of nitrogen deposition on sensitive sites.

Poor air quality from traffic fumes is exacerbated by the production of the toxic gas ozone (O_3) during hot sunny days. Although this gas does drift long distances through the atmosphere, it tends to be concentrated in the more rural areas especially around woodland canopies. In the UK, lowland beech and yew woodlands are in areas where ozone concentrations were moderate to high >4750 ppb. h based on 1999-2003 values (Sniffer, 2007). Improved monitoring for this gas is essential especially as warmer summers are predicted.

This toxic gas interferes with the ability of foliage to photosynthesise with a reduction in carbohydrate synthesis (Ainsworth et al., 2012). Since at least 20% of these carbohydrates are passed on to the trees supporting mycorrhizal associates, their efficiency may be reduced. There is much current research about this topic as there are so many variables to be considered. Using abundance of fruiting bodies can show some trends but changing weather patterns add another variable to be considered.

Little is known about the impact of microplastics on the soil microbiome. The levels of toxic heavy metals are on the rise too, and certain species of fungi accumulate these in their fruiting bodies. Natural England has produced Nutrient Mitigation Advice (2021).

Built development

Acute pressures from built development threaten many sensitive habitats including ancient woodlands, unimproved chalk grasslands, heathlands, and agricultural land with potential loss of fungal species. The methodology for biodiversity off-setting has yet to take fungal associations into account. Urban areas require green spaces with trees, gardens, and tree lined streets to provide shelter, soak up excess precipitation as well as mitigation for higher temperatures due to climate change. Healthy trees and shrubs improve poor air quality, some trapping particulates on their leaves. Urban trees supported by ectomycorrhizal fungi have been shown to reduce the nitrogen load from surface water runoff. Most trees and shrubs require the support of mycorrhizal fungi, and every effort must be made to ensure that these can thrive in urban areas.

Fungi and people

There is a growing awareness of the value of the countryside for health and wellbeing and with access to smart phones records of what has been seen on an excursion can be easily identified and logged using apps such as iRecord. Guided walks led by skilled naturalists help visitors to understand the interaction between organisms in the wild and many sites have dedicated trails and assorted methods of interpretation of what can be observed.

There is an increased interest in foraging mainly for small scale consumption with several organisations provide courses with strict limits on collection. If such sites become better known, then commercial collecting may become an issue. Large scale picking of edible (and non-edible) fruiting bodies reduces potential for spore dispersal and removes the supply for organisms which rely on them for food. Most publicly accessible sites now have a no foraging policy.

Many of the habitats capable of supporting good assemblages of fungi are available for public recreation. With the increased use of the countryside, land managers are faced with intense year-round pressure on their sites. Trampling and compaction of mycelium and fruiting bodies result from poorly sited public activities such as mountain biking, car parking and organised events with checkpoints, refreshment and toilet areas sited on species-rich areas of parkland. On some sites leaf blowing is the expected norm and this will reduce the availability of substrate for the common decomposers which help to release nutrient into the soil, thus encouraging carbon capture.

Other management issues include the use of mechanical bracken control during the sporophore producing season. The use of tractors in wet conditions lead to localised ploughing and severing of mycorrhizal roots and mycelial cords and networks. Compaction by heavy machinery, repeated use of paths by cyclists or lots of trampling especially in wet weather can lead to poor drainage in clay soils, this leads to smaller spaces between soil particles which can reduce fungal activity.

Recording, monitoring and research

Fungi are everywhere, and certain species are more commonly noticed than others. Some even glow in the dark. With reference to suitable guidebooks visual identification of many macrofungi is possible as they produce beautiful and colourful fruiting bodies. These include various forms such as toadstools, bracket fungi, tooth fungi, coral fungi, puffballs, earthballs, earthstars, earthtongues and spindles. More challenging are crusts, bird's nest fungi, cup fungi, rusts and smuts which reveal hidden structures when viewed through a lens or microscope. Some of these groups can be confidently identified by their fruiting bodies, even from a photograph, but less easily identified species require close examination with skills in microscopy and laboratory analysis. Confirmation of many records usually involves input from more than one mycologist with the data submitted to recording schemes. The appearance of a recognisable specimen does not necessarily reflect the number of individual organisms, which is difficult to quantify. Most micro-fungi require specialised identification techniques, and their distribution is less well documented. Fungal threads which encase algal cells to form lichens are not included in this report.

An additional challenge in the compilation of site records is that the prevailing weather conditions influences the production of fruiting bodies, which in some species is erratic, spasmodic, and unpredictable. For example, the very poisonous *Inocybe patouillardii* was recorded in 2017 beneath beech trees in Lullingstone Park after an absence of plus 20 years (Joyce Pitt, pers. comm.).

Since the integrity of all habitats is underpinned by a biodiverse mycota, continued monitoring of well recorded sites should be ongoing. The Kent Nature Partnership monitors the number of local sites in positive conservation management each year; ideally some method of assessing their fungal condition should be developed.

Conclusion

The range of habitats within Kent support an incredible diversity of fungi, some of which are incredibly rare and are of conservation concern. Specific species confined to the relic areas heathland and unimproved chalk grassland are at considerable risk from high levels of pollution and increased recreational pressures.

Across the county a wide variety of species underpin the integrity of ancient and plantation woodlands, landscaped and urban parks, agricultural land, orchards and allotments, gardens, street trees and coastal sand dunes and shingle. Collectively though their activities fungi are assisting in the storage of carbon as well as providing other economically important ecological services. Increased pressures from population growth, urban intensification tourism and climate change will impact on all habitats with some changes in the mycota.

Information about the role of fungi in underpinning all ecological systems and the need for their protection must be highlighted so that this can be better understood and integrated into policy decisions, especially around the development of new woodlands, changing farming practices and urban design for green spaces. Although largely hidden from view fungi have a significant role to play in the mitigation for climate change.

Monitoring the status and populations of fungi within the county is a massive challenge, but the increasing interest in the natural world can be utilised to encourage the development and implementation of appropriate citizen science projects to help trained mycologists with this challenge to record and better understand any trends in their distribution.

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Lady Orchid *Orchis purpurea*
Bonsai Bank a Kent Biodiversity Strategy species
© David Steere

KENT'S VASCULAR PLANTS

SUE BUCKINGHAM & GEOFFREY KITCHENER, KENT BOTANICAL RECORDING GROUP

Summary

- More than 2,500 taxa make up the Kent flora, past and present, of which some 950 species are native and 130 are ancient introductions.
- In the last 10 years, four native species have been added and 14, previously thought to have been lost, have been re-found. Some coastal plants have continued to increase their range but there have been declines elsewhere. Species including threatened orchids, thought 10 years ago to have been suffering serious declines, have been found to be faring much better than was feared.
- A few non-native species from warmer climates have reached Kent and colonised motorways and other roads.
- Plants of nutrient-poor soils, grasslands, wetland habitats and waterbodies have suffered the largest population decreases.
- Habitat loss, nutrient enrichment, habitat neglect and mismanagement are the main drivers of change.
- The formation of the Kent Botanical Recording Group (KBRG) in 2010 has resulted in new data relevant to habitat management.
- A Rare Plant Register (RPR) for the county has been produced with accounts covering the distribution and history of the 333 species listed.

Vascular plant flora of Kent

As a reflection of its enormously varied topography and geology, more than 2,500 species, subspecies and hybrids of vascular plants have been recorded growing wild in Kent. Of these around 950 are native and the remainder are introductions by man, either deliberate or accidental. Ancient introductions (archaeophytes) number about 130. Those which have arrived in Britain in recent times (after 1500 AD) are termed neophytes and although they can be of considerable botanical interest, their conservation value is not generally regarded as highly as that of the native species and archaeophytes with which this report is mostly concerned.

Our native and archaeophyte species have been assessed at the levels of both England and Great Britain as a whole to establish the level of threat of extinction faced by each species. In Kent we have responsibility for 194 plants with Red List status, six of which are Critically Endangered, 33 are Endangered and 77 are Vulnerable. The remainder are listed as Near Threatened because although they do not currently qualify as threatened, they are sufficiently close to being so under IUCN accepted criteria.

In 2010 the previous county Red List (Pitt, 2000) was reviewed by the newly formed KBRG, to establish a rolling RPR for Kent, which currently lists 333 species. All threatened and near threatened plants are included along with nationally rare or nationally scarce plants such as Wild Cabbage *Brassica oleracea* var. *oleracea* and Coralroot *Cardamine bulbifera,* both of which have significant Kent populations. Similarly, plants are covered which are rare or scarce in Kent, such as those of heathlands, even though plentiful elsewhere, e.g., Bog Asphodel *Narthecium ossifragum*. Except for seven species, all the Kent RPR plants have been seen in the county during the last 10 years.

The distribution of the Kent flora was documented by Hanbury & Marshall (1899) and Eric Philp's two Atlases of the Kent flora, the first covering the period 1971-1980 and the second 1991-2005 (Philp, 1982 & 2010). A significant addition to these is a reconstruction of Francis Rose's Flora of Kent, mostly dealing with the 1940s-1960s and recently published online. Although incomplete, it goes towards filling a gap in our knowledge of a time which saw the greatest changes to the Kent countryside and the major declines of many plant species.

Status and trends

In 2012 a list of 'probably extinct Kent plants' with last recorded dates and locations was published online by KBRG as a supplement to the Kent RPR. The intention was to raise awareness and encourage rediscovery. The list included 63 species which between 1920 and 2010 had been recorded apparently for the last time in Kent and might therefore be considered 'lost' to the county over the last 100 years. However, 14 of those have been re-found during the last 10 years. They include Slender Spike-rush *Eleocharis uniglumis*, missing since 1997 and found in four locations; Western Eyebright *Euphrasia tetraquetra*, re-found at Dover where last recorded before 1981; and Small Cord-grass *Spartina maritima*, an Endangered species, which was rediscovered at its old location along the Swale where it had been hiding since 1990. A particularly remarkable discovery was that of Few-flowered Spike-rush *Eleocharis quinqueflora* at Ham Fen after 142 years of absence from the county. It is likely that its seeds were brought to the surface as the result of habitat management by Kent Wildlife Trust.

Most species on the 'probably extinct' list have been rare in the county and in some instances the last date is likely to have been the first and only sighting. Some species would have persisted for a time and some of those are listed in Table 1. Experience suggests it might not be unreasonable to suppose that more may reappear should conditions once again become favourable for them.


Common Rock-rose *Helianthemum nummularium* a chalk grassland species
© Sue Buckingham

Table 1 Native plant species (including archaeophytes) lost°, gained^ and rediscovered‡ in Kent

Species changed in the last 100 years	Year	Species changed in the last 10 years	Year
Moonwort° *Botrichium lunaria*	1960	Martin's Ramping Fumitory^ *Fumaria reuteri*	2011
Flat-sedge° *Blysmus compressus*	1988	Four-leaved Allseed^ *Polycarpon tetraphyllum*	2011
Purple Small-reed° *Calamagrostis canescens*	1967	Cornish Moneywort^ *Sibthorpia europaea*	2017
Lesser Tussock-sedge° *Carex diandra*	1968	Killarney Fern^ *Trichomanes speciosum*	2016
Small-fruited Yellow-sedge° *Carex oederi*	1947	Corn Chamomile‡ *Anthemis arvensis*	(1976)° 2015‡
Dwarf Mouse-ear° *Cerastium pumilum*	1977	Lesser Hairy-brome‡ *Bromopsis benekenii*	(1986)° 2014‡
Meadow Thistle° *Cirsium dissectum*	1971-80	Few-flowered Spike-rush‡ *Eleocharis quinqueflora*	(1875)° 2017‡
Frog Orchid° *Coeloglossum viride*	1998	Slender Spike-rush‡ *Eleocharis uniglumis*	(1997)° 2013‡
Crested Buckler-fern° *Dryopteris cristata*	1962	Western Eyebright‡ *Euphrasia tetraquetra*	(c.1980)° 2017‡
Narrow-lipped Helleborine° *Epipactis leptochila*	1972	Copse-bindweed‡ *Fallopia dumetorum*	(c.1980)° 2020‡
Red-tipped Cudweed° *Filago lutescens*	1963	Tall Ramping-fumitory‡ Fumaria bastardii	(1950s)° 2015‡
Shoreweed° *Littorella uniflora*	1950	Round-fruited Rush‡ *Juncus compressus*	(1986)° 2011‡
Marsh Clubmoss° *Lycopodiella inundata*	1930	Frog Rush‡ *Juncus ranarius*	(1986)° 2019‡
Mousetail°[1] *Myosurus minimus*	1975	Grass-poly‡ *Lythrum hyssopifolia*	(1968)° 2011‡
Alternate Water-milfoil° *Myriophyllum alterniflorum*	1974	Tasteless Water-pepper‡ *Persicaria mitis*	(1955)° 2020‡
Childing Pink° *Petrorhagia nanteuilii*	1960	Southern Polypody ‡ *Polypodium cambricum*	(1859)° 2015‡
Red Pondweed° *Potamogeton alpinus*	1974	Shiny Glasswort‡ *Salicornia emerici*	(1960s)° 2011‡
Common Wintergreen° *Pyrola minor*	1971-80		
Round-leaved Dog-rose° *Rosa obtusifolia*	1972		
Marsh Stitchwort° *Stellaria palustris*	1986		
Field Fleawort° *Tephroseris integrifolia*	1970s		
Lesser Bladderwort° *Utricularia minor*	1966		
Slender Tare° *Vicia parviflora*	1972		
Plus 30 others (not listed)°			

1 Although this report otherwise considers the state of Kent's flora up to 2020, mousetail was re-found while it was in preparation (May 2021).

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The species listed in Table 1 reflect natural colonisation, so far as can be ascertained, although evidence of non-anthropogenic origin may at times be equivocal. The most impressive native discovery was that of Killarney Fern *Trichomanes speciosum*, which was found in sheltered sandstone crevices as a gametophyte and so without fronds. It appears to be a survivor of warm and wetter climate conditions, perhaps some thousands of years ago. In contrast, during the last 10 years, Kent has seen a great increase in deliberate wildflower introductions, largely in the form of agri-environmental schemes aimed at increasing species biodiversity or providing food for wild birds or bees. Some conservation bodies actively support reintroductions where they consider it appropriate. Narrow-leaved Hemp-nettle *Galeopsis angustifolia*, a Critically Endangered archaeophyte, has been sown at an east Kent location under Plantlife's Colour in the Margins project. Hanbury & Marshall (1899) regarded it as frequent in Kent in cornfields but changes in farming practices caused it to disappear from farmland during the last century.

Now it is confined to the Dungeness shingle where its population appears to be stable. The RPR accounts give details of rare plant introductions where feasible, so that their unaided distribution is understood, but this is reliant upon details being passed to the county recorder for the Botanical Society of Britain & Ireland (BSBI).

Information used to assess trends over the last 10 years is taken from KBRG's data. The records collected by its 140 members and others are at one-kilometre square resolution, allowing for greater accuracy than tetrad (2 km x 2 km) level used in the 1971-80 and 1991-2005 surveys published by Eric Philp. However, it is possible to compare with the previous surveys and doing so has produced some encouraging surprises. Although native species often continue to decline, current records show that the rate of decline is sometimes less severe than previously thought, and some species show an increase. For instance, White Helleborine *Cephalanthera damasonium* was recorded in 84 tetrads by Philp (1982), but only 45 by Philp (2010).

Ostensibly, this would appear to have been a product of the decline which, nationally, is reflected in the species' Vulnerable status; but instead, it could well have been an artefact of different recording methods or input. The 144 different monad records made for White Helleborine in 2010-20 equate to 96 different tetrads, indicating that this not a declining species in Kent. Similarly, Man Orchid *Orchis anthropophora*, a nationally scarce species with its core UK distribution in the county, has been found in 10 further tetrads over the 1971-80 survey with the result that current records do not back the 50% decline indicated when comparing the two Philp surveys. Green-winged Orchid *Anacamptis morio*, which has been regarded as a declining indicator species of old unimproved meadowland, has been found to be more extensive than indicated by Moyse (2011) and seems capable of colonising new sites, sometimes aided by artificial means, viz. the spreading of green hay from existing locations.

Sea Holly *Eryngium maritimum*, Yellow-horned Poppy *Glaucium flavum* and Sea Spurge *Euphorbia paralias* continue their spread on beaches on the north Kent coast. Nationally scarce Dittander *Lepidium latifolium* has doubled its range over the last 10 years colonising more banks and grassland near the sea and moving inland, including alongside roads where salt tolerance is advantageous. Wall Bedstraw *Galium parisiense*, a Vulnerable species, once known just from a few sites on wall tops, has been seen in many new locations: on sand and gravel at Lydd, old chalk pits, railway ballast and colliery shale. A tiny inconspicuous plant, it may have been overlooked in the past.

Fine-leaved Fumitory *Fumaria parviflora,* Stinking Chamomile *Anthemis cotula* and Night-flowering Catchfly *Silene noctiflora* are Vulnerable weeds of farmland which have benefited from the voluntary Countryside Stewardship scheme, whilst Broad-leaved Cudweed and others continue to thrive under appropriate management at Ranscombe Farm.

With new finds and the rediscovery of some of its old sites, more is known about the Kent status for True Fox-sedge *Carex vulpina* than at any time since Frances Rose's 1940's investigations. A nationally rare species largely confined to Kent, it has been highlighted in the Kent Biodiversity Strategy. Further targeted searches have led to discoveries of new and old sites for White Sedge *Carex canescens*, Star Sedge *Carex echinata*, Elongated Sedge *Carex elongata* and Bladder-sedge *Carex vesicaria*, species which, though having no national importance, are or were considered rare or scarce in Kent.


Greater Water-parsnip *Sium latifolium* Romney Marsh
© Sue Buckingham

Another Kent Biodiversity Strategy species, Dwarf Milkwort *Polygala amarella*, maintains a presence at each of its three extant sites, responding well to conservation measures at Godmersham Downs, with 196 plants recorded in May 2019 but, although searched for, has not been seen at any previously known locations. Adoption of Lady Orchid *Orchis purpurea* for monitoring under the Kent Strategy will hopefully enable better understanding of the requirements of this most iconic of Kent plants, suspected to be in gradual decline. Monitoring began in 2020.

In spite of conservation measures, the rarer wildflowers associated with farming remain rare, although there have been further sightings. Moyse (2011) lists the following as showing the greatest losses in Kent: Corn Buttercup *Ranunculus arvensis* with just one site (this increased to three, 2010-2019); Pheasant's Eye *Adonis annua* was discovered in 2014 on an East Kent farm operating a stewardship scheme for arable plants; Field Woundwort *Stachys arvensis* (2010-2019 recording showed an increase from 23 to 32 tetrads); and Shepherd's-needle *Scandix pecten-veneris* (an increase from three to seven tetrads (2010-2019)). However, Field Pepperwort *Lepidium campestre* and Treacle-mustard *Erysimum cheiranthoides* show alarming declines of 60% and 89% respectively since Philp (1982). In 2014, *A Vascular Plant Red List for England* (Stroh et al, 2014) was published in which both these and 49 other Kent species had their threat level raised from Least Concern to Near Threatened. Plants were included which came as a surprise, such as Quaking Grass *Briza media*, Wild Strawberry *Fragaria vesca*, Field Scabious *Knautia arvensis*, Wood-sorrel *Oxalis acetosella* and Goldenrod *Solidago virgaurea*. It is not that these plants are yet rare, but their rate of decline in England is alarming, and this is confirmed by our Kent data. Kent decline was especially pronounced between the county surveys of 1971-80 and 1991-2005, but in some cases it continues. An example is Goldenrod *S. virgaurea* which, as a species of nutrient poor habitat, may be affected by increasing levels of atmospheric nitrogen on banks and woodland margins. There does not seem to be a single explanation for the decline of all these newly Near Threatened species, although habitat loss or change through eutrophication, grassland 'improvement', drainage and cessation of grazing are likely to feature.


Field Scabious *Knautia arvensis* listed Near Threatened
© Sue Buckingham

Opposite-leaved Pondweed *Groenlandia densa*, a species of clean alkaline water, was recorded extensively in multiple ditches in the Worth area in 1982 and, though searched for, has been recorded at only two Kent sites in the last 10 years. Aquatic plants and particularly submerged species continue to be hard hit by factors such as poor water quality and eutrophication from chemicals used on adjoining land and by overgrown or dried-up ditches and waterbodies.

Non-native and invasive species

As trade with other countries has increased, so ever more non-native plants have found their way to Kent and sometimes in remarkable ways. Those that have managed to hitch a ride here as seed carried on vehicle tyres from Europe have become known as "motorway plants" and it is possible to track their route across Europe. Stinking Fleabane *Dittrichia graveolens* a weedy annual from the Mediterranean, Twoscale Saltbush *Atriplex micrantha* and Eastern Parsnip *Pastinaca sativa* subsp. *urens* have arrived in this manner during the last 10 years and are now well established in the centre reservation and by slip roads of the M20. An annual Mediterranean grass, Water Bent *Polypogon viridis* most likely reached us in a more traditional manner as a flowerpot weed with nursery-grown plants. Noted in Kent for the first time in 1997 since a casual introduction in 1960, it has increased its presence over the last 10 years such that now it occurs as a common street weed in nearly every 10 km square in Kent. The rapid speed of its colonisation is like that of another grass from warm climates, Cockspur Grass *Echinochloa crusgalli*, which occurs mostly as a constituent of gamebird seed mixes.

As predicted by Philp (2010), following discovery at the edge of a car park near Sevenoaks, Bilbao's Fleabane *Erigeron floribundus* has spread widely across the county in the last 10 years in the wake of Argentine and Canadian fleabanes. Most neophytes colonise ruderal habitats rather than the wider countryside and as such generally pose little or no threat to the native flora. The few notorious plants that have caused major problems in the wider countryside continue to do so, including *Cotoneaster horizontalis* which seriously suppresses the flora of thin soil on chalk slopes, and New Zealand Pigmyweed *Crassula helmsii*, still a major problem in ponds and wetlands.

For 20 years the Medway Valley Countryside Project has been successfully controlling invasive non-native species such as Giant Hogweed, *Heracleum mantegazzianum*, Floating Pennywort, *Hydrocotyle ranunculoides* and Japanese Knotweed, *Fallopia japonica* in the River Medway catchment area. In 2020, chemical treatment was applied to 9022 Giant Hogweed plants by the Project in its Kent area in addition to many plants covered by its contractors. The same year, Floating Pennywort was removed from at least 50 sites in and near the Medway.

Impatiens glandulifera, Himalayan Balsam as an annual species poses less of a problem although it out-competes native riparian flora and has been suspected to reduce the soil mycorrhiza and threaten species diversity on riverbanks. However, studies in the Czech Republic conclude that Himalayan Balsam poses no long-term effect on diversity other than by opening banks to erosion. A biological control measure for this species has been tested in Kent but is not yet fully available.

The introduced garden form of Yellow Archangel *Lamiastrum galeobdolon* subsp. *argentatum*, which has silver patches on its leaves, appears to have roughly doubled its range in the last 10 years and readily spreads as a garden throw-out into woodland where it may pose a threat to the native form. Green Alkanet *Pentaglottis sempervirens* also appears to have increased, by around 250% since the 1970s, especially on banks and woodland edges, usually near habitation. Both species are vigorous and enjoy nitrogen-rich sites.

Key habitats and their protection

Chalk grassland

With such a wide range of habitats in Kent, each having its own plant communities, it is difficult to choose one as being more important than another. However, if selection is made based on the number of species, then the choice would be unimproved chalk grassland of which some 700 ha occur across the county upon the shallow infertile soils of the North Downs on the escarpment, the slopes of dry valleys, coastal cliffs and along river gaps of the Darent, Medway and Stour. The habitat is home to some of our best-known and loved wild flowers such as Common Rock-rose *Helianthemum nummularium*, Cowslip *Primula veris*, Marjoram *Origanum vulgare*, Milkwort *Polygala* spp., Harebell *Campanula rotundifolia*, Wild Thyme *Thymus polytrichus*, and a suite of Red List rarities such as Slender Bedstraw *Galium pumilum*, Chalk Eyebright *Euphrasia pseudokerneri*, Oxtongue Broomrape *Orobanche picridis*, Meadow Clary *Salvia pratensis* and wild orchids including Late Spider Orchid *Ophrys fuciflora* which has its only UK population in the East Kent Downs. The sward consists of fine-leaved grasses and herbs which thrive on nutrient-poor soil and together have formed a characteristic vegetation as a product of centuries of sheep grazing. Many species such as Dwarf Milkwort *Polygala amarella* are dependent on areas of thin skeletal soils, short open turf, and bare disturbed ground to allow for seed germination and development. Without livestock, broad-leaved grasses and especially Tor Grass *Brachypodium pinnatum* agg. take over, leading to development of scrub and eventually woodland. The effects of spring and summer drought are then worsened, and species richness is reduced as small plants are shaded out.

Acid grassland and heath

Grasslands on all soil types have their own special species allied to factors such as soil pH, relative moisture, and historic land use. The few remaining areas of acid grassland and heath in the county are all the more important for supporting the last Kent populations of Common Sundew *Drosera rotundifolia*, Common Cotton-grass *Eriophorum angustifolium*, Bog Asphodel *Narthecium ossifragum*, Marsh St John's-wort *Hypericum elodes* and Heath Rush *Juncus squarrosus*. All are species of nutrient-poor habitats and open conditions, and all are common on a national scale. Perceivable threats may come from climate change, drought periods and the ever-present threat to any open habitat that comes from encroaching scrub and tree cover.

Woodland

Records from the last 10-year period indicate that there is little change in the frequency of woodland plants. However, a record for a plant in a one-kilometre square indicates just presence and not frequency. Lack of traditional or indeed any kind of management in many Kent woods affects the abundance of woodland species. Where coppicing, glade-creation and ride widening is practised, light-loving woodland species such as Lady Orchid *Orchis purpurea* can flower and


Wild Cabbage *Brassica oleracea* nationally scarce
© Sue Buckingham,

multiply. More encouragement is desirable for land managers to open woods and maintain clearings. Woodland edges are affected by nutrients running off adjacent farmland with Garlic Mustard *Alliaria petiolata* and Cow Parsley *Anthriscus sylvestris* taking over from primroses and violets. Neglect of woodland in recent years is particularly evident where large blocks have been fragmented and sold off in small plots. Without an overall management strategy, these small areas are in time often abandoned by their owners who may not have the ability to maintain them. They may become overgrown, species diversity is lost, and where there is access to a road or lane the resulting air of

abandonment encourages unwanted social issues such as fly tipping.

Brownfield sites

During the 10-year period, several brownfield sites have featured in relation to discoveries of important species, further emphasising their significance as key habitats for plants. Soils may range from alkaline to acid, dry or wet, but by nature are generally low in organic matter allowing a vegetation to maintain itself at pioneer or early succession stage even when left alone for many years. One such site is on colliery shale at Betteshanger and is currently threatened by a large housing development. Over a period of some 15 years, it has developed a diverse assemblage of habitats with 12 plant species listed on the Kent rare plant register. With their propensity to provide ideal conditions for plants of infertile soils and their suitability for the species, brownfield sites have more importance than ever in providing ideal refuges for our threatened plants. This importance, and other wildlife interest, is reflected in Natural England's 2021 designation of the Swanscombe peninsula as an SSSI.

Lowland meadow

Lowland meadow in the Medway and Eden floodplain is primary habitat for True Fox-sedge *Carex vulpina* where it reacts well to disturbance from periodic flooding, gravel workings and ditch digging. The main threat to its existence occurred in the 1980s when low-lying grazing fields were converted to arable.

Drivers of change

Over the last 10 years, more habitats have been lost and continue to be lost to housing development. Locally scarce Bog Pimpernel *Lysimachia tenella* is currently at risk from a proposed housing development on fragile spring-line meadowland near Charing. Atmospheric nitrogen deposition has a detrimental effect on grasslands of all types. Coarse grasses and broad-leaved herbs are becoming more frequent and as they further enrich the soil, conditions become increasingly unsuitable for annuals and plants requiring low levels of nutrient, resulting in a loss of


Coralroot *Cardamine bulbifera*
© David Steere

species diversity. This can readily be seen on some chalk sites, on acid and neutral grasslands and in stabilised sand dunes.

The remarkable spread across the county in recent years of warmth-loving native annuals Early Meadow-grass *Poa infirma* and Four-leaved Allseed *Polycarpon tetraphyllum* may reflect a warming climate. Both species previously had a restricted south-westerly distribution, but their colonisation of urban pavements, driveways and car parks might equally be put down to their arrival on vehicle tyres or via imported pot-grown garden plants. Whatever the reason, they have settled down well. As an apparent symptom of a changing climate, recent dry springs and hot summers have been seen to affect the growth, flowering, and seed production of some plants. The flowers of grassland orchids such as late spider orchid may not open properly and fail to produce seed and small annual clovers and other ephemeral species dry up before flowering thus, endangering their future prospects.

Conversion of grazing pasture to arable farmland in areas such as Romney Marsh results in chemical run-off from fields polluting ditches and adversely affects the abundance of aquatic or semi-aquatic plants such as Critically Endangered Sharp-leaved Pondweed *Potamogeton acutifolius* and Endangered Greater Water-parsnip *Sium latifolium*. More and more of the multitude of field ponds which are a feature of the Kent Low Weald have become neglected, overgrown and silted up. They are traditional sites for aquatic species such as Water-violet *Hottonia palustris*, water-crowfoots, pondweeds, and uncommon sedges.

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Other drivers for change include the potential for introduction of disease, such as Chalara Ash dieback, which may play a part in opening up woodlands, at least in the short term and especially in East Kent. Insect-related changes may affect habitat, for example the discovery of Oriental Chestnut Gall Wasp *Dryocosmus kuriphilus* at Farningham Woods in 2015 led to the felling of 35 acres of chestnut for control purposes; if the wasp continues to spread, it may give rise to disease weakening chestnut generally in the county. The well-publicised decline of insect pollinators, whether related to pesticides or otherwise, is likely to show an increasing effect on those plants which are obligate out-crossers and so rely upon cross-pollination.

Recording, monitoring and research

Unlike neighbouring counties of Surrey and Sussex which both have long standing botany groups, up until 2010 there was no such organisation concerned purely with the recording of vascular plants in Kent. With no consistency as regards where records were being sent there was a need to clarify the situation. Thus, the KBRG was formed in March 2010 by Geoffrey Kitchener, upon assuming the post of county recorder. The purpose of the group was to be a focus for the recording of vascular plants in Kent by providing those interested with a means of contact and communication. The plan was to liaise with and support other natural history organisations and to pass records to the BSBI and to Kent and Medway Biological Records Centre (KMBRC). An annual programme of field meetings has been held across the county, designed to obtain records and to encourage and inform members.

During the ensuing 10 years more than half a million records have been collected by KBRG members and others and entered into the Kent database. These have contributed to the BSBI 10-year date class (2010-2019) for comparison with previous 10-year date classes to identify trends in the distribution of our flora. Also, to the BSBI's Atlas 2020 project, which seeks to map the current status of the British and Irish flora, following up the last mapping (Preston et al, 2002), twenty years before. Recording emphasis has been and continues to be on searching out and providing detailed records of those plants which are listed on the Kent Rare Plant Register. They in turn contribute to the register accounts, which provide a detailed picture for each species of its Kent history and current status. The accounts can be viewed on the Kent page of the BSBI website along with annual reports of the group's activities at https://bsbi.org/kent.

Publications produced by KBRG members in the 10-year period and available for viewing at the same address are:

- *The Flora and Vegetation of Stodmarsh National Nature Reserve* and *The Flora and Vegetation of Hothfield Heath*, both written by Alex Lockton.
- Identification aids in the form of videos and keys by Liam Rooney on difficult plant groups.
- A reconstruction of Francis Rose's *Flora of Kent*.

KBRG also provided most of the mapping data for David Johnson's Wild Orchids of Kent (Johnson, 2019).

Conclusion

The last 10 years have seen great advances in habitat improvement for wild plants on Kent's nature reserves and elsewhere in the county. Kent Wildlife Trust have established pioneering evidence-based information to inform management decisions and provide better outcomes for plants on its reserves and in the wider countryside. Many farmers and landowners have successfully taken part in voluntary schemes targeted at encouraging uncommon arable weeds and grassland plant communities, whilst landscape-scale partnerships such as the Upper Beult Farming Cluster, involving farmers, landowners and water authorities, can be expected to benefit aquatic and meadowland plants in the Low Weald by improving water quality and habitats.

However, wildflowers continue to decline and particularly those which grow on nutrient-poor grasslands and those associated with water bodies and wet habitats. Insufficient grazing, scrub


Meadow Clary *Salvia pratensis*
Queendown Warren © Daphne Mills

invasion and nutrient enrichment together alter soil composition and reduce the number of wildflowers that can survive in grasslands. Nitrogen-hungry broad-leaved grasses and herbs out-compete delicate grassland plants for space so that no bare ground remains for annual species to germinate. For plants of ponds, rivers and ditches, water extraction and lack of management causes water bodies to dry up, whilst poor water quality affects the survival of species that grow submerged in the water.

Without help some of our grassland and wetland species are at risk of disappearing and more needs to be done to persuade land managers to implement appropriate measures for their long-term conservation. The Kent flora is better documented now than ever before and recording our flora can be seen to identify those plants most in need of assistance. Francis Rose, one of Kent's greatest botanista said of the county and its flora (Rose, 1962):

"Kent is still one of the loveliest of the English counties, with a variety of scenery and wildlife unique in the British Isles. Its flora is remarkably rich, both in number of species and in interesting plants. On a conservative estimate, Kent has still 1,200 species of native or established vascular plants; only Hampshire and Sussex have more. This total includes 30 species of orchids (only Hants. and Oxford have as many) and eight of our ten British broomrapes."

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Sea Holly *Eryngium maritimum*
Sandwich Bay © Daphne Mills

Copse Bindweed *Fallopia dumetorum*
previosly lost and re-found
© Sue Buckingam

Distinguished Jumper Spider *Attulus distinguendus*

KENT'S SPIDERS

HELEN SMITH AND TONY RUSSELL-SMITH, BRITISH ARACHNOLOGICAL SOCIETY

Summary

- Kent has a rich spider fauna with 473 species representing almost 71% of the 670 recorded from the British Isles.
- In total, 22 spider species that occur in Kent are listed as threatened with extinction in Britain, with a further 11 listed as Near Threatened (NT). Among these 33 species there are six for which all UK records are from Kent while a seventh, *Clubiona pseudoneglecta*, is only known from the Scilly Isles and Kent.
- Of 12 species newly recorded in Kent in the last decade most are non-native and relatively new to Britain; half of these are likely to have colonised via the Thames corridor.
- Hot spots for these species are to be found in Kent's chalk grasslands, ancient woodlands, and coastal habitats.
- Acute pressures on coastal habitats from commercial developments in the Thames Gateway, tourism, and the increasing impacts of climate change, are currently prominent among many drivers of change in Kent's spider fauna.
- Our data comes from the national Spider Recording Scheme (SRS). Although this has almost comprehensive coverage of Britain at hectad level, systematic recording has not yet been targeted at a finer scale. This currently restricts our ability to quantify trends in occurrence.

Spider fauna of Kent

In common with other south coast counties, Kent's spider fauna is relatively rich. Its 473 species represent almost 71% of the British fauna, exceeded only by Hampshire (498 species), Dorset (483) and Sussex (480). The county's warm climate, together with the mix and variety of habitats, are the likely major drivers of species richness, but proximity to continental Europe is also important. Kent is in the front line for spider species colonising both naturally by aerial dispersal – so-called ballooning – and as 'hitchhikers' in freight and luggage.

Status and trends

Kent's rich native spider fauna has a relatively high proportion of spiders of conservation concern, including around a quarter of all species red listed as threatened with extinction in Britain (Harvey *et al*. 2017). This figure is high in comparison with counties under less development pressure. For example, Kent has a conspicuously higher proportion of species in both the threatened categories (Critically Endangered (CR), Endangered (EN) and Vulnerable (VU)) and the Near Threatened (NT) category, than the more sparsely populated rural county of Norfolk, for which figures are also readily available (see Table 1). Kent also has more species than Norfolk on the Amber List which highlights relatively common species that appear to be undergoing rapid decline (Harvey et al. 2017). By contrast, Kent does not exceed Norfolk in the proportions of species with designations less closely tied to extinction threat: the national rarity designations and, to an extent, the Section 41 list of the NERC Act.

Table 1 Comparison of conservation and rarity designations of spiders from Kent with those from Britain as a whole and from Norfolk, based on 664 assessed species for the British Red List. Species considered to be exclusively synanthropic or very recent colonists are excluded

Designation	Number of species in GB	Number of species in Kent	% GB total in Kent	% GB total in Norfolk
Red List:				
Regionally Extinct	3	0	0	0
Critically Endangered	18	2	11	6
Endangered	30	7	23	10
Vulnerable	54	13	24	15
Near Threatened	29	11	40	21
Schedule 41 (S41) (England) (formerly BAP)	31	12	39	36
Amber List	43	27	63	72
Nationally Scarce	171	110	64	53
Nationally Rare	152	43	28	15

Kent has 43 species that are listed as Nationally Rare (NR: recorded from 15 or fewer hectads in Britain) and a further 110 are Nationally Scarce (NS: recorded from between 16 and 100 hectads). These designations are based on restricted distribution rather than an assessment of risk although, inevitably, many of the Nationally Rare also have threaten statuses. Detailed accounts of these species can be found on the national (SRS) website.

Since 2011, 12 new spider species have been recorded from Kent. Of these, three have long been recorded elsewhere in Britain and may either have been overlooked in Kent or increased their range. Over the same period, a quarter of the Kent's spider species have not been re-recorded although this cannot be

interpreted as a loss from the fauna; large spatial and temporal differences in recording effort make it difficult to analyse trends and interpret absences, because most spider recording in Britain relies on the collation of non-systematically collected records. Of the species not re-sighted in Kent in the last decade, 65% are either Nationally Rare or Nationally Scarce. This compares with only 22% among the spiders that have been re-recorded in this period. Although some of this difference is likely to be attributable to further declines in abundance, or potentially to loss from the county, it is impossible to know at this stage which of these rare species have simply been overlooked, or their habitat not searched.

Non-native and invasive species

It is often difficult to know whether newly recorded species are new arrivals in Britain or native species that have not hitherto been recorded. The latter is a much more significant issue with spiders than with more conspicuous taxa. Many spider species are very small and cryptically coloured. They may be active mainly in winter or at night, and may live in inaccessible or rarely sampled habitats, such as soil or rock crevices. However, many of the 12 species newly recorded in Kent in the last decade are non-native and relatively new to Britain as a whole (shown in Table 2). Half were first reported in Britain from the Thames corridor emphasising its importance as a route for introduction of new species.


Trichopterna cito

While it can be difficult to assess whether a newly recorded species is non-native, it is even more difficult to know whether recent, non-native colonists have the potential to become problematic and justify the term invasive. Even among spider species that have become global colonists, very few are termed invasive, but this reflects more on their lack of impact on humans than on prey or competitor species (N.B. none of those new to Kent in the last decade is of medical significance). While the potential must exist for some to displace native species, the extent of this will remain speculative in the absence of critical research. Although no substitute for research, anecdotal evidence exists for one species, the Wasp Spider *Argiope bruennichi*, which was first recorded in Britain – probably as a deliberate introduction – in 1922 at Rye, East Sussex and remained restricted to the south coast until the 1970s. Since then, it has expanded rapidly northward as far as Lincolnshire, and become common in Kent. It builds substantial orb-webs in tall tussocky grasslands and feeds on grasshoppers and similar large invertebrates. Although it shares this habitat with other large orb-web spiders, principally *Araneus* and *Larinioides* species, there have been no indications of population declines in these co-occurring spiders or in its usual prey items.

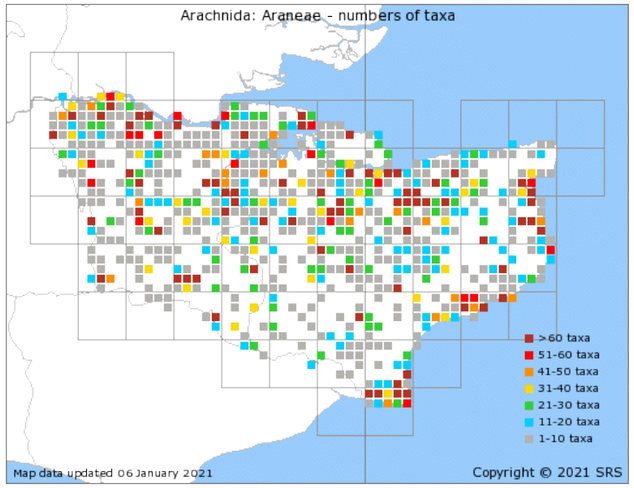
Table 2 Spider species added to the Kent list between 2011 and 2020, with the number of hectads from which they have been recorded (out of 56) and their likely origins

Species	First recorded in Kent	First recorded in GB	Kent hectads	Habitat	Possible origin
*Anyphaena sabina**	2014	2011	1	Gardens/brownfield	S. Europe
Mermessus trilobatus	2016	2007	2	Grassland	U.S.A.
Porrhomma oblitum	2020	Pre-1950?	1	Wetland	UK
Neriene emphana	2020	2000	3	Woodland	N. Europe
Pirata tenuitarsis	2019	1975	1	Acidic wetland	UK
Ero aphana	2013	1968	3	Various dry habitats	UK
*Philodromus buxi**	2014	2014	1	Trees & bushes	N. Europe?
*Philodromus rufus**	2017	2014	1	Open scrub	N. Europe?
*Macaroeris nidicolens**	2012	2002	3	Pine trees & scrub	N. Europe
Steatoda triangulosa	2015	1996	1	Buildings	S. Europe
*Zodarion rubidium**	2016	1997	1	Brownfield	S. Europe
*Zoropsis spinimana**	2016	2013	3	Buildings	S. Europe

* Species were first recorded in Britain from the Thames corridor.

Key habitats and their protection

Concentrations of species richness and of threatened species in Kent reflect the locations of key habitats for spiders (see Figure 1). Although these hot spots are inevitably influenced by geographical differences in recording effort this is unlikely to disguise the broad patterns of habitat preference. Tetrad maps show concentrations of species richness in the habitats for which the county is best known – coastal habitats (sand dune, saltmarsh, and shingle), ancient woodland, unimproved areas of downland, and in the Thames gateway (Figure 1). Most of these hot spots also have the highest concentrations of threatened and Near Threatened spiders. With the notable exception of the Swanscombe peninsula, this is less the case in the London area, where diversity is boosted by high concentrations of synanthropic species. Of Kent's threatened and Near Threatened species the greatest proportion (37.5%) depends on coastal habitats – 42% associated with shingle, 33% with sand dune and 25% with saltmarsh. Among these, the Running Foliage Spider *Agroeca lusatica* (EN) is entirely confined in Britain to the dunes at Sandwich Bay and Greatstone. The tiny sand dune specialist *Trichopterna cito* (EN), has been recorded in only seven hectads in Britain. Although four of these are in Kent, it has been recorded in only one, at Greatstone, this century and not seen at former sites in the Sandwich Bay area since the early 1990s.



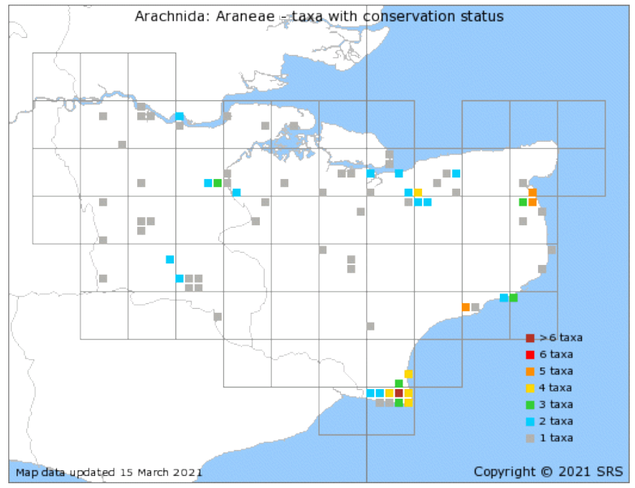


Figure 1 Numbers of recorded spider species (top) and numbers of those with threatened status on the British Red List (bottom) in Kent tetrads

Chalk grassland hosts 12.5% of Kent's threatened species, including the only known British localities for three species: the Ant-eating spider *Zodarion vicinum* (VU) recorded only from grassland around Dover, most recently in 2005; the Small Crab Spider *Ozyptila pullata* (VU) recorded from a sparsely vegetated chalk quarry in Burham, most recently in 2002, and the tiny Jumping Spider *Talavera thorelli* (VU) recorded only from Castle Hill, Folkestone in 1989. Near-by, the very large Crab Spider *Bassaniodes robustus* (EN) was recorded from Sugarloaf Hill, Folkestone in 1955 but has not been found in Kent since – elsewhere, it occurred in nine hectads in Dorset and Hampshire but has only been found in one of them this century.

Ancient, deciduous woodland is the third most important habitat type, hosting just under 10% of Kent's threatened spiders. All the deciduous woodland species are now only known from the Blean Woods complex near Canterbury although there are historical records for *Centromerus cavernarum* (NT) from Maidstone and Matfield. Beech and sweet chestnut coppice in the Blean Woods host Britain's only known population of the money spider *Walckenaeria mitrata* (VU) while the Truncated Crab Spider *Pistius truncatus*

(CR) may also be confined to this area. It was first found in the New Forest in 1896 but not seen again until 1985 when it was discovered in East Blean Woods, where it was last recorded as recently as 2021. Although other habitat types host relatively few of Kent's threatened spiders, they are important to the conservation of these species in a national context. The Distinguished Jumping Spider *Attulus distinguendus* (EN, S41), for example, is the only threatened species confined to a brownfield site - the Swanscombe peninsula - which provides the microhabitat conditions typical of its natural grey dune habitat. As one of only two British sites for this species, both under intense pressure from development, its importance is clear and is increased by the presence of adjacent saltmarsh hosting the Duffey's Bell-head Spider *Praestigia duffeyi* (EN, S41) and the Yellow-striped Bear Spider *Arctosa fulvolineata* (NT, S41). The wetland species *Pardosa paludicola* (EN), a large and distinctive wolf spider of wet grasslands, has been recorded in six hectads in Britain, but in only three this century. Its recent rediscovery in Sussex, after a gap of 67 years, leaves hope that it may not yet be extinct in Kent where it was last recorded in Cudham, prior to 1950.

Table 3 Spiders from Kent with threat statuses from the British Red List, Schedule 41 status, habitats preferences, last recorded dates, and hectads in which they occur as a percentage of those recorded in Britain as a whole, including historically

Species	Red List Status	Schedule 41 (S41) status	Habitat	Last record	%GB hectads in Kent
Pistius truncatus	CR		Deciduous woodland	2021	**50**
Attulus distinguendus	CR	Yes	Brownfield	2007	**50**
Praestigia duffeyi	EN	Yes	Saltmarsh	2004	**33**
Gonatium paradoxum	EN		Chalk grassland	2004	**50**
Trichopterna cito	EN		Sand dunes	2014	**57**
Pardosa paludicola	EN		Grassland?	Pre-1950?	13
Agroeca lusatica	EN		Sand dunes	2014	**100**
Bassanioides robustus	EN		Chalk grassland	1955	10
Cozyptila blackwalli	EN		Fen?	1967	9
Dipoena erythropus	VU		Heathland	1885	10
Walckenaeria mitrata	VU		Deciduous woodland	2004	**100**
Trichoncus saxicola	VU		Chalk grassland	2009	15
Lathys stigmatisata	VU		Shingle	2002	17
Apostenus fuscus	VU		Shingle	2000	**100**
Clubiona pseudoneglecta	VU		Shingle	2016	**60**
Zodarion vicinum	VU		Chalk grassland	1991	**100**
Phaeocedus braccatus	VU		Chalk grassland	1992	7
Zelotes longipes	VU		Saltmarsh	2004	5
Rhysodromus fallax	VU	Yes	Sand dunes	2014	7
Ozyptila pullata	VU		Chalk grassland	2002	**100**
Talavera thorelli	VU		Chalk grassland	1988	**100**
Pellenes tripunctatus	VU		Shingle	2018	**43**
Acartauchenius scurrilis	NT		Ant nests	1989	8
Centromerus cavernarum	NT		Deciduous woodland	2003	**31**
Meioneta mollis	NT		Grasslands	2016	5
Araniella displicata	NT		Heathland	2000	5
Arctosa fulvolineata	NT		Saltmarsh	2008	10
Agroeca cuprea	NT	Yes	Sand dunes	2014	24
Clubiona frisia	NT		Sand dunes/heath	2017	20
Clubiona juvenis	NT		Reedbeds	2004	13
Euophrys petrensis	NT		Not recorded	1995	3
Phlegra fasciata	NT		Shingle	2018	24
Neon pictus	NT		Shingle	2018	**25**

Emboldened text indicates where a quarter or more of the GB hectares are from Kent.

Drivers of change

There have undoubtedly been multiple drivers of change in the spider fauna of Kent over the past 10 years, including land use change (particularly increased urbanisation and industrial development), agricultural intensification, lack of appropriate management of semi-natural habitats, public pressure arising from an increasing human population and, almost certainly, climate change.

However, without consistent recording effort over time (see below) it is impossible to evaluate the relative importance of these factors. The habitats most threatened by land use change are likely those that have already suffered major declines during the late 19th and 20th centuries and for which few specialist spider species now remain on the Kent list. These include lowland meadow grassland and, particularly, heathland of which all but a tiny fraction of the thousands of hectares that once covered the High Weald and greensand ridge has been lost to agricultural intensification and urbanisation. By contrast, Kent has one of the largest areas of ancient woodland and chalk grassland in Britain, much of which is under conservation management. While the threat of outright loss of these habitats may have diminished, lack of appropriate management (e.g., coppicing, and grazing regimes) remains a threat to spiders and other invertebrates.

The biggest threat is to coastal habitats where the human pressures are acute, well known, and ongoing. Saltmarshes are particularly at risk from both rising sea levels and commercial development along the Thames Gateway. Saltmarsh erosion along the Thames estuary has been recorded since the 1960s and continues at increasing speed. In the absence of compensatory coastal realignment, this presents challenges to specialist saltmarsh species, such as Yellow-striped Bear Spider and Duffey's Bell-head Spider. At the same time, the major developments proposed for the Swanscombe peninsula at the time of writing threaten the only location where the latter species has been seen in Kent since 1998. Loss of this site would also eliminate from Kent the Distinguished Jumping Spider, illustrating the ease with which the county's rich spider fauna can be depleted. The risk to the county's remaining sand dune as well as saltmarsh species also remains high, with pressures from tourism being a major driver.

Recording, monitoring and research

The national SRS, run by the British Arachnological Society, provides up-to-date distributional and autecological data on all British spider species. It is run by a National Organiser supported by Area Organisers, each responsible for one or more vice-counties. Because of the difficulty of identifying many species of spiders, careful checking of records is first done by Area Organisers who then forward records, and sometimes specimens for confirmation, to the National Organiser.

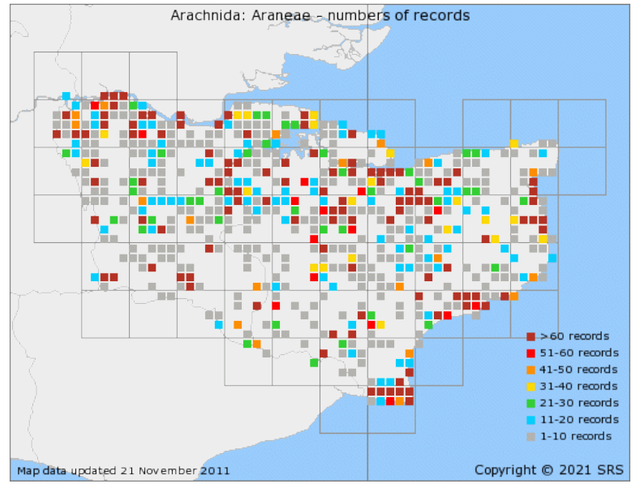


Figure 2 Kent tetrads showing the numbers of spider records submitted to the national SRS

In Britain, spiders have been recorded in almost all National Grid 10 km squares. The recording scheme holds approaching 1.17 million records. Systematic recording has not been targeted at a finer scale, and so coverage at a tetrad level is inevitably much patchier, even for a populous county like Kent (see Figure 2). Unsurprisingly, the records are biased towards more populated areas and the parts of the countryside most visited by naturalists (Figure 2). For spiders, and many other invertebrate taxa, it is not yet possible to achieve reasonably comprehensive coverage at tetrad level given the vast amount of fieldwork needed and the limited number of recorders with appropriate expertise. The future introduction of more systematic recording of spiders, together with already increasing interest in this critical and fascinating group, will improve our ability to measure distributional and population changes and to monitor more closely the many species of conservation concern.

Conclusion

Kent's still relatively rich spider fauna includes many species of conservation concern, and for some of these Kent supports the only British populations. Historically, the destruction of most of the county's extensive tracts of heathland and lowland meadows through agricultural intensification and urbanisation is likely to have caused the loss of many specialist spider species dependent on these habitats. The semi-natural habitats for which the county is best known – ancient woodland, chalk downland and coastal sand dunes, shingle, and mud flats – are now hot spots for species richness and species of conservation concern. Among many drivers of population change, pressures on coastal habitats from development, tourism and the impacts of climate change are likely to cause most losses from the county's spider fauna in the next decade and should be a focus for conservation action. Although numbers of non-native species are increasing, with evidence that the Thames Gateway is an important route of entry, no evidence is available on their impacts on native species. Our ability to detect trends in spider populations is restricted by a lack of systematic recording but increasing interest in this challenging and important group will facilitate the implementation of new recording methodologies that are urgently needed to inform more effective spider conservation.

Wolf Spider *Aretosa fulvolineata*

Crab Spider *Pistius truncatus*

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Goldenrod Crab Spider *Misumena vatia*

KENT'S DRAGONFLIES AND DAMSELFLIES

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Summary

- When it comes to dragonflies, Kent is one of the most species-rich counties in the UK; the county currently hosts 36 species of Odonata that are classified as resident or regular migrants.
- Over the past 100 years, Kent has gained eight new species through natural colonisation. There is no evidence to suggest that any of these new arrivals have had a negative impact on the wetland communities of the sites they have colonised; consequently, none are classed as 'invasive'.
- The abundance and diversity of wetlands in Kent is a significant factor influencing its abundance and diversity of dragonflies. Kent's large swathes of grazing marshes form a rich mosaic of pools and ditches that support some of the country's rarest species, including the UK's only Dainty Damselfly populations.
- However, the future of these species-rich habitats is uncertain, as sea level rise is predicted to threaten many of these coastal and flood plain wetlands. In addition, changes in rainfall patterns, another result of climate change, are threatening some of Kent's rarest wetland habitats, in particular lowland bogs, and their associated peatland specialist dragonflies.
- Changes in land use and land use practices, such as urban development and the intensification of agricultural practices, historically have been, and continue to be, a key driver of species trends through the destruction, fragmentation, and degradation of habitat.
- Citizen science is the main provider of data for species trend analysis and research. The National Recording Scheme for Odonata, run by the British Dragonfly Society (BDS), promotes public involvement in the recording of Odonata, species that are data deficient or classified in the Odonata Red Data List for Great Britain.

Downy Emerald *Cordulia aenea*
© Marc Heath

Brilliant Emerald *Somatochlora metallica*
© Marc Heath

Dragonfly and Damselfly (Odonata) fauna of Kent

When it comes to dragonflies, Kent is one of the most species-rich counties in the UK. This is, in part, a result of Kent's warm climate, as Odonata diversity is generally positively associated with temperature, and declines with altitude. Located on the south-east coast, Kent is also perfectly situated to receive new colonists and migrants from the continent. As our climate becomes hotter, due to climate change, some European species are increasing their range northwards; as a result, there has been an increase in overall species diversity in Kent over the past 100 years.

Kent currently has 36 species of Odonata that are classified as resident or regular migrants (see Table 1). Of these, one, the Norfolk Hawker *Aeshna isoceles*, is listed as legally protected under Schedule 5 of the Wildlife and Countryside Act (1981) and five are listed in the Odonata Red Data List for Great Britain (2008).

Norfolk Hawker *Aeshna isosceles*
© Marc Heath

Table 1 List of resident, migratory and transient Odonata of Kent

British and Irish name	Scientific name	Status	Odonata Red List status for Great Britain
Azure Damselfly	*Coenagrion puella*	Resident	
Banded Demoiselle	*Calopteryx splendens*	Resident	
Beautiful Demoiselle	*Calopteryx virgo*	Resident	
Black Darter	*Sympetrum danae*	Migrant	
Black-tailed Skimmer	*Orthetrum cancellatum*	Resident	
Blue-tailed Damselfly	*Ischnura elegans*	Resident	
Brilliant Emerald	*Somatochlora metallica*	Resident	Vulnerable
Broad-bodied Chaser	*Libellula depressa*	Resident	
Brown Hawker	*Aeshna grandis*	Resident	
Common Blue Damselfly	*Enallagma cyathigerum*	Resident	
Common Darter	*Sympetrum striolatum*	Resident	
Dainty Damselfly	*Coenagrion scitulum*	Resident	Not assessed (extinct in UK at time of last review)
Downy Emerald	*Cordulia aenea*	Resident	
Emerald Damselfly	*Lestes sponsa*	Resident	
Emperor Dragonfly	*Anax imperator*	Resident	
Four-spotted Chaser	*Libellula quadrimaculata*	Resident	
Golden-ringed Dragonfly	*Cordulegaster boltonii*	Resident	
Hairy Dragonfly	*Brachytron pratense*	Resident	
Keeled Skimmer	*Orthetrum coerulescens*	Resident	
Large Red Damselfly	*Pyrrhosoma nymphula*	Resident	
Lesser Emperor	*Anax parthenope*	Migrant	
Migrant Hawker	*Aeshna mixta*	Resident	
Norfolk Hawker	*Aeshna isoceles*	Resident	Endangered
Red-eyed Damselfly	*Erythromma najas*	Resident	
Red-veined Darter	*Sympetrum fonscolombii*	Migrant/ Transient	
Ruddy Darter	*Sympetrum sanguineum*	Resident	
Scarce Chaser	*Libellula fulva*	Resident	Near Threatened
Scarce Emerald Damselfly	*Lestes dryas*	Resident	Near Threatened
Small, Red-eyed Damselfly	*Erythromma viridulum*	Resident	
Southern Emerald Damselfly	*Lestes barbarous*	Resident	
Southern Hawker	*Aeshna cyanea*	Resident	
Southern Migrant Hawker	*Aeshna affinis*	Resident	
Vagrant Emperor	*Anax ephippiger*	Migrant	
Variable Damselfly	*Coenagrion pulchellum*	Resident	Near Threatened
White-legged Damselfly	*Platycnemis pennipes*	Resident	
Willow Emerald Damselfly	*Chalcolestes viridis*	Resident	

Status and trends

In the case of many Odonata species, maintaining an accurate profile of their status and trend history poses a significant challenge. Many species show a strong tendency for dispersal and as a result, the geographic distributions of their populations can shift dramatically year-on-year. In addition, Odonata populations tend to naturally fluctuate in size year-on-year and thus, ascertaining a population's trajectory requires long term monitoring. Accurate data collection is often difficult due to the nature of many Odonata breeding habitats, such as reed beds and marshland, which are often unnavigable on foot. The information presented in this document is the result of innumerable hours of recording carried out by the public through citizen science initiatives. Table 2 lists the eight new species that naturally colonised Kent over the past 100 years; no species went extinct from Kent over the same time span.


Scarce Chaser *Libellula fulva*
© Marc Heath

Table 2 List of Odonata lost° or gained^ in Kent over the past 100 years and past ten years

Change in the last 100 years		Change in the last ten years	
Species	**Year**	**Species**	**Year**
Dainty Damselfly^ *Coenagrion scitulum*	2010	Norfolk Hawker ^ *Aeshna isosceles*	2011
Lesser Emperor^ *Anax parthenope*	1990		
Migrant Hawker^ *Aeshna mixta*	1958		
Small, Red-eyed Damselfly^ *Erythromma viridulum*	2001		
Southern Emerald Damselfly^ *Lestes barbarous*	2003		
Southern Migrant Hawker^ *Aeshna affinis*	2010		
Willow Emerald Damselfly^ *Chalcolestes viridis*	1992		

Source: NBN Atlas (2021), Biological Records Centre (2021).

Species that naturally colonised Kent over the past 100 years

Dainty Damselfly

This species was first found in the UK near Benfleet, Essex, in 1946; however, this population was lost due to coastal floods in 1953. The Dainty Damselfly *Coenagrion scitulum* was rediscovered on the Isle of Sheppey, Kent, in 2010, at two small private sites. In 2019 a new population was found in Sandwich Bay; the following year, recorders found exuviae as well as 180 adults (British Dragonfly Society, 2020a). This species is not currently featured in the Odonata Red Data List for Great Britain as it was extinct in the UK at the time of the last review (2008).

Lesser Emperor

The Lesser Emperor *Anax parthenope* is an annual immigrant species, which is being recorded with increasing frequency in the UK and which is now apparently developing small resident populations. Scattered records have come from coastal sites in Kent; however, the wetlands at Dungeness have produced regular sightings for over two decades, and breeding is strongly suspected (NBN Atlas, 2021, Biological Records Centre, 2021).

Migrant Hawker

As the name suggests this species was historically a migrant and was first recorded in Kent in 1958. However, by the 1980s the Migrant Hawker *Aeshna mixta* had colonised wetlands across the whole county and far beyond. This species is now common across much of England and Wales and has spread to south Scotland (Cham *et al*, 2014).

Norfolk Hawker

Historically this species has had a localised, scattered distribution in East Anglia. In 2011 Norfolk hawkers *A. isosceles* were identified in Kent: single individuals were seen at Stodmarsh, as well as Worth, near Sandwich Bay. The first evidence of successful breeding in Kent was found in 2014; an exuvia was found at Westbere marshes. Annual sightings of Norfolk Hawker *A. isosceles* are now reported, concentrated around the Stodmarsh NNR and Westbere marshes. The species is showing a gradually westwards range expansion in East Anglia and can now be found breeding at a few sites in Cambridgeshire plus at least one in

Hertfordshire (NBN Atlas, 2021, Biological Records Centre, 2021). However, the Kent population may have derived from continental migrants.

Small Red-eyed Damselfly

The Small Red-eyed Damselfly *Erythromma viridulum* was first found in the UK in 1999 in Essex, with records also from the Isle of Wight in 2000. By 2010 the species had colonised much of south-east England and now has a scattered, yet widespread, distribution in Kent (Cham *et al*, 2014).

Southern Emerald Damselfly

First recorded in the UK in 2002 at Winterton Dunes, Norfolk, the Southern Emerald Damselfly *Lestes barbarous* has been slow to spread and colonise new sites since then. The species was found at Sandwich Bay in Kent in 2003; however, the breeding habitat was destroyed by winter flooding in 2004-2005 and the species was subsequently lost from the county. In 2010 a breeding population was found in the well-vegetated ditches of Cliffe marshes (Cham *et al*, 2014). This population persists to the present day; there have also been sporadic further records of the species from Sandwich Bay.

Southern Migrant Hawker

First recorded in the UK in 1952 from Romney Marsh, for many years Southern Migrant Hawker *Aeshna affinis* was a very rare migrant to Britain; however, over time the frequency and size of migrant influxes increased. In 2010 there was a significant influx recorded on the Thames Estuary marshes in Kent and nearby Essex; subsequently, a breeding colony established at Cliffe marshes. The species is now also recorded yearly in Kent from coastal wetlands such as Sandwich Bay and Oare marshes. The species is easily confused with migrant hawker so is possibly under-recorded (Cham *et al,* 2014).

Willow Emerald Damselfly

This species was first recorded in Kent in 1992 when an exuvia was found at Cliffe marshes. In 2007, Willow Emerald damselflies *Chalcolestes viridis* appeared in south-east Suffolk; this marked the beginning of the species' colonisation of the UK. Its colonisation of Kent started in 2010 when a population was discovered near Reculver, north-east Kent. Since then, the species has spread across the whole county and further west. In 2020 the species had spread as far north as East Yorkshire and as far west as Warwickshire (see Figure 1) (British Dragonfly Society, 2020b).

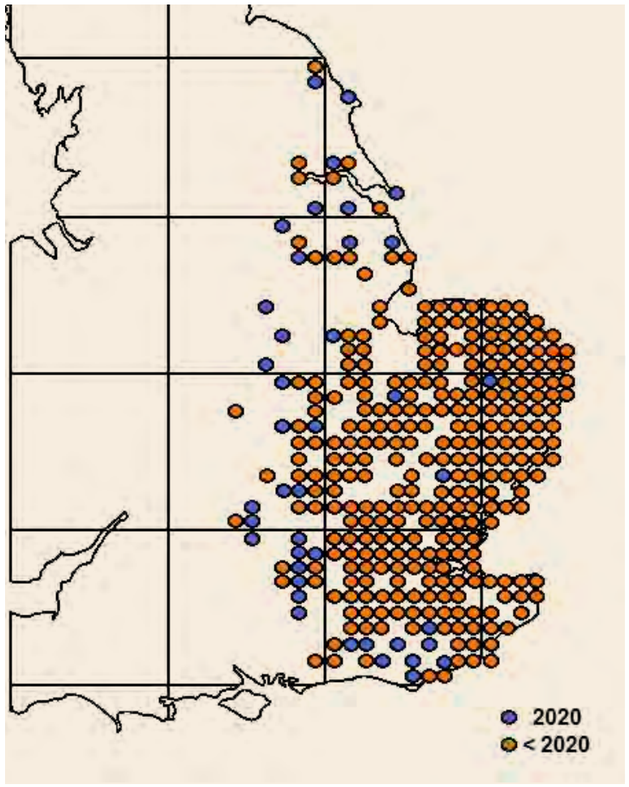

Figure 1 Map comparing the UK distribution of pre-2020 and 2020 willow emerald damselfly records. Credit Adrian Parr

Red Listed species and other species of interest

Beautiful Demoiselle

The Beautiful Demoiselle *Calopteryx virgo* has been expanding its range from the west across Kent and has been found as far east as the Royal Military Canal near Warehorne. This follows a national trend of steady range expansion from the species' historic south-western core range (NBN Atlas, 2021, Biological Records Centre, 2021).

Brilliant Emerald (Vulnerable)

Only a few populations of Brilliant Emerald *Somatochlora metallica* survive in Kent (sites include Bedgebury National Forest and Scotney Castle Estate) and represent the eastern edge of the species distribution in England (NBN Atlas, 2021, Biological Records Centre, 2021).

Downy Emerald

Downy Emerald *Cordulia aenea* has a south-west distribution in Kent and has sparse scattered populations; sites including Bedgebury National Forest and Scotney Castle Estate (NBN Atlas, 2021, Biological Records Centre, 2021).

Golden-ringed Dragonfly

As with the Downy Emerald *C. aenea*, the Golden-ringed Dragonfly *Cordulegaster boltonii* has a Kent population limited to a few isolated sites in the west of the county, including Scotney Castle Estate and Bedgebury National Forest (NBN Atlas, 2021, Biological Records Centre, 2021).

Hairy Dragonfly

Kent, as well as Sussex, are historic strongholds for this species. Since the 1970s the Hairy Dragonfly *Brachytron pratense* has expanded its range north-west, becoming increasingly common within Kent. Strong populations can be found at coastal sites such as the lower River Medway, Sandwich Bay and Dungeness (NBN Atlas, 2021, Biological Records Centre, 2021, Cham et al, 2014).

Keeled Skimmer

The Keeled Skimmer *Orthetrum coerulescens*, a rare species in Kent; there is only one known site left at Hothfield Reserve (NBN Atlas, 2021, Biological Records Centre, 2021).

Scarce Chaser (Near Threatened)

The Scarce Chaser *Libellula fulva* is showing national range expansion. There are two well-established Kent populations on North Stream at Sandwich Bay and on the Great Stour at Westbere marshes. Since 2015 there have been scattered sightings elsewhere from wetlands including Leybourne Lakes, Scotney Castle Estate and Haysden County Park (NBN Atlas, 2021, Biological Records Centre, 2021).

Scarce Emerald Damselfly (Near Threatened)

Restricted to south-east England, Kent is a historic stronghold for this species. Scarce Emerald Damselfly *Lestes dryas* was recorded at several sites in Kent in the 1940s but was absent in the 1950s, although this may have been due to oversight. Since then, the number of known sites has increased; however, this might be due to improved recording effort. This species can now be found on the north Kent marshes, Isle of Sheppey and at Sandwich Bay. This species often has a transitory nature utilising ephemeral pools; consequently, measuring changes in the species abundance/ distribution is more difficult (Cham *et al*, 2014).

Red-veined Darter

Historically a rare migrant, influxes are becoming increasing frequent with breeding at coastal sites. Red-veined Darter *Sympetrum fonscolombii* is now reported annually from Sandwich Bay and Dungeness (NBN Atlas, 2021, Biological Records Centre, 2021).

Variable Damselfly (Near Threatened)

The Variable Damselfly *Coenagrion pulchellum* has a sporadic distribution within the UK. However, Kent has a significant proportion of known populations; sites include Stodmarsh National Nature Reserve, Sandwich Bay and Dungeness (NBN Atlas, 2021, Biological Records Centre, 2021).

Non-native and invasive species

There is no evidence that any of the Odonata species that have colonised Kent over the past 100 years (all of which arrived unaided) have had a negative impact on the county's flora and fauna, or agricultural economy.

Key habitats and their protection

Ponds

A large proportion of UK Odonata utilise ponds for breeding, making them one of the most Odonata-rich habitat types. Brilliant Emerald *S. metallica* prefer ponds (as well as lakes) bordered by trees, which provide the sheltered, shaded edges, and leaf detritus, used as refuge by their larvae. For example, in Kent they can be found breeding in the large pond at Scotney Castle.

Scarce Emerald Damselfly *Lestes dryas*
© Marc Heath

Rivers

Rivers, and other flowing water habitats, generally support a lower species diversity than lentic habitats. On the other hand, they provide breeding habitat for a range of flowing water specialists, such as the Scarce Chaser *L. fulva*. This species has only been found at a few sites in Kent where it utilises slow flowing waterways with lush emergent vegetation, such as the Great Stour at Westbere marshes.

Coastal and floodplain grazing marsh

The grazing marshes of Kent are home to several priority species. Coastal marshes, including those at RSPB Cliffe Pools, support populations of the transient Scarce Emerald Damselfly *L. dryas*, which breeds in the site's rush-choked shallow pools and ditches. With its tolerance to brackish conditions and fast larval development, this species can utilise temporary coastal wetlands that other species cannot. Further upstream, where conditions are less brackish, Norfolk Hawkers *A. isosceles* have colonised the vegetation-rich ditches of Stodmarsh and Westbere. The grazing marshes of Stodmarsh are also home to Variable Damselfly *Coenagrion pulchellum*, which requires still/slow-flowing waterways that are sunny, yet sheltered, and support an abundance of rich marginal vegetation. In the past year (2020) a significant population of Dainty Damselfly *C. scitulum* has been located breeding in the grazing marshes at Sandwich Bay. This species favours shallow, warm wetlands and, like the Variable Damselfly *C. pulchellum*, still/slow-flowing ditches with abundant submerged vegetation (Cham *et al*, 2014).

Lowland dry acid grassland / Lowland heathland

Peatland habitats are some of the UK's most vulnerable habitats; they are also home to several specialists Odonata, which, as a result are also threatened by the loss of peatland sites. For example, Hothfield Heathlands is one of the last heathland sites in Kent; it is home to the county's only population of Keeled Skimmer *Orthetrum coerulescens*, which breeds in the site's vegetated runnels and pools.

Variable Damselfly *Coenagrion pulchellum*

Drivers of change

Habitat

The extent of freshwater habitats within Kent is only a small remnant of their historic coverage (Kent Nature Partnership, 2020). Drainage to make way for agricultural land and urban development has left its surviving wetland systems fragmented. Dragonflies, due to their ability to fly, are more resilient to habitat fragmentation compared to some other groups of invertebrates and can disperse to find new breeding grounds should theirs be lost. Unfortunately, many of their surviving wetlands are also degraded by a myriad of anthropogenic pressures, such as over-abstraction and pollution from agricultural run-off. The impact of these pressures varies from species to species; for example, the Blue-tailed Damselfly *Ischnura elegans* has a much greater tolerance to poor water quality than the variable damselfly. It must be noted that significant efforts have been made in the last 100 years to improve the ecosystem health of Kent's catchments, through greater restrictions on abstraction and the disposal of wastewater, which has had a massive positive impact on waterways such as the River Darent (BBC, 2011).

Climate change

Climate is one of the primary factors influencing the distribution of dragonflies. The increasing presence of migrants such as the Red-veined Darter *S. fonscolombii* is believed to be, in part, a result of climate change making the climate of Kent more suitable for local breeding. Rainfall predicts the availability of wetland sites; thus, the increasing frequency of droughts the UK has experienced over recent decades is a cause for concern and threatens Kent's smaller, shallower wetlands. Kent's last remaining bogs are particularly vulnerable to climate change as an ecosystem associated with cool, wet conditions; their peat and mosses are susceptible to desiccation during periods of dry hot summer weather. Many of Kent's most species-rich wetland sites are floodplain and coastal grazing marshes; these sites are most at risk from sea level rise with many projected to sit below annual flood levels by 2050 (Climate Central Inc, 2021).

Land use

Sensitive wetland management techniques are essential, particularly at sites that support species with specific habitat requirements. Maintaining a suitable vegetation structure is often a key factor in dragonfly wetland management as some species require specific structural niches to complete their life cycles. For example, the Dainty Damselfly *C. scitulum* requires abundant submerged vegetation, such as watermilfoils, for ovipositing. Excessive removal of vegetation through grazing or cutting can destroy these important niches while, on the reverse, a lack of control can also lead to their loss through natural succession. Vegetation control must be sensitive of the dragonfly life cycle and carried out outside the breeding season; for example, bankside vegetation cutting during spring can disturb and destroy emerging adults. The use of invasive wetland management techniques is a concern for species with highly localised populations; for instance, dredging of rivers to increase flow rate can remove large numbers of benthic larvae and destroy the microhabitats they are associated with.

Non-native species and disease

There are concerns regarding the impacts of several non-native aquatic predators on native Odonata. For example, the introduction of Signal Crayfish *Pacifastacus leniusculus* to a river system is associated with a decline in macro-invertebrate abundance, including Odonata. As omnivores, these crustaceans consume dragonfly larvae, the prey of dragonfly larvae, and the aquatic vegetation dragonfly larvae use for refuge (Ott, 2018, Vaeßen and Hollert, 2015). Particularly vulnerable are species with scattered, isolated populations, such as the Variable Damselfly *C. pulchellum*, where predator introduction could cause local extinction; this species is particularly sensitive to the introduction of non-native fish, as their larvae are weak swimmers. There is no current evidence that disease is affecting Odonata populations in the UK.

Human pressure /disturbance / persecution

Odonata, while not as popular as some other insect groups, remain free from persecution. Disturbance because of human recreational activities is a concern at popular tourist sites and was a significant issue during the summer of 2020 because of increased local tourism during covid lockdown. However, the issue is usually localised to specific sites and is not a key driver of population change.

Pesticides

Unfortunately, there is not enough detailed national data on species abundance to accurately measure the impacts of pesticides on UK dragonflies. However, it is safe to assume that the continuing decline in flying pollinators, and aquatic invertebrates, the main prey of Odonata, is having a negative impact (Sánchez-Bayoa and Wyckhuys, 2019, Leather, 2017).

Recording, monitoring and research

The National Recording Scheme for Odonata has been running in the UK since 1968 and today it is managed by the BDS (British Dragonfly Society, 2020c). In Kent the collection and verification of records is overseen by BDS volunteer County Dragonfly Recorder, Marc Heath. Members of the public are encouraged to adopt local sites to survey throughout the dragonfly season. All records collected feed into BDS reports; in 2021 the charity will be releasing the State of Dragonflies report, an update to the trends presented in their 2014 Atlas of Dragonflies in Britain and Ireland. Over the years, the BDS has also run several targeted recording projects, such as the Willow Emerald Watch, which has been running since 2015, and encourages the reporting of Willow Emerald Damselfly *Chalcolestes viridis* sightings to help track the spread of this new colonist. There is also the Migrant Dragonflies Project, which functions largely through social media, encouraging the search for, and documenting of, migrant and vagrant species. Yearly project reports are published in the BDS magazine: Dragonfly News. The most recent species project has been the White-legged Damselfly Investigation. This species has a historic south-westerly distribution in Kent; a 2018 review of Kent White-legged Damselfly *Platycnemis pennipes* records suggested there was a lack of recent data for the species (only a small proportion of records were post 2010). The White-legged Damselfly Investigation citizen science project has since promoted the recording of the species within Kent and as a result, the continued presence of the species has been confirmed along much of its historical waterways. The results of the White-legged Damselfly Investigation in 2020 are shown in Figure 2.

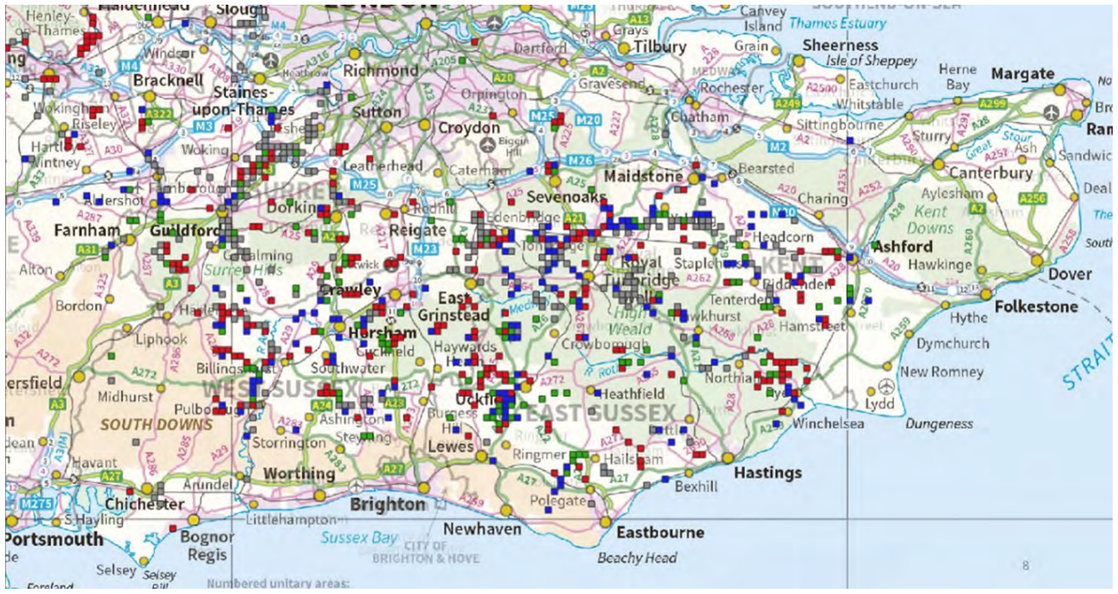

Figure 2 Results of White-legged Damselfly Investigation 2020. All the coloured squares displayed are 1km monad squares. Maps were produced in QGIS with Ordnance Survey data © Crown copyright and database right 2017

In addition to citizen science surveys, the BDS assists reserve managers and private landowners to set up monitoring projects at sites for priority species and habitats and encourages the adoption of dragonfly-friendly management techniques to cater for the needs of resident species. Information on the National Odonata Recording Scheme can be found on the BDS website.

Conclusion

The future of Odonata in Kent will no doubt be interesting, as well as uncertain for some of its habitat specialists. Climate change is causing rapid changes in species distribution and the county is likely to become home to more new colonists soon. Climate change, however, also threatens several of Kent's resident species, those that occupy low lying flood plains and coastal marshes, which are at risk from sea level rise, as well as peat bogs and shallow streams/ pools, which are at risk from desiccation because of rising summer temperatures and increasing droughts. Consequently, conservation strategies need to explore the best way of mitigating these long-term changes and aim to strengthen population resilience of priority dragonfly species to ensure their long-term survival in the county. Aims should include safeguarding priority populations and their wetland sites, developing connectivity between fragmented areas of habitat, and improving overall ecosystem health within the wider landscape by tackling intrinsic issues, such as pollution.

Cooperation and assistance from local landowners and communities will be key in developing the resilience of Kent's wetland ecosystems to such threats, through landscape-scale habitat enhancement and restoration. Building connections between communities and their local wetland habitats and wildlife provides them with a greater sense of ownership and encourages their support of, and participation in, safeguarding their local dragonfly populations.

Monitoring species distribution and population health is essential to plan effective species safeguarding and habitat enhancement. The communities of Kent have played an important role in supporting Odonata recording in the county through citizen science, and their continued support and involvement in dragonfly recording and conservation is essential.

Introduction | Headlines | Drivers | Conservation | Kent's Species | Landscape-scale | Case Studies | Conclusion
Fungi | Plants | Spiders | Dragonflies & Damselflies | Flies | Ants, Bees & Wasps | Beetles | Grasshoppers & Crickets | Butterflies | Moths | Amphibians | Reptiles | Birds | Mammals | Bats | Marine | Seaweed

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KENT'S FLIES

LAURENCE CLEMONS, DIPTERA RECORDER/REFEREE

Summary

- Kent has a rich Diptera fauna with some 60% of the British species recorded.
- While some species have not been found for many years several were recorded nationally for the first time from the county and over 400 species assigned to the rarer categories are known.
- Of the non-native and invasive species only *Drosophila suzukii* has become widely established.
- Key habitats for some of the rarer species include broad-leaved woodland, chalk grassland, coastal grasslands, grazing marshes and saltmarsh and private gardens.
- The use of veterinary biocides may account for the decline in parasitic species associated with vertebrates.
- Recording, monitoring and research of the Kent Diptera fauna is healthy and facilitated by on-line recording platforms.

Diptera fauna of Kent

Over 7,200 species of Diptera within 109 families have been recorded from the British Isles. Chandler (1998) gave 6,669 species of valid status and later (2021) 7,216 species; a rate of change approximating to 25 species per year. The literature references are vast with no single book or series of books devoted to the entire fauna and the majority of species are small and frequently require detailed preparation and microscopic examination for determination with relatively few identifiable from a photograph. At least 3,500 species have been recorded from Kent with the approximate percentage of British species per family shown in Figure 1.

Hoverflies *Eristalis nemorum* © Janet Packham

A hoverfly, *Eristalis intricaria*
© Laurence Clemons

A hoverfly, *Volucella pellucens*
© Laurence Clemons

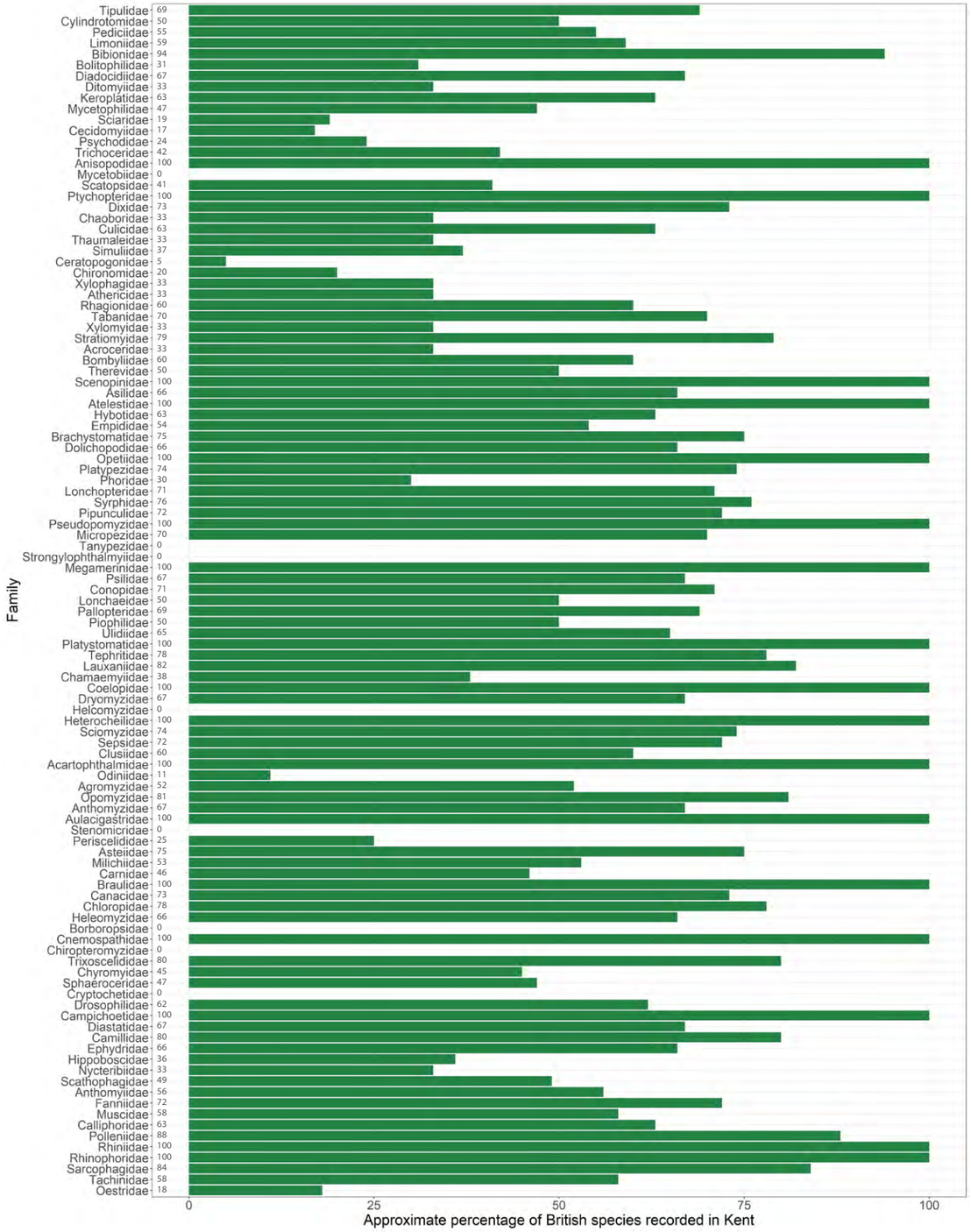

Figure 1 The approximate percentage of British Diptera species per family recorded in Kent


Hornet Robberfly *Asilus crabroniformis*
© Steve Weeks

While the under-recording of the Lower Diptera families Cecidomyiidae, Ceratopogonidae, Chironomidae and Sciaridae and Lower Cyclorrhapha family Phoridae is due to the specialised nature of determination it is likely that Kent supports at least 60% of the known British fauna. Information on some of the rarer species was published by Clemons (2000a).

Status and trends

Many of the older records in the literature were not accompanied with a date and some of the species names may be suspect. Where it has been possible to ascertain a decade the essential data since the beginning of the 20th century are presented in Table 1.

Table 1 Total number of known Diptera species, recorders and unique Diptera species per decade between 1900 and 2010

Decade beginning	Number of species	Number of recorders	Number of unique species
1900	233	25	6
1910	142	13	4
1920	111	18	7
1930	238	29	11
1940	208	30	1
1950	245	50	11
1960	871	45	16
1970	1114	61	37
1980	2336	71	207
1990	2168	94	119
2000	2247	173	157
2010	2409	400	263

In Table 1 the final column denotes the number of species recorded only from the relevant decade. For example, *Stemonocera cornuta* (Tephritidae) had been recorded from Deal in 1905 but not subsequently and *Anthrax anthrax* (Bombyliidae) was not reported earlier than 2019 (Woods, 2020).

Since 2000 more than 500 species were added to the known Kent fauna, over half of which were from the decade beginning 2010. Several species were first recorded as new to Britain from the county and these include:

- *Chymomyza amoena* (Drosophilidae). First recorded from Dering Wood, Pluckley on 27 September 2008 (Clemons, 2009).
- *Crossopalpus curvinervis* (Hybotidae). First recorded at Oare Marshes on 9 September 2012 (Clemons, 2012).
- *Dolichopus calinotus* (Dolichopodidae). First recorded from Pegwell Bay on 4 July 2016 (Drake & Pollet, 2017).
- *Drosophila suzukii* (Drosophilidae). First recorded from East Malling on 29 August 2012 (Harris & Shaw, 2014).
- *Hydrobaenus distylus* (Chironomidae). First recorded from exuvia found at Bough Beech Reservoir on 12 May 2004 (Langton & Ruse, 2010).
- *Lipara pullitarsis* (Chloropidae). Reared from galls collected at Stodmarsh on 3 April 2017 (Jennings, 2017).
- *Macrobrachius kowarzii* (Mycetophilidae). First recorded from Ashenbank Wood, Cobham in Autumn 2016 (Alexander, 2017).
- *Sarcophaga bulgarica* (Sarcophagidae). First recorded from Wraik Hill, Whitstable on 13 June 2009 (Whitmore *et al.* 2020).
- *Stevenia deceptoria* (Rhinophoridae). First recorded from Lydden LNR on 30 July 2000 (Clemons, 2006).
- *Tephritis matricariae* (Tephritidae). First recorded from Sandwich Bay on 29 April 2000 (Clemons, 2000b).
- *Thelyconychia solivaga* (Tachinidae). First recorded from Dungeness on 27 June 2006 (Clemons & Perry, 2011).

In addition, Ismay & Clemons (2001) reported *Aphaniosoma melitense* (Chyromyidae) as new to Britain from Queenborough, Sheppey in 1999 and Gibbs (2018) gave details of two species of Pipunculidae new to Britain. These are a male *Chalarus immanis* from Berengrave Lane LNR, Rainham TQ8267 on 6 July 1994 and a female *Chalarus proprius* from Darland Banks, Gillingham TQ7965 on 22 June 1984.


A hoverfly *Eristalis nemorum*

Over 400 species assigned to the rarer British statuses (Critically Endangered/Provisionally Critically Endangered, Data Deficient, Endangered/Provisionally Endangered, Nationally Rare, Nationally Scarce/Provisionally Nationally Scarce, Near Threatened/Provisionally Near Threatened and Vulnerable/Provisionally Vulnerable) in the more recent formally-published synopses (Ball & Morris, 2014, Chandler, 2017, Drake, 2017, Drake, 2018, Falk & Pont, 2017, Falk & Chandler, 2005, Falk & Crossley, 2005 and Falk, Ismay & Chandler, 2016) have been found in Kent. Of the Critically Endangered/Provisionally Critically Endangered species *Paragus albifrons* (Syrphidae) is known from seven monads in five hectads with recent records being from the Queenborough area of Sheppey in 2016 and 2017.

There have been no authentic Kent records for *Ortochile nigrocoerulea* (Dolichopodidae) since 1939 when it was found at Abbey Wood near Plumstead (Drake, 2018). *Polyodaspis sulcicollis* (Chloropidae) has its national stronghold at Dungeness and is elsewhere known only from Rye Harbour in Sussex.
Among the other categories the following are well represented in the county:

Data Deficient - *Pseudolyciella pallidiventris* (Lauxaniidae) and *Rhamphomyia marginata* (Empididae).

Nationally Scarce/Provisionally Nationally Scarce - *Agathomyia wankowiczii* (Platypezidae), *Atylotus latistriatus* (Tabanidae), A*ulogastromyia anisodactyla* (Lauxaniidae), *Cheilosia barbata* (Syrphidae), *Dicraeus scibilis* (Chloropidae), *Dicraeus tibialis* (Chloropidae), *Dolichopus virgultorum* (Dolichopodidae), *Empis woodi* (Empididae), *Homoneura notata* (Lauxaniidae), *Hydotaea parva* (Muscidae), *Lispe loewi* (Muscidae), *Melieria picta* (Ulidiidae), *Nemotelus pantherinus* (Stratiomyidae), *Neoascia interrupta* (Syrphidae), *Orthoceratium sabulosum* (Dolichopodidae), *Oscinimorpha arcuata* (Chloropidae), *Rhaphium antennatum* (Dolichopodidae), *Stratiomys longicornis* (Stratiomyidae) and *Symphoromyia immaculata* (Rhagionidae).

Near Threatened/Provisionally Near Threatened - *Blaesoxipha plumicornis* (Sarcophagidae), *Dorycera graminum* (Ulidiidae) and *Lejops vittatus* (Syrphidae).

Vulnerable - *Campsicnemus magius* (Dolichopodidae).

The statuses of some of the families such as Conopidae, Cylindrotomidae, Limoniidae, Scathophagidae, Sciomyzidae, Tachinidae, Tephritidae and Tipulidae which fall under the criteria Endangered, Extinct, Nationally Notable, Rare and Vulnerable given by Falk (1991) have yet to be revised formally using IUCN criteria. The total number of species from each category is shown in Table 2. Figure 2 shows the distribution of species from each of the categories with the proviso that sites and habitats change over time.

Table 2 Total number of Diptera species from all rarer categories, inlcuding statuses given by IUCN and Falk (1991)

Status	Number of species	Using IUCN criteria	Falk, 1991
Critically Endangered	2	2	-
Provisionally Critically Endangered	1	1	-
Endangered	11	1	10
Provisionally Endangered	5	5	-
Extinct	1	-	1
Data Deficient	41	41	-
Data Deficient (Nationally Rare)	1	1	-
Nationally Notable	71	-	71
Nationally Rare	15	15	-
Nationally Scarce	174	174	-
Provisionally Nationally Scarce	135	135	-
Near Threatened	15	15	-
Provisionally Near Threatened	36	36	-
Rare	25	-	25
Vulnerable	28	10	18
Provisionally Vulnerable	14	14	-

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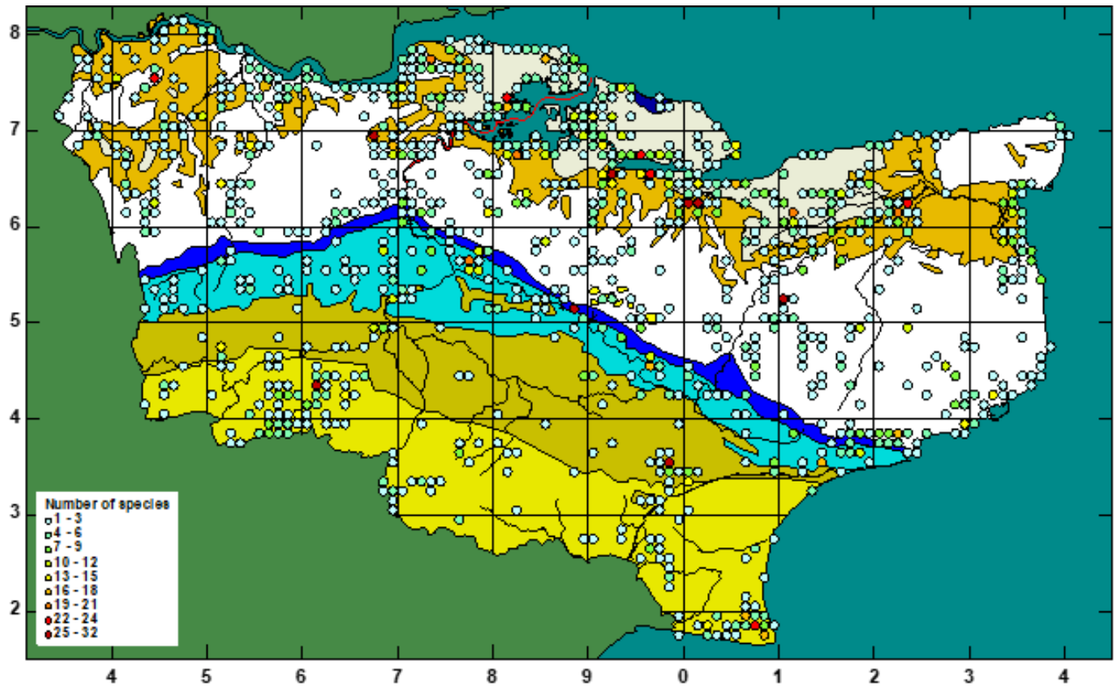

Figure 2 The known spatial distribution of Diptera species from all rarer categories in Kent by monad

In addition, *Asilus crabroniformis* (Asilidae), *Callicera spinolae* (Syrphidae), *Campsicnemus magius* (Dolichopodidae), *Dorycera graminum* (Ulidiidae), *Lipsothrix nervosa* (Limoniidae) and *Phortica variegata* (Drosophilidae) have also been designated as UK Biodiversity Action Plan species but it is unknown whether any of the major conservation bodies in Kent have been able to address the recommendations.

Many species are known from single sites and while some of these are of the more difficult taxa some may genuinely no longer occur in the county. Three noteworthy examples are *Coenosia dubiosa* (Muscidae) found at Sandwich Bay in 1956 and 1957 (d' Assis-Fonseca, 1957), *Eutolmus rufibarbis* (Asilidae) abundant in Farningham Wood in the first half of the 20th century (Andrews, 1924, 1939) and *Villa cingulata* (Bombyliidae) found at Soakham Down in the late 1930s. Niblett (1956) reported *Cornutrypeta spinifrons* (Tephritidae) from Westerham, without details, but in the Natural History Museum, London there is a series of specimens taken in Woolwich Wood, Womenswold in 1956 and 1957 by Edmund d' Assis-Fonseca. *Teichomyza fusca* (Ephydridae) was last found nationally at Dover in 1902, when sanitary conditions were less advanced than today, and is presumed extinct in Britain (Falk, Ismay & Chandler, 2016). For the majority of species, however, it would be premature to speculate whether some are extinct or simply under-recorded in the county. There was a gap of 116 years between 1901 when *Villa modesta* (Bombyllidae) was recorded at Farningham Wood and 2017 when discovered at Cliffe RSPB Reserve (Clemons, 2017). In 2019 it was found at Graveney Marshes and Pegwell Bay and in 2020 at Sandwich Bay and has found a niche. *Litophasia hyalipennis* (Tachinidae) was declared nationally extinct by Falk (1991) but has now been found in ten monads within 8 hectads since 1987. *Conops vesicularis* (Conopidae) is currently known in the county only from woods in the Pembury area and *Dicranoptycha fus*cescens (Limoniidae) has been found just twice in 1973 and 2001 from the Darenth Wood area near Dartford (Clemons, 2002).

Non-native and invasive species

Allen (1999) reported a specimen of *Bactrocera cucurbitae* (Tephritidae) from a suburban garden at Charlton in 1998 and there are several Kent records for *Ceratitis capitata* (Tephritidae) but these are occasional imported species and have not become established in the British Isles. In addition to Dering Wood *Chymomyza amoena* (Drosophilidae) has been recorded from Farthings Wood, Herne Common on 8 July 2012 and Church Wood, Blean on 5 September

2012 (Clemons, 2012). In contrast *Drosophila suzukii* (Drosophilidae) has spread considerably in England (Chandler, 2018). *Cheilosia caerulescens* (Syrphidae), a leaf-miner of *Sempervivum* and other species of Crassulaceae, was added to the British list from Surrey in 2006 (Collins & Halstead, 2008) and has been found in seven monads within seven hectads since 2011.

Key habitats and their protection

While the precise biology of most Diptera has yet to be elucidated a comprehensive list of associated organisms was given in Chandler (2010). All members of the families Agromyzidae, Opomyzidae, Psilidae and Tephritidae together with most Anthomyiidae, Cecidomyiidae and Chloropidae develop in vascular plants, often a narrow range of species, and hence will mostly be found in sites where these grow. For example, larvae of *Myopites eximius* (Tephritidae) develop in the capitula of *Inula crithmoides* (Magnoliidae, Asteraceae), a plant characteristic of saltmarshes, sea-walls and amongst drift-litter on beaches and occasionally on sea-cliffs (Philp, 2010). In addition, Pipunculidae are parasitoids of hopper bugs (Hemiptera, Auchenorrhyncha) which are also associated with plants. Cleptoparasitic species of aculeate Hymenoptera, such as some *Leucophora* (Anthomyiidae), require breeding grounds favourable to their hosts. Furthermore, many adults fly in search of suitable conditions; it was unusual to find *Campiglossa plantaginis* (Tephritidae), the larvae of which develop in the capitula of the essentially saltmarsh plant *Aster tripolium* (Magnoliidae, Asteraceae), in a *Calluna* heath over ten km from the coast (Clemons, 2007). Galls of *Agathomyia wankowiczii* (Platypezidae) have been found on the brackets of *Ganoderma applanatum* (Basidiomycotina, Ganodermatales) from a range of trees (Pitt, 2002) and *Gnophomyia viridipennis* (Limoniidae) has sporadically been found in sites with the frequently planted neophyte *Populus nigra 'italica'* (Magnoliidae, Salicaceae) (Clemons, 2003). Some species which are widespread in the British Isles have a limited distribution in Kent due to the relative paucity of suitable habitats. The Dolichopodidae *Dolichopus atratus*, *Dolichopus atripes* and *Rhaphium longicorne* are strongly associated with *Sphagnum* bogs and another member of the family, *Liancalus virens*, seems restricted to waterfalls and weirs. *Pedicia littoralis* (Pediciidae) is apparently limited to cool streams emanating from the chalk in the south-east of the county.

Habitats are dynamic and with them the species. Some old woodlands such as Birch Wood near Swanley, a favourite collecting site for entomologists in the 19th century, no longer exist (Mendel, 2016) and others such as Darenth Wood near Dartford and Woolwich Wood, Womenswold have deteriorated since their heyday. While many species-rich post industrial areas such as Murston near Sittingbourne have been lost through commercial development relatively new areas such as Samphire Hoe, Dover have revealed species such as *Campiglossa producta* (Tephritidae), *Heterostylodes nominabilis* (Anthomyiidae), *Hydrophorus viridis* (Dolichopodidae) and *Labigastera forcipata* (Tachinidae) formerly regarded as rare or unknown in the county.

Private gardens have been the main source of records for *Mintho rufiventris* (Tachinidae). Broad-leaved woodlands are important for Drosophilidae (*Phortica variegata* and *Stegana nigrithorax*), Mycetophilidae (*Allodia neglecta*, *Allodia silvatica*, *Brachypeza armata*, *Exechiopsis membranacea*, *Grzegorzekia collaris*, *Mycetophila caudata*, *Mycomya punctata*, *Mycomya trivittata*, *Phronia persimilis*, *Sceptonia flavipuncta*, *Sciophila interrupta*, *Trichonta fragilis* and *Trichonta fusca*) and Platypezidae (*Paraplatypeza bicincta* and *Seri obscuripennis*). It is also the principal habitat for *Oscinella capreolus* (Chloropidae), *Oedalea apicalis* (Hybotidae), *Rhipidia uniseriata* (Limoniidae), *Phaonia amabilis* (Muscidae), *Psilota anthracina* (Syrphidae) and *Tipula selene* (Tipulidae). Chalk grassland is rich in many species with *Cheilosia nigripes* (Syrphidae), *Leptarthrus vitripennis* (Asilidae), *Microdon devius* (Syrphidae) and *Urophora cuspidata* (Tephritidae) known only from this habitat.

Grazing marshes support *Cercagnota collini* (Anthomyzidae), *Chrysotus collini* and *Gymnopternus blankaartensis* (Dolichopodidae), *Rhamphomyia lamellata* (Empididae), *Parydroptera discomyzina* (Ephydridae), *Cheilotrichia imbuta* and *Erioptera bivittata* (Limoniidae), *Leptometopa latipes* (Milichiidae), *Phaonia fusca* (Muscidae), *Oestrus ovis* (Oestridae) and *Pherbellia brunnipes* (Sciomyzidae). Coastal grasslands and saltmarsh are frequented by the Anthomyiidae (*Botanophila depressa* and *Pegomya conformis*), Chloropidae (*Elachiptera austriaca*, *Eribolus slesvicensis* and *Eurina lurida*), Dolichopodidae (*Campsicnemus magius*, *Dolichopus calinotus* and *Poecilobothrus ducalis*), Muscidae (*Coenosia karli*, *Coenosia minutalis*, *Lispe caesia*, *Lispe loewi* and *Villeneuvia aestuum*), Sarcophagidae (*Sarcophaga sinuata*), Stratiomyidae (*Stratiomys longicornis*), Syrphidae (*Lejops vittatus*, *Neoascia interrupta* and *Paragus albifrons*), Tabanidae (*Atylotus latistriatus* and *Hybomitra expollicata*) and Ulidiidae (*Melieria cana* and *Melieria picta*).

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Drivers of change

The use of veterinary biocides has undoubtedly contributed to the decline of species of Oestridae such as *Gasterophilus intestinalis* (last found from pupae in horse dung at Murston in 1979 and reared) and *Oestrus ovis* (last found on Sheppey in 2005), the larvae of which develop internally in horses and sheep. Furthermore public hygiene methods mean that *Teichomyza fusca* (Ephydridae) is unlikely to be found here soon.

While no Dipteran was given protected status in the Wildlife and Countryside Act 1981, and the order is not a priority for the major conservation groups in the county, lack of knowledge of the precise biology for the majority of Diptera has resulted in some unsympathetic land management. This includes the removal of Bracken *Pteridium aquilinum* on which *Alliopsis billbergi* (Anthomyiidae) develops and Scots Pine *Pinus sylvestris* wherein larvae of *Lipoleucopis praecox* (Chamaemyiidae) are specialised predators of aphids (Hemiptera, Sternorrhyncha). The former has been recorded from 13 monads within ten hectads between 1912 and 2019 with the latter from one site in 2007 (Clemons, 2008).

A significant driver of change is possibly variation in recorder interest, capability and also chance. The best recorded site for Diptera is from what is now referred to as Hothfield Heathlands, with over 900 known species since the beginning of the 20th century. Major publications of pertinence to Diptera were by Felton (1975, 1980) and Freeman & Adams (1972). Rickards (2014) summarised changes to the nature of the area between 1974 and 2012. Freeman & Adams specifically targeted craneflies (Tipulidae, Pediciidae, Cylindrotomidae and Limoniidae) and listed 59 species. Sixteen species have not been reported from the area since 1967 when the study was undertaken and a further 13 species recorded just once in the years between 1983 and 2016. A perusal of known records of all taxa from the site since Felton's last paper suggests chance i.e. the recorder being in the right place and at the correct time.

Recording, monitoring and research

There are currently national recording schemes and study groups for approximately 60 families of British Diptera (Sumner, 2021) and Laurence Clemons has been collating records of Kent Diptera since 1974 (Clemons, 2014). One of the main advances in the past decade has been the establishment of on-line recording platforms such as iRecord which enable critical review and this partly accounts for the dramatic increase in the number of recorders shown in Table 1.

Conclusion

There are currently more recorders of Diptera than at any time in history with data exchange increasingly facilitated by electronic means. While some species formerly recorded from the county may no longer be found here the state of Kent's Diptera is healthy. More consideration for the biology of the species needs to be addressed in conservation planning and delivery.

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Shrill Carder Bee *Bombus sylvarum*
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KENT'S ANTS, BEES AND WASPS

ROSIE BLEET, GEOFF ALLEN, AND GRANT HAZLEHURST

Summary

- The aculeate fauna in Kent totals 523 species. However, 42 of these are regarded as extinct meaning that the current total of extant species is 481, which includes 219 species of bee, 221 species of wasp and 41 species of ant.
- The county is home to a nationally important aculeate fauna. Due to its proximity to continental Europe, several new species have been recorded in the county in recent years, but there have also been losses during the last century.
- Several new species have colonised Kent in the last decade, most arriving from the continent. With a warming climate, it is expected that more species will arrive over the coming years.
- Aculeates inhabit a wide range of habitats in the county. Being a largely thermophilic group, they tend to prefer sunnier, more open areas.
- Habitat loss is the main driver of change for the aculeate fauna, whether this is through direct loss of sites to development or inappropriate habitat management. Other important factors affecting their populations include climate change and pesticide use.
- Kent receives a fair amount of attention from entomologists in terms of aculeate recording and has been host to several aculeate focused projects in recent years. However, most species recording and project focus is on bumblebees and other bees to an extent, while the wasps and ants do not attract as much attention and many of which remain under-recorded.

Ant, bee, and wasp fauna of Kent

The ant, bee, and wasp (collectively 'aculeate') fauna is in a state of flux (here and in continental Europe), with a significant number of new species being found in the county and sometimes country. The latest recount of the species and species aggregates tallies 486 taxa (Allen, 2020). It is known that some of the aggregates have two or more cryptic species which cannot yet be separated by morphology. The number of extant "species" is 481 and there are 42 regarded as extinct (some of the latter have not been recorded for a matter of 30 or 40 years, whilst others have not been found in the county for well over a century). Therefore, the total number of species and aggregates in the county is 523.

237 species of bee have been recorded in the county, of which 18 are thought to be extinct. Of these bees in general, 155 species are independent nesters, including 16 bumblebee species, whilst 64 are parasitic. The parasitic bees can be broken down into six inquilinous (cuckoo) bumblebees and 58 cleptoparasites of solitary bees. Bees are the most important pollinators of both human crops and many wildflowers.

The Apoid Wasps (once known as the "sphecoid" Wasps) account for 98 species, of which nine are thought to be extinct. Of the 98, only three are parasitic – species of *Nysson* are cleptoparasitic on *Gorytes* and related genera.

Turning to the Chrysidoidea, the jewel and Rubytail wasps (Chrysididae) are the only ones known in any detail. 27 species of jewel wasp have been found in the county, several of these within the last ten years. Five species are probably extinct. The species are mostly highly specialised parasitioids which develop in the nests of other aculeates: apoid and mason wasps are the main hosts. The other families in this superfamily, Dryinidae, Embolemidae and Bethylidae, are parasitoids of plant hoppers and leaf hoppers in the case of the first two families, and larvae of Coleoptera or Lepidoptera in Bethylidae. Altogether, they total 35 species, with one extinct (not recorded for 115 years). They are little known, however.

43 ant species have been recorded from Kent, of which two are probably extinct (or with only one record in the past). A further three are non-natives which have been found outdoors. Two species, *Tetramorium atratulum* and *Myrmica hirsuta*, are inquilines in the nests of other species of their respective genera, whilst five species of *Lasius* and one of *Myrmica* (*M. vandeli*) are believed to be obligatory temporary social parasites. In two *Formica* species, the new queens can either be adopted by colonies of their own species or by related species. One of these *Formica* (*F. sanguinea*) is predatory on other *Formica* ants and can adopt robbed pupae after eating some, rearing them as "auxiliaries" or slaves in their nest.

In the spider-hunting wasps, there are 34 Kentish species but two of these are long extinct, if ever native to the county. One extinct species of *Ceropales* and two species of *Evagetes* are cleptoparasites of other pompilids. Some species are parasitoids (i.e., not constructing a nest), while others show the most primitive kind of predatory behaviour, catching their prey spider before digging the nest, then laying the egg. More advanced species construct the nest cell

first, then capture a spider prey. There is only one prey item used per cell, which means the hunting female must carry a spider larger than herself to the nest site. In the related family Mutillidae, the three species are parasitoids of other aculeates, the largest, *Mutilla europaea*, developing in nest cells of bumblebees. Mutillidae have wingless females and are called "Velvet Ants". The Sapygidae has only two species, but these are wasps which develop by eating the pollen that female bees have stored for their own larvae, therefore they are cleptoparasites. The female *Sapyga* lays her eggs, one per cell, in the nests of mason bees. The two UK species of *Tiphia* are both found in the county, the larger one probably expanding in range. They are parasitoids of Dung Beetle larvae.

Finally, the pleated winged wasps, now usually included in only one family, Vespidae, contains the mason wasps and social wasps. There are 16 species of the former group so far found in Kent, one of these considered extinct. They are the hosts of many species of rubytail wasps. Two species of "social paper wasp", genus *Polistes*, have been found in Kent; one or perhaps both may be in the process of establishing bridgehead UK populations, perhaps moving northwards because of the warming climate. The hornets and yellow jackets, *Vespa*, *Vespula* and *Dolichovespula* have only nine species in the UK and Kent, but the Inquilinous (Cuckoo) Wasp, *Vespula austriaca*, has only been recorded once from the county, many years ago (pre-1970).

Status and trends

There have been a total of six aculeate species lost in the last century in Kent, some of which are also now nationally extinct. However, 17 aculeate species have been added to the county list, with the majority of these being discovered in the last decade. Some species, such as *Andrena florea*, have expanded their range in the UK, while others, such as *Polistes biglumis*, have colonised from continental Europe.

Paper wasp *Polistes biglumis*

Grey-backed mining bee
Andrena vaga - female

Table 1 Aculeate species lost° and gained^ in Kent, with date last‡/first◊ recorded

Species changed in the last 100 years	Year	Species changed in the last ten years	Year
Ancistrocerus antilope°	1925‡	*Andrena florea* ^	2014◊
Andrena nana°	1930‡	*Colletes cunicularius* ^	2014◊
Anthophora retusa°	1966‡	*Crabro scutellatus* ^	2017◊
Bombus subterraneus°	1988‡	*Crossocerus congener* ^	2015◊
Eucera nigrescens°	1970‡	*Hedychridium coriaceum* ^	2014◊
Hedychrum nobile ^	2005◊	*Hedychrum rutilans* ^	2019◊
Hylaeus pectoralis ^	2009◊	*Lasioglossum sexstrigatum* ^	2012◊
Mimumesa spooneri°	1924‡	*Nomada alboguttata* ^	2013◊
Nomada subcornuta ^	2005◊	*Nomada bifasciata* ^	2018◊
Nomada zonata ^	2010◊	*Stelis odontopyga* ^	2017◊
Psenulus chevrieri ^	1987◊	*Polistes biglumis* ^	2020◊
		Andrena nitidiuscula ^	2020◊

Kent has a nationally important aculeate fauna, with one of the highest diversities in the UK. This reflects a combination of areas of suitable habitat, a diversity of habitat types, the warm summers and the proximity to Europe, a source of new arrivals. Amongst these species, Kent is nationally important for:

- *Andrena gravida* – this species is largely confined to Kent in the UK. There is evidence that following a long term decline it is now spreading within Kent.

- *Andrena polita* – this has only ever been found at a handful of sites in the Medway Valley in the UK. Until recently it was thought to be extinct in the UK, having been last recorded in 1934 from near Halling. However, in 2020 a population was rediscovered, again near Halling, where it appears to be highly localised. The coincidence of location might well suggest it is a relict population as opposed to representing a recent recolonisation. If this supposition is correct, it would make it one of Britain's rarest and most endangered bees. *Andrena polita* is not just rare in Britain it is also considered rare and endangered in other countries in Western Europe.

- *Andrena vaga* – this species is a recent colonist to the UK, with a population known to be present at Dungeness since 2008 (although there are some records of single individuals prior to 1946 in south-eastern England). It is a specialist on *Salix* pollen. It has since been found at a handful of other sites in Kent and south-eastern England, but still has a very restricted distribution and Dungeness perhaps remains the best site in the UK to see it.

- Shrill Carder Bee *Bombus sylvarum* – the Thames Estuary is a stronghold for this species, which is England's rarest bumblebee. It occurs in various habitats but is now largely confined to coastal areas. It is the only aculeate species highlighted in the Kent Biodiversity Strategy and there is a national conservation strategy associated with it (Page et al., 2020).

- *Cerceris quadricincta* – this species is only found in Kent and Essex in the UK, and Kent is where it is most widely distributed. It is most often found in open sandy habitats and coastal soft rock cliffs. There is evidence that it is spreading in Kent.

- *Coelioxys mandibularis* – this bee has a very localised distribution in the UK being restricted to some coastal sites in Wales and Merseyside, with a disjunct population along the East Kent coast between Deal and Foreness. The Kent form is smaller than the western populations.

- *Osmia pilicornis* – this bee has only been recorded in recent years from Kent and Sussex, appearing to have undergone a dramatic decline during the latter half of the 20th century. A population remains at Denge Wood near Canterbury, which is the only reliable known site for the species in the country.

Species trends in Kent largely mimic those at a national level. There are several aculeates that have been on the increase in the county in recent years such as the following:

- *Andrena bucephala* – appearing in Kent in 1966, this bee has since extended its range from the chalky areas of the North Downs to the sandy areas of the county such as the High Weald.

- *Lasioglossum malachurum* – first recorded in Kent in the 1960s, this bee is now one of the most encountered bee species in the county with a significant range expansion in the 1970s and early 1980s.

A reintroduction of the Short-haired Bumblebee *Bombus subterraneus,* following its extinction in the UK was carried out at Dungeness from 2011. Queens collected in Sweden were released in subsequent years, while ongoing habitat creation and restoration work looked to ensure enough suitable habitat at Dungeness and the surrounding Romney Marsh. Regular monitoring work has found continued presence of other scarce bumblebee species such as *B. humilis*, however, *B. subterraneus* does not appear to have become established thus far.

Non-native and invasive species

Due to the proximity of Kent to continental Europe and the constant state of flux of aculeate species, there are several species that are recent additions to the county list or expected to establish in the coming years. The following provides some examples of these:

- *Colletes cunicularius* – this large bee was first found in Kent in 2014 and has since spread to several sandy sites. Very large numbers can now be found nesting at some sites in Kent with expanses of warm sand. Until recently it was confined to Northwestern Britain, so it is possible that this recent addition to the Kent list is the result of a separate colonisation from mainland Europe.

- *Lasius emarginatus* – a non-native species of ant that was first recorded in the county in 2020. It can out-compete the native *L. niger* in some urban habitats and is expected to spread further in the county, but only in built-up areas.

- *Lasius neglectus* – this ant is an invasive non-native species, which has yet to be recorded in Kent but could be a potential colonist in future years as it currently occurs in other counties in southern England.

- *Nomada zonata* – the earliest record of this species being in Britain is from 2010, where it was found at Lydden Temple Ewell chalk grassland. Since then, it has spread significantly and can be found across Kent and south-eastern England, in a broad range of habitats including suburban areas.

- *Polistes biglumis* – recorded for the first time in the UK in 2020, from Samphire Hoe, where there was at least one colony. This wasp is only known from Samphire Hoe and appears to be a new arrival from continental Europe. It can live in cooler conditions than its congeners, so may become established and widespread in the UK.

- *Polistes dominula* – this non-native species of wasp is a vagrant, with records from the county from 1958. With

the climate continuing to warm it is thought it could become established in future years.

- *Stelis odontopyga* – the earliest British record for this small bee was from 2017 from Sandwich. Since then, it has been found at a small number of other sites in Kent and elsewhere in England. It is a cleptoparasite of the widespread bee *Osmia spinulosa*, so it may in time become similarly widely distributed.

- *Vespa velutina* – this non-native wasp is considered invasive by Defra and there have been two cases so far of records in the county (2018 and 2019). These are likely to be vagrants from continental Europe, where the species is established.

- *Xylocopa violacea* – a large, distinctive species of carpenter bee that is native to continental Europe and is likely to establish in the UK. It was first recorded in Kent in 1996 and has recently successfully nested in the county.

Key habitats and their protection

Aculeates occur in a broad range of habitats, but a key characteristic of this group is that they are largely thermophilic. Therefore, sunnier, open areas tend to have the greatest diversity of species. Areas with lighter soils and sparser vegetation tend also to attract more aculeates, many of which are ground nesting. Other species are reliant on opportunities for 'aerial' nesting such as in dead wood, galls, and hollow plant stems. Some species are more specialist and rely on specific plant species for foraging or specific host species, while others are more generalists.

The specific habitats that aculeates are strongly associated with in Kent are lowland heathland, lowland mixed broad-leaved woodland, lowland meadow, chalk grassland, coastal and floodplain grazing marsh and brownfield. These habitats provide a range of nesting and foraging opportunities. For example, lowland heathland with its characteristic sandy soils and areas of bare ground attracts a broad suite of aculeates that can make use of this for nesting sites. Open-structured woodland such as recently coppiced areas provide dead wood nesting opportunities and a diverse ground flora with foraging opportunities for species such as the scarce *Osmia pilicornis*. Meadows, grassland, and marshes are particularly important for some of the rarer bumblebee species like *Bombus sylvarum*. Brownfield habitat offers a diverse habitat structure, which numerous aculeate species can exploit, and such open mosaic habitats are some of the richest sites for aculeates in the county.


Maidstone mining bee *Andrena polita* - female

Other important habitats include hedgerows, lowland dry acid grassland, traditional orchard and intertidal mudflats and coastal saltmarsh. The latter is particularly important for the Section 41 species *Colletes halophilus*, which is associated with the Sea Aster plant, collecting pollen solely from this species.

Drivers of change

The British aculeate faunal list is growing, driven by arrivals from the near continent. Warming climate is probably the cause of these often-thermophilic species being able to expand their range. Kent as the county closest to continental Europe is often a bridgehead for these species, new arrivals being detected in Kent first, before spreading elsewhere in the UK. For instance, *Nomada zonata* was first detected in the UK in Kent in 2010 and within ten years has become widely distributed across south-eastern England. However, whilst the faunal list is growing, the general trends in species abundance is presumed to be declining, mirroring that of other insect species (e.g., Defra 2020).

Habitat loss

The main driver of change about aculeates is habitat loss. Loss of flower rich habitat (directly or through unsympathetic management) has had a significant impact on many bee species that rely on an ample supply of forage. In turn, this influences those aculeates that use these species as hosts. Similarly, the "tidying up" of land, such as of dead wood in woodlands, may have impacted negatively on the species that are reliant on this for nesting. Changes in management practices such as reduction in coppicing and traditional meadow management is likely to also have had a significant impact on some aculeate species, particularly during the latter half of the 20th century.

Climate change

While climate change may be resulting in more species colonising from the continent, the extreme weather that can result has the potential for a detrimental impact on Kent's aculeate fauna. For example: a lack of nectar during periods of drought; flooding of nests during wetter periods; build-up of parasites during milder winters; and flowering time becoming out of sync with species flight periods.

Pesticides and insecticides

There is a growing body of evidence on the potential impact of pesticides on aculeates. Much of this has focused on the group of systemic insecticides classed as neonicotinoids (Woodcock *et al.,* 2016: Woodcock *et al.,* 2017). However, there is also research suggesting that herbicides like the commonly used Glyphosate can also have a detrimental impact on bee species (Battisti *et al.,* 2021; Straw *et al.,* 2021). Most of this research has been focused on social bee species, which are arguably more resilient than solitary species. Therefore, there is the potential that pesticides could be having more of a damaging effect on aculeates in the county than we currently realise.

Non-native species and disease

The impact of pathogens and non-native species are less well studied about aculeates. There is some suggestion that pathogens from imported *Apis mellifera* and *Bombus terrestris* colonies from continental Europe may be able to spread to wild bees (Mallinger *et al.,* 2017). There is growing evidence suggesting that *Apis mellifera* can have a negative impact on wild aculeate species, such as through direct competition for floral resources (Goulson & Sparrow, 2009).

Recording, monitoring and research

Kent is a well recorded county for aculeates, with many amateur entomologists visiting various sites regularly. There is a general bias towards sites that are considered better for aculeates, especially those at the coast, and more records in the vicinity of places where some of the main recorders in the county live. However, with increasing public interest in bees and increasing accessibility in terms of the identification of this group, more records have been submitted in recent years from the public, such as through iRecord. More identification resources online and the popularity of social media groups (e.g., the UK Bees, Wasps & Ants Facebook group) has no doubt helped to drive this. Some of the more obscure aculeate families remain quite under recorded, such as the Dryinidae, Embolemidae and Bethylidae.

Given that Kent is home to numerous rare and scarce aculeate species, several recent projects have focussed on their conservation. These include:
Back from the Brink Shrill Carder Bee Recovery Project – running from 2017 to early 2020 as part of the national Back from the Brink initiative, this project focussed specifically on *Bombus sylvarum* in the Thames Estuary and Somerset. Bumblebee Conservation Trust were the project lead, with Buglife as project partner delivering the work in Kent. The project focussed on advising land managers on enhancements for the species, training volunteers to survey and monitor bumblebees and the development of a ten-year conservation strategy for the species at a national level (Page *et al.,* 2020).


Hairy-horned Mason Bee *Osmia pilicornis* - male

Making a Buzz for the Coast – this 3.5-year project focussed on the Kent coast from Dartford to Deal with Bumblebee Conservation Trust taking the lead in partnership with several different organisations. Shrill Carder Bee *B. sylvarum* was the priority species but the project also focussed on other Section 41 Bumblebee and solitary bee species such as *Colletes halophilus*. Work was centred around providing advice to land managers, carrying out habitat works for the benefit of these species and raising public awareness about the importance of Kent for these species and providing training on bee identification.

Short-haired Bumblebee project – this long running project is a partnership between Bumblebee Conservation Trust, Hymettus, Natural England, and RSPB. It aimed to reintroduce the extinct *Bombus subterraneus* to Dungeness and the surrounding Romney Marsh. While the reintroduction does not appear to have been successful, significant work was carried out with land managers in the area to enhance the landscape for this species and other bumblebees. The project received much media attention and has helped to raise the profile of the species and other bumblebees in Kent and beyond.

Conclusion

Aculeates in Kent are generally suffering from downward trends. This is particularly true of some of the more specialist species in this group. However, some more generalist species appear to be on the increase and the number of aculeates recorded in the county is growing year on year because of new species colonising from continental Europe or variable species being recognised as multiple cryptic species.

With a changing climate and more development pressure in an already crowded county, it is likely that the general trend of aculeates will continue to decrease. However, increasing public interest in bees and pollinators may help to reverse the fortunes of some of these species, coupled with the conservation work that is being carried out by various organisations across the county. The adoption of Kent's Plan Bee by Kent County Council (KCC, 2019) and further pollinator action plans at the local authority level may help too.

While many aculeates are quite mobile and adaptable species, some have very specific needs, and therefore the protection of key aculeate sites and sites for priority species is vitally important. Sites along the Thames Estuary, which is an area under much pressure from development and is home to many rare and threatened aculeate species, are of particular importance. It is important for land managers to understand that habitat management for aculeates is about more than just providing flowers; it is about wider foraging opportunities, nesting habitat and overwintering habitat. The latter two elements are often neglected and should be more at the forefront of the minds of conservation practitioners.

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Paper wasp *Polistes biglumis*

Darkling Beetle *Helops caerulea*
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KENT'S BEETLES

TONY WITTS, KENT & MEDWAY BIOLOGICAL RECORD CENTRE

Summary

- Almost 68% of Britain's beetles have been recorded in Kent.
- Kent is home to many threatened and specialised species vulnerable to the effects of environmental change and degradation, though recording of beetles is patchy, and trends are difficult to determine.
- Kent's position close to the continent makes it a gateway for new species to arrive either by natural dispersal, or by human assisted migration.
- The effects of non-native species are rarely studied unless they are potentially economically important pests.
- Beetles can be found in almost all habitats in Kent, semi-natural habitats hold the richest diversity of species.
- Habitat loss, degradation and fragmentation pose serious threats to Kent's beetle fauna.
- Kent's beetle fauna is dynamic with new species being found annually.
- Beetles are not a popular group of insects for naturalists to study, though recent developments in on-line recording and free identification resources may open the group for greater attention.

Beetle fauna of Kent

The most recent checklist of beetles of the British Isles (Duff, 2018) includes 4,072 species in 103 families; with new species being added frequently. The known Kent fauna currently comprises 2,758 species in 99 families[1, 2]. This total is likely to be less than the number recorded over all time since the historic records held in the record card index - maintained by Eric Philp prior to computerised databases - have not yet been digitised.

A single species has a global threat level, *Pseudotriphyllus suturalis* a member of the Mycetophagidae (hairy fungus beetles) is almost entirely restricted to England and Wales[3] where it is widespread, but local in bracket fungi on trees (Duff, 2020). A total of 116 species have been designated with some level of threat of extinction in Great Britain in the latest tranche of status reviews published by Natural England (Table 1)[4], a further 286 species are listed as Nationally Rare or Nationally Scarce. So far not all beetle families have been assessed; ground beetles, leaf beetles, darkling beetles, soldier beetles, dung beetles, longhorn beetles, water beetles and some of the smaller families have been reviewed, whilst only a small number of rove beetles and none of the weevils or click beetles have been evaluated. These three families represent over 1,000 species found in Kent that have not yet been assessed against IUCN criteria.

Table 1 The number of species per IUCN threat level in the Red List for Great Britain found in Kent since 1827

Red List status	Number of species
Data Deficient	9
Near Threatened	46
Vulnerable	33
Endangered	17
Critically Rare	2
Critically Rare (Probably Extinct)	5
Regionally Extinct	4
Total	116

The four regionally extinct species are: *Meloe cicatricosus* (last seen in Kent 1906), *Meloe variegatus* (last seen in Kent 1883), *Polyphylla fullo* and *Lagria atripes*. *Polyphylla fullo*, the Pine Chafer, this species formerly native to Kent appears to have become extinct around 1850, since then a few presumably human assisted adventives have been recorded, most recently at Dover Docks in 2018. This large and distinctive chafer is a strong flier, with a population present along the Channel coast in France making it a contender for re-colonisation. *Lagria atripes* has recently been re-discovered breeding at a site in Kent where it is possible it has been continually present but unrecorded. Prior to its recent discovery it was only known from the New Forest in Hampshire and Blean woods in Kent, where it was last recorded in 1957.

Twenty-seven species are listed as species of conservation concern in Section 41 of the Natural Environment & Rural Communities Act 2006. Sixty-two species are regarded as non-native, these are largely accidental imports that have arrived through global trade in food, timber, live plants, and textiles. Some of these have been successful and have become widespread e.g., the Harlequin Ladybird *Harmonia axyridis,* whilst others are restricted to living synanthropically e.g., the Churchyard Beetle *Blaps*

1 This includes one non-native family not on the British checklist; the Dynastidae included due to a recent record of the large European rhinoceros beetle *Oryctes nasicornis* found in Broadstairs in July 2020. Its origin is unknown.
2 Only records held by the Kent & Medway Biological Records Centre have been used. NBN Atlas data was not consulted for this review.
3 See https://www.gbif.org/species/1045500 for the known global distribution of *Pseudotriphyllus suturalis*
4 http://publications.naturalengland.org.uk/category/4707656804597760

mucronata. Colonisation by natural dispersal from the near continent is hard to prove, and for any other than the most conspicuous species this process goes largely unnoticed. Good candidates for natural adventives include *Trichius gallicus*, *Agapanthia cardui* and *Sitaris muralis* which have recently recorded colonies in Kent at coastal sites.

Status and trends

Beetles, despite being generally ubiquitous, are not a popular group for study so coverage of the county is limited by the small number of people looking for them. They tend to be rather small and difficult to identify without killing specimens and consulting technical identification keys. This deters many amateur naturalists from taking up their study. The lack of recent records for a species is not necessarily evidence for its absence in the county; nearly one thousand species have been seen less than five times. Out of the 2,758 species of beetle recorded in Kent over 1,200 have not been seen in the last ten years, while 79 new species have been recorded in the county in the same period (Table 2). Kent's beetle fauna is still being discovered with several new species being added to the list annually (Figure 1). It is not possible to draw any firm conclusions about the status of Kent's beetles in general over relatively short time spans.

Generalist species such as the Seven-spot Ladybird *Coccinella septempunctata,* Thick-legged Flower Beetle *Oedemera nobilis,* Common Red Solder Beetle *Rhagonycha fulva,* Black Clock Beetle *Pterostichus madidus*, and the Pollen Beetle *Meligethes aenea* remain widespread and common. Some previous rarities have become widespread and common i.e., the flea beetles *Longitarsus parvulus* and *Aphthona euphorbiae*, both of which have benefitted from the increase in cultivation of linseed (Cox, 2007).

A species can probably be considered to be extirpated from Kent if it has not been seen since 1970; there are 93 such species in the current data set (Table 2).

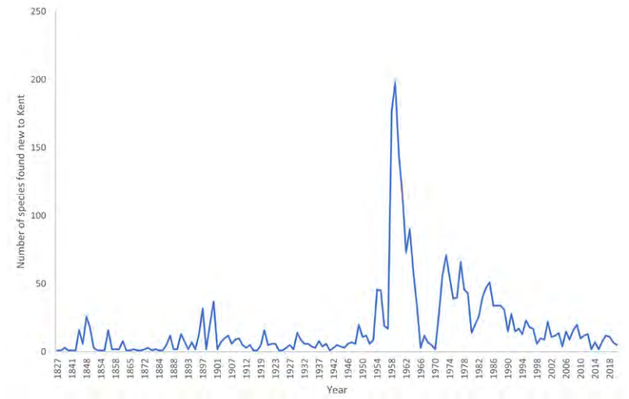

Figure 1 Annual numbers of species of beetle not previously known from Kent

Table 2 Beetle species lost° (not seen for fifty years) and those gained^ (seen for the first time in the last ten years) in Kent - includes the first and last dates of occurrence at any time of year

Species lost in last 50 years	Year of last record	Species gained in last ten years	Year of first record
Phyllobius viridicollis°	1800	*Acanthoscelides obtectus*^	2010
Polydrusus confluens°	1800	*Acrotrichis pumila*^	2010
Rhynchites bacchus°	1843	*Bledius subniger*^	2010
Acentrotypus brunnipes°	1850	*Clitostethus arcuatus*^	2010
Neocoenorrhinus pauxillus°	1867	*Cryptophagus populi*^	2010
Meloe variegatus°	1882	*Dermestes maculatus*^	2010
Lamprohiza splendidula°	1884	*Harpalus griseus*^	2010
Bagous binodulus°	1890	*Harpalus laevipes*^	2010
Sirocalodes quercicola°	1890	*Olibrus millefolii*^	2010
Stictonectes lepidus°	1900	*Acrotrichis josephi*^	2011
Hypocoprus latridioides°	1902	*Aleochara tristis*^	2011
Ampedus pomonae°	1904	*Bisnius subuliformis*^	2011
Lixus vilis°	1905	*Chrysolina coerulans*^	2011
Meloe cicatricosus°	1906	*Coprothassa melanaria*^	2011
Meloe rugosus°	1906	*Dermestes frischii*^	2011
Agabus undulatus°	1907	*Gnathoncus buyssoni*^	2011
Enicocerus exsculptus°	1910	*Hylesinus wachtli*^	2011
Bagous brevis°	1913	*Involvulus cupreus*^	2011
Bagous nodulosus°	1913	*Melanotus castanipes*^	2011
Eutheia plicata°	1913	*Rhinocyllus conicus*^	2011
Bagous frit°	1920	*Saprinus virescens*^	2011
Helophorus tuberculatus°	1927	*Chaetocnema picipes*^	2012
Laccobius atratus°	1927	*Cryptophagus rotundatus*^	2012
Paracymus scutellaris°	1927	*Cypha seminulum*^	2012
Oxypoda recondita°	1932	*Ernobius angusticollis*^	2012
Trypophloeus binodulus°	1935	*Euheptaulacus sus*^	2012
Lixus paraplecticus°	1942	*Hydraena rufipes*^	2012
Labidostomis tridentata°	1945	*Megarthrus prosseni*^	2012
Scarodytes halensis°	1945	*Omalium exiguum*^	2012
Meloe violaceus°	1947	*Perigona nigriceps*^	2012
Anthribus fasciatus°	1949	*Philonthus lepidus*^	2012
Chrysomela tremula°	1949	*Philonthus spinipes*^	2012
Cleopomiarus plantarum°	1949	*Pityogenes trepanatus*^	2012
Agabus unguicularis°	1950	*Tachyporus scitulus*^	2012
Calathus micropterus°	1950	*Otiorhynchus crataegi*^	2013
Epuraea rufomarginata°	1950	*Pyrrhidium sanguineum*^	2013
Perapion lemoroi°	1950	*Carpelimus erichsoni*^	2014
Xylodromus testaceus°	1950	*Longitarsus curtus*^	2014
Sibinia pyrrhodactyla°	1952	*Rhyzobius chrysomeloides*^	2014

Table 2 Continued

Species lost in last 50 years	Year of last record	Species gained in last ten years	Year of first record
Ptiliolum spencei°	1955	*Rhyzobius lophanthae^*	2014
Acrolocha minuta°	1957	*Sacium pusillum^*	2014
Eubria palustris°	1958	*Thamiocolus viduatus^*	2014
Laccophilus poecilus°	1958	*Trypodendron lineatum^*	2014
Melanophthalma transversalis°	1958	*Otiorhynchus armadillo^*	2015
Glocianus moelleri°	1959	*Rugilus angustatus^*	2015
Hypocaccus rugifrons°	1959	*Anisoxya fuscula^*	2016
Pseudopsis sulcata°	1959	*Bruchidius imbricornis^*	2016
Quedius riparius°	1959	*Bruchus brachialis^*	2016
Apteropeda splendida°	1960	*Coelositona cinerascens^*	2016
Barypeithes pyrenaeus°	1960	*Dochmonota clancula^*	2016
Isochnus foliorum°	1960	*Onyxacalles gibraltarensis^*	2016
Anthonomus piri°	1961	*Porotachys bisulcatus^*	2016
Anthonomus ulmi°	1961	*Stictoleptura rubra^*	2016
Bessobia occulta°	1961	*Agapanthia cardui^*	2017
Ceutorhynchus thomsoni°	1961	*Anthonomus spilotus^*	2017
Cidnopus aeruginosus°	1961	*Corticarina lambiana^*	2017
Lasiorhynchites sericeus°	1961	*Cryptophagus corticinus^*	2017
Oxypoda mutata°	1961	*Eulagius filicornis^*	2017
Dissoleucas niveirostris°	1962	*Heterobostrychus hamatipennis^*	2017
Philonthus corruscus°	1962	*Micrambe woodroffei^*	2017
Philonthus ebeninus°	1962	*Orthoperus corticalis^*	2017
Sphaerosoma pilosum°	1962	*Otiorhynchus aurifer^*	2017
Stenus circularis°	1962	*Rhyssemus germanus^*	2017
Blethisa multipunctata°	1963	*Sericoderus brevicornis^*	2017
Brachypterolus vestitus°	1963	*Trichius gallicus^*	2017
Cryptocephalus sexpunctatus°	1963	*Anotylus clypeonitens^*	2018
Enochrus affinis°	1963	*Anthrenus scrophulariae^*	2018
Gymnetron beccabungae°	1963	*Cartodere norvegica^*	2018
Harpalus puncticollis°	1963	*Chlaenius tristis^*	2018
Hydrosmecta fragilis°	1963	*Dorcatoma substriata^*	2018
Longitarsus obliteratoides°	1963	*Henosepilachna argus^*	2018
Nitidula carnaria°	1963	*Plagionotus arcuatus^*	2018
Phloeostiba plana°	1963	*Polydrusus prasinus^*	2018
Stenus formicetorum°	1963	*Polyphylla fullo^*	2018
Anthonomus humeralis°	1964	*Rhyzobius forestieri^*	2018
Bagous puncticollis°	1964	*Sitaris muralis^*	2018
Cyanapion gyllenhalii°	1964	*Bledius dissimilis^*	2019
Harpalus calceatus°	1964	*Carpelimus similis^*	2019
Procas picipes°	1964	*Gabrius exiguus^*	2019
Rhagocneme subsinuata°	1964	*Georissus crenulatus^*	2019
Squamapion vicinum°	1964	*Hololepta plana^*	2019
Trypodendron signatum°	1964	*Lathrobium rufonitidum^*	2019

Table 2 Continued

Species lost in last 50 years	Year of last record	Species gained in last ten years	Year of first record
Aphodius borealis°	1965	*Paropsisterna selmani^*	2019
Atomaria strandi°	1965	*Callosobruchus maculatus^*	2020
Dorytomus affinis°	1965	*Cryptophilus integer^*	2020
Malthodes fuscus°	1965	*Luperus flavipes^*	2020
Meotica pallens°	1965	*Oryctes nasicornis^*	2020
Orthotomicus erosus°	1965	*Phyllobrotica quadrimaculata^*	2020
Philonthus rufipes°	1965		
Tachyusa constricta°	1965		
Zeugophora flavicollis°	1965		
Microdota excelsa°	1968		
Amara nitida°	1969		

For some of these species, their presence in Kent may have only been fleeting, for example the glow-worm *Lamphrohiza splendidula* which is known, in Britain, from two individuals collected at Leeds near Maidstone in 1884 and not seen since (Alexander, 2014). Others, such as the Oil Beetle *Meloe cicatricosus*, were known to have well established colonies around the coast of Thanet. Despite significant development in the area their presumed solitary bee hosts still have good populations, so the cause of their demise is unknown (Philp, 2002). For many species, their persistence is inextricably linked to the availability and quality of their habitat. Species that have very specific habitat requirements such as a single host plant that is itself restricted in the county i.e the Leaf Beetle *Longitarsus quadriguttatus* on Hound's-tongue, or a very restricted habitat resource such as bare damp sand i.e., Spangled Button Beetle *Omophron limbatum*, and the Ground Beetle *Dyschirius politus*, are highly vulnerable to changes in their environment.

New species recorded in Kent over the last decade fall into three categories:

- Exotic species imported with food and other plant material e.g.: *Euophryum confine* a small weevil of damp fungoid wood native to New Zealand and now widespread in Kent; the Chinese Auger Beetle *Heterobostrychus hamatipennis* in imported furniture from Asia; and the Cowpea Beetle *Callosobruchus maculatus* now a cosmopolitan species found in stored legume seeds which probably originates from West Africa (Tran & Credland, 1995).

- Occurrences of naturally dispersing species from the near continent are difficult to prove but potential candidates include: *Sitaris muralis*, *Agapanthia cardui* (Chumrova *et al*., 2018) and *Rhyssemus germanus*, all of which have established colonies on the South coast in recent years.

- Established British species not previously found in the county e.g., *Chlaenius tristis*, *Georissus crenulatus*, *Olibrus millefolii* and *Luperus flavipes*. These may be previously over-looked species or may have arrived from elsewhere in Britain or the continent.

There are some Kentish species worth highlighting:

Southern Oyster Mushroom Beetle *Triplax lacordairii* – Listed as endangered in the European Red List of saproxylic beetles, though not yet reviewed for Great Britain. This beetle is a focus species for the Species Recovery Trust. It is found in association with oyster mushrooms in Ancient Woodland, its British stronghold is the New Forest but increasing numbers of records for Kent show that the county is also important for this species.

Pride of Kent Rove Beetle *Emus hirtus* – A rare and highly distinctive rove beetle formerly known from the New Forest but now only found on the grazing marshes of the Thames Estuary. It is a predator of the larvae and adults of dung dwelling beetles, most frequently in bovine dung (Krawczynski *et. al.*, 2014). In much of its European range, it is known from wood pasture systems so could be a beneficiary of the introduction of European Bison into the Blean.

Kentish Clown *Hister quadrimaculatus* – Quite rare, but formerly somewhat widespread, this distinctive clown beetle is now only known from three sites in Britain, two of which are in Kent: Dungeness and the North Kent Marshes of the Swale. It is red listed as vulnerable

in Britain. Like *Emus hirtus* it is reliant on coprophagous invertebrate prey for its survival, although there is evidence that it will possibly predate mining bee larvae too (Lane *et al.*, 2020).

Polistichus connexus – This ground beetle is scarce and considered to be declining in Britain with a status Near Threatened. Its stronghold in Britain appears to be in the Thames Estuary where it is associated with soft rock cliffs and water seepages. It occasionally comes to light (T. Witts, pers. obs.).

Spangled Button Beetle *Omophron limbatum* – This unusual looking ground beetle was first found in Britain in 1969 at Rye, and subsequently discovered at Dungeness in 1972 (Philp, 2002). In Kent it is still known only from there where it can be found in great numbers on sparsely vegetated or bare damp silty sand at the edge of former gravel extraction pits. It is fully winged and is a natural colonist, from the continent. Populations have also been found in Suffolk and Norfolk (Nash, 2007). It requires a fresh supply of silt and a bare fine-grained substrate for its survival, so is sensitive to vegetational succession and cessation of disturbance in the water replenishing the supply of silt (Nash, *ibid.*)

Bembidion coeruleum – A ground beetle found only a handful of times in Britain and only ever in a few small areas of bare damp sand at Dungeness RSPB reserve, in association with *Omophron limbatum* and other rare beetles (Telfer, 2001). It was first found in 1989 and was most recently found in 2009. A survey of the beetles of some of the damp sand habitats at Dungeness was carried out in 2019, but it was not found. It is thought to live at extremely low densities.

Sandwich Click Beetle *Melanotus punctolineatus* – This click beetle is a priority species in England. It is best known in Britain from Sandwich Bay. It was formerly present in South Wales and has recently been found in Sussex. Not recorded in Kent since 1999, it should be looked for at plant roots or on low plants.

Non-native and invasive species

The beetle fauna of Kent includes 62 species considered to be non-native, having arrived either through the activities of humans or by natural dispersal from the continent or elsewhere in Britain. The arrival in 2004 and subsequent spread of the Harlequin Ladybird *Harmonia axyridis* is probably the best known of these and is well described by Roy and Brown (2015) who show that the arrival of the Harlequin Ladybird is closely correlated with the decline of seven native species of ladybird out of eight species assessed. Figure 2 shows the known distribution of the Harlequin Ladybird in Kent to 2020,

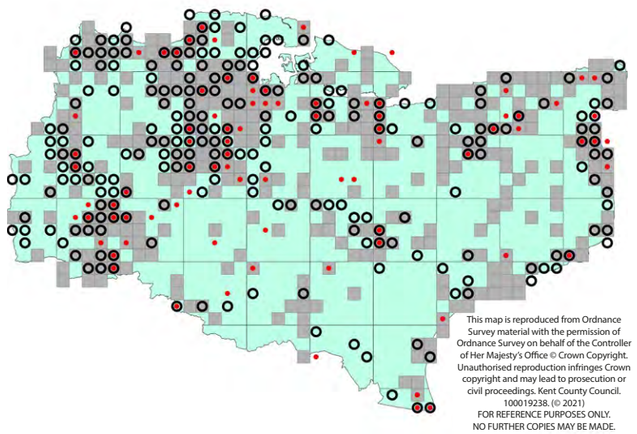

Figure 2 The known distribution of 2-spot Ladybird in Kent before and after the arrival of the Harlequin Ladybird in 2004. Open black circles pre-2004, red dots 2005 – 2020. Tetrads[5] occupied by Harlequin ladybirds shaded grey.

and a corresponding contraction of the distribution of 2-spot Ladybird *Adalia bipunctata* from 2005.

The Harlequin Ladybird is unusual amongst non-native arrivals, in that it has triggered a concerted effort to study its spread and subsequent effects, by launching a citizen science project within the UK Ladybird Survey. For most non-native beetles, their impact on native species is unknown. Horizon scanning by the GB Non-Native Species Secretariat highlights three beetle species that could potentially pose an economic threat to woodlands and conifer plantations in Kent in the next ten years:

- Asian Longhorn Beetle *Anoplophora glabripennis*
- Citrus Long-horned Beetle *Anoplophora chinensis*
- European Spruce Bark Beetle *Ips typographus*
- Two of these species have already been found in Kent (Asian Longhorn Beetle and European Spruce Bark Beetle) and eradicated.

Forest Research also list several non-native beetles that could potentially reach Kent through the timber or horticultural trade and cause economic damage to Kent woodlands:

- Two-lined Chestnut Borer *Agrilus bilineatus*
- Bronze Birch Borer *Agrilus anxius*
- Emerald Ash Borer Beetle *Agrilus planipennis*
- Red-necked Longhorn Beetle *Aromia bungii*

Key habitats and their protection

In Kent, beetles can be found in all terrestrial and aquatic habitats bar sublittoral sediments and the open sea. The Kent species have been analysed using the PANTHEON system to determine their key habitats and resources[6].

[5] A tetrad is a 2 km x 2 km square based on the Ordnance Survey grid.
[6] https://www.brc.ac.uk/pantheon/

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European oil beetle
Meloe proscarabeous

Almost 700 of our species are herbivores, relying on flowering plants as either an adult or in their larval stage. Families strongly associated with plants include the leaf beetles and weevils. Many of these are either monophagous or only narrowly polyphagous and so are reliant on specific plant species or genera being present in the landscape, at a density that allows their successful movement between patches to find mates and breed. Some species need different resources in their larval stage to their adult stage i.e., a predacious larval and a nectivorous adult as in many of the soldier beetles.

Therefore, open and botanically diverse habitats are vitally important for maintaining diversity in the beetles. Unimproved semi-natural grasslands on a variety of substrates: i.e., brownfield sites, chalk grassland, lowland dry acid grassland, sand dunes, vegetated shingle, and lowland meadows; species rich arable field margins and wetlands such as grazing marshes and saltmarshes are key in this. Botanically rich habitats are now scarce in the wider countryside due to the intensification of agriculture. On the urban fringe development of brownfield sites has a significant impact on beetles since they can offer a rich mosaic of substrates, capable of supporting an enormous diversity of plant species and consequently herbivorous Beetles and their predators (Robins *et al.*, 2013). Pressures on herbivorous beetles from modern agriculture include ploughing of pasture for arable, pesticides and herbicides (Hubble, 2014). Many of our most botanically diverse sites are now designated within the SSSI or LWS system, offering some protection for their plants and beetles so long as their management is appropriate. Priority species associated with diverse grasslands include: *Carabus monilis, Ophonus laticollis, Ophonus melletii, Ophonus puncticollis, Melanotus punctolineatus,* and *Meloe proscarabaeus.*

About 50 species are coprophagous, using the dung of herbivorous mammals mostly in open habitats like coastal and floodplain grazing marsh, and chalk grassland. The botanical diversity of the pasture, condition of the soil, structure of the sward and the veterinary input into the animals are important factors in maintaining dung beetle diversity (Lane and Mann, 2016), as well as for the 50 species of predatory beetles that feed on coprophagous insects in dung.

Lowland mixed broadleaf woodlands too are of critical importance for beetles, not only for approximately 100 species of herbivorous beetles, but also for about 150 species that are fungivores reliant on woodland with plenty of veteran trees and decaying wood. Dead wood (standing and fallen) is used by a further 100 species of xylophagous and saprophagous beetles and 38 associated predators. Loss of woodland, reduction in traditional management techniques, removal of dead wood, loss of a diverse age structure, and increasing distance between individual woodlands coupled with a loss of diverse hedgerows are all factors degrading our beetle fauna (Alexander, 2019). Priority species associated with woodlands include: *Cryptocephalus coryli*, *Cryptocephalus punctiger*, *Orchestes testaceus*, *Ampedus rufipennis*, *Lucanus cervus*, *Malachius aeneus*, and *Byctiscus populi*. Additionally, there is a general lack of appreciation for veteran trees outside woodlands, i.e., in wood pasture and parkland, whose sun warmed branches are vital for some species (Alexander, ibid). Traditional orchards are an important and threatened feature in Kent's


Typical view of a coleopterist

countryside, and a few of them support the Noble Chafer *Gnorimus nobilis*, another priority species.

Wetland and coastal habitats support over 650 species including herbivores, predators, and detritivores in reedbeds, ditches, ponds, marshes, lakes, and rivers. Pollution, draining of the land, development, agricultural improvement, sea-level rise, climate change and coastal erosion are all threats to these species. Fortunately, many of our wetlands are now within protected sites, but still come under pressure from agricultural run-off, atmospheric pollution, climate change and extreme weather events.

Priority species associated with wetlands include: *Anisodactylus poeciloides*, *Bembidion quadripustulatum*, *Bracteon argenteolum*, and *Chlaenius tristis*.

Beetles can also be found in the nests of social wasps (*Metoecus paradoxus*), solitary bees (*Sitaris muralis*, *Meloe proscarabaeous*), and ants (*Leptacinus formicetorum, Myrmetes paykulli* etc.). Others use mammal burrows e.g., *Laemostenus terricola* and bird's nests e.g., *Trox scaber*.

Drivers of change

Anthropogenic changes in the environment must be adversely affecting Kent's beetles; however with such a large and dynamic fauna that is not systematically monitored specific examples are difficult to demonstrate. It is not, however, unreasonable to presume that their populations have suffered any less than those of other insect groups i.e., bees, moths, and butterflies.

Habitat loss

Beetles, being highly speciated, have evolved to occupy a myriad of ecological niches so are vulnerable to habitat degradation and landscape homogenisation. The loss of semi-natural habitats beyond the boundaries of nature reserves is well documented e.g., Lawton *et al.* 2010. Habitat loss and degradation due to the intensification of agriculture and land use changes pose a direct threat to beetles. Reduction or eradication of host plants by herbicide use, re-seeding, ploughing of pasture for arable, changes in hydrology and soil fertility drive homogenisation in our agricultural landscapes by removing extreme conditions where specialised native plants thrive (Moyse, 2011). By degrading variety in the landscape, the number of different ecological niches available for occupation are reduced and thus the species diversity in beetles is reduced.

Habitat fragmentation

Where specialised beetles occur in pockets of good quality habitat, they are vulnerable to local extinction. Habitat fragmentation drives declines in species populations by making it harder for individuals to move between patches of suitable habitat. Whilst many beetles are fully winged and can fly, this is not the case for all species who are restricted to one location. Those that can fly can only do so when the conditions are right, i.e., humid, warm, and still. Some like the oil beetles rely on solitary bees to disperse their young. Decreasing patch size and increasing patch isolation have measurable negative impacts, by increasing species extinction rates, not only on herbivorous beetles but also on their predators (Kruess & Tscharntke, 2000).

Climate change

Climate change is already impacting insect populations (Halsch *et al.*, 2021). All organisms live within a restricted set of physical parameters defined by maximum and minimum temperatures, and the availability of water (precipitation and humidity) - their climatic envelope. As the mean annual temperature rises, mobile species can expand their range poleward to a distance concomitant with their dispersal ability, reproductive rate, and the availability of their habitat (Platts *et al.*, 2019). Beetle species already at the northern edge of their range in southern Britain will find their climatic envelope moving closer to their optimum, which may result in them being able to exploit new resources and increase their abundance and range (Wilson *et al.*, 2007). However, those species who are colder adapted will find the conditions intolerable and will need to seek suitable habitat if it exists within a reachable distance.

Recording, monitoring, and research

146,222 records are held in the Kent Coleoptera database, the earliest being *Heterocerus obsoletus* by renowned coleopterist F.W. Hope on the Isle of Sheppey in 1827. Coverage of the county is almost complete with only 14 tetrads/part tetrads without any records (Figure 3), though most tetrads have less than 100 species recorded (Figure 4). Most of these records have been collected by amateur entomologists, most notably members of the Kent Field Club, without whom we would know a lot less about the beetle fauna of Kent.

Recently, three ongoing citizen science projects have contributed to our understanding of beetles in Kent:

- The Great Stag Hunt – run by The People's Trust for Endangered Species (PTES), this survey has recorded the distribution of the Stag Beetle *Lucanus cervus* in Britain and shows how important north Kent is for this species. The Stag Beetles have the fourth highest record total in the Kent database.

- The UK Ladybird Survey – run by The UK Centre for Ecology and Hydrology. The arrival of the Harlequin

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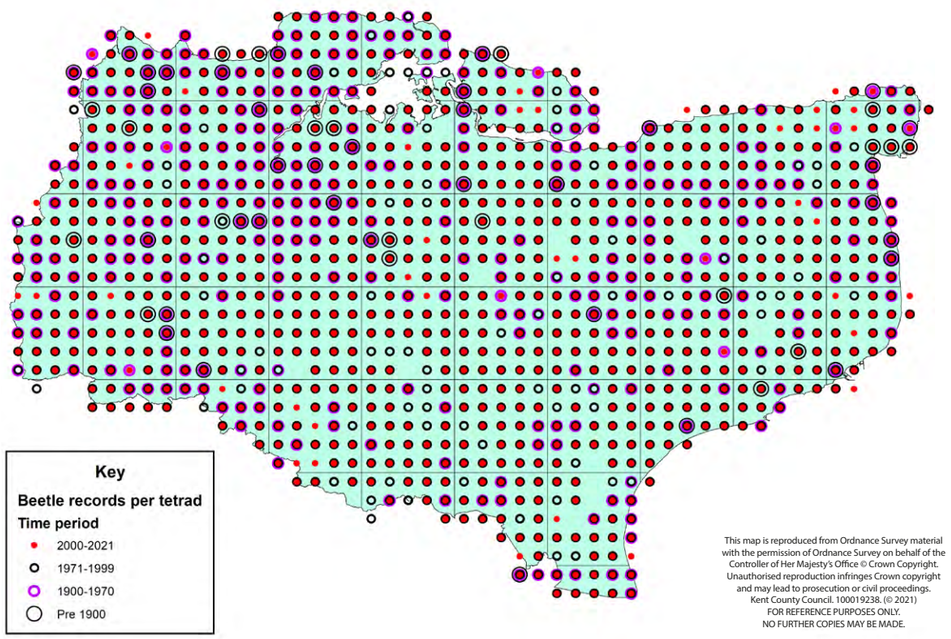

Figure 3 The spatial and temporal distribution of beetle recording in Kent from 1827 to 2020

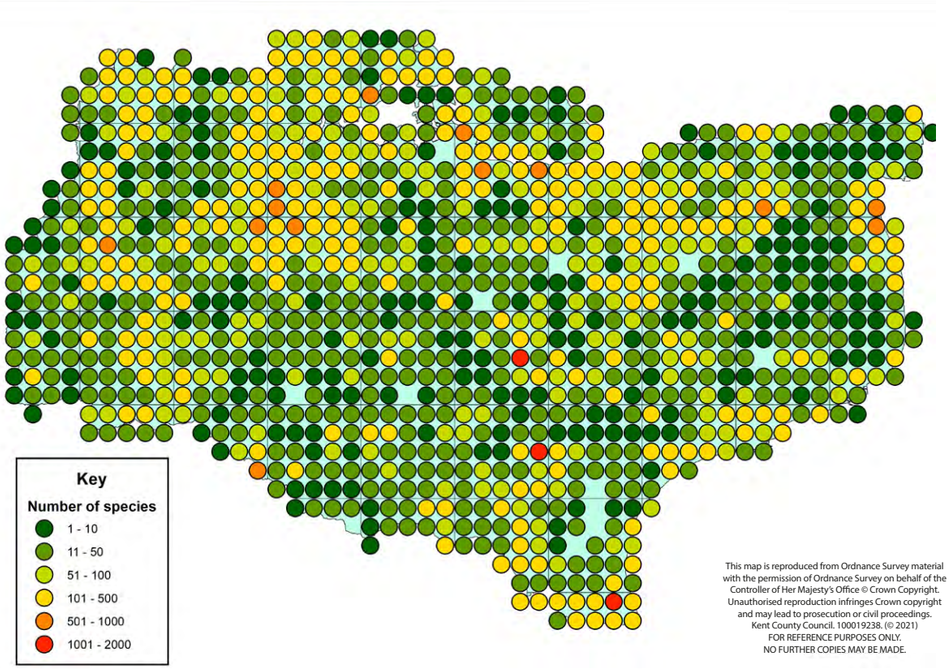

Figure 4 The number of beetle species recorded per tetrad in Kent from 1827 to 2020

Ladybird and the coverage in the media it received, brought ladybirds to the attention of the public so much that ten species of ladybird account for almost 10% of all records held in the Kent database.

- The Oil Beetle Hunt – run by BugLife, has added new information about the distribution of the Black Oil Beetle *Meloe proscarabaeus* in Kent, which is proving to be quite widespread in Kent and is possibly increasing its range.

Other structured surveys running include Noble Chafer survey by PTES, *Ips typographus* survey by Forest Research.

The collation and dissemination of records made by naturalists has been greatly facilitated by the development of on-line recording platforms such as iRecord and iSpot. It should be noted that care must be taken when validating records for inclusion in the Kent database, as some records are based on field identification or digital photographs of species that are only determinable by microscopic examination or even dissection.

Surveys conducted by professional entomologists, sometimes related to development, and sometimes to investigate specific habitats regularly produce new species for Kent and/or Britain e.g., Hodge and Williams, 2007; Telfer and Stüben, 2017.

Beetles are effective indicators of habitat quality due to their specialisation and general mobility e.g., ground beetles (Ludwiczak *et. al.*, 2020), water beetles (Pakulnicka *et. al.*, 2015), dung beetles (McGeoch *et. al.*, 2002). Therefore, several surveys have been conducted in the county to either assess the results of habitat management or to inform future management.

Bringing Reedbeds to Life: RSPB project to inform better reedbed management.

Dungeness damp sand beetles: KMBRC on behalf of the RSPB to investigate the effectiveness of vegetation control on damp sand margins aimed at conserving the beetle assemblage.

Vegetated shingle brash plot trials: KWT, RSPB and KMBRC to investigate the effectiveness of brash piles as a mechanism for vegetated shingle habitat restoration.

Studying beetles is extremely easy, with good reliable on-line identification resources[7] and the Beetles of Britain and Ireland series of books by Andrew Duff (Duff, 2012; Duff 2016; Duff, 2020), with only the rove beetles yet to be completed.

[7] For example http://coleonet.de/coleo/texte/coleoptera.htm, https://www.coleoptera.org.uk/home, https://sites.google.com/view/mikes-insect-keys

Conclusion

Kent's beetle fauna is both diverse and dynamic and is unlikely to be fully known. Kent is home to many rare and specialised species due to our rich variety of habitats. Though anthropogenic change in the environment is undoubtably having an effect, the recording and monitoring of beetles is patchy both in space and time, so trends are hard to determine. Generalist species seem to be doing well in Kent, however there is no baseline data on their abundance. Specialist species are restricted by the availability of their habitat and are threatened by habitat loss and fragmentation, though some, at the northern edge of their climate envelope in Kent, may be able to broaden their niche as the climate warms and thrive. Changes in beetle assemblages can be used to detect change in the environment and inform management techniques.

Kent's position in the United Kingdom makes it a gateway for species following their climate envelope under climate change, as well as an entry point for non-native species from further afield via transport links. It is important that:

1. Rare and threatened habitats are monitored for their beetle communities.
2. Widespread species are not taken for granted.
3. A new generation of coleopterists develops - who recognise the value in responsibly collecting beetle specimens for critical determination.

Searching for beetles

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Searching for beetles, Dungeness

Ground beetle *Carabus problematicus*

Darkling beetle *Lagria atripes*

Large conehead *Ruspolia nitidula*
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THE STATE OF GRASSHOPPERS, CRICKETS AND ALLIED INSECTS OF DUNGENESS

DAVID WALKER, DUNGENESS BIRD OBSERVATORY

Summary

An overview and detailed information about the state of grasshoppers, crickets and allied insects is difficult to provide for Kent, given the lack of a county recorder and paucity of recording effort. As a group, however, these species have been actively recorded at Dungeness since 1999, providing an opportunity to detail the fauna at this important location for invertebrates in the county.

Since 1999, there have been a number of exciting discoveries with many of these involving apparent colonisation from the continent and are seemingly indicators of responses to climate change. The first point of reference was the book *Grasshoppers and Allied Insects of Great Britain and Ireland* by Judith A. Marshall and E.C.M. Haes published in 1988 and updated in 1990. Appendix III details a number of outstanding sites across Britain and includes Denge Marsh and Denge Beach. It describes the general site and lists a total of 15 species recorded as follows:

- Great Green Bush-cricket *Tettigonia viridissima*
- Dark Bush-cricket *Pholidoptera griseoaptera*
- Grey Bush-cricket *Platycleis albopunctata*
- Short-winged Conehead *Conocephalus dorsalis*
- Speckled Bush-cricket *Leptophyes punctatissima*
- Cepero's Ground-hopper *Tetrix ceperoi*
- Slender Ground-hopper *Tetrix subulata*
- Common Ground-hopper *Tetrix undulata*
- Common Field Grasshopper *Chorthippus brunneus*
- Meadow Grasshopper *Chorthippus parallelus*
- Lesser Marsh Grasshopper *Chorthippus albomarginatus*
- Mottled Grasshopper *Myrmeleotettix maculatus*
- Lesser Cockroach *Capraiellus panzeri*
- Common Earwig *Forficula auricularia*
- Lesne's Earwig *Forficula lesnei*

Of these original 15 species, 13 have been found during surveys led by the bird observatory. The other two species, Dark Bush-cricket and Meadow Grasshopper, have been found around Lydd and Greatstone but off the shingle. The 13 remaining species described by Judith A. Marshall and E.C.M. Haes (1988, 1990) are displayed in Table 1 with accompanying notes on their abundance at Dungeness and where they can be, or have been, recorded.

Table 1 The species of grasshopper, cricket and allied insects present at Denge Marsh and Denge Beach in 1990 and notes on their abundance and locations since 1999 as recorded by D. Walker

Species	Abundance notes
Great Green Bush-cricket *Tettigonia viridissima*	Has always been abundant on the RSPB Reserve, but was notable by its absence from the Point itself. In very recent times (since 2007) there are signs that this is changing, with an increasing number of records of both nymphs and singing adults.
Grey Bush-cricket *Platycleis albopunctata*	Abundant and can be easily found.
Short-winged Conehead *Conocephalus dorsalis*	Abundant around the Hookers Pit on the RSPB Reserve, but in recent years access has been less easy, so it can only be presumed it is still there.
Speckled Bush-cricket *Leptophyes punctatissima*	Previously fairly hard to come across. It was first found in the Observatory recording area in 2009 and it is now a very frequent find.
Cepero's Ground-hopper *Tetrix ceperoi*	Infrequently recorded from around the vegetated margins of the Long Pits and around ARC pit.
Slender Ground-hopper *Tetrix subulata*	Frequently recorded from around the vegetated margins of the Long Pits and around ARC pit.
Common Ground-hopper *Tetrix undulata*	Infrequently recorded from around the vegetated margins of the Long Pits and around ARC and is in fact probably the least common of the three ground-hoppers.
Common Field Grasshopper *Chorthippus brunneus*	Easily the commonest of the grasshoppers occurring right across the peninsula.
Lesser Marsh Grasshopper *Chorthippus albomarginatus*	Abundant and widespread across the peninsula.
Mottled Grasshopper *Myrmeleotettix maculatus*	Seems to vary in abundance but is quite widely distributed across the peninsula, being found in more exposed, sunny areas. Numbers seem to be higher in hot late springs/early summer.
Lesser Cockroach *Capraiellus panzeri*	Abundant and can be found pretty much everywhere.
Common Earwig *Forficula auricularia*	Abundant and can be found pretty much everywhere.
Lesne's Earwig *Forficula lesnei*	Has not really been looked for, but one was found in a moth trap at the Observatory on 1st August 1999.


Large Conehead habitat Dungeness

Dungeness, with its close proximity to the continent, clearly makes it an important area for species arriving from across the Channel, and a number of significant species have now been added to the Marshall and Haes 1988 list:

Mediterranean Stick-insect *Bacillus rossius* was added to the area list in 2020. Although clearly an accidental introduction, several individuals were found in a bramble bush that was growing against the wall of the bird observatory. A previous assistant warden had a small colony in an insect cage and this was presumably the original source material.

Oak Bush-cricket *Meconema thalassinum* has been recorded on one occasion on 18th October 2010.

Southern Oak Bush-cricket *Meconema meridionale* was first found in the observatory recording area in 2010. It is now regularly seen in small numbers around the bird observatory garden.

Large Conehead *Ruspolia nitidula* was added to the area list in 2020 when an estimated total of 32 adults were found in two locations in the recording area. This was part of a widespread arrival of this species across southern Britain and is the first potential breeding colony to have been found.

Roesel's Bush-cricket *Metrioptera roeselii* were first noted on the RSPB reserve in 1999 and have now spread widely across the peninsula. They were first recorded in the bird observatory recording area in 2007.

Long-winged Conehead *Conocephalus discolor* was first recorded in 1999 and is now widespread and numerous in suitable habitat across the peninsula.

Sickle-bearing Bush-cricket *Phaneroptera falcata* was first seen on 26th September 2009, when a female was found by day on a fence post at the garden of the old lighthouse. On 26th August 2015, an adult female was also found whilst surveying the newly discovered Tree Cricket by torchlight. Further surveying gave an estimate of 11 adults present. Numbers increased in 2016 to 26 adults, after which numbers declined until another good summer in 2020 with about 30 individuals.

Tree Cricket *Oecanthus pellucens* was first noted on 20th August 2015, and was subsequently found in huge numbers in a fairly restricted area of rough grassland, brambles and open shingle in the area known as 'the desert'. It has been present in large numbers in the same area every summer/autumn since then, and in 2020 the extent of the colony showed signs of expanding into the large area of sallows, known as the Trapping Area.

Italian Cockroach *Ectobius montana* is a species that has confused recorders since 2015, when several individuals of a cockroach were discovered while surveying for Tree Crickets and Sickle-bearing Bush-crickets. The mystery cockroach was similar in appearance to Dusky Cockroach *Ectobius lapponicus*, and several anticipated individuals of the species were spotted in the same area in the following summers. A sample specimen was caught on the Observatory wall in 2018 and was sent to Professor Horst Bohn at Munich University, who identified it as *Ectobius montana*. The species was previously unknown outside of Italy. In 2020, several individuals were sighted at a second location on the Point and further searching of this area is planned for the following summers.


Tree Cricket singing

Conclusion

Dungeness has an excellent range of orthoptera and allied species, and nine species have been added to the list originally published in Marshall and Haes (1988) since 1999. Six of these can probably be attributed to the effects of climate change as the main driver of the range expansion. With much of the land legally protected as an NNR and SSSI – and owned by EDF Energy and the RSPB – there would appear to be no immediate threats to these populations. There remains the distinct possibility of more new species arriving into Britain in the future and Dungeness is perfectly positioned to receive them.

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Tree and Bush Cricket site

Grayling *Hipparchia semele* © Peter Eeles

KENT'S BUTTERFLIES

MIKE EASTERBROOK, BUTTERFLY CONSERVATION – KENT & SOUTH EAST LONDON BRANCH

Summary

- Kent has 42 of Britain's 59 resident species of butterfly, including three of the rarest species.
- Two of the nationally scarce species, Heath Fritillary *Melitaea athalia* and Duke of Burgundy *Hamearis lucina*, have done well in the last decade, increasing in numbers and extending their range slightly. The spread of Silver-spotted Skipper *Hesperia comma* has slowed, but several other species, including Adonis Blue *Polyommatus bellargus*, have expanded their range. Grayling *Hipparchia semele* is on the brink of extinction in Kent.
- The non-native Long-tailed Blue *Lampides boeticus* has bred in Kent on several occasions since 2013, but has not survived the winter.
- The short grassland of the North Downs is a key habitat in Kent, especially for species such as Adonis *Polyommatus bellargus* and Chalk Hill Blues *Polyommatus coridon*; however, amounts of suitable habitat continue to decrease due to growth of scrub or housing, industrial or agricultural development. The reduction in coppicing has made most woods unsuitable for many butterflies.
- Habitat loss and fragmentation, and changes in land use, are key drivers of loss of butterfly colonies. Increased planting of wild flowers as part of environmental stewardship schemes on farms can provide opportunities for some species to colonise. Sowing of wild flowers alongside roads and minimising the mowing of road verges can also provide foodplants for larvae and nectar sources for adults. It is vital that conservation measures are undertaken on a landscape scale.
- Recording and monitoring provide vital information on changes in butterfly populations. Projects organised by BC, KWT, Natural England and other conservation organisations have been important for the survival and increase of several species.

Butterfly fauna of Kent

Forty-two species of butterfly are resident in Kent; this total includes regular migrants from continental Europe, such as Painted Lady *Vanessa cardui* and Clouded Yellow *Colias croceus*, that breed here in most years. Not included in this total are rarer migrants, such as the continental form of Swallowtail *Papilio machaon*, Large Tortoiseshell *Nymphalis polychloros*, Scarce (yellow-legged) Tortoiseshell *Nymphalis xanthomelas,* Camberwell Beauty *Nymphalis antiopa* and Queen of Spain Fritillary *Issoria lathonia*. In addition, Long-tailed Blue *Lampides boeticus* has reached Kent on several occasions since 2013 and has produced another generation, though this has not survived the winter.

Two nationally-scarce butterflies breed in Kent: Heath Fritillary *Melitaea athalia* and Duke of Burgundy *Hamearis lucina*. Both species have been doing better in the last decade and have extended their range slightly. However, one of our native species, the Grayling *Hipparchia semele*, is on the brink of extinction in the county, with a sighting in 2020 the first for seven years. Brown Hairstreak *Thecla betulae*, which hadn't been seen in Kent since 1971, was recorded again in 2016, and is slowly expanding its range in Kent, having reached the county from Surrey in two areas.

Status and trends

Butterflies are probably the best recorded group in the Kent fauna. This is due to the large number of records collected and assessed by BC, which includes regular transects, enabling comparison of numbers between years. Species that have been lost and gained in both the last decade and last 100 years are displayed in Table 1. No species have been lost in Kent over the last decade, though the Pearl-bordered Fritillary *Boloria euphrosyne* was lost in 2003. The Brown Hairstreak *Thecla betulae* has colonised from Surrey and is gradually spreading, while the Long-tailed Blue *Lampides boeticus* is now reaching Kent from continental Europe more regularly and has bred here, though it is unable to survive the winter.

In contrast, the Grayling *Hipparchia semele* is on the brink of extinction in the county. Since 2005, this species was found only at Folkestone Warren, but it hasn't been seen there since 2013. In 2020, however, one was seen at Samphire Hoe, giving the hope that this butterfly may still be present on inaccessible cliffs in that area. Attempts to improve the habitat for this species in the area are being made by the White Cliffs Countryside Project. Colonies of this species on chalk downland have also declined in other counties, e.g. Sussex, for reasons that are not clear, leaving only two sites in the rest of south-east England for the 'chalk race' of this species.

The expansion in range of another nationally rare species – the Silver-spotted Skipper *Hesperia comma* – has slowed or even reversed (see Table 2), as some sites have become unsuitable due to lack of land management. It has been lost from Burham Down, where it was re-introduced in 2003; however, a few new sites were discovered in 2020.

Table 1 Butterfly species **lost**° and **gained**^ in Kent, with date last/first recorded over two time periods

Change in the last 100 years		Change in the last 10 years	
Species	**Year**	**Species**	**Year**
Wood White° *Leptidea sinapis*	1915	Brown Hairstreak^ *Thecla betulae*	2016
Black-veined White° *Aporia crataegi*	1922	Long-tailed Blue^ *Lampides boeticus*	2013, but not breeding every year
Marsh Fritillary° *Euphydryas aurinia*	1945		
Silver-studded Blue° *Plebejus argus*	1966		
High Brown Fritillary° *Fabriciana adippe*	1971		
Small Pearl-bordered Fritillary° *Boloria selene*	1997		
Pearl-bordered Fritillary° *Boloria euphrosyne*	2003		

Adonis Blue *Polyommatus bellargus* has continued to expand its range westwards and is now found in almost twice as many tetrads as in 2000-04 (see Table 2). Translocation of Adonis Blue to Queendown Warren was conducted by Kent Wildlife Trust in 2002, and was successful in establishing breeding populations on chalk grasslands throughout the Medway Towns. Expansion of its range has probably happened naturally, as a similar expansion has been observed in other counties, but unofficial releases can't be ruled out entirely. Similarly, Small Blue *Cupido minimus* has been found or re-found at many new sites, belying its reputation as a sedentary species with poor powers of dispersal.

Species that were confined to the extreme west of the county at the end of the 20th Century have continued to expand their distribution eastwards and northwards. White Admiral *Limenitis camilla* and Silver-washed Fritillary *Argynnis paphia* can now be found throughout Kent, and Purple Emperor *Apatura iris* now occurs in many woods in the western half of the county. Marbled White *Melanargia galathea*, Ringlet *Aphantopus hyperantus* and Green Hairstreak *Callophrys rubi* have spread into new areas, and Wall has re-occupied some former parts of its range. The reasons for these increases in distribution are not clear, but the butterflies may have benefitted from changes in climate; certainly, there have not been increases in suitable habitat. There have been similar increases in range of these species on a national scale.

The apparent increase in range of Common Blue *Polyommatus icarus* in the 2015-19 period (Table 2) is almost certainly related to the increased number of records received in that period, and the number of tetrads occupied is similar to that for 1995-99. In reality, many colonies of Common Blue *P. icarus* have been lost to development for housing, industry and transport links, though planting of its larval foodplant, bird's-foot trefoil, alongside new roads and in flower strips on the edges of arable fields may have helped this species. The Common Blue *P. icarus* has been identified within the Kent Biodiversity Strategy as a good indicator species for the health of the wider countryside and also the abundance, connectivity and isolation of flower-rich habitats, particularly within towns (Kent Nature Partnership, 2020).

Colonies of several species of butterfly, including Dingy *Erynnis tages*, Grizzled *Pyrgus malvae*, Silver-spotted Skippers *Hesperia comma*, Dark Green Fritillary *Speyeria aglaja*, Adonis *Polyommatus bellargus* and Chalk Hill Blues *Polyommatus coridon*, have been lost because of changes in habitat, particularly the loss of huge areas of chalk downland to arable farming or to scrub.

Two of the priority species, Heath Fritillary *Melitaea athalia* and Duke of Burgundy *Hamearis lucina*, have increased in numbers and range, thanks to the efforts of conservation organisations and volunteers. Heath Fritillary *M. athalia* has been gradually increasing in numbers and colonising new woods and this continued in 2020 (see Figure 1), with high numbers seen at several sites and a new colony discovered.

Duke of Burgundy *Hamearis lucina* has also been found at new sites, and numbers are at the highest level for some time (see Figure 2). By 2020, there were 13 colonies, with five of them classified medium to large (peak count of nine to 53) and eight small (peak count two to eight). This compares favourably with the early years of this century, when only one site was known for this species and numbers there were low.

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Table 2 Number of tetrads (2km squares) occupied by selected species in different time periods (note that these numbers include parts of Greater London)

Species	2000-04	2005-09	2010-14	2015-19
Silver-spotted Skipper *Hesperia comma*	24	18	17	16
Dingy Skipper *Erynnis tages*	46	59	82	70
Grizzled Skipper *Pyrgus malvae*	34	43	62	53
Green Hairstreak *Callophrys rubi*	54	93	128	136
Small Blue *Cupido minimus*	24	30	31	39
Common Blue *Polyommatus icarus*	483	381	448	643
Adonis Blue *Polyommatus bellargus*	36	43	59	61
Duke of Burgundy *Hamearis lucina*	2	7	9	10
White Admiral *Limenitis camilla*	45	112	139	124
Purple Emperor *Apatura iris*	6	16	29	41
Silver-washed Fritillary *Argynnis paphia*	9	58	108	148
Heath Fritillary *Melitaea athalia*	9	9	12	14
Wall *Lasiommata megera*	140	72	101	122
Marbled White *Melanargia galathea*	132	173	239	378
Ringlet *Aphantopus hyperantus*	179	216	239	423

Adonis blue *Polyommatus bellargus*
© Neil Hulme

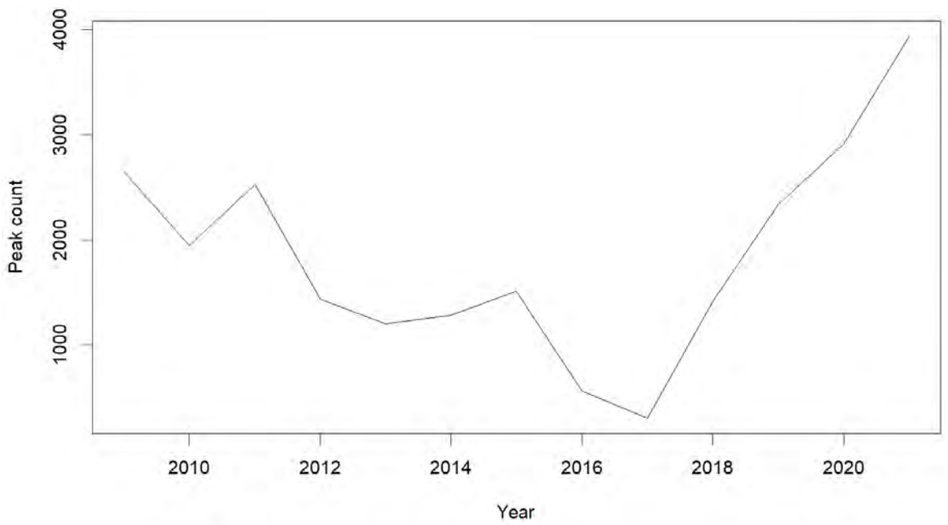

Figure 1 Peak counts of Heath Fritillary in the Blean woodland complex, Kent 2008-2020. Source: Steve Wheatley, Butterfly Conservation

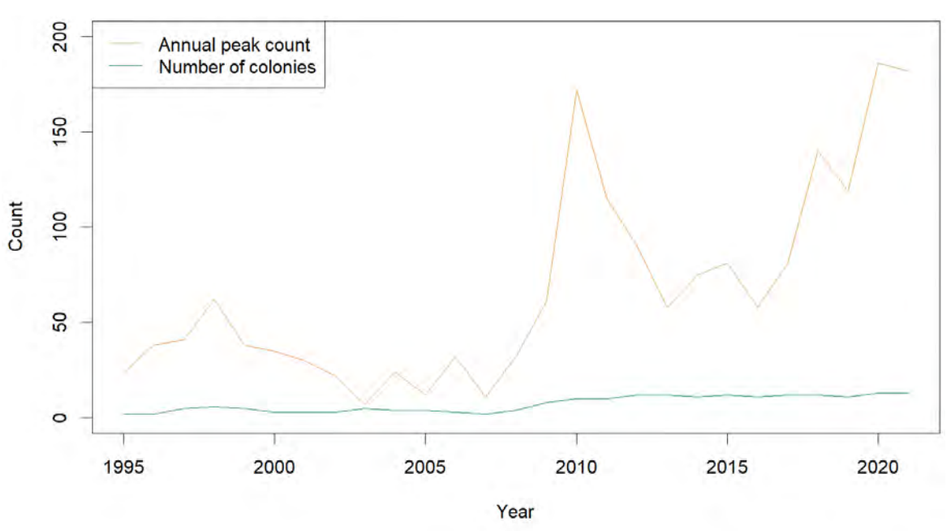

Figure 2 Population of Duke of Burgundy in Kent, orange line shows annual peak count and green line the number of colonies. Source: Dan Tuson, Natural England

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Non-native and invasive species

There has been some temporary, limited-scale breeding by two species from continental Europe, the Long-tailed Blue *Lampides boeticus* and the continental sub-species of Swallowtail *Papilio machaon*; however, there is no evidence of permanent colonisation so far. Long-tailed Blue *L. boeticus*, a non-native species, has bred in Kent on a temporary basis between 2011 and 2021. Breeding of other immigrants, such as the large Tortoiseshell *Nymphalis polychloros* (which bred in Kent at times in the 20th Century), Camberwell Beauty *Nymphalis antiopa* and Queen of Spain Fritillary *Issoria lathonia*, has not been observed. All continental species which breed here occasionally are not considered to be invasive.

Key habitats and their protection

Chalk grassland

The chalk grassland of the North Downs is a key habitat for several species, including Adonis *Polyommatus bellargus*, Chalk Hill Blues *Polyommatus coridon*, Silver-Spotted *Hesperia comma* and Dingy Skippers *Erynnis tages*. These species require larval foodplants that grow only on calcareous soil, such as Horseshoe Vetch *Hippocrepis comosa* and short turf. Key downland reserves, such as Lydden Temple Ewell, Queendown Warren and Fackenden Down, need to be protected and provided with funding to maintain the habitat. The Kent County Council Country Park at Lullingstone is a key site for Dark Green Fritillary *Speyeria aglaja*. More areas of downland need to be given protection to prevent loss or damage from development, intensive agriculture, or lack of management leading to invasion by scrub.

Woodland clearings (lowland mixed broadleaved woodland)

Two of our rarest species, Heath Fritillary *Melitaea athalia* and Duke of Burgundy *Hamearis lucina*, require large clearings in woods where their larval foodplants, respectively Cow-wheat and Cowslip/Primrose, can flourish. When woods were coppiced regularly to produce hop poles, fence posts, etc. this was less of a problem, but as markets for these products declined, coppicing ceased or became too infrequent. This led to woods becoming dense and the foodplants were shaded out. This was also one of the factors that led to the loss of Pearl-bordered Fritillary *Boloria euphrosyne* in Kent.

Coastal and floodplain grazing marsh

The reclaimed marshland of North Kent, particularly on the Hoo Peninsula, has important populations of the uncommon Wall Butterfly *Lasiommata megera*. Also, species such as Common Blue *Polyommatus icarus*, Brown Argus *Aricia agestis* and Small Heath *Coenonympha pamphilus* benefit from the shelter provided by the 'sea wall' alongside the Thames and Medway rivers. These areas need to be protected from development and inappropriate levels of grazing. Water levels need to be regulated carefully.

Lowland meadow

Meadows can provide suitable habitat for many butterflies, including Small Copper *Lycaena phlaeas*, Common Blue *Polyommatus icarus*, Brown Argus *Aricia agestis*, Meadow Brown *Maniola jurtina* and Marbled White *Melanargia galathea*. Large numbers of meadows have been lost to development, or seeded with a monoculture of grasses. Butterflies require larval foodplants to be present, so the greater the diversity of plant species, the higher the number of butterfly species.

Hedgerows

Hedgerows not only provide shelter, enabling butterflies to fly in windy conditions, but they also provide vital nectar sources. They also act as green corridors to facilitate the movement of butterflies around the countryside. They may contain larval foodplants, e.g. Blackthorn *Prunus spinosa* for Brown Hairstreak *Thecla betulae* and Elm for White-letter Hairstreak *Satyrium w-album*, and often have other foodplants growing at their base, such as Hedge Garlic *Alliaria petiolate* for Orange-tip *Anthocharis cardamines*. Many hedgerows have been lost, so those remaining should be protected and the planting of new hedges encouraged.

Silver-washed fritillary *Argynnis paphia*
© Michael Easterbrook

Drivers of change

Habitat loss

The destruction and deterioration of habitats as a result of land-use change (e.g. intensification of agriculture and changing woodland management) are still considered the prime causes of long-term decline among habitat specialist butterflies in the UK (Fox *et al*., 2015). In Kent, there has been substantial loss of chalk grassland due to ploughing and lack of management, which has led to scrubbing over. Direct destruction of hedgerows and woodlands removes habitat for butterflies.

Habitat loss can also occur when there is a change in the management plan. One example is woodlands becoming too shaded as management techniques like coppicing are ceased or reduced.

Due to intensification of agriculture, many areas of arable and grazing land have very low numbers of butterflies. The lack of flowers as nectar sources for adults and foodplants for larvae make these habitats unsuitable for many species. Increased planting of wild flowers as part of environmental stewardship schemes on farms can provide opportunities for some species to colonise.

Unnecessary mowing and strimming of road verges by local councils and private contractors can remove larval foodplants and nectar sources for adults. Sowing of wild flowers alongside roads and minimising the mowing of road verges can provide vital foodplants and nectar sources. Several butterflies have limited powers of dispersal, so can be marooned on islands of suitable habitat. It is critical that future conservation measures are undertaken on a landscape scale to maintain these suitable habitats and enable movement between them.

Climate change

Previous research into the likely impacts of climate change on UK butterflies had suggested that southern and lowland species should generally benefit from warmer conditions and become more numerous and widespread (Fox *et al*., 2015). This could be relevant for species found in Kent that are currently at the northern edge of their range, and therefore may benefit from increased temperature. However, we can no longer assume that southerly-distributed species will necessarily benefit from climate change. The sustained periods of drought and heat, which are likely to increase in Kent due to climate change, can desiccate larval foodplants, especially on thin chalk soils. Another area of concern is the increased likelihood of extreme climatic events such as flooding, which could result in drowning of immature stages. The loss of four species of fritillary butterflies (Marsh


White admiral *Limenitis camilla*
© Michael Easterbrook

Euphydryas aurinia, High Brown *Fabriciana adippe*, Small Pearl-bordered *Boloria selene* and Pearl-bordered *Boloria euphrosyne*) was probably due partly to climate change.

Non-native species

Predator/parasitoid species that have become established in Kent can affect butterfly populations; for example, the Tachinid Fly *Sturmia bella*, which has colonised Kent from continental Europe, is a parasitoid of the pupae of some butterflies. Adults and larvae of Harlequin Ladybird *Harmonia axyridis*, an invasive species, feeds on eggs and caterpillars of butterflies.

Pesticides

Insecticides can have a serious deleterious effect on all stages of butterflies – this can arise from direct spraying or from spray drift. Modern insecticides, such as neonicotinoids, are toxic at extremely low doses. Herbicides can destroy larval foodplants in and alongside fields. Use by councils and private contractors in locations, such as road verges, should be restricted.

Recording, monitoring and research

BC collects huge amounts of data from individual recorders, but also from schemes such as The Garden Butterfly Survey, Big Butterfly Count and Wider Countryside Butterfly Survey (62,000 records in 2019). In addition, transects are walked by volunteers and staff of organisations such as KWT, White Cliffs Countryside Project and RSPB, and these results enable comparisons to be made between numbers of butterflies in different years.

Records are also exchanged with the KMBRC. Heath Fritillary *Melitaea athalia* benefits from monitoring and habitat management by BC regional and national staff, KWT staff, RSPB staff and volunteers from these organisations. Similarly, a project to improve the population of Duke of Burgundy *Hamearis lucina* that was set up by BC in 2007 is now being continued by a group of BC volunteers and coordinated by Natural England and with cooperation from local landowners. Natural England has also liaised with farmers to plant wildflower strips that contain the larval foodplants of this species. The result of these initiatives has been an increase in the number and size of colonies of this butterfly in the last decade.

Adonis Blue *Polyommatus bellargus* butterflies were the subject of a major study, developed by KWT's Nature's Sure Connected project, which examined how to measure connectivity at a landscape scale using connectivity modelling tools and a field survey to validate the model outputs. Field surveys to look for the two species were conducted by volunteers across the landscape area of the North Downs, Kent. Three new locations for Adonis Blue *P. bellargus* were located by this project.

Conclusion

The last decade has seen an improvement in fortunes for several species of butterfly in Kent. The nationally scarce species Heath Fritillary *Melitaea athalia* and Duke of Burgundy *Hamearis lucina* have increased in number and extended their range slightly. This is thanks to the efforts of conservation organisations and their staff, many volunteers, and some private landowners. Other species have increased their range considerably, for reasons that are not clear, but may involve climate change. Brown Hairstreak *Thecla betulae* has colonised Kent from Surrey, but Grayling *Hipparchia semele* is on the brink of extinction in the county.

Although these results paint a favourable picture for butterfly populations, it is unrealistic to some extent, as many colonies of our commoner butterflies have been lost to development for housing, industrial use, new roads, etc. and this seems to be happening at an increasing pace.

The outlook for butterflies in Kent is bleak unless key habitats are protected from development and linked together to enable butterflies to move between them. Funding for habitat management needs to be increased. There is great potential for creating butterfly-friendly areas by planting wild flowers and larval foodplants in places such as road verges, public parks, and as part of housing and industrial developments.

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Silver-spotted skipper *Epargyreus clarus*
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Black-veined moth *Siona lineata*
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KENT'S MOTHS

IAN HUNTER AND DAVE SHENTON, KENT MOTH GROUP

Summary

- Nationally, the abundance of macro moths in the UK has shown a decline of 33% over 50 years. It is greater in the south at 39%. With the more limited data available for micros moths, the abundance shows a similar trend.
- Trends in Kent for all moths show a mixed picture over the last 10 years, but it appears that more species show an increase than a decrease. There are an increasing number of species establishing breeding populations in Kent.
- All key habitats in Kent hold at least one population of nationally important macro or micro moth species.
- It appears that climate change is now the main driver of change for populations of Kent moths. Other factors include land use (including the use of chemicals and eutrophication) and artificial light at night.
- The number of macro moth records received by KMoG has more than doubled over the last five years and now exceeds more than 100,000 records a year. This is partly driven by an increase in interest and also an increase in active data sharing. Historically, there have always been fewer records of micro moths, but these are now increasing faster than the number of macro moth records and now exceed more than 50,000 records per annum.
- BC monitor the more critically endangered/ threatened species in the county and their Kent's Magnificent Moths project began in April 2021. This focuses on a small selection of both macro and micro moth species.

Moth fauna of Kent

Approximately 750 species of macro moth have been recorded in Kent, which includes some very scarce migrants and some now believed to be extinct, representing about 80% of the UK macro moth species. New species continue to be recorded every year in Kent. Kent has important populations of a number of rare moth species, including Straw Belle and Black-veined Moth on the Kent Downs, the principally coastal species Bright Wave and Fiery Clearwing, and Fisher's Estuarine Moth around the Thames Estuary. Kent is currently home to somewhere between 1,300 and 1,400 species of micro moth, the list being in constant flux. The positive news is that many species have been added to this list in the last few years, some of which also represent the first record for the UK.

The early part of the 21st Century has seen a significant rise in interest in micro moths that mirrors that witnessed for macro moths at the end of the last century. The advent of high quality identification guides on micro moths, coupled with a growth in online identification resources, has helped to promote and support this. Previous reports into the state of Kent's moths and indeed national publications on the State of Nature have always focused solely on the larger moths, perhaps for obvious reasons. While the same detailed picture of species gains and losses can't necessarily be portrayed, to exclude the smaller moths completely would seem remiss, especially when it is considered how they constitute almost two thirds of all moth species in the UK. As a result, the Kent Moth Group report covers both macro and micro moths.

Status and trends

Macro moths

A complete review of the UK macro moth population was published by the BC in 2021 (Fox *et al*., 2021). It had access to sufficient data sources to review the distribution and abundance of 427 UK macro moth species. The data held by KMoG does not allow a robust review of Kent macro moth abundance, but it does highlight trends.

The total abundance of macro moths was calculated by BC using the Rothamsted Insect Survey. This indicated that throughout Britain abundance had declined by 33% in 50 years (1968 to 2017). Losses in the southern half of Britain were greater at 39%. The long-term abundance trends for 427 species were calculated. The analysis of long-term abundance is important because populations fluctuate year to year. For instance, at present there appears to be an increase in abundance, but the long-term trend is a decrease. Forty-one per cent (174 species) had a decrease, 10% (42 species) increased, with the remaining 49% (210 species) having trends that did not show statistically significant change. It found that 37% (187 species) had increased in distribution and 32% (165 species) had a decreased distribution. It also showed that Kent has one of the highest number of species-rich (300-548 species) 10km x 10km grid squares in the UK.

The review identified the 30 species of macro moth with the highest rates of decrease in abundance measured over an average 10-year period. Of these, 22 species occur in Kent (shown in Table 1). The changes in the number of individuals reported to KMoG from 2000-2009 compared with 2010-2019 are included in Table 1 as a basic measure.

Table 1 The UK macro moth species that show the highest rates of decrease in abundance measured over an average 10 year period and which also occur in Kent, and the changes in the number of individuals reported to Kent Moth Group from 2000-2009 compared with 2010-2019 and the overall trend in Kent

Species	BC abundance trend	Trend in Kent	No. individuals 2000-2009	No. individuals 2010-2019
Golden Plusia *Polychrysia moneta*	-58%	decrease	11	3
Garden Dart *Euxoa nigricans*	-54%	decrease	112	29
Large Thorn *Ennomos autumnaria*	-53%	decrease	285	182
Oak Lutestring *Cymatophorina diluta*	-52%	slight increase	662	691
Figure of Eight *Diloba caeruleocephala*	-48%	decrease	106	18
Dusky-lemon Sallow *Cirrhia gilvago*	-47%	increase	162	331
Spinach *Eulithis mellinata*	-47%	decrease	173	65
Dusky Thorn *Ennomos fuscantaria*	-45%	increase	552	2208
Double Dart *Graphiphora augur*	-45%	decrease	10	2
Hedge Rustic *Tholera cespitis*	-44%	increase	412	1655
Juniper Pug *Eupithecia pusillata*	-44%	slight increase	28	36
Large Nutmeg *Apamea anceps*	-44%	increase	193	303
Maple Pug *Eupithecia inturbata*	-44%	increase	190	319
Beaded Chestnut *Agrochola lychnidis*	-41%	increase	905	3984
Dot Moth *Melanchra persicariae*	-40%	increase	2594	4712
Dark-barred Twin-spot Carpet *Xanthorhoe ferrugata*	-40%	decrease	557	305
Broad-barred White *Hecatera bicolorata*	-40%	increase	606	1291
White-line Dart *Euxoa tritici*	-39%	increase	1059	14417
Satyr Pug *Eupithecia satyrata*	-38%	decrease	12	2
Lackey *Malacosoma neustria*	-38%	increase	1140	5055
Larch Pug *Eupithecia lariciata*	-38%	decrease	57	33
Broom-tip *Chesias rufata*	-38%	decrease	189	79

It is interesting to note that, even with this raw KMoG data, in Kent 12 of the species displayed in Table 1 show an increase in the later 10-year period. Using solely the KMoG figures, the 10 species with the largest declines are shown in Table 2.

Table 2 The 10 macro moth species with the largest declines in abundance in Kent, in the last two decades, according to Kent Moth Group data

Species	No. individuals 2000-2009	No. individuals 2010-2019	% decrease
Marsh Mallow Moth *Hydraecia osseola*	486	58	88.1%
Alder Kitten *Furcula bicuspis*	267	39	85.4%
Black-veined Moth *Siona lineata**	1369	311	77.7%
Narrow-bordered Five-spot Burnet *Zygaena lonicerae*	2129	506	76.3%
Flame Carpet *Xanthorhoe designata*	580	283	51.7%
Dark-barred Twin-spot Carpet *Xanthorhoe ferrugata*	557	305	45.2%
Little Emerald *Jodis lactearia*	575	327	43.1%
Six-spot Burnet *Zygaena filipendulae*	2238	1283	43%
Grey Pine Carpet *Thera obeliscata*	1071	694	35.2%
Magpie *Abraxas grossulariata*	931	703	24.5%

*Intensive management by Natural England and farming partners using agri-environmental schemes has led to a resurgence in numbers.

Of the 747 species on the KMoG database (including rare vagrants), 139 show a decrease in numbers reported. The 10 species with the greatest increases are all species which have always been common, but they are still large increases (see Table 3).

Table 3 The 10 macro moth species with the largest increases in abundance in Kent, in the last two decades, according to Kent Moth Group data

Species	No. individuals 2000-2009	No. individuals 2010-2019	% increase
Setaceous Hebrew Character *Xestia c-nigrum*	22923	155055	576%
Uncertain *Hoplodrina octogenaria*	7263	41244	467%
Vine's Rustic *Hoplodrina ambigua*	13062	61280	369%
Dark Arches *Apamea monoglypha*	20762	95655	360%
Heart and Dart *Agrotis exclamationis*	31744	112789	320%
Common Footman *Eilema lurideola*	9879	37195	276%
Lunar Underwing *Omphaloscelis lunosa*	16059	50972	217%
Riband Wave *Idaea aversata*	12876	37504	188%
Large Yellow Underwing *Noctua pronuba*	54147	146897	171%
Square-spot Rustic *Xestia xanthographa*	22214	57761	160%

All but Common Footman are considered generalist feeders, favouring open areas such as grassland and gardens. Common Footman feeds on lichens and algae, although it will feed on some hedgerow plants such as Hawthorn. The populations of the Footman group of moths have increased nationally since the introduction of the Clean Air Act (Randle *et al*., 2019).

The UK BAP review 2007 identified 56 priority macro moth species (Butterfly Conservation, 2007) and in 2020, BC highlighted the Great Britain red listed species (Tordoff *et al*., 2020). Pale Shining Brown, Bordered Gothic and Orange Upperwing all used to occur in Kent, but are now thought to be extinct in the UK. The Great Britain Red List species, highlighted by BC in 2020 and occurring in Kent, also included Fisher's Estuarine Moth. The macro moths that occur in Kent and their associated UK BAP and Great Britain Red List species designations are shown in Table 4.

Table 4 Macro moths that occur in Kent and their associated UK BAP and Great Britain Red List species designation

Species	UK BAP priority species	Great Britain Red List species	Species notes
Goat Moth *Cossus cossus*	X		
Fiery Clearwing *Pryopteron chrysidiformis*	X	X	Restricted to Kent.
Forester *Adscita statices*	X		
Bright Wave *Idaea ochrata*	X		Restricted to East Kent.
Chalk Carpet *Scotopteryx bipunctaria*	X		
Drab Looper *Minoa murinata*	X		
Barred Tooth-striped *Trichopteryx polycommata*	X		
Sloe Carpet *Aleucis distinctata*	X		
Black-veined Moth *Siona lineata*	X	X	Restricted to a small number of sites within 7km of Wye in East Kent.
Straw Belle *Aspitates gilvaria*	X	X	Restricted to Kent and one site in Surrey.
Rest Harrow *Aplasta ononaria*	X		UK resident at five sites in Kent – possibly spreading.
Sussex Emerald *Thalera fimbrialis*	X	X	Restricted to East Kent.
Speckled Footman *Coscinia cribraria*	X		Probably only as a migrant.
Clay Fan-foot *Paracolax tristalis*	X		
Common Fan-foot *Pechipogo strigilata*	X		Now restricted to 10 sites in the UK.
Olive Crescent *Trisateles emortualis*	X		
Dark Crimson Underwing *Catocala sponsa*	X		
Light Crimson Underwing *Catocala promissa*	X		
Four-spotted *Tyta luctousa*	X		
Marsh Mallow Moth *Hydraecia osseola*	X	X	Restricted to Kent and the border in Sussex.
Sandhill Rustic *Luperina nickerlii*	X		
Concolorous *Photedes extrema*	X		
Heart Moth *Dicycla oo*	X		Only four sites in UK one of which is in Kent.
White Spot *Hadena albimacula*	X		

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In the UK, the number of moth species (including micro moths) considered extinct since 1900 now stands at 51, which is considerably lower than reported in the previous macro moth assessment in 2013 (63 species) (Fox *et al*., 2013; Fox *et al*., 2021).

With its proximity to the continent, Kent has been at the forefront as new species move northwards and others recolonise. Climate change may have sped this up more recently. Two recent re-colonists are Clifden Nonpareil and Dark Crimson Underwing, both of which are now breeding in Kent after a long gap. It is likely that Light Crimson Underwing will join this revival after an arrival in 2020. One species new to the Kent list is Cryptic Fern; however, it may have been present for some time as it is very similar to the Fern Moth and was not identified until 2019 (Smith & Clancy, 2019). Since then, there have been retrospective records from East Sussex and Kent.

Double figures were recorded in Kent in 2020. Gypsy Moth is a species which used to be confined to wet fenland areas in East Anglia; however, there is a European population which is a more generalist feeder. After an increase in reports from coastal locations in the last decade, there were widespread reports of adults and larvae across Kent in 2020. It is also increasing rapidly in London, possibly due to accidental introductions (Randle *et al*., 2019).

There have been a significant number of new arrivals in Kent which have established breeding populations. Jersey Tiger is now the most reported moth by the general public to KMoG. It was first reported in South London in 2004 and has swept across Kent with a total of 6,149 individuals reported in 2010-2019, compared to 76 in the previous century (Randle *et al*., 2019). Table 5 contains a selection of species which have arrived and established in the last two decades.

Table 5 Macro moth species which have arrived and established in Kent in the last two decades

Species	Individuals 1900-1999	Individuals 2000-2009	Individuals 2010-2019
Tree-lichen Beauty *Cryphia algae*	0	600	3180
Splendid Brocade *Diataraxia splendens* *	0	475	2457
Plumed Fan-foot *Pechipogo plumigeralis*	4	21	1102
Clancy's Rustic *Platyperigea kadenii*	0	236	1093
Beautiful Hook-tip *Laspeyria flexula*	2	26	604
Red-necked Footman *Atolmis rubricollis*	32	148	484
Channel Island Pug *Eupithecia ultimaria*	0	12	418
Golden Twin-spot *Chrysodeixis chalcites*	13	49	410
Four-spotted Footman *Lithosia quadra*	45	61	361
Bloxworth Snout *Hypena obsitalis*	0	2	232
Oak Rustic *Dryobota labecula*	0	0	190
Dusky Hook-tip *Drepana curvatula*	2	9	191
Olive Crescent *Trisateles emortualis*	1	33	154
Black-spotted Chestnut *Conistra rubiginosa*	0	0	39
Four-spotted *Tyta luctousa* ~	1	4	19
Portland Riband Wave *Idaea degeneraria* ~	0	0	11
Pale Shouldered Cloud *Chloantha hyperici* ~	1	1	11
Raspberry Clearwing *Pennisetia hylaeiformis* #	0	0	5

* Very recently declined to less than 10 per year

~ Breeding suspected

Recent increased awareness of field signs and use of pheromones

Micro moths

Proximity to the continent means that Kent is well placed to see both colonisation of new species and recolonisation by those previously lost to Kent's moth fauna. Species include *Caloptilia honoratella*, *Parornix atripalpella*, *Pseudopostega auritella* and *Nemapogon inconditella*. The good news continues, as a growing number of species are also spreading across Kent – and beyond – very rapidly, with some very noticeable and readily identifiable species amongst them, including *Bisigna procerella*, *Metalampra italica*, *Gravitarmata margarotana* and *Catoptria verellus*.

Kent is graced with many rare and threatened species of smaller moth. The diminutive *Stigmella zelleriella*, whose larvae live out their entire life cycle living within and mining the leaves of Creeping Sallow, are known only from Sandwich Bay; their only other known site being The Burren, Ireland. The discovery of what appears to be an already thriving colony of *Pseudopostega auritella* in Kent in 2020 was especially noteworthy, as this was previously known only from a handful of sites in Norfolk and Cambridgeshire. The recent apparent 're-discovery' in the downland of West Kent of the eye-catching *Hypercalia citrinalis* is another encouraging development.

Non-native and invasive species

One major factor responsible for the establishment of non-native insect species in the UK is the global plant trade. The importation of plants (both native species and exotics) into Britain provides a direct pathway for the increasing arrival of new insect species. The Oak Processionary Moth was a scarce migrant to the UK, records being primarily the more mobile males. However, in the mid-2000s it is thought to have been accidentally introduced to London, probably as eggs, on imported Oak trees (Randle *et al*., 2019). Since then, it has spread rapidly. There has also been an increase in immigration activity detected by coastal moth traps. The species can cause allergic reaction in humans and livestock. Initially, pesticides toxic to other moth and butterfly species were widely used to try to control the species. Data from moth recording was used to highlight the risk to other species and to push for less damaging methods of control.

Key habitats and their protection

The very high number of moth species occurring in Kent is partly as a result of the wide variety of habitats within the county and the presence of associated larval foodplants. The particularly valuable habitats include mixed broadleaved woodland, ancient dune systems, vegetated shingle and chalk downland. The important plants include Nottingham Catchfly, Wild Carrot and Hog's Fennel.

Drivers of change

A major review of factors affecting UK moth populations was undertaken by BC in 2021 (Fox *et al*., 2021). It highlighted the following key areas which are relevant to Kent; each can have either negative or positive effects depending on a particular species life cycle:

Land use

Both the destruction of habitats and major changes in management intensity are considered the key drivers of long-term moth declines, particularly those associated with the intensification of agriculture. More sympathetic management (e.g. through agri-environment schemes), often leads to increased abundance and species richness. For example, reduced frequency and intensity of hedgerow cutting in GB agricultural landscapes benefited Lepidoptera communities. Urbanisation is linked to reductions in moth numbers and diversity, particularly the loss of habitat specialist species, but also favours larger, more mobile moths.

Climate change

Substantial effects of climate change on moths, butterflies and other insects are evident – new species have colonised but other studies have found negative climatic impacts on moth abundance and distribution. The extent to which species are able to expand through fragmented British landscapes is limited by habitat availability.

Chemical pollution

Chemical pollution is a much more nuanced situation. Nitrogen enrichment of habitats is expected to affect moths via changes to plant communities, which in some cases might be of benefit, and in others detrimental. The recovery of lichen populations due to air quality improvements has benefitted moth species whose larvae feed on lichen.

Artificial light

Studies are beginning to reveal diverse effects on the growth and phenology of larval food plants and aspects of some species' life cycle e.g. pheromone production and larval growth.

Recording, monitoring and research

The Rothamsted Insect Survey, which covers trends across the UK, is the longest running standardised insect survey in the world. The National Moth Recording Scheme was established in 2007 and is run by BC. This collates data from citizen scientists across the UK, which is validated by a network of volunteer County Moth Recorders, including Ian Hunter for macro moths and Dave Shenton for micro moths in Kent. BC conducts annual surveys for species of conservation concern and publishes these reports. Natural England has led intensive conservation efforts, funded by agri-environment schemes, to create a series of species rich grasslands from intensive farmland using arable reversion and grassland restoration. This is particularly targeted to benefit the critically endangered Black-veined Moth, but also has benefits for other species with the same habitat needs. In 2016, a small group of volunteers established an online platform for the KMoG to encourage the sharing and dissemination of information about moths from the citizen scientists who were collecting data on moths in the county. In 2021, BC obtained funding from the National Lottery Heritage Fund to run a three-year project – Kent's Magnificent Moths – to support the conservation of a target group of species in key environments in East Kent. This project also has a focus on the engagement of the public.

Conclusion

Given that the excellent variety of moth species in Kent relies on the variety of habitats available in the county, it is important to maintain this variety and not just focus on headline catching initiatives, such as tree planting. It is important to maintain effective monitoring of moth populations in Kent as the speed of change seems to be increasing, at least partly due to climate change which will result in the loss of some species and the gain of others. This is important as moths are vital to the functioning of ecosystems, for example being major pollinators of plants and are an important part of food webs. A very small number of particular species of concern is being supported through the Kent's Magnificent Moths project.

It is hoped moth recording and monitoring can continue to go from strength to strength; however, in order to achieve this, more people need to look for and record both macro and micro moths. This review only begins to scratch the surface of the world of Kent's moths, including micros for the first time, and hopefully serves as some encouragement for people to participate in moth recording.

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Great Crested Newt *Triturus cristatus*

KENT'S AMPHIBIANS

MIKE PHILLIPS, KENT REPTILE AND AMPHIBIAN GROUP

Summary

- Kent's native amphibian fauna consists of five species. Of these there are three different newt species and two are frogs and toads; the Common Frog and the Common Toad.
- The Great Crested Newt is a European Protected Species and all other amphibians have partial protection under the Wildlife and Countryside Act. Although trends at a county level are difficult to establish, expert opinion suggests that populations of all of Kent's amphibian species are reasonably stable, though significant losses of all species are likely to have occurred throughout the 20th Century that were primarily linked to the loss of breeding ponds.
- The Marsh Frog has become established in Kent over the last 80 years and the range of the species continues to expand. The impact of the Marsh Frog on native amphibian species is still unclear.
- Amphibians are dependent upon the presence of breeding ponds with suitable terrestrial habitat. Lowering of pond density can result in damaging levels of population fragmentation. The Low Weald has the highest pond density in Kent and is consequently the stronghold of Great Crested Newts.
- The amount of suitable habitat, and particularly suitable breeding ponds, has been the most critical driver of change over the last century. This remains the case, and conservation efforts need to focus on the creation and management of high quality, connected breeding ponds. Disease and climate change also pose considerable threats to amphibian species.
- The KRAG and its partners will continue to focus their efforts on long-term recording projects. These projects will aim to establish changes in the range of each amphibian species, as well as monitor the long-term changes at well-studied sites.

Amphibian fauna of Kent

Great Britain has only six native species of amphibian, with the reintroduced Pool Frog sometimes being classed as a seventh. The number of native amphibian species in countries at similar latitudes around the world is often much higher than in Britain. The formation of the British Isles after the last ice age, the poor dispersal abilities of amphibians and the loss of a land bridge to Europe left Britain with a very low number of species. Consequently, Kent boasts only five native species of amphibian; however, just 20 or so miles away in northern France, it is possible to record three times that number in a single survey session. As the climatic conditions and available habitat are largely similar on the British side of the English Channel, Kent is vulnerable to the release of non-native species, with the Marsh Frog and the Alpine Newt having established viable breeding populations over the last century and continuing to expand their range.

Of the five native species of amphibian in Kent, two are frogs and toads, and three are newts. They are the Common Frog, the Common Toad, the Smooth Newt, the Palmate Newt and the Great Crested Newt. The Great Crested Newt has European Protected Species status and the Common Toad is on England's list of species of principal importance. The Natterjack Toad became extinct in Kent in the 1960s and native Pool Frogs have never been recorded in the county.

Status and trends

Although the recording effort of amphibians in Kent has been extensive, amphibians are cryptic animals and unless formal survey work takes place, most species are rarely recorded. During the breeding season, amphibians congregate at ponds and so may be relatively easy to record; at other times they are rarely encountered. Consequently, getting a full understanding of the conservation status of amphibians in Kent can be problematic. The occupancy rates for each species (Table 1) show that the Common Frog is the most widespread amphibian species, with the Palmate Newt having a range that is more restricted than the introduced Marsh Frog.

There is little evidence to support significant changes in the range of Kent's five native amphibian species over the last century. Kent surveys have not been designed to quantify changes in populations of the native species, though general trends of habitat loss across the 20th Century suggest that populations have declined over this time period. As pond loss slowed at the end of the 20th Century and survey effort increased, there have been several assessments made of the percentage of ponds occupied nationally by different amphibians (Table 2). Pond occupancy has remained relatively stable over this period, but pond occupancy is not necessarily a proxy for population size. Research suggests that the percentage of ponds occupied by newts in Kent is significantly higher than those shown in Table 2. For example, it has been estimated that 44% of ponds in Kent are occupied by Great Crested Newts, with 32% of ponds suitable for breeding (Lee Brady, pers. comm.).

Table 1 Occupancy of the 4,365 kilometre squares of the vice counties East and West Kent by amphibian species, including a correction for survey effort

Species	Occupied km squares	% squares occupied	% occupancy controlled for survey effort
Common Frog *Rana temporaria*	965	22.1	35.3
Common Toad *Bufo bufo*	698	15.9	25.5
Great Crested Newt *Triturus cristatus*	589	13.4	21.5
Palmate Newt *Lissotriton helveticus*	290	6.6	10.6
Smooth Newt *Lissotriton vulgaris*	776	17.7	28.4
Marsh Frog (non-native) *Pelophylax ridibundus*	291	6.6	10.6

The status of Kent's amphibians is very strongly linked to the number of ponds that can be used for breeding. Although a wide range of ponds can be used by different species, there is a need for these ponds to be surrounded by habitat suitable for the terrestrial phase of amphibians. As pond loss has been so significant over the 20th Century, it can be assumed that the size of Kent's amphibian populations has mirrored these declines. There are, however, factors that impact the conservation status of each species which will be outlined in the following paragraphs.

The Common Toad, Common Frog and Smooth Newt are found throughout Kent where habitat is suitable, though in areas of low pond density, such as the chalky areas of the North Downs, their populations are often small and largely isolated. The status of Common Frogs appears to depend largely on the number of small ponds available that are free of fish and newts. Their strategy of breeding early in the season allows them to use small ponds that have a tendency to desiccate early in the year. Consequently, Common Frogs are doing increasingly well in urban areas where small garden ponds are popular, but they are often absent from ponds in the wider countryside that are larger and may have been colonised by fish and newts that predate heavily on frogspawn and render attempts to breed unsuccessful.

Conversely, Common Toads tend to favour large ponds and can co-exist with fish as bufotoxins found in their skin makes them unpalatable. Large populations may be found at single ponds and the loss of certain ponds can be particularly damaging to local populations. The Toad Patrol Project in Kent is monitoring toad numbers at specific sites in the county, and although numbers of toads at most sites have declined over the last eight years of the study, it is still too early to tell whether these declines represent cyclical changes or a more permanent loss.

Table 2 Percentage pond occupancy for native species in Great Britain

Species	Common Frog	Common Toad	Great Crested Newt	Smooth Newt	Palmate Newt
Pond occupancy (%) Swan & Oldham (1993)	52	30	11	22	11
Pond occupancy (%) NARRS 2007 – 2009	60	33	13	26	30
Pond occupancy (%) NARRS 2007 - 2012	60	33	12	28	27

Source: Wilkinson and Arnell, 2012

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Smooth Newts and Palmate Newts are similar in size and life history. They frequently occupy the same ponds that are usually fish-free; however, Palmate Newts are more tolerant of acidic conditions (Brady & Griffiths, 1995) and consequently, Palmate Newts are more often found in woodland ponds. An analysis of Palmate Newt observations in Kent has shown that it is absent from areas that are not heavily wooded, such as Dungeness, Thanet and Sheppey. Studies in the Blean (Kent's most wooded area) have shown many ponds are only occupied by Palmate Newts despite both Smooth Newts and Great Crested Newts being regularly encountered on the margins of the woodland complex.

Great Crested Newt conservation status is most influenced by the density of rural ponds. As the Low Weald has very high pond density, it is one of the most important Great Crested Newt areas anywhere within its range. Great Crested Newts are largely absent from areas with low pond density such as Thanet and the North Downs. Pond loss and neglect have been associated with major declines in Great Crested Newt populations throughout the 20th Century, to which both European and UK authorities have responded with legislation to protect both the newts and their habitats. The future status of the Great Crested Newt in Kent is likely to go hand in hand with pond creation schemes throughout the range of the species.

The historical range of the Natterjack Toad in Kent is not well understood, though elsewhere in Britain and where it occurs in Northern France the species prefers sand dune, salt marsh and heathland habitats. These habitats are not common in Kent and coastal defence work during the 20th Century, coupled with the loss of heathland, has resulted in there being very little suitable habitat. A reintroduction of Natterjack Toads that took place in Kent just over 10 years ago appears not to have been successful, although breeding did take place.

Non-native and invasive species

Since the Marsh Frog's introduction to Stone-in-Oxney in 1936, their range has continued to expand. They had become well established on Romney Marsh, Isle of Sheppey, Hoo Peninsula and at Stodmarsh by 2000, but they have increasingly been recorded further to the west of Kent, throughout the Lower Stour and the North Kent Marshes in the last 20 years. This expansion in range is shown in Figure 1. The range of Marsh Frogs is likely to increase further in the next 10 years. Pool Frogs were once native to Britain, but were presumed extinct in 1995 and were thereafter reintroduced to Britain. Edible Frogs are a hybrid of Pool and Marsh Frogs and all three are part of the green frog complex. There have been no confirmed records of Pool or Edible Frogs in the last 10 years, though introduced individuals have been recorded in Kent in the past. It is, however, difficult to distinguish between members of the green frog complex, so it is likely that some Pool Frogs and Edible Frogs are still present.

There have been isolated records of Alpine Newts in Whitstable and Dartford in 2014 and 2015 respectively, and a population in Tyler Hill and Canterbury (also recorded in 2015). Somewhat surprisingly, however, no further sightings of Alpine Newts have been received since. Although the species has become well established in isolated populations in Kent, there are few signs of significant range expansion in the last 10 years.

American Bullfrogs are likely to have been fully eliminated following an eradication programme set up by Natural England. The last confirmed record of an American Bullfrog in Kent was in 2000.

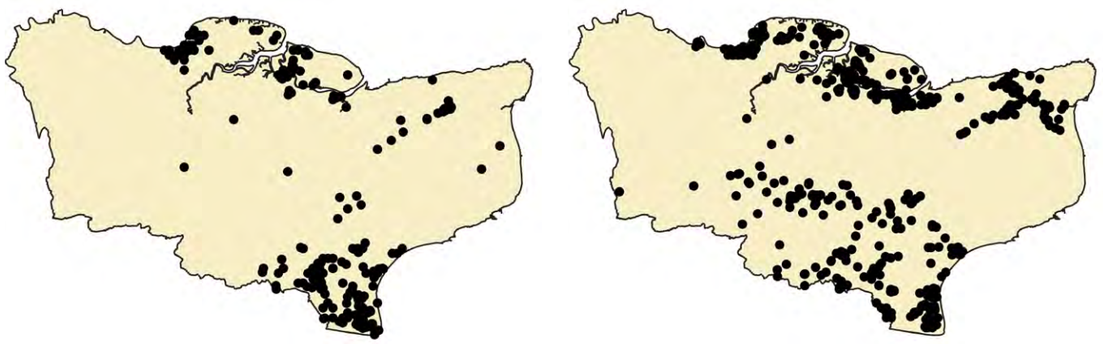
American bullfrog
Lithobates catesbeianus

Key habitats and their protection

Amphibians require habitat that provides foraging, shelter and breeding opportunities. There are three key components to high quality amphibian habitat:

Breeding habitat – The Kent Biodiversity Strategy mentions ponds as a key habitat for the county, and a high pond density with good water quality (preferably fish-free) will greatly improve amphibian breeding opportunities. Amphibians have also been known to breed in larger lakes (particularly Common Toads), canals, drainage ditches and sometimes even wheel ruts and temporary ponds that desiccate by late spring.

Terrestrial habitat – Of equal importance, for forage and shelter, is good quality, structurally complex vegetation, both surrounding and linking ponds together.



Up to 2000

2001 onwards

Figure 1 Marsh frog distribution in Kent up to 2000 and from 2001 onwards

A connected landscape – In an increasingly fragmented, human dominated landscape, amphibian populations can become isolated, less resilient and ultimately vulnerable to extinction without ponds connected with high quality habitat, allowing movement between breeding ponds.

The Low Weald has one of the highest pond densities in England and this is highlighted by the designation of the Wealden Great Crested Newt Important Area for Ponds by the Freshwater Habitats Trust (Keeble, 2007). With its lowland meadows (foraging), wet woodland (hibernation and foraging) and hedgerows (connectivity and foraging) – all key habitats for Kent – the Low Weald is justifiably the highest priority for amphibian conservation within the county, especially for Great Crested Newts that are particularly favoured by high pond density.

Within anthropogenic habitats, the promotion and building of fish-free ponds in gardens and community areas should also be a priority, to ensure that amphibian species remain a part of our living environment.

Drivers of change

Habitat loss

In the 20th Century, up to 80% of lowland ponds may have been lost either due to neglect or filling in. As ponds are an essential part of an amphibian's habitat, these losses are generally accepted to have been the main driver of losses in amphibian populations in modern times. Although some evidence suggests that these reverses have been halted (Williams, 2007) and pond numbers may have even increased in places, pond densities are still much lower than historic levels. The current best estimate of the number of ponds in Kent is 18,000, not including most of those found in gardens. Whilst ponds are still being lost due to changes in agricultural practices and through development, ponds are also being created in Kent. The increasing popularity of wildlife ponds in gardens is believed to be particularly beneficial for Common Frogs and Smooth Newts. Loss of good quality habitat near ponds, or the creation of good quality ponds without terrestrial habitat, can negatively impact all amphibian species. These losses are driven by high intensity farming and often by a desire for neatness in public areas.

Habitat degradation

Good quality amphibian habitats can become lost either through neglect or through unsympathetic management. Lack of knowledge of amphibian populations may result in barriers to dispersal being placed in the way of migrating populations. Common Toads make long distance migrations and are thus particularly vulnerable to road building and other development projects. Unsympathetic management of ponds and terrestrial habitat can render them unsuitable for amphibians. Again, this can often happen due to a lack of understanding of amphibian populations and the use of conservation goals that are not compatible with the needs of amphibians. This can include, but is not limited to, introducing fish or wildfowl to a pond, managing the terrestrial habitat of a pond as a wildflower meadow and cutting or grazing during the active season, or the removal of vegetation from a pond. Management plans informed by an understanding of the needs of amphibian populations can help to alleviate this driver for change.

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Habitat fragmentation

Amphibians have relatively poor powers of dispersal. As a consequence of this, amphibian populations are particularly vulnerable to becoming isolated from one another because of relatively minor barriers that prevent populations mixing. The more isolated populations become, the more vulnerable they are to extinction. Fragmentation may happen for a number of reasons, including housing development, changes in farming practices, and management of terrestrial habitat that limits the ability of populations to migrate. Due to the crucial role that ponds play in the amphibian life cycle, the loss of just a single, critical breeding pond can impact multiple surrounding populations and potentially render them unviable. A better understanding is needed of the important role of well-functioning metapopulations, particularly for Great Crested Newts, and how development, farming practices and management of nature reserves can significantly impact amphibians. Since the Lawton Report (Lawton, 2010) was published, there are signs that the connectedness of wildlife habitats is being taken more seriously.

Government policy

The 25 Year Environment Plan outlines the government's approach to declining biodiversity. There are, however, two issues that are likely to impact the health of amphibian populations over the next 10 years. The first is the role of agri-environment schemes. Currently, farmers and landowners have a number of options to help improve habitats for amphibians, including payments to create ponds, plant and manage hedgerows, and leave rough grass buffer strips. These schemes will be replaced by the ELM scheme and while the exact incentives that will be offered to land managers are not yet established, it is hoped that there will be additional opportunities for wildlife habitat creation. The success of these schemes for amphibians will depend upon good quality advice being given to farmers and other land managers.

Secondly, development mitigation can result in the creation of new ponds and the Great Crested Newt District Level Licensing Scheme that was launched in Kent in 2019 is creating new ponds across the county. The impact of District Level Licensing on Great Crested Newts is yet to be established, but it could impact both the number of breeding ponds and hence the range of the species. Another change that may impact amphibian populations is the introduction of Biodiversity Net Gain. This is due to be introduced as part of the recently passed Environment Bill, 2020. This will require developments to result in a net gain of habitat, resulting in better quality habitat within development sites or opportunities to mitigate off site on high quality amphibian sites.

Climate change

There is no full understanding of how human induced climate change will impact Kent's weather in the future; many studies suggest that there will be warmer, wetter winters. Although more research is needed, Griffiths *et al*. (2010) suggests, somewhat counter-intuitively, that amphibian populations decline and animal health deteriorates under these conditions. It is thought that warm winters compromise the ability of amphibians to hibernate effectively, and that flooding of animals when they are becoming more active may even cause mortalities. Hotter, drier summers may cause the desiccation of ponds earlier in the year and lead to breeding failures. This is more likely to affect newt populations that have a more protracted breeding season. Research by Dunford and Berry (2012), based on modelling of British species in different climate change scenarios, suggests that significant losses of Smooth Newt, Common Frog and Great Crested Newt could be expected in Kent by 2080, even in low emission scenarios. Whilst Palmate Newts and Common Toads are predicted to have fairly stable populations under low emission scenarios, under high emission scenarios losses can also be expected for these species. There is concern over the status of Common Toads, as the declining body conditions of female toads (thought to be a consequence of warmer winters) has limited reproductive output, as evidenced by Reading and Clarke (1995), amongst others.

Non-native species and disease

The impact of non-native species is not fully understood, but there are likely to be pressures on native populations caused by the ever-expanding range and size of Marsh Frog populations, as well as the persisting Alpine Newt populations in the Canterbury area. What has been established, however, is that non-native species can be carriers of disease, making introductions potentially dangerous for other reasons. In the last 10 years, significant concern has been voiced over the discovery of the fungi *Batrachochytrium dendrobatidis* and *Batrachochytrium salamandrivorans*, which cause the disease chytridiomycosis. This disease has caused mass mortalities of amphibians across the world and in Europe. Although detected in multiple species in Britain, no mass mortalities have yet been suffered; however, the ongoing threat of diseases of this nature can't be underestimated. It also highlights the need for good bio-security and to minimise the movement of animals.

Public awareness

The impact of actions by the public can be complex. Inadvertent damage can be done to amphibian populations through the introduction of fish into ponds or the introduction of disease (particularly ranavirus or red leg in Common Frogs) caused by moving frog spawn from one pond to another. However, public awareness of amphibians and how people can take simple steps to aid their conservation status is greater now than it has ever been. The KWT Wild About Gardens project and other similar initiatives have dramatically increased not only the number of fish-free ponds in gardens, but the quality of the terrestrial habitat available for amphibians that choose to breed in those ponds.

Recording, monitoring and research

KRAG runs two long-term amphibian recording projects that are dependent upon volunteer effort. The first is the Great Crested Newt Monitoring Project, which was initiated in 2004 and has trained volunteers in amphibian survey techniques on an annual basis ever since. This project has generated 6,348 amphibian records, including 974 Great Crested Newt records. The second is the Kent Toad Patrol, and although the primary aim of this project is to prevent toad mortalities on roads during their springtime migration, the project also generates a significant number of records. These records are from the same sites every year, producing some significant longitudinal data sets.

The Durrell Institute of Conservation and Ecology at the University of Kent also conducts significant amounts of recording and research. The long-term study of Great Crested Newts at the field site in Canterbury has now been running for more than 20 years and has contributed to significant advances in the understanding of newt ecology.

Conclusion

The distribution and status of Kent's amphibians is better known now than ever before. Awareness and knowledge of the needs of amphibians in terms of habitat creation and management, as well as the need for good biosecurity, is also unprecedented. This provides a strong basis for the future conservation of amphibians at a landscape scale. However, the uncertainties around the future of farming in a post-Brexit environment, uncertainties over the protected status of the Great Crested Newt, and the continued pressure placed on Kent's landscape by development, all cast an uncertain shadow over the future of amphibians in the county. With amphibians considered to be particularly vulnerable to environmental degradation, the need to prioritise their conservation at strategic and practical levels is as essential in 2021 as it has ever been.

Amphibian Recorders

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Male adder *Vipera berus* © Rick Hodges

KENT'S REPTILES

RICK HODGES, KENT REPTILE AND AMPHIBIAN GROUP

Summary

- Kent's native reptile fauna includes two snakes, the Grass Snake and Adder, and two lizards, the Viviparous Lizard and the Slow Worm. Sand lizards have been reintroduced into Kent following extinction in the late 1960s.
- Expert opinion suggests that all four native species are in decline, although all have partial protection under the Wildlife and Countryside Act. Of most concern is the Adder, which is thought to be in more urgent need of new conservation efforts than any other British reptile.
- Non-native species include the Wall Lizard, which has breeding populations at several locations in Kent. Terrapins have also been found in various water bodies, but without evidence of reproduction.
- Kent's reptiles use a range of habitats, of which chalk grassland and its associated low scrub is particularly important. While areas of chalk grassland are often wildlife reserves, reptile populations may still be threatened by unsympathetic management. Brownfield sites are important, but sometimes overlooked as reptile habitats.
- Habitat loss and fragmentation are currently the most significant drivers of change; however, the first evidence of the negative impacts of climate change – especially for Adders and possibly also Slow Worms – is beginning to emerge.
- The KRAG has an extensive database of reptile records that are shared with local and national recording bodies. Among KRAG's reptile conservation projects is a long-term monitoring programme on the North Downs to assess the impacts of climate on Adder populations.

Reptile fauna of Kent

Only six of Europe's 150+ reptile species are native to Britain (Beebee & Griffiths, 2000; Inns, 2009). Of these six species, four have a widespread distribution, and it is these four that are found naturally in Kent. They include two species of snake, the Grass Snake and Adder, and two species of lizard, the Slow Worm and Viviparous Lizard. The Grass Snake found in Britain has recently been promoted from a sub-species *(Natrix natrix helvetica)* to a full species *(Natrix helvetica)*; it has a western European distribution. Female Grass Snakes lay eggs, while Kent's three other native reptiles bear live young. The Adder and the Viviparous Lizard have the distinction of being the most northerly distributed reptiles, with populations ranging north of the Arctic Circle. Although reptile biodiversity may be low in Britain, reptile population densities may be higher than in central Europe owing to the climatic benefits of the Gulf Stream. In the 1960s, one reptile species, the Sand Lizard, is believed to have become extinct in Kent. A reintroduction programme (2004 to 2006) established a population of Sand Lizards in a dune system in East Kent where the species was last observed in 2018 and may still persist.

Status and trends

Assessing the status and trends for reptile populations is hampered by the fact that they are secretive and cryptic, and is constrained by factors that limit detectability (e.g. inclement weather). Nevertheless, expert opinion considers that all Britain's widespread reptile species are experiencing declines. The occupancy rates for the two lizard species in Kent are very similar (Table 1), while the two snake species are quite different, with Adders apparently far more restricted in range. It is estimated that 25% of monads (km squares) are considered to offer above average suitability for Adders, but the species has only been recorded from 8.6% (Table 1).

Table 1 Occupancy of the 4,365 kilometre squares of the Vice Counties East and West Kent by reptile species, including a correction for survey effort

Species	Occupied km squares	% Squares occupied	% Occupancy controlled for survey effort
Slow Worm *Anguis fragilis*	926	21.2	33.9
Viviparous Lizard *Zootoca vivipara*	1026	23.4	37.5
Grass Snake *Natrix helvetica*	873	19.9	31.9
Adder *Vipera berus*	237	5.4	8.6

Adder

In 2011, an Adder-focused conference in Chatham, attended by more than 100 reptile conservationists, issued a press release stating that, "The Adder is in more urgent need of new conservation efforts than any other reptile or amphibian species in Britain." Nationally, there is evidence of a considerable decline in Adder distribution. In the period 1980 to 2005, 15,154 monads were recorded as occupied

by the species. Between 2006 and 2011, this fell to 9,237, which amounts to a potential decline of 39% (Gleed-Owen & Langham, 2012). A national long-term surveillance project, 'Make the Adder Count', found that sites with small populations (peak counts < 10 individuals) declined by 55% over the 11-year period 2005 to 2016. By contrast, sites with large populations (site with mean peak counts > 10) on average showed a 33% increase over the same period (Gardner *et al.,* 2019). If these trends are representative of Britain as a whole, then within 15 to 20 years Adders will become restricted to just a few sites with large populations (Julian & Hodges, 2019). This already appears to be the case in Belgium and the Netherlands, and without intervention, in Britain the Adder could become a rare species flourishing in just a few areas.

In Kent, the Adder is highly localised with populations centred on areas of high quality habitat. Typically, such areas are found in or close to woodland and/or scrub, with many of Kent's Adder populations restricted to areas of chalk grassland and scrub along the North Downs. Healthy Adder populations may consist of only five or six adults per hectare. However, a combination of factors results in Adder populations responding only slowly to improvements in habitat conditions; these include low population densities, slow onset of sexual maturity (taking four or five years), and female Adders reproducing only every second or third year. Fortunately, Adders are relatively long-lived, and in favourable conditions have been recorded surviving to 30 or more years. The Adder is a priority species in the Kent Biodiversity Strategy.


Male blue spotted slow worm *Anguis fragilis*
© Rick Hodges

Grass Snake

Encounter rates with this species appear to be higher in areas close to freshwater, and ponds in particular are important habitat features. However, Grass Snakes also forage up to several kilometres from moist habitats. They occupy a wide range of different habitats and some individuals may even spend significant amounts of time in arable fields (within the crop, not just field margins). Their need to lay eggs may limit some Grass Snake populations if there is poor access to egg laying sites, such as manure heaps. Increased populations of non-native amphibian species, such as the Marsh Frog, may have increased Grass Snake populations locally.


Grass snake *Natrix natrix*
© Rick Hodges

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Common Lizard *Zootoca vivipara*
© The Wildlife Trusts

Slow Worm

Being semi-fossorial, Slow Worms prefer habitats with previously disturbed ground (e.g. gardens, old allotments, and brownfield sites) and appear to be less frequently encountered in areas that are subject to regular flooding (e.g. Romney Marsh). Population estimates at favourable sites have revealed densities of more than 2,000 Slow Worms per hectare. Although population levels within the wider countryside are generally considered to be lower, with sympathetic management, populations can become very high. At one site in East Kent, more than 130 slow worms were observed in a single survey session from a 1.5 ha area of chalk grassland where sheep grazing had been suspended for seven years.

Viviparous Lizard (or Common Lizard)

This species uses a wide variety of habitats, typically very sunny locations on chalk grassland, heathland, woodland edges and larger gardens. Brownfield sites are also frequently occupied and population estimates at such sites have revealed densities of more than 500 Viviparous Lizards per hectare. Detailed observations of Viviparous Lizard populations in Kent suggest that individuals typically reach sexual maturity within a year of birth and reproduce the following season. In suitable habitat, populations can therefore increase rapidly. As the quality of a site declines (e.g. due to decreased complexity of the sward caused by increased grazing pressure), populations can also decline rapidly. In such situations, Viviparous Lizards may appear to become 'edge species', occupying areas of rough vegetation along hedgerows, roadsides, etc.

Non-native and invasive species

In Kent, the Wall Lizard was first recorded in 1996 in Folkestone. Subsequently, the species has expanded its range to Folkestone Warren, Ospringe (near Faversham), and areas of Rochester. There are many sightings of Red-eared Terrapin from ponds and lakes in urban parks and other sites, and The Turtle Tally, a national citizen science project initiated in 2019, has received six Kent records of Red-eared Terrapins. There is no evidence that these species can reproduce in Britain, but as these turtles may live for 40 years it is likely that the same individuals may be recorded many times. At the time of writing, neither Wall Lizards nor Red-eared Terrapins are considered invasive, but they could become so quite rapidly if our climate becomes warmer.

Table 2 Habitat types in Kent showing the number of 'Key Reptile Sites' that have been designated[1] for each habitat and the number of sites in which Kent's native reptile species[2] can be found

Habitats	No. sites	Number of sites with Adder	Number of sites with Grass Snake	Number of sites with Viviparous Lizard	Number of sites with Slow Worm
Chalk grassland & scrub ± deciduous woodland	24	18	15	23	23
Deciduous woodland	12	6	11	11	11
Lowland heath and acid grassland ± deciduous woodland	8	4	7	8	8
Rough grassland, scrub and meadow	8	3	7	7	8
Allotment	1	0	1	1	1
Ancient woodland	1	0	1	1	1
Riparian	1	0	1	1	1
Sand dunes	1	0	1	1	1
Totals	56	31	44	53	54

[1] for designation methodology see KRAG 'Key site Register' https://kentarg.org/project/key-site-register/#03
[2] Excluding the Sand Lizard which is a reintroduction

Key habitats and their protection

Reptiles occupy at least eight habitat types in Kent, within which there are designated 'Key Reptile Sites' (Table 2). Anthropogenic habitats that may support significant reptile populations are mostly missing from Table 2; these include railway and roadside embankments, gardens, allotments, and brownfield sites, which are often characterised by a structurally complex vegetation sward that covers a topographically diverse ground strewn with debris (e.g. bricks, tyres, wooden posts, etc.). These areas often provide vital refuges for reptiles in our living landscape. Nearly all the designated sites include Slow Worms and Viviparous Lizards, 79% have Grass Snakes, while only 55% have Adders. Adders are particularly prevalent in chalk grassland, while Grass Snakes are more widely spread, appearing in all the defined habitat types. Chalk grassland has the greatest number of designated key sites, and although these sites tend to be wildlife reserves, they are still vulnerable to unsympathetic management. In particular, it is generally acknowledged that on chalk grassland, reptiles require a mosaic made up of open areas and at least 15% low scrub, and if there is livestock grazing then it needs to be extensive and confined to October to February, when reptiles are relatively inactive (Edgar *et al.*, 2010).

Female adder *Vipera berus* © Rick Hodges

Drivers of change

Habitat loss

Currently, the greatest threat to Kent's reptiles is direct loss of habitat through changes in land use; this includes the development of brownfield sites, which may have been derelict for many years, but often support good populations of Viviparous Lizard and Slow Worm. Pre-development work frequently includes the capture and translocation of many hundreds of individual animals to receptor sites. Work undertaken by ecological consultants has revealed that such projects can succeed in establishing new populations – at least in the short term. However, translocation projects are often poorly monitored and insufficient data is available to determine long-term population trends at receptor locations. Increasing pressure from agriculture and development will continue to impact on available habitat and lead to increased habitat fragmentation.

Habitat fragmentation

Reptiles require a range of different habitat features, including hibernation sites, areas for foraging and for basking, egg laying substrate, sheltering vegetation and refuges. Such habitat features may be scarce resources and may only be found across several 'sites' with individual animals having to move between them. The poor dispersal capabilities of reptiles result in the relatively slow colonisation of new habitat, and sites that are isolated by significant dispersal barriers (e.g. major roads, large arable fields etc.) may never be colonised or, following extirpation, never recolonised.

Land use

Reptile populations may be lost when either their presence or their habitat requirements are neglected in land management decisions. At one well-studied, but isolated, site close to Maidstone, a neglected Viviparous Lizard population disappeared due to unsympathetic management. Subsequent changes in the management regime resulted in a significant improvement to reptile habitat, but natural recolonisation was prevented by the surrounding dispersal barriers so that lizards had to be reintroduced. This demonstrates that simply reversing unsympathetic management practices may not be enough to result in natural recolonization. A common example of neglected habitat features are the winter time subterranean shelters (hibernacula) used by groups of Adders.

These hibernacula are critically important, yet their specific locations may not be known to land managers. Unsympathetic management of habitat around hibernacula can result in increased shading (e.g. tree planting in forestry plantations), or at the other extreme, excessive vegetation clearance may increase the detectability of Adders to predators during the spring 'lying out' period.

In recent years, specific advice on land management for reptiles has become more freely available (e.g. Edgar et al., 2010; Julian & Hand, 2018). It is notable that lizard and Adder populations prey upon invertebrates and small mammals that favour structurally complex vegetation swards, and that a visual appearance of 'abandonment' and 'neglect' often indicates the mid-successional scrub dominated habitat that is so important for viable reptile populations. For the future, the ELMS may present an opportunity to create structurally diverse habitat mosaics within the agricultural landscape.

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This is something that Countryside Stewardship and other agri-environment schemes rarely achieved, except as an unintended consequence of options designed to enhance habitats for other species groups.

Climate change

Now that British summers are becoming hotter and drier, and winters wetter and warmer, the first evidence of a serious threat to reptiles is beginning to emerge. For reptiles, both changes potentially lead to loss of body condition. Greater desiccation in drier summers may limit food supply and, in order to conserve water, will enforce periods of inactivity. During winter, warmer temperatures (>8°C) may be high enough for reptile bodies to remain physiologically active and thereby consume bodily reserves without the opportunity of replenishment by feeding. The potential impacts of climate change on British reptiles have been assessed by climate envelope modelling. In a low emissions scenario (+2C by 2080), those Kent species with a distribution extending into southern Europe, for example the Slow Worm and Grass Snake, at least in theory stand to gain as conditions will become more favourable. For those species with only a more northerly distribution (or restricted to higher altitude in the south) such as the Adder and Viviparous Lizard, the expectation is of a largely negative impact. Figure 1 shows the contrast between a species with a southerly distribution (Slow Worm) and one with a northerly distribution (Adder). The negative Adder scenario has some credibility, as at the southern edge of the Adder's range (e.g. Germany) the species is considered to be associated with wet heaths, and in otherwise dry areas can only exist where there is some standing water. Furthermore, on-going long-term Adder monitoring on the North Downs has detected population declines in habitats more prone to desiccation. In particular, dry habitats, the construction of ponds or the facilitation of easy access to cattle drinking troughs may be of significant benefit to Adders. The predictions of the model for the Slow Worm (Figure 1) seem less convincing, since long-term monitoring on the North Downs suggests that drier springs and/or summers are unfavourable for Slow Worms, since they rely on mollusc prey that are particularly vulnerable to desiccation. In contrast, the recent hotter, drier conditions on the North Downs appear to have been favourable for Viviparous Lizards, the opposite of model expectation for a northerly species.

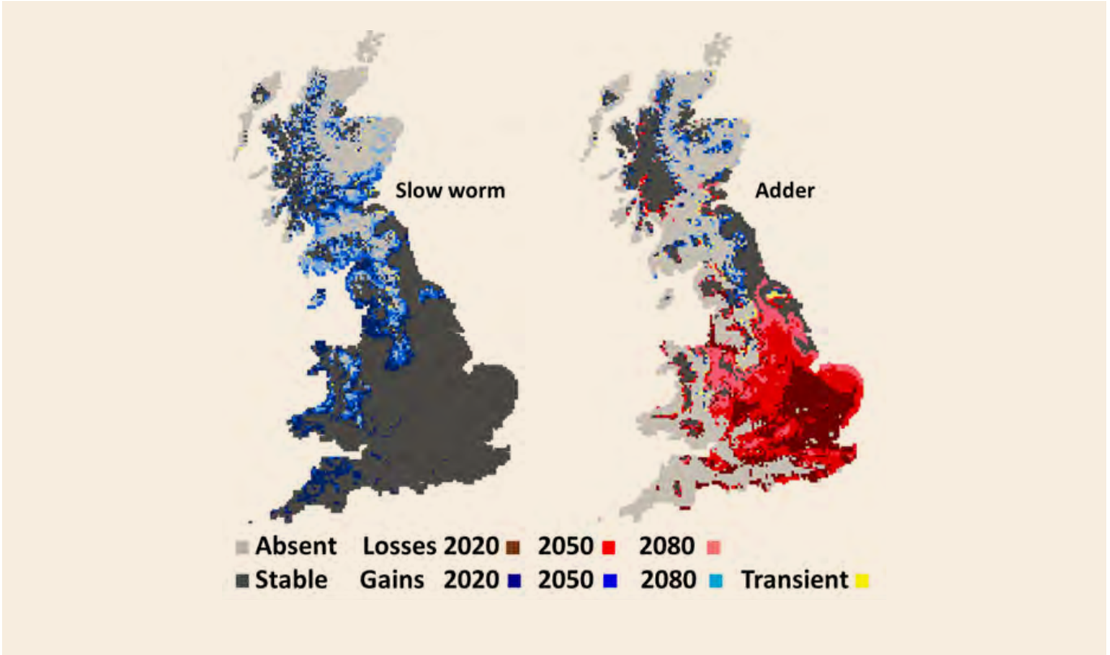


Figure 1: Climate envelope model predictions of changes in British reptile distributions under a low emissions scenario (+2°C by 2080). The Slow Worm (left) has a stable or expanding distribution, while the Adder (right) shows mostly distribution losses. Source: Reproduced from Dunford & Berry, 2012 with kind permission of ARC Trust

Human pressure / disturbance / persecution

Significant attempts have been made in recent years to raise awareness of reptiles amongst conservation practitioners and the general public; however, pressure on reptile habitats will only continue to increase. Fortunately, some human activities can actually benefit reptiles, for example the rising interest in composting provides opportunities for Slow Worm and Grass Snake. Engendering public sympathy for reptiles, and Adders in particular, is important. Warning signs are often expressed in terms that encourage dislike and fear, e.g. 'Beware Adders!', however, they could be reimagined in terms that encourage respect and appreciation, e.g. 'Adders need peace and quiet too! Please stay on the path and keep your dog on a lead.' (Julian & Hodges, 2019).

Disease

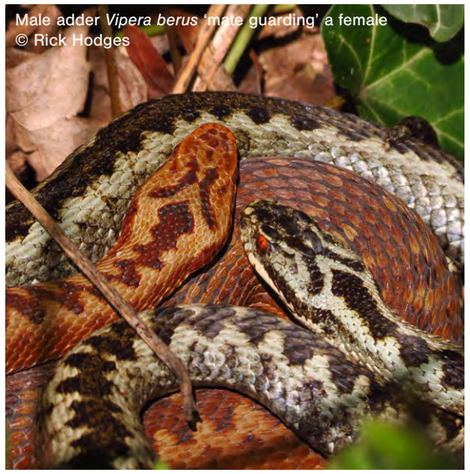
In the last few years, SFD has been detected in Britain, especially in Grass Snakes in the east of England. The disease manifests itself on the ventral scales as small (1-5mm diameter), thickened, brown lesions with an irregular surface. Although SFD can prove fatal, its significance for snake populations is still not understood, but increasing stress from climate change may result in greater prevalence.

Recording, monitoring and research

KRAG holds a database of faunal records (currently 34,999 validated records) that are used as the basis for ecological appraisal of development activities, to plan and manage conservation projects, and to designate Key Reptile Sites (Table 1) (Hodges et al., 2013). The database receives records from diverse sources and there are data sharing agreements with many ecological consultants, Kent and Medway Biological Recording Centre, and Record Pool. KRAG undertakes database search requests for those organisations and individuals needing access to this important information. A search request form is available on the KRAG website.

Since 2008, KRAG has undertaken an intensive, long-term Adder monitoring project in a chalk grassland reserve on the North Downs to observe factors (especially climatic ones) that may lead to reptile declines (Hodges & Seabrook, 2018). In areas more prone to desiccation, Adder populations have been in steep decline, whereas in a less exposed area the population has remained stable. A full analysis and interpretation of the long-term data is expected within the next two or three years. In the meantime, the data has been analysed to show other important aspects of Adder biology, including the thermal relations of Adders using artificial refuges (Hodges & Seabrook, 2016) and emigration and seasonal migration (Hodges & Seabrook, 2019).


Neonate adder *Vipera berus*
© Rick Hodges


Male adder *Vipera berus* 'mate guarding' a female
© Rick Hodges

Conclusion

The current status of Kent's reptiles relates directly to past and present human activity. Intensive agriculture and development have resulted in habitat loss and fragmentation. Of particular conservation concern is the Adder both nationally and in Kent. The first evidence of the impacts of climate change on this species is beginning to emerge as a result of particularly desiccating spring and summer weather. Greater awareness of both reptile distribution and habitat requirements provide a solid foundation for future conservation efforts.

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KENT'S BIRDS

ANDREW HENDERSON, MURRAY ORCHARD, AND JOHN YOUNG, KENT ORNITHOLOGICAL SOCIETY

Summary

- About 245 bird species have been recorded regularly in Kent during the past 100 years, 150 of them breeding. Kent's location in the south-east makes it well-placed to receive new colonists of Britain, and also to support birds at the limit of their European range. The long coastline and especially the estuaries are vital to huge numbers of wintering and passage birds; most notably waterfowl.
- Over the century, similar numbers of species have increased and decreased, with plenty showing no clear overall change. Taking the abundance of species into account, there is strong evidence of declines, especially in specialist farmland and woodland birds from the 1960s onwards. Recently, declines have started to affect groups, such as wintering waterfowl that formerly were increasing.
- Non-native species have contributed to the species increases over the years, including six species of wildfowl, some becoming very numerous. While these contribute to biodiversity, they pose some threats, including competition with other species, damage to crops and other habitats, and disease risk.
- The most important habitats at a national and international scale are coastal ones (shallow offshore waters, estuaries and grazing marsh), which support important populations of wintering and some breeding birds. Also noteworthy are the large areas of woodlands and the many artificial and natural wetlands; however, all land use types, including farmland and built development, have their distinctive features for birds.
- Land use and habitat change has been the primary driver of changes in bird numbers, now exacerbated by climate change, though altering levels of disturbance and persecution, and introductions of non-native species, have played their part. For migrant birds, similar effects on migration routes or on breeding or wintering grounds also are influential.
- The KOS is the leading body recording and reporting the bird life of the county. It also contributes to national long-term bird monitoring schemes run by the BTO, and assists the BTO, the RSPB, and KWT with individual species research and conservation casework.

Bird fauna of Kent

Kent is located on migration routes used by thousands of terrestrial and coastal birds that make annual journeys between their breeding grounds in the northern hemisphere and wintering areas in the south. Almost 430 species of bird have been recorded in Kent, including both residents and migrants, but this total includes some that are rare visitors, occurring only occasionally and in very small numbers. Some 245 species have been regularly recorded in Kent for all or part of the last 100 years and 149 species have regularly bred at some point over this period.

Kent supports national strongholds of species, whose ranges are contracting towards the south-east, including the rapidly declining Turtle Dove and Nightingale. Being close to the continent, Kent is well-placed to receive the first pairs of colonising species that are expanding their range, such as Cetti's Warbler in the 1970s and Black-winged Stilt in the last decade. Kent's long coastline and the estuaries are vital for large populations of non-breeding waterfowl (taken here to include ducks, geese, swans, waders, herons, cormorants, divers, coots and rails, gulls and terns); the more important species depend on a range of habitats – intertidal mud, freshwater bodies and grassland – and include, for example, Brent Goose, Shoveler, Black-tailed Godwit and Dunlin.

Status and trends

Assessments of changes reported here are based on summaries of birds' status at five points over a little more than 100 years (Ticehurst, 1909, Harrison, 1953, Taylor et al., 1981) and current assessments, using a similar range of county and national sources including the annual Kent Bird Reports, the Breeding Bird Survey and Wetland Bird Survey, (Clements *et al* (2015) and BTO (2021)).

These summaries have allowed the identification of trends in four periods using descriptions of their distributions and measures of their abundance which become gradually more quantified. The large amount of information helps the interpretation of changes of a birds' status, but it is also something of a problem, since there can be differing trends in successive periods, or between resident and migratory populations of the same species. Allowances have been made for the changing numbers, skills and focus of observers; however, it should be stressed that, deciding on what the trend has been for any one species is often a matter of judgement.

Turtle dove *Streptopelia turtur*
© Steve Ray

Figures 1 and Figure 2 summarise assessments of the numbers of species decreasing, increasing or showing little change in each of the four periods, separating information for breeding species from that for all regularly occurring species. Rare migrants are not included in these charts.

Table 1 shows numbers of species that are believed to have decreased or increased between 1909 and 2021. Table 2 provides more detail for those species that have been lost or gained (i.e. they were present at the beginning of the 100 year period but absent at the end of it, or vice versa). Occurrence at any time of year is shown separately from breeding status and, for the latter, changes in the most recent 10 years are shown separately from those up to 2010. The birds that have been lost are primarily species with specialised habitat requirements, whether in coastal situations, farmland, woodland or scrub. In contrast, the longer list of gains includes some similarly specialist birds, as well as some introduced species, a range of wetland birds, and birds of prey.

The lists omit species that were present at the start and end of the 100 years but absent at some point during the period (such as Sparrowhawk which ceased breeding through the 1960s) or which bred only for part of the 100 years (such as Kittiwake which bred from 1967 to 2012 and Ruddy Duck which bred from 1995 to 2011). The numbers of species increasing or decreasing (Table 1) are too large to list individually, but they too include species with a range of ecological requirements.

While increases and decreases have continued during the most recent period (2011-2021), only two breeding species have been lost, and no species have been added as regular breeders, although three seem likely to do so soon. Snipe was a scarce and localised breeding species of marshes, especially in the Stour Valley, but ceased breeding in Kent in about 2015. Redstart also was always a scarce breeding bird throughout south-east England; its British range has contracted towards the west and it was lost to Kent in about 2016.

Black-winged Stilt, Cattle Egret and Red Kite are included in Table 2 as recently gained regular breeders, although strictly speaking they have not yet bred for long enough to establish that status. The Black-winged Stilt historically occurred no nearer than the Mediterranean but its range has expanded northwards. Few occurred in Kent before the 1940s, but they have been annual since 2014, with several breeding attempts including the first successful nesting at Cliffe Pools in 2017.

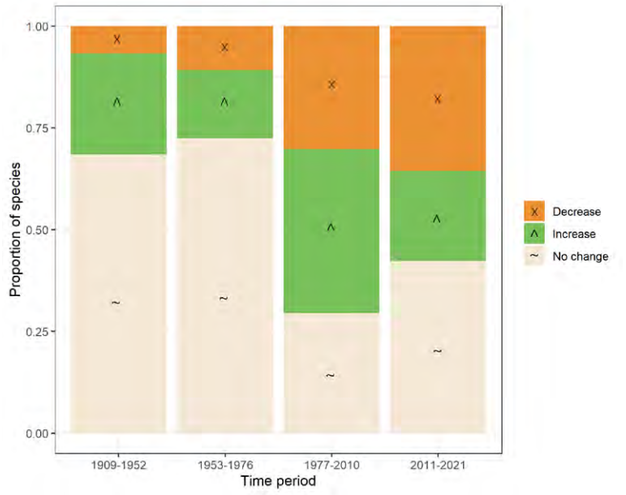

Figure 1 Numbers of regularly occurring bird species in Kent showing negative or positive population changes

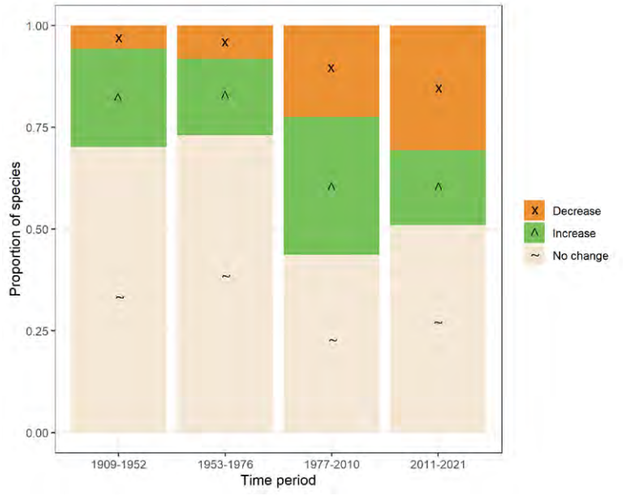

Figure 2 Numbers of breeding species in Kent showing negative or positive population changes

Table 1 Numbers (and percentage) of bird species lost or gained, or decreasing or increasing, since 1909 in Kent

Change	Presence	Breeding
Species lost	2 (1%)	13 (9%)
Population decrease	56 (23%)	37 (25%)
Population increase	64 (26%)	31 (21%)
Species gained	13 (5%)	30 (20%)

Table 2 Bird species **gained**^ and **lost**° in Kent, including the last or first dates of occurrence at any time of year (presence) and of regular breeding occurrence (breeding)

Species	Regular presence last 100 years	Breeding up to 2010	Breeding last 10 years
Canada Goose *Branta canadensis* ^	1940s	1950s	
Greylag Goose *Anser anser* ^	p	1960s	
Egyptian Goose *Alopochen aegyptiaca* ^	1970	2006	
Mandarin Duck *Aix galericulata* ^	1910	1935	
Gadwall *Anas strepera* ^	p	1970s	
Tufted Duck *Aythya fuligula* ^	p	1935	
Collared Dove *Streptopelia decaocto* ^	1957	1957	
Corncrake *Crex crex* °	p	1947	
Great Crested Grebe *Podiceps cristatus* ^	p	1911	
Black-necked Grebe *Podiceps nigricollis* ^	p	2001	
Stone-curlew *Burhinus oedicnemus* °	p	1965	
Black-winged Stilt *Himantopus himantopus* ^	p		2017
Avocet *Recurvirostra avosetta* † ^	p	1983	
Little Ringed Plover *Charadrius dubius* ^	1938	1949	
Kentish Plover *Charadrius alexandrinus* °	p	1934	
Snipe *Gallinago gallinago* °	p		2015
Mediterranean Gull *Larus melanocephalus* ^	1957	1984	
Common Gull *Larus canus* ^	p	1919	
Great Black-backed Gull *Larus marinus* † ^	p	2003	
Sandwich Tern *Sterna sandvicensis* ^	p	1978	
Guillemot *Uria aalge* °	p	1926	
Fulmar *Fulmarus glacialis* ^	p	1966	
Cormorant *Phalacrocorax carbo* ^	p	1994	
Bittern *Botaurus stellaris* ^	p	1958	
Cattle Egret *Bubulcus ibis* ^	1992		2019
Great White Egret *Ardea alba* ^	1977		
Little Egret *Egretta garzetta* ^	1957	2000	
Honey-buzzard *Pernis apivorus* ^	p	1999	
Marsh Harrier *Circus aeruginosus* ^	p	1989	
Buzzard *Buteo buteo* † ^	p	1999	
Red Kite *Milvus milvus* † ^	p		2019
Wryneck *Jynx torquilla* °	p	1968	
Ring-necked Parakeet *Psittacula krameri* ^	1960s	1969	
Red-backed Shrike *Lanius collurio* °	p	1974	
Golden Oriole *Oriolus oriolus* °	p	1989	
Raven *Corvus corax* † ^	p	2009	
Willow Tit *Poecile montanus* °	2005	2005	
Bearded Tit *Panurus biarmicus* † ^	p	1960	
Cetti's Warbler *Cettia cetti* ^	1968	1973	
Wood Warbler *Phylloscopus sibilatrix* °	p	1997	
Yellow-browed Warbler *Phylloscopus inornatus* * ^	1915		
Pallas's Warbler *Phylloscopus proregulus* * ^	1958		
Savi's Warbler *Locustella luscinioides* ^	1960	1960	
Firecrest *Regulus ignicapilla* ^	p	1970s	
Black Redstart *Phoenicurus ochruros* ^	p	1930	
Redstart *Phoenicurus phoenicurus* °	p		2016
Whinchat *Saxicola rubetra* °	p	1970s	
Cirl Bunting *Emberiza cirlus* °	2006	1958	
Siskin *Spinus spinus* ^	p	1966	

p Species occurred in Kent throughout the 100 year period
* Although occurring regularly, remains a scarce or rare migrant
† Bred regularly in the nineteenth century

The Cattle Egret is another species that has been colonising Britain; though not yet breeding regularly in Kent, it first nested in 2019. One other member of the heron family (Great White Egret) is likely to follow suit. Red Kite is presumed to have bred in the 19th Century or earlier, but was very rare in the early 20th Century. Several reintroduction schemes began elsewhere in England from 1989 onwards; numbers occurring in Kent have increased as a result and breeding is on the cusp of becoming well-established.

Twenty-two species changed from increase during 1976-2010 to decrease subsequently. The list is dominated by water birds, with five species of wildfowl including Bewick's Swan, Gadwall and Pintail, and seven species of wader including Oystercatcher, Grey Plover and Curlew. It is likely, with less severe winters, that wintering waterfowl are able to remain to the north and east and not reach Britain ('short-stopping'); however, this may not be the sole reason and the trend is of concern. Combined with the continuing declines of farmland birds, some woodland birds and trans-Saharan migrants, we are seeing wide-ranging declines in the diversity and abundance of birds. The decreases are not offset by the increases of some birds of prey and wetland species, nor by the seven introduced species that increased during the most recent 10 years.

The analysis above has looked at whether species have increased or decreased, and has not considered the scale of those changes. For most species, there is inadequate data to investigate abundance trends at county level, but they are available nationally. Indices of farmland, woodland and wetland birds are produced annually (BTO, 2021); almost all of these are now showing declines, even generalist farmland birds and wintering waterfowl, which until recently were stable or increasing.


Lapwing *Vanellinae*
© Richard Enfield

Kent Biodiversity Strategy priority species

Five breeding birds are among the priority species in the Kent Biodiversity Strategy: Lapwing and Sandwich Tern allocated to the coastal zone, and Turtle Dove, Swift and Nightingale to terrestrial habitats. Four of these species are in decline, with Turtle Dove and Nightingale at risk of being lost in Kent as breeding species. Sandwich Tern is also vulnerable, as its breeding population is restricted to a single area.

Sandwich Terns have colonised the Medway estuary islands and these have held up to 700 pairs, but numbers fluctuate greatly. Threats to the colony include tidal flooding, predation (by birds and mammals) and disturbance. A range of factors adversely affect the other four species. All of them have probably experienced large reductions in food availability. These reductions will have been driven by land use and habitat changes, such as agricultural intensification and abandonment of coppicing, with diffuse air and water pollution from fertilisers and pesticides perhaps playing an important part. Turtle Dove, Swift and Nightingale, being trans-Saharan migrants, are likely affected by habitat change in Africa, while overlaying all of these factors is climate change. For Swifts, loss of nest sites during building renovation and lack of nest sites in new builds is likely an important factor. Lapwings are impacted by increased numbers of avian and mammalian predators - which puts pressure on breeding populations while wintering birds will be affected by similar pressures on their continental breeding grounds.

Non-native and invasive species

Non-native bird species attract differing reactions. For some, they are an attractive addition to our avifauna, especially when so many species have declined. For others, they are undesirable. Potentially serious risks associated with these species include competition with less dominant species for food and nest sites, damage to agricultural crops or natural habitats, and transmission of disease.

Eleven species derived mainly from introductions occur regularly in Kent (Table 3). Most (especially game birds and wildfowl) were introduced for ornamental purposes, for shooting, or both, over an extended period from the 18th to mid-20th Centuries. Some of these, perhaps especially Canada and Greylag Geese, are now among the more numerous and prominent species of wildfowl occurring here. Ruddy Duck, a species posing potentially very serious risks, would be included here but is no longer regularly present (see Table 2).

Not all of these species are non-native. For some of the wildfowl (Barnacle and Greylag Geese and Gadwall), some birds from natural stocks do occur in winter but the bulk of populations, certainly of those that breed in Kent, derive from released birds. Red Kite is colonising Kent from birds derived from the introduction schemes in the Chilterns and other counties across the UK. These reintroductions ceased a while ago as populations became self-sustaining and are now naturally spreading. Kent's population can be classed as an expanding re-introduced population. The bird has never been reintroduced to Kent and was present here historically.

For some of the wildfowl, the steep increases since the 1960s now seem to be levelling off. For others, we may yet see further substantial spread and rises in numbers; perhaps the most likely candidates for this are Barnacle Goose and Egyptian Goose. Other wildfowl, such as Red-crested Pochard, or cage birds such as Monk Parakeet, could increase significantly, but there is little sign of that yet. Additionally, further reintroductions of species that bred in Kent historically may take place, e.g. White-tailed Eagle and Chough.


Red Kite *Milvus milvus*
© Shalley Lewis

Table 3 Non-native± and reintroduced* bird species occurring regularly in Kent. Reintroduced species occur/occurred naturally but introduced stock makes up the bulk of current breeding populations

Species	Introduction to Britain Approximate period	Kent breeding population pairs/territories
Red-legged Partridge *Alectoris rufa* ±	18th Century	1,600-2,000 + releases
Pheasant *Phasianus colchicus* ±	11th Century	48,000-58,000 + releases
Canada Goose *Branta canadensis* ±	19th Century	1,000-1,500
Barnacle Goose *Branta leucopsis**	Late-20th Century	10-30
Greylag Goose *Anser anser**	Mid-20th Century	700-1,000
Egyptian Goose *Alopochen aegyptiaca* ±	18th Century	20-50
Mandarin Duck *Aix galericulata* ±	Early 20th Century	100-150
Gadwall *Anas strepera**	19th Century	150-200
Red Kite *Milvus milvus**	Late-20th Century	1-10
Little Owl *Athene noctua* ±	19th Century	2,000-4,000
Ring-necked Parakeet *Psittacula krameri* ±	Mid-20th Century	1,000-1,500

Key habitats and their protection

There are few habitats that are not of interest for birds in one way or another. For example, residential and industrial areas, while supporting a limited range of species, do hold significant numbers of key species, from Peregrines and Swifts, through to House Martins and Black Redstarts. Nevertheless, it is the more natural or undeveloped habitats that hold the majority of important species, and many of those are protected by conservation designations. Table 4 shows habitats that hold bird assemblages and populations of major importance within Kent, drawing attention to significant threats within each.

Redstart *Phoenicurus phoenicurus*
© Steve Ray

Table 4 Habitats of major importance for birds in Kent

Habitat	Key bird features	Threats
Shallow offshore waters, Thames estuary, Goodwin Sands and near Dungeness	Feeding areas for fish-eating species in winter. Red-throated Diver at internationally important levels; other species such as Great Crested Grebe, Cormorant and Guillemot probably nationally important.	Pollution is a constant threat, and now also inappropriately located windfarm development. Offshore nature conservation protection is an emerging practice, and damage is possible before appropriate designations are in place.
Intertidal areas of estuaries, especially Thames, Medway and Swale	Internationally and nationally important for many waterfowl (geese, ducks, waders) in winter and on passage. Examples include Shelduck, Grey Plover, Black-tailed Godwit and Dunlin. Saltmarshes also nationally important for breeding waders and terns, including Sandwich Tern.	Significant threats are industrial and port development, pollution, and disturbance from recreational boating and landing on islands.
Grazing marsh, especially in north Kent	Nationally important for a wide range of breeding birds, including Marsh Harrier, Shoveler, Pochard, Lapwing and Redshank. Also a feeding area for internationally and nationally important wintering waterfowl including Brent Goose, Wigeon and Shoveler.	Conversion of grazing marsh to arable use caused big losses in the 1960s-1980s, but that process has been reversed to an extent; further reversion is desirable.
Broadleaved woodland, coppice and scrub	Kent has more woodland than many counties, holding large numbers of specialist woodland birds. Some are widespread and numerous, such as woodpeckers, Nuthatch and Treecreeper. Others are now scarce and declining, such as Hawfinch, Tree Pipit and Nightingale. Willow Tit, once widespread, has been lost.	Traditional woodland management, especially coppicing, has declined, affecting a range of species. Climate change and diffuse air pollution may be having adverse effects on woodland ecology. Some woodlands are protected, as SSSIs for example, but many are not.
Freshwater wetlands	The growth of artificial wetlands in the 20th Century, from aggregate working, has contributed to large increases of many waterbirds, such as Greylag Goose, Tufted Duck and Great Crested Grebe. In addition, the expansion of reedbeds and other marshlands, often on nature reserves, has created further habitat for other wetland birds including specialists such as Bittern and Bearded Tit.	Many of the more natural wetlands are protected but relatively few of the artificial sites are. Lack of appropriate management can damage even the protected sites. Recreational disturbance from boating, angling or merely public access can reduce bird diversity and numbers.
Farmland	Farmland occupies a large proportion of Kent. In total, it supports large numbers of birds in both cropped land and marginal habitats (hedges, ditches, etc). It is the primary habitat of many of Kent's most sharply declining species, including Grey Partridge, Skylark, Linnet and Corn Bunting.	Successive agri-environment schemes have attempted to reverse these trends with only limited success; the declines continue.

Drivers of change

In many cases, we have a good idea what has caused changes, while in others we are less certain – and it should be stressed that these causes are seldom proven. We have used our own judgement to allocate a primary driver of that change to most species showing marked changes. Table 5 summarises the numbers of species for which each of a range of drivers of population change is most important and, below, we also give some examples of species affected by these drivers. Note that for a significant number of species, the reason behind the changes is not known.

Most of the changes experienced by birds in Kent are similar to those elsewhere in south-east England and more widely. Where there is a difference, it is generally one of scale rather than a contrary trend. Thus, for example, there is evidence that Greenfinches have been declining for longer in Kent than elsewhere, while for species like Nightingale, the decline in Kent has not yet been as severe as in most counties.

Where one driver is judged to be the principal one, another may have subsidiary or linked effects. For example, new housing developments increase recreational disturbance by bringing people closer to habitats that were previously less accessible. Birds that are stressed by poor food supply will have that factor increased in severity if they are frequently disturbed.

One complex relationship especially pertinent to Kent concerns Nightingale; as it has declined, its preference has changed from coppice woodland to damp scrub, probably associated with food supply issues but perhaps the reduction in coppice areas has also contributed, as habitat changes and prey abundance in wintering and migration sites may also have done.

Climate change

Climate change has always affected bird distributions and numbers, however, the rapid anthropogenic change now underway is having a multitude of complex effects. Warmer conditions, especially in winter, have allowed cold-intolerant species such as egrets and Cetti's Warbler to spread north and colonise Kent. Initially, the warmer conditions also provided better conditions for wintering wildfowl and waders such as Bewick's Swan, Wigeon and Grey Plover; however after sustained increase, many such species are now declining as they can remain on the continent.

Climate change may also be having impacts on birds far away from Kent, but with consequences still felt here. In Africa, drier conditions can mean that our summer visitors are unable to find enough food before northward migration, and a widening Sahara Desert will become an even greater barrier. Similarly, warmer conditions in the Arctic breeding grounds of winter visitors may lead to changes in the delicate balance of those ecosystems, resulting in lower productivity.

Increasing sea levels resulting from global warming have serious implications for our coastal birds, including those of the internationally important estuaries. With artificial sea banks and walls, the ability for the zone of tidal influence to move inland is prevented, resulting in 'coastal squeeze' – a narrowing of the area exposed by falling tides, with obvious consequences for the birds that feed there. Areas of 'managed retreat', where the sea barrier is moved inland, can obviate coastal squeeze locally, but often it is not possible because of the presence of development close to the shore.

Table 5 Drivers of population change in Kent birds where figures indicate the numbers of species increasing or decreasing as a result of the listed factors

Drivers of change	Breeding Increases	Regularly occurring Increases	Breeding Decreases	Regularly occurring Decreases
Climate change	9	13	8	10
Habitat and land use change	17	14	16	15
Disturbance, persecution	10	6	5	3
Mixtures of the above	7	21	11	14
Introductions	9	11	0	0
Unknown	9	13	10	17

Source: Kent Ornithological Society

Changes in the timing of migration, especially the earlier arrival of summer migrants, may adversely affect the survival or productivity of those species. Particularly, there may be mistiming between the birds' breeding cycle and the peak availability of the larvae on which they feed their young. Breeding success may further be affected by the predicted increase in summer storms and, conversely, birds at all seasons may be affected by the increased prevalence of droughts.

Land use and habitat change

Land use change has been a major driver of changes in bird numbers over the past century. The greatest effects have come from progressive agricultural intensification, beginning with the shift from horse to mechanical power, and then the increasing and more effective applications of artificial fertilisers, herbicides and pesticides. These have, between them, allowed farms to become more specialised and uniform, lacking the diversity that enables a range of species to co-exist. Hedgerow removal, loss of winter stubbles, earlier harvests, and cleaner crops with greatly reduced amounts of weed seeds and insect prey have all deleteriously affected birds.

One agricultural change particularly affecting Kent was the conversion of grazing marsh around the north Kent estuaries to arable use. Almost 50% of north Kent grazing marsh was lost during 1935-1982 (Williams *et al.*, 1983), reducing the numbers of breeding and wintering birds. That process has reversed to an extent, with some grazing marsh reinstated, but a net loss remains.

Two changes in woodland management have brought about major changes in bird communities. The reduction and, in many areas, cessation of coppicing has made broadleaved woodlands more uniform. Species favouring the first few years of coppice regrowth, including Nightjar, Tree Pipit and Nightingale, have tended to decline. Those losses have not been offset by increases in mature stands, where bird densities tend to be lower. Much broadleaved woodland was converted to single-species coniferous stands in the middle years of the twentieth century. This increased numbers of species such as Coal Tit, Goldcrest and occasionally Crossbill, but probably also caused losses of a greater number of broadleaved woodland species.

One form of land use change to which Kent has been notably prone is built development. Large areas have been taken for housing, industrial projects and infrastructure, some in areas of major importance for wildlife. One example is Lappel Bank on the Isle of Sheppey: formerly an important feeding area for waterfowl, this is now a huge car park for imported vehicles.

One side-effect of development beneficial to birds has been the growth of waterbodies in disused aggregate quarries. These have provided conditions for gains and increases of many waterbirds including Great Crested Grebe, Gadwall, Tufted Duck and Coot.

The growth of the nature conservation movement has benefited birds. This has been achieved through advocacy and education, but most obviously through the creation of nature reserves and the designation of sites of international and national importance. These areas safeguard habitats against damaging land use change and where possible are managed in the best interest of wildlife including birds that occur there. In some instances, major habitat changes are put in place to improve the land for wildlife. Examples are the RSPB's Northward Hill reserve, where arable land was restored to grazing marsh, and the KWT's Blean reserves, where conifer plantations are being reverted to broadleaved coppice woodland.

Pesticides and pollution

From the mid-20th Century, harmful effects on birds of artificial chemicals were evident. Most significant initially were the persistent organochlorine pesticides, such as DDT and dieldrin, which caused direct poisoning of many birds and also reduced productivity, especially of predatory species such as Peregrine and Sparrowhawk, by thinning eggshells which then broke. The banning of those pesticides allowed recovery of the affected species but, at the same time, the increased use of more effective and targeted chemicals to control weeds and insect pests in crops reduced the abundance of prey and thus farmland bird numbers. Many species have been affected, but examples suffering major reductions are Grey Partridge, Skylark and Corn Bunting.

Nightingale *Luscinia megarhynchos* © Glenn Honey

Although they are now better targeted and more precisely applied, the near-universal use of pesticides and herbicides on farmland continues to hinder recovery of farmland bird numbers, despite agri-environmental schemes. There is also evidence that diffuse pollution by air and water affects areas at some distance from the crops, causing mortality of non-target organisms and eutrophication of soils. This process is implicated in the huge reduction in insect abundance over the past 50 or so years, with knock-on effects on the birds that prey on them.

Marine pollution, most visibly of spilt oil but including such materials as plastic waste and PCBs, can disrupt breeding behaviour or directly kill seabirds such as Gannets and Guillemots. In some cases, this may have population level effects, reducing bird numbers.

Little tern *Sternula albifrons* © Terry Laws

Human pressure / disturbance / persecution

All wild birds are shy of human proximity and the sheer numbers of people throughout Kent will most likely reduce bird numbers, at least of the more sensitive species. Some facets of human behaviour have more severe effects. Direct persecution of birds, by trapping, shooting or egg-collecting, may in some instances reduce bird numbers severely, though this tends to be the case only for rare species or those at the top of food chains. An example in Kent is Buzzard, which became extinct in the county then recovered as persecution decreased.

A converse effect of reduced persecution is the increased populations of species such as Fox and Carrion Crow that were once routinely killed. Some research has found that the increased numbers have not contributed to population declines of smaller birds, but this remains an open question. It is known that, locally at least, removal of these species results in improved survival of ground-nesting birds such as Lapwing.

Provision of food for birds in gardens and in farmland has benefited some species such as Blue Tits, Goldfinches and Woodpigeons. However, by concentrating birds in small areas it can also pose risks from disease (see below) and predation, and perhaps of increasing some birds' numbers to the detriment of more sensitive species.

Birds in Kent are also affected by human disturbance - both deliberate or accidental. Most severely affected have been species that nest on beaches and other coastal habitats, including Stone-curlew, Kentish Plover, Ringed Plover, Little Tern and Wheatear, which have been reduced to tiny populations or become extinct in the county. Landing from boats on saltmarsh islands, as in the Medway estuary, is believed to have caused abandonment of some areas by Mediterranean Gulls and Sandwich Terns. More widely, uncontrolled pets including dogs off leads are a threat to breeding and wintering birds.

Wintering birds are adversely affected by being displaced from feeding areas. This requires energy expenditure and reduces the time they can spend finding enough food to maintain condition to cope with severe weather. Activities such as bait-digging, windsurfing and jet-skiing on mudflats and inshore waters can be especially disturbing to birds, but any human activity including birdwatching or simply walking in the countryside will be a problem when concentrations of birds are made to fly.

Non-native species and disease

Introduced non-native species have the potential to displace native species from their breeding or wintering habitats. There is little direct evidence of this in Kent (it is not easy to demonstrate effects with certainty), but possible examples include Greylag and Canada Geese excluding other waterfowl from areas, and Ring-necked Parakeets excluding Starlings from nest sites, in that case exacerbating declines caused by poor food supply.

Birds suffer from disease as much as any species, and some of the more severe examples are associated with human activity. An example is avian botulism, which sometimes causes mass deaths of waterfowl, typically when birds are feeding in areas with rotting material such as landfill sites or deoxygenated lakes. A more recent problem, from around 2005, is trichomonosis, a protozoan parasite that is implicated in the major decline in Greenfinch numbers and now perhaps also Chaffinches. It is possible that the disease is promoted through birds feeding in concentrations at bird feeders, where the parasite can build up in dirty conditions.

Tree diseases such as Dutch elm disease and Ash dieback, caused by introduced pathogens, may also have affected or be about to affect bird communities through altering the structure and species composition of woodlands and hedges. It is believed that some of the early increase of Great Spotted Woodpecker, and perhaps some temporary increase in Lesser Spotted Woodpecker, may have been linked with Dutch elm disease. It is too early to know the full impact of Ash dieback on birds, but as a more important constituent of Kent woodlands than elm, this is an issue of concern.

Recording, monitoring and research

KOS (formed in 1951) is at the heart of bird recording in Kent. It gathers records from observers through its own recording system, and also collects data from other organisations, notably from the BTO's BirdTrack. It produces the annual Kent Bird Report, summarising each year's sightings, and other publications such as the *Kent Breeding Bird Atlas 2008-13*. Reviews of the status of individual species or groups are published within the annual report and newsletters, together with descriptions of the bird communities of areas or habitats. More information including distribution maps are available on the KOS website and planning is underway for a major expansion of the website to provide details of each species' status.

The KOS organises occasional single species surveys of its own, but co-ordinated survey work usually is encouraged as part of wider schemes. It is not a campaigning organisation but does support other conservation bodies including the RSPB and KWT in major cases affecting birds, and provides data to bona fide requests.

The BTO is the leading bird research institution in Britain. Key elements of its activity affecting Kent are the BirdTrack bird recording system, long-term monitoring schemes, single species surveys and research. A recent example of the last of these especially relevant to Kent is the 2012 Nightingale survey and detailed research on the species. Long-running surveys that identify trends in bird populations include:

- The Breeding Bird Survey, which monitors about 120 species, enabling reliable data on long-term trends across the UK, regionally and (for a reduced list of species) at county level.

- The Wetland Bird Survey, which monitors the UK's coastal and freshwater waterbirds, concentrating on non-breeding populations in winter. Long-term trends are identified and the importance of individual sites, such as the north Kent estuaries, are identified.

- The Bird Ringing Scheme and Nest Record Scheme generate information on the survival, productivity and movements of birds, helping us to understand why populations are changing.

RSPB is the UK's leading bird conservation body, and it also undertakes detailed research in an attempt to resolve conservation problems. An example of relevance to Kent is the 2021 Turtle Dove survey, which forms part of long-term studies into the species' ecology and is being run in Kent in conjunction with KOS.

Conclusion

Over the century or so since 1900, species' fortunes seem to have been fairly evenly matched. Broadly speaking, the numbers of increases are similar or a little greater than the numbers of decreases, but this masks a good deal of complexity within the lists of species involved, and this comparison does need to be qualified for several reasons.

Firstly, measuring change simply by the number of species increasing or decreasing ignores changes in abundance. Evidence at national level is that, for the past 50 years, many species groups, most notably specialist farmland and woodland breeding birds, have been declining in abundance. Even those groups, such as wintering waterfowl, that had been increasing in abundance are now showing declines (BTO, 2021).

Secondly, there is a strong possibility that the qualitative descriptions of species' abundance on which have been relied until around 1970, are insufficiently precise to infer actual changes. Thus, a bird may be described as very common in both 1909 and 1953, despite having increased or decreased significantly. As an example, both Redwing and Fieldfare have been described as common winter visitors across the century. The early descriptions are supported by no hard data and, while some counts are available since 1950, they are patchy and dependent on chances of coverage – there has been no systematic winter bird monitoring. It is suspected that declines


Black winged stilt *Himantopus himantopus*
© David Gardiner


Redshank *Tringa totanus*
© Philip Sharp

have occurred; however there is no firm evidence and so the species is treated as 'no change'. The imprecision of status descriptions may well have obscured many real changes.

Thirdly, some species – perhaps many – have not simply increased or decreased over the century. At some times, populations have declined and at others they have recovered. Such ups and downs have occurred over the long-term or even within short periods. A good example is Rook, for which there are quite good early status descriptions and even survey data from as early as 1949. From this information, it appears that numbers increased in the first half of the 20th Century, then declined in the post-war period before stabilising or even increasing towards the end of the century, but that the decline has now resumed. Such a pattern of changes makes judging the overall trend difficult.

These limitations should be considered while observing that, up to the 1970s, most species seemed to undergo little change and increases outweighed decreases. Over the next 30 years or so, with better evidence, an increased number of changes are apparent, but the balance is still towards more species showing a population increase. In the most recent period, since 2010, that situation has reversed, and decreases exceed increases. Taking abundance changes into account, as well as species richness, the current picture is one of substantial and worrying loss of biodiversity.

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KENT'S MAMMALS

STEPHEN HEDLEY, KENT MAMMAL GROUP

Summary

- Twenty-nine terrestrial mammal species are found in Kent. Eight mammal species in Kent are of major conservation concern; these are the IUCN Red Listed: Water Vole, Hedgehog, Hazel Dormouse, Harvest Mouse, Otter, Polecat and Eurasian Beaver, which is a critically endangered mammal.
- The Red Squirrel was lost from Kent in the 1950s, along with the Otter. The Otter has returned in small numbers, whilst the Grey Squirrel (introduced more than 100 years ago) has supplanted the Red Squirrel. The Polecat and Wild Boar have also returned to Kent in recent years. Trends over time indicate that Hedgehog, Water Vole, Hazel Dormouse and Brown Hare populations are all declining.
- The main non-native species of importance in Kent is the American Mink, which escaped from fur farms in the late 1950s. It is a major predator of the native Water Vole.
- Terrestrial mammals occupy all identified Kent priority key habitats. The Hazel Dormouse stronghold is predominantly the woodlands of Kent and other southern counties. The Beaver, Otter and Water Vole all require sympathetic riparian habitats. Hedgerows are an important priority habitat for many species including Hazel Dormouse, Harvest Mouse and Hedgehog.
- The factors driving change are discussed; the majority relate to negative change, including loss of habitat and/or loss of habitat quality, effects of climate, land use, disease and pesticides. For the IUCN Red Listed mammal species in Kent, a reduction of negative drivers of change is needed.
- Recording of Kent's mammals is undertaken online or via apps. Nationwide programmes are undertaken in Kent and phase two of the Kent Harvest Mouse survey has recently started, with phase one ending in 2020.

Mammal fauna of Kent

This section is an account of those mammals that are typically considered as terrestrial. It includes the following mammal groupings: rodents, lagomorphs, insectivores, carnivores, and ungulates. Bats are considered separately in this report. Many of these are well known, some are highly charismatic, while others may be thought of as problematic, principally due to their conflict with humans. Mammals occupy all habitats within Kent and occupy a range of niches. Their status and associated trends (both population size and distribution) over time vary dependent on species, as does the legal protection afforded them.

The checklist of mammal species in Kent (Young J.S *et al.*, 2015a) totalled 27 native or established introduction species (see Table 1). In addition to this list, two other notable new species in Kent are the Eurasian Beaver and the Polecat. (Note – mammal species are considered native species if they arrived naturally after the last ice age, i.e. before the land bridge with Europe was severed. Established introductions are those species that have been introduced, establishing free living populations of more than 100 individuals for more than 10 years).

Around half of the total terrestrial British mammal fauna occur in Kent and a description of the Kent species can be found elsewhere (Young J.S et al., 2015b) with a fuller description in *Mammals of the British Isles: Handbook*, 4th Edition (Harris S. & Yalden D.W, 2008a). Those mammals in Kent and England with IUCN Red List status are listed in Table 2. In 2020, the Mammal Society highlighted that one in four of Britain's mammal species, including bats, are threatened with extinction (The Mammal Society, 2020). Four of the threatened non-bat species are found in Kent and are presented under their respective IUCN Red List status: Critically endangered~, Endangered ‡ or Vulnerable ◊. In addition, four other Red List species are considered threatened in the county.

Water vole *Arvicola amphibious*
© Michael Vurley

Brown hare *Lepus europaeus*
© Russ Miles

Table 1 Mammal species of Kent (native or established introduction) categorised by taxonomic groups

Rodentia	Carnivora	Artiodactyla	Lagomorpha	Eulipotyphla
Grey Squirrel *Sciurus carolinensis*	Fox *Vulpes vulpes*	Wild Boar *Sus scrofa*	Rabbit *Oryctolagus cuniculus*	Common Shrew *Sorex araneus*
Hazel Dormouse *Muscardinus avellanarius*	Badger *Meles meles*	Reeves' Muntjac *Muntiacus reevesi*	Brown Hare *Lepus europaeus*	Pygmy Shrew *Sorex minutus*
Bank Vole *Myodes glareolus*	Otter *Lutra lutra*	Fallow Deer *Dama dama*		Water Shrew *Neomys fodiens*
Field Vole *Microtus agrestis*	Stoat *Mustela erminea*	European Roe Deer *Capreolus capreolus*		Hedgehog *Erinaceus europaeus*
Water Vole *Arvicola amphibius*	Weasel *Mustela nivalis*			Mole *Talpa europaea*
Harvest Mouse *Micromys minutus*	American Mink *Neovison vison*			
Wood Mouse *Apodemus sylvaticus*	Polecat *Mustela putorius*			
Yellow-necked Mouse *Apodemus flavicollis*				
House Mouse *Mus domesticus*				
Common Rat *Rattus norvegicus*				
Eurasian Beaver *Castor fiber*				

Table 2 Kent mammals with IUCN Red List status

Critically Endangered	Endangered	Vulnerable	Other
Eurasian Beaver ~ *Castor fiber*	**Water Vole** ‡ *Arvicola amphibius*	**Hazel Dormouse** ◊ *Muscardinus avellanarius*	**Harvest Mouse** *Micromys minutus*
		Hedgehog ◊ *Erinaceus europaeus*	**Otter** *Lutra lutra*
			Polecat *Mustela putorius*
			Brown Hare *Lepus europaeus*

Status and trends

To understand the status and trends of mammal populations it is necessary to undertake systematic surveys on a regular basis. Where these have not been undertaken, some indication of the presence of a species can be determined from reported sightings. Several mammal species have been fully lost from Kent in recent times, although some of these have also recovered slightly through assumed natural re-colonisation from other counties. These changes over two time periods are described in Table 3.

Table 3 Mammal species **lost**° and **gained**⁺ in Kent, with date last/first recorded over two time periods

Species change in the last 100 years	Year	Species change in the last 10 years	Year
Red Squirrel ° *Sciurus vulgaris*	1959	Otter^ *Lutra lutra*	2011
Grey Squirrel^ *Sciurus carolinensis*	Introduced in late 19th Century and colonised all of Kent by 1952	Polecat^ *Mustela putorius*	Confirmed reports in the last five years
Eurasian Beaver^ *Castor fiber*	2001		
Wild Boar^ *Sus scrofa*	1980s/1990s		

Sources: Young, J S. et al. 2015c; Mathews F, et al., 2018a; Harris, S.J., et al. 2021.

Red Squirrel

The Red Squirrel was last recorded in Kent in 1959. It is the only squirrel species native to the UK, and has been present for around 10,000 years.

Grey Squirrel

The Grey Squirrel was introduced to the UK in the late 19th Century and had colonised all of Kent by 1952. National estimates and surveys indicate that the population is stable, with interannual variation. There is no reason to think that the situation in Kent is any different from that nationally. Grey Squirrels compete more successfully than Red Squirrels for food and habitat, and also carry a virus known as squirrelpox. While greys are actually immune to the disease, they transmit it to reds, for whom it is fatal.

Wild Boar

The provenance of the Wild Boar population is unknown, but is likely to result from escapes from boar farms. Records are too sparse to evaluate recent trends. Presence of woodland and culling are thought to be the key drivers. The population straddles the Kent/ East Sussex border.

Brown hare *Lepus europaeus*
© Russ Miles

Hedgehog

The Hedgehog has been identified within the Kent Biodiversity Strategy as a priority species (Kent Nature Partnership, 2020). Nationally, estimates of the population in Great Britain have reduced from 1.5 million individuals in 1995 to a mere 500,000 in 2018 (Mathews F, *et al.*, 2018b). The most recent State of Britain's Hedgehogs report estimated Hedgehogs in rural areas have declined by a half, and in urban areas by a third since 2000 (Wilson, E. and Wembridge, D. 2018). The Kent mammal distribution atlas (Young, J S. *et al.*, 2015d) is based on ad hoc records and the Kent Mammal Group's voluntary mammal recording projects. There is, however, no reason to suggest that the national decline is any different in Kent.

Water Vole

The Water Vole in the UK is primarily a riparian species, typically preferring slow flowing rivers, streams and marshes. It has suffered a catastrophic reduction in population from an estimated British population of 1.169 million to 132,000 (Mathews F, *et al.*, 2018c). In Kent, Water Vole distribution is linked with the complex water systems and extensive reed beds in the North Kent marshes, the Lower Stour Marshes (including Stodmarsh) and Romney Marsh. Future conservation efforts are strongly linked to the integrity of suitable habitat and control of its main predator, the non-native American Mink.

Hazel Dormouse

The Hazel Dormouse is a mainly broadleaved woodland species, although adaptable to other kinds of woodland, scrub and hedgerows (where not over managed). Its stronghold is in Kent and the rest of southern England. The NDMP, however, indicated a 51% population decline since 2000 (Wembridge *et al.*, 2019a).

Harvest Mouse

The Harvest Mouse is Europe's smallest rodent. It is very charismatic, living in the 'stalk zone' of tall grasses and herbaceous vegetation that die back in winter and re-grow in spring. It is probable that the Harvest Mouse has been adversely affected by changes to agricultural practices; however, it is difficult to quantify the scale of any impacts, not only because of a lack of national baseline data, but also because there are large seasonal and annual fluctuations in population size.

Otter

The Otter is found in freshwater habitats from coast to upland, but can also exploit marine environments; this has been seen in Scotland, where there is high food supply. There was a severe decline in population across England from 1957 and it has only slowly recolonised most of its former range in Great Britain since then. The species was thought to have been extinct in the 1950s in Kent, due to pollution and other factors. Kent was the last county in mainland Britain to be re-colonised, possibly due to its relative isolation from other parts of Britain. Numbers will only increase if there is favourable riparian habitat.

Polecat

The Polecat is a generalist carnivore species in terms of both habitat selection and diet, but typically preferring woodland edge, farm buildings and field boundaries. It is found in small numbers in much of central and southern England (Croose, 2016), having been confined to mid-Wales by the early 20th Century. It was believed to have been extinct in Kent for more than 100 years. Nationally, the Polecat has made a recovery, but it is still limited in Kent and recent records received by the Kent Mammal Group indicate small isolated pockets in north and south-west Kent. The Polecat is also the ancestor of the domestic Ferret, and together they can hybridise to produce Polecat-ferret hybrids. These hybrids are similar to Polecats and are therefore difficult to distinguish. The impact of the hybridisation is currently unknown (Croose *et al.*, 2018).

Brown Hare

The Brown Hare lives predominantly on farmland and it has limited legal protection, although it was a BAP priority listed species. Population estimates indicate a decline in the south-east of England, although it is thought to be stable across the UK, but declining in England (Harris *et al.*, 2020a).

Eurasian Beaver

The Eurasian Beaver primarily occupies riverine and wetland habitat and requires access to fresh water with suitable vegetation for forage and dam-building. It is a keystone species that can modify sub-optimal habitats, by building dams, burrows and lodges. The species was re-introduced to Kent by KWT to an enclosed area of Ham Fen in 2001. Numbers in the UK are likely to increase, following re-introductions (Mathews et al., 2018d). Unofficial re-introductions of beavers into the wild in east Kent are also known to have occurred (Bramley, 2019).

Brown hare *Lepus europaeus*
© Russ Miles

Non-native and invasive species

American Mink became established in the UK in the 20th Century following fur farm escapes and releases. It is a generalist predator and shows a strong preference for riparian habitats, and hence is a major predator of Water Vole and other riparian species. As a result, measures have been taken to remove American Mink. National population estimates indicate a slight decline (Mathews *et al.*, 2018e). In Kent, American Mink show a similar spatial distribution to that of the Water Vole (Young *et al.,* 2015e). Inter-specific competition with the Otter is considered to lead to a negative pressure on the American Mink (Mathews *et al.*, 2018f).

Key habitats and their protection

Kent's more generalist mammals have adapted to the changing environment across the county e.g. Red Fox and Grey Squirrel, whilst other species are far less adaptable. Thus these mammals are totally reliant on the preservation and sympathetic management of specific habitats for their survival. The priority habitats of Kent (Kent Nature Partnership, 2020) are therefore vital for the Red List species identified in this chapter, as well as other non-listed mammal species that are not specifically mentioned.

Rivers and associated water features

The Otter, Beaver and Water Vole are all riparian Red Listed species reliant on the Kent priority habitats of rivers and associated water features e.g. lakes and streams. The Otter relies on sympathetic management of the riparian habitat. As an ecosystem engineer, the Beaver can create additional priority habitat and accordingly increase biodiversity. Water Vole populations in Kent are of national importance, including three national key sites at Elmley, the North Kent Marshes and the Lower Stour Marshes (Kent Nature Partnership, 2020).

Coastal and floodplain grazing marsh

Water Vole, Harvest Mouse and Brown Hare are Red Listed species using coastal and grazing marsh. Water Vole populations occur in the reed beds on Romney Marsh and south of Reculver. Reed beds and reed lined saline lagoons with brackish tidal ditches (where there is an abundance of vegetation) may reduce the risk of American Mink predation, and are therefore important. The Kent Harvest Mouse survey identified that the Harvest Mouse, traditionally associated with agricultural fields, uses other grass habitats and favours Kent's wetter areas, including the whole of Romney Marsh and along the north Kent coast. The Brown Hare is typically associated with arable land, preferring open spaces, including areas of pasture and marshland.

Introduction | Headlines | Drivers | Conservation | Kent's Species | Landscape-scale | Case Studies | Conclusion
Fungi | Plants | Spiders | Dragonflies & Damselflies | Flies | Ants, Bees & Wasps | Beetles | Grasshoppers & Crickets | Butterflies | Moths | Amphibians | Reptiles | Birds | **Mammals** | Bats | Marine | Seaweed

Woodland

The Hazel Dormouse is a nocturnal and arboreal Red Listed species that is predominantly found in Kent and the other southern counties of England. Mixed woodland habitats are preferable with different plants and trees producing flowers, pollen, nuts and fruits on a rotational basis, plus a supplement of insects. Identified Kent priority habitats include lowland mixed broadleaved woodland, lowland beech and yew woodland. The Beaver is also associated with lowland fen where there is wet woodland.

Hedgerows

The Hazel Dormouse, Harvest Mouse and Hedgehog are the Red Listed species associated with this Kent priority habitat, all requiring species-rich hedgerows. Rural fragmentation and change, plus the loss of hedgerows and hedgerow quality, have contributed to the decline and movement of the Hedgehog to more urban habitats. Hedgerows are important wildlife corridors for mammals, linking fragmented habitats.

Lowland meadows

The Harvest Mouse is the Red Listed species most associated with this Kent priority habitat. Both the Brown Hare and Hedgehog are also associated with lowland meadows. The Brown Hare is more likely to be found in areas with surrounding wide open spaces and the hedgehog in locations close to woodland or hedgerows nearby with suitable nest sites.

Other Kent priority habitats – arable field margins, vegetated shingle and brownfield sites

Arable field margins with a diverse floral base are an important Kent priority habitat used by the Red Listed Harvest Mouse and other non-listed mammal species. The Brown Hare is found on the vegetated shingle found at Dungeness. The loss of hedgerows has contributed to the movement of the Hedgehog to more urban habitats including brownfield sites. Any regeneration of these sites may limit Hedgehog expansion of urban areas.

Drivers of change

This section focuses mainly upon the priority taxa, discussed earlier. To date, few specific quantitative studies and data are available for terrestrial mammals in Kent, so the following information is mainly drawn from the Natural England Joint Publication JP025 (Mathews *et al.*, 2018g), which is considered to be representative of the county.

Habitat

Negative changes include the total habitat loss, fragmentation and the loss of quality of a habitat. Specialist mammal species are most likely to experience the greatest dis-benefit. Most of the population of the Hazel Dormouse in Kent is found in broadleaved woodlands at low densities; consequently, any fragmentation of woodland leading to a reduction in woodland species' diversity is a negative driver for the Hazel Dormouse. The Hazel Dormouse is protected by law and may not be killed, injured, or disturbed in their nests, except under licence. Change in the management of ancient and/or coppiced woodlands, such as a revival of the practice, has in recent years provided more optimal habitat for the Hazel Dormouse.

Changes to agricultural practice and competition with livestock reduce food and shelter opportunities for the Brown Hare, as well as other species e.g. the Field Vole (an important prey for the Kestrel and Barn Owl). Early flailing of hedges and mowing of verges and ditches can destroy late breeding Harvest Mouse nests. Factors detrimental to the Water Vole habitat include wetland drainage, the encroachment of cultivated land into riparian and wetland habitats, overgrazing, and the degradation of the structural and vegetative suitability of banks for Water Vole burrows. River bank reinforcement programmes have also negatively affected the suitability of riparian habitat for the Water Vole and Otter. The improvement to water quality driven by the Water Framework Directive is likely to provide a positive benefit.

Climate change

Changes to agricultural practice as a result of climate change, for example, moving away from lowland arable or pastoral land with associated plant species diversity, presence of hedgerows, and unfarmed habitat, where Brown Hare abundance is positively associated with, have a negative impact. Climate change may also cause a change in food availability for the Hazel Dormouse through the alteration of fruiting cycles, invertebrate egg-laying and disease. Wetter summers too may limit range expansion of the Harvest Mouse, but conversely warmer temperatures may increase survivorship and reproductive success. An increase in the frequency of spate events along river banks can detrimentally impact on Water Vole burrows.

Land use

Changes in land use are likely to be negative for many species through habitat loss and fragmentation. One example is the loss of habitat when hedgerows are removed and therefore habitat connectivity is reduced. Development in Kent, including removal of brownfield sites, increasing urbanisation and road building, lead to loss of nesting habitat of Hedgehogs, Hazel Dormouse, Harvest Mice and Badger. Changes in land management, including wetland drainage, arable cultivation and watercourse canalisation has led to decline of the Water Vole. Urban changes in land use, for example building roads, may also result in a

greater number of vehicle collisions of Hedgehogs and Badgers. Conversely, for some species increasing urbanisation may lead to a potential increase in urban populations owing to high food availability e.g. the Red Fox.

Non-native species and disease

Non-native mammals mainly arise by escape of individuals from collections or by their illegal release. In recent times, the most devastating non-native species was the American Mink, which is a major reason for the decline of the Water Vole. Myxomatosis was first found in Kent in 1953 and has rapidly spread through the UK Rabbit population. Since its initial first spread, there has been some recovery, but outbreaks continue to arise leading to severe local impacts. Viral rabbit haemorrhagic disease is also a fatal disease of the Rabbit and was first diagnosed in 1992. A new variant of rabbit haemorrhagic disease virus is of concern as it has caused a decline in Rabbit populations across the UK of more than 50 percent and has also jumped species to the Brown Hare, resulting in mortality (Harris *et al.*, 2019).

Human pressure/disturbance/persecution

Persecution was a major reason for decline of the Polecat and Otter in Kent. Alleviation of this pressure may mean that there will be an increase in numbers through time, although for the Polecat, hybridisation with the Polecat-ferret is probable. The population density of Brown Hare is locally adversely affected by hunting in Kent. Conflict with other socioeconomic interests has also led to the localised persecution of the Beaver in other parts of the country.

Pesticides

Persistent organic pollutants caused the decline in the Otter population. The consequent recovery of the species has been linked to banning of these pesticides. For the Hedgehog, prey declines resulting from changes in agricultural practice (and possibly pesticide use) have negative impacts on populations, especially in more rural areas. There may also be an impact of pesticide use, including in gardens, on prey abundance.

Recording, monitoring and research

Online and app-based recording of all mammal species in Kent can be completed via the Kent Mammal Group website, iRecord, Mammal mapper, Living Record and via email. These all rely upon observer participation and consequently this recording tends to be ad-hoc, with much of the recording undertaken by volunteers. All records are validated and verified prior to acceptance. Once accepted, all records of Kent mammal sightings (including tracks and signs) are stored in databases


Muntjac *Muntiacus Cervidae*
© Amy Lewis

maintained by the KMG and the KMBRC. Other records may arise from mammal (and bird) surveys undertaken in conjunction with organisations such as the PTES, KWT, Vincent Wildlife Trust, RSPB and BTO. Additional recording can be undertaken in ecological reports for development projects, although the findings are not always reported to the KMG or KMBRC.

The Kent Harvest Mouse Survey 2015 to 2020 is the only recent detailed survey of a Kent mammal species that has been undertaken. This survey established a baseline of distribution and confirmed that the Harvest Mouse is widespread across Kent. It showed that wetter areas were favoured and that populations were scattered and local along the North Downs (Kirk, 2020). They inhabited the grassy verges of many Kent roads, including the numerous A roads. However, there remains many blanks to fill in, with just under half of the county not surveyed. Phase two of the survey (funded by the KMG) will help complete the picture and increase confidence in the estimated population sizes and trends over time.

Other nationally run ongoing surveys that include Kent are:

- The NWVMP organised by the PTES. Earlier surveys demonstrated the dramatic decline of the Water Vole. The NWVMP involves surveys of 500m lengths of riverbank once a year, between 15th April and 15th June, recording all Water Vole signs seen, along with any Otter and American Mink field signs.
- The NDMP has been running since the early 1990s. It is co-ordinated by the PTES; the aim is to monitor the long-term Hazel Dormouse population trend. Each NDMP site contains a minimum of 50 Hazel Dormouse boxes installed in a woodland or hedgerow that are checked at least twice a year – in May or June, and September or October – between the 15th and 25th of the month. The number, sex, weight and age of Hazel Dormice found are recorded to give an indication of Britain's dormice.
- The National Hedgehog surveys, which are co-ordinated by the PTES and BHPS. These incorporate PTES, BHPS and BTO survey data and were last reported in 2018, and previous to that in 2015 and 2011. The Hedgehog Street campaign, which has been running for the past 10 years, seeks to inspire the British public to help protect Hedgehogs, including reporting their sightings.
- The BBS, run by the BTO, is an annual survey of breeding birds using randomly selected 1km grid squares. Mammal recording was introduced to the BBS in 1995 and now more than 80% of BBS observers actively look for mammals during their bird-count visits.

Conclusion

Eight mammal species in Kent are of major conservation concern; these are the IUCN Red Listed: Water Vole, Hedgehog, Hazel Dormouse, Harvest Mouse, Otter, Polecat and Eurasian Beaver. The Eurasian Beaver is critically endangered and the recent re-introduction in the UK has led to a small number of Beaver in the wild and in enclosed trial sites. However, to ensure a fully successful return to Kent, the right balance with all relevant stakeholders needs to be struck. For the other Red Listed mammal species in Kent, a reduction of negative drivers of change in relation to habitat is needed, specifically the prevention of further loss, fragmentation and deterioration of quality. To supplement this, continued organised monitoring and research is needed to help understand any population changes over time, as well as any change in distribution of the mammal species across the county.

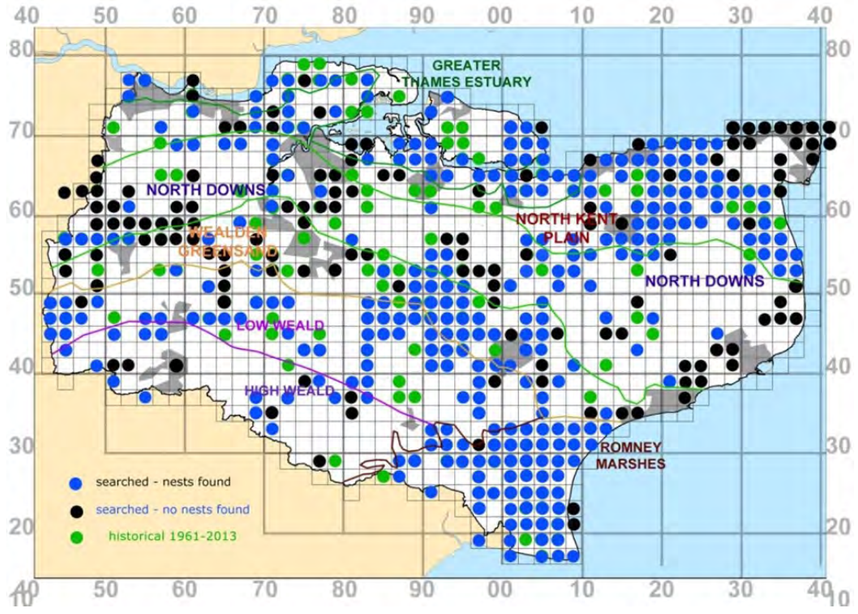

Figure 1 Kent Harvest Mouse Survey 2015 to 2020 results; presence/absence of harvest mouse for each 4 km squared grid across the whole county

Roe at harvestime *Capreolus capreolus*
© Don Sutherland

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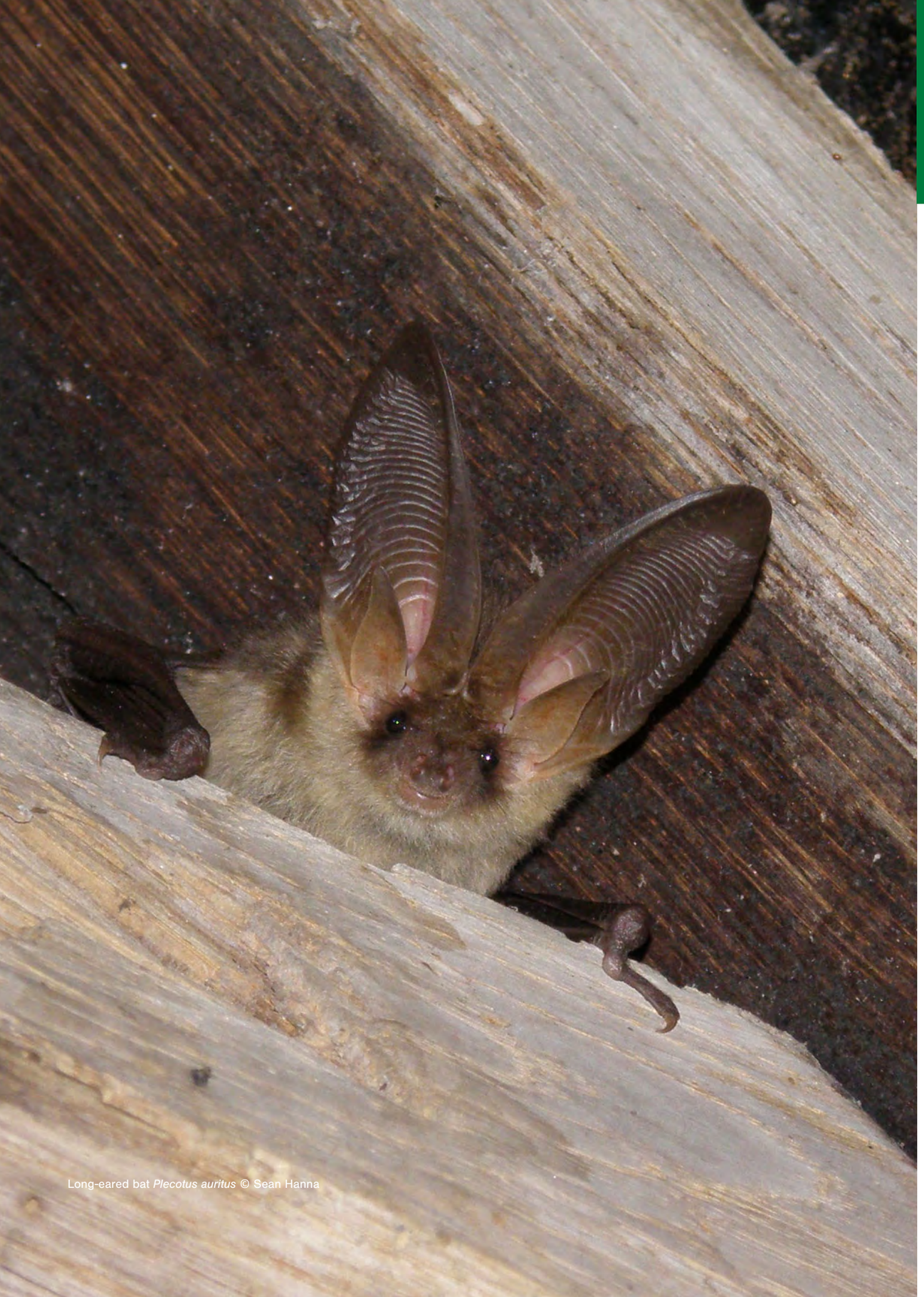

Long-eared bat *Plecotus auritus* © Sean Hanna

KENT'S BATS

SHIRLEY THOMPSON, KENT BAT GROUP

Summary

- Kent has a rich fauna of bats with 17 of the UK's breeding species recorded in the last 10 years, but populations of most species have much reduced in recent decades.
- Three species of bat new to Kent have been recorded in the last 10-year period: Lesser Horseshoe, Greater Horseshoe and Kuhl's Pipistrelle. The status of these species is currently unknown; however, the rediscovery of the two horseshoe bat species after a long absence is very encouraging. It is significant that both species were recorded in an area of restored grassland habitat.
- There have been several records of Kuhl's Pipistrelle, as elsewhere in the UK, but its status is unclear. There is a suggestion its presence may be linked to climate change.
- The importance of Kent coastal waterbodies to migrating Nathusius' Pipistrelles has become apparent by trapping. Two of this species trapped in East Kent had been ringed in Lithuania.
- The loss and 'improvement' of grazed grasslands are of particular concern. Native woodland is over managed with excessive coppicing in much of Kent, to the detriment of the less common woodland bats.
- Recording and research, including in partnership with BCT, has increased knowledge of the populations and distribution of bats in Kent.

Bat fauna of Kent

The small size of bats, their power of flight, their nocturnal and secretive way of life and their vulnerability to disturbance all combine to make bats particularly difficult to study. In addition, some species show close physical similarities so that what was previously considered a single species has sometimes been found to be two or even three separate species, each with slightly different ecological requirements.

There are records from Kent for all eighteen species of bat considered to occur regularly in the UK. Sixteen species have been recorded in Kent since 2011 and are shown in Table 1. Barbastelle and Grey Long-eared Bat are both considered absent from the county.

Table 1 Bat species recorded in Kent since 2011 and their current status

Species	Resident	Migratory	Present but no maternity roost recorded	Unknown	Possible vagrant	Species of conservation priority in Kent
Common Pipistrelle *Pipistrellus pipistrellus*	X					
Soprano Pipistrelle *Pipistrellus pygmaeus*	X					
Brown Long-eared Bat *Plecotus auritus*	X					
Serotine *Eptesicus serotinus*	X					X
Leisler's Bat *Nyctalus leisleri*	X					
Noctule *Nyctalus noctula*	X					X
Daubenton's Bat *Myotis daubentonii*	X					
Whiskered Bat *Myotis mystacinus*	X					
Natterer's Bat *Myotis natteri*	X					
Bechstein's Bat *Myotis bechsteinii*	X					X
Alcathoe Bat *Myotis alcathoe*	X					X
Nathusius's Pipistrelle *Pipistrellus nathusii*	X	X				X
Brandt's Bat *Myotis brandtii*			X			
Greater Horseshoe Bat *Rhinolophus ferrumequinum**				X		X
Lesser Horseshoe Bat *Rhinolophus hipposideros***				X		X
Kuhl's Pipistrelle *Pipistrellus kuhlii*					X	

*Identified by sound analysis of echolocation call 2019-2
**A single hibernation record 2021

Status and trends

A high proportion of Kent's remaining bat species is likely to have undergone substantial reductions in population during the 20th Century; however, providing an overview of changes over the last 100 years is problematic. Before the early 1980s, when protection of all species became law, there were few studies of bats and no baseline by which to judge them, as so much of the information prior to that period is anecdotal. A lack of systematic data, except in the latter few decades of the century, makes it difficult to establish definite, long-term population trends.

At a UK level, there is currently sufficient data, collected by the NBMP, to produce population trends for 11 of Great Britain's 17 breeding bat species. Of these species, all are considered to have been stable or to have increased since the baseline year of monitoring (1999 for most species). Species considered to have increased in Great Britain in comparison to the baseline year of monitoring are the Greater Horseshoe Bat, Lesser Horseshoe Bat, Natterer's Bat, Common Pipistrelle and Soprano Pipistrelle (Bat Conservation, 2020).

Although data collected by the NBMP suggests that populations of many UK bat species are stable or recovering, it is important to note that these trends reflect relatively recent changes in bat populations. This indicates that current legislation and conservation action to protect and conserve bats is proving successful, and it is vitally important that this continues (Bat Conservation 2020).

Until recently, three species of bat were believed to have been lost from Kent during the 20th Century; these were the Greater Horseshoe Bat, Lesser Horseshoe Bat and Barbastelle. The first Barbastelle in the UK was discovered in Dartford in 1802, but nearly 100 years passed before the second was found in Allington, Maidstone. No confirmed sightings have been made since a male was recorded in High Halstow church in December 1950.

Two species of bat have been rediscovered in Kent in the last 10-year period, these are the Lesser Horseshoe Bat and the Greater Horseshoe Bat. Kuhl's Pipistrelle is a new species to be recorded in Kent in the last 10-year period (shown in Table 2). The status of these species is currently unknown. The Greater Mouse-eared Bat was last recorded in Kent in 1985 and was officially declared extinct in 1990. The Grey Long-eared Bat is not considered a resident and was last recorded in 1995.

Table 2 Bat species lost° and gained^ in Kent – includes the first and last dates of occurrence at any time of year

Species change in the last 100 years	Year	Species change in the last 10 years	Year
Grey Long-eared Bat° *Plecotus austriacus*	1995	Greater Horseshoe Bat^ *Rhinolophus ferrumequinum*	2019
Greater Mouse-eared Bat° *Myotis myotis*	1985 (only Kent record)	Lesser Horseshoe Bat^ *Rhinolophus hipposideros*	2020
Barbastelle Bat° *Barbastella barbastellus*	1950	Kuhl's Pipistrelle^ *Pipistrellus kuhlii*	2013

In the 19th Century, Greater Horseshoe Bats were reported as abundant in both Rochester and Canterbury Cathedrals, and there were at least five other records at sites in Kent. The last definite sighting from the 19th Century was a single bat seen in 1909 in Sevenoaks. The rare Greater Horseshoe Bat has recently been recorded in Kent for the first time in more than 100 years. Acoustic recordings of the echolocation calls of the Greater Horseshoe Bat were made by several consultants and verified by national experts. A single Lesser Horseshoe Bat was also observed in hibernation from December 2020; previously, the most recent record was a single bat hibernating in Willington Caves, Maidstone in 1954. It is significant that both species were recorded in an area of restored grassland habitat.

National trends based on the NBMP results suggest populations of Whiskered, Brandt's, Daubenton's, Natterer's and Noctule Bats have been relatively stable between 1999-2019, as have populations of Brown Long-eared Bats. The population of Common Pipistrelle in England is considered to have increased since 1999, and Soprano Pipistrelle may have increased since 1999. Nationally, Serotine increased gradually from 2003 to a peak in 2011, before declining gradually in recent years. This species has suffered a serious decline in Kent since records began in 1987. It is a Kent Biodiversity Strategy species. The maternity roost of Serotines – which has been monitored since the 1980s – has shown a steady decline; at the present rate it is feared it may not be sustainable.

It is assumed, from current knowledge, that the very large summer roosts of Pipistrelles – which were not unusual 50 years ago – were of Soprano Pipistrelles. Several such roosts of about a thousand bats were recorded by KBG in the early 1980s. Regular monitoring for the NBMP shows that the largest Soprano Pipistrelle roost in Kent has declined in number.

The population of Noctule Bats in Great Britain is considered nationally to have been stable over the period 1999-2019; however, although widespread across the county, it is uncommon and declining in Kent. Nathusius's Pipistrelle is rare but widespread throughout Great Britain. NBMP analysis confirms that Nathusius' Pipistrelles migrate from Eastern Europe to the UK and that there is also a resident population in the UK. Kent is one of only three counties in England where maternity roosts have been recorded; it is also where high numbers of bats have been recorded and ringed on migration.


Nathusius' pipstrelle *Pipistrellus nathusii*
© Roger L Jones

Non-native and invasive species

No non-native species of bat have been recorded in Kent between 2011 and 2021, and no species found in Kent are considered to be invasive.

Key habitats and their protection

Ancient broadleaved woodlands are important in providing the diversity of insects and roosting opportunities needed by many bats, particularly woodland specialists such as: Brown Long-eared, Natterer's, Whiskered, Brandt's, Alcathoe, Bechstein's and Noctule. Ancient oak woodland is particularly important to the very rare Bechstein's Bat. Noctule Bats are dependent on tree roosts throughout the year, and the loss of large trees has reduced opportunities for safe winter hibernation. Whilst management such as coppicing may help some species of bat and other wildlife, others, such as Bechstein's and Natterer's, require more structured, less disturbed and dense woodland with many mature trees. The preponderance of coppice management in much of the UK may well be a key reason why Bechstein's bat is so rare here. Even for species which do better in more intensively managed woodland, removal of older trees with cracks and holes may result in loss of important roost sites. Mature hedgerows and treelines are also needed to provide connectivity across the landscape between areas of high value bat habitats, as these provide sheltered foraging habitats.


Soprano pipstrelle *Pipistrellus pygmaeus*
© Daniel Hargreaves

The loss and 'improvement' of grazed grasslands are of particular concern for bat species. Biodiverse grazed grassland is an important habitat for Natterer's and Horseshoe Bats in particular.

Clean waterbodies, rivers and chalks streams, gravel pits and reservoirs are important in supporting the aquatic insects vital for many species, especially Soprano Pipistrelles and Daubenton's Bats. Studies have also highlighted the importance of these sites to Nathusius' Pipistrelles on migration.

Hibernation sites, such as ragstone and chalk mines, deneholes, caves, redundant railway tunnels and ice houses, should be left undisturbed. Though the use of many of these sites for swarming by a range of species is not fully understood, they are known to be vital for social and genetic interaction. Disturbance or loss of a single site within an area may affect the local species differently, and even comparatively small swarming sites may be critical in terms of their conservation value. The most important and most studied hibernation site in Kent is Westerham Mines.

Urban and suburban habitats are also important for some species. This should be taken into account with developments delivering biodiversity net gain and local nature recovery strategies being expected to cover urban as well as rural areas. Mote Park in Maidstone, is a good place for watching several species of bat.

Drivers of change

Bats have three main habitat requirements:

- Suitable roosting sites – Roosts include maternity sites used by females to give birth and raise young, spring gathering roosts, mating roosts, night roosts, and hibernation roosts. Some hibernation sites are also used for autumn 'swarming' by some species, an important social activity which is little understood.
- Good foraging areas within commuting distance of their roosts – All UK bats feed on insects, eating large numbers to provide the energy needed for flight.
- Safe links between roosting and foraging.

Bats are long-lived, produce small numbers of young, and are faithful to traditional feeding and roosting sites. They are therefore very vulnerable to change; if a habitat or feature on which they have depended is lost or degraded, their breeding success may be reduced or their very survival threatened. The following drivers of change all have direct effects on all three of these habitat requirements:

Habitat loss

Roosting sites and foraging sites must be close enough to enable bats to travel economically (in energy terms) between one and the other with safe commuting routes linking them. In particular, foraging sites close to the maternity roost are essential for young just learning to fly and echolocate. Fragmentation of remaining habitats has undoubtedly contributed to the long-term decline of many species.

The impact of habitat loss varies with species. Bats use woodland for foraging and roosting; however, the over management of woodland – with loss of ancient trees and canopy, and deadwood removal – has reduced diversity of bats and their insect prey. Agricultural expansion and intensification, and the use of pesticides, reduces insect prey availability. Degrading and intensive management of agricultural land has also been identified as negatively impacting at least six bat species.

Industrial faming with heavy insecticide use, loss of pastures and hedgerows, plus fragmentation, appeared to be having a major impact on known Serotine maternity roosts. However, restoration of biodiverse grassland in East Kent at a landscape-scale for two decades under various environmental schemes is appearing to help local populations. Static detectors at a few of these restoration grassland sites have shown high foraging activity of Serotine Bats. Further studies should be undertaken to find and monitor the appropriate maternity roosts.

It was only with the Wildlife and Countryside Act 1981 that bats and their roosts received protection. Prior to this time, deliberate exclusion or destruction of bats in houses and other buildings undoubtedly had an impact on local populations. Further impacts came from the use of timber treatments (such as Lindane) which were highly toxic to mammals. While more closely regulated, loss of roost sites still occurs as a result of built development from road schemes to barn conversions. Development and building alterations can lead to roost disturbance and maternity roost loss; deliberate persecution and roost exclusion reduces adult female survival and bat community diversity. Barn conversions affect Natterer's Bats and Brown Long-eared Bats in particular.

Climate change

There is evidence of species shifting their range due to climate change. Extreme weather events pose threats from increased summer temperatures leading to roost abandonment and roost switching behaviour, to mild winter temperatures changing hibernation patterns increasing the incidence of waking.

Natterer's bat hibernating *Myotis nattereri*
© Shirley Thompson

Human pressure / disturbance / persecution

Bats are often brought into direct conflict with humans due to roost choice, which has led to disturbance, deliberate persecution, and roost exclusion. Unpopularity of bats based on fear and misunderstanding can still be a threat to bats roosting in houses, when direct action may be taken to exclude them. Legal exclusion is carried out in certain circumstances under licence. Domestic cats are the most significant predators of bats.

Wind turbines

Wind energy production has increased rapidly in recent decades, resulting in conflicts with various wildlife species globally. Bat mortality at wind farms has been documented, with research showing that migratory species suffer disproportionately. Offshore wind farms in the North Sea are a particular problem to the migratory species. The direct impacts of wind farms include collision and barotrauma (damage to tissues from air pressure changes around turbines). Other indirect impacts also include habitat loss (roosts, commuting routes and foraging areas) and fragmentation (Bat Conservation Trust, 2021b).

Roads

Bat-specific impacts of roads include mortality from vehicle collisions, habitat destruction and fragmentation, edge effects, barrier effects, road avoidance, chemical pollution, and disturbance from light and noise. BCT are keen to see further pre- and post-construction monitoring and research across the UK and Europe to consolidate knowledge on what constitutes effective mitigation for the fragmentation of commuting routes by roads. An essential part of helping to ensure the survival of our bat species is mitigation for the impacts of roads (Bat Conservation Trust, 2021c).

Artificial light

Artificial light at night affects both the behaviour of bats and their insect prey. By disrupting insect breeding cycles it alters roost emergence timings and available foraging periods, which in turn affects breeding success. Roost severance and isolation, and habitat fragmentation also results from lighting at night. Studies have shown the slower-flying broad winged species, such as Long-eared Bats, Myotis species, Barbastelle and Horseshoe Bats generally avoid all street lights. Therefore, bat species which are less light tolerant are put at a competitive disadvantage. They are less able to forage successfully, which can have a significant impact upon fitness and breeding success (Bat Conservation Trust and Institute of Lighting Professionals, 2018).

Counting emerging pipistrelles for NBMP survey. credit © Shirley Thompson

Water pollution

Bats are at risk of exposure to, or ingestion of, water pollutants. Indirectly, eutrophication and acidification of water affects insect prey abundance. This is of particular importance for those species whose preferred prey are insects with aquatic larvae (Soprano Pipistrelle, Nathusius' Pipistrelle, Daubenton's and Natterer's).

Pesticides and insecticides

Bats have very high energy requirements, so need to eat huge numbers of insects. Insecticides and pesticides reduce the availability of food. Dung flies and dung beetles are an important component of the diet of Serotine and Noctule Bats. The reduction of cattle grazing, and the use of chemicals, such as Ivermectin given to cattle to control internal parasites, is believed to be a major cause of the decline of these larger species. In addition, the accumulative effect of pesticides in their fatty tissues on reduced fitness and breeding success is not fully known. Insecticides are a double-edged sword for bats. They reduce their prey in number, but small amounts of poison remaining in insects that survive accumulate in the bats, leading to later problems.

Recording, monitoring and research

Public awareness of bat species has been raised nationally and locally by multiple conservation organisations. The BCT run a series of courses – targeting professionals and others – on bats, their legal protections and their conservation needs. In Kent, KBG is raising awareness through bat walks for the general public and talks to a wide range of audiences including schools, gardening societies, natural history societies and others.

The following NBMP surveys are undertaken annually by KBG and records collected are included in the national results:

1. Colony counts of Soprano Pipistrelle, Common Pipistrelle, Brown Long-eared and Serotine Bats.
2. Waterway surveys for Daubenton's Bats.
3. Field surveys for Serotine, Noctule, Common Pipistrelle and Soprano Pipistrelle Bats.
4. Hibernation surveys of underground sites.
5. BCT Bechstein's Bat survey 2007-2011. This survey expanded Kent records significantly, especially of woodland species in the county. Part of BCT's national survey lead to the discovery of the first maternity roost of Bechstein's Bat in Kent.
6. BCT Nathusius' Pipistrelle survey started in 2014 and is still ongoing. It involves trapping and ringing at waterbodies. In 2015, two of this species ringed in Lithuania were recaptured in Kent – at Oare and Stodmarsh.
7. Small Myotis project to increase knowledge of the ecology and distribution of all three small Myotis species in the UK – Whiskered, Brandt's and Alcathoe Bat. This has been led by BatCRU since 2016 and is still ongoing.
8. KBG bat box survey of woodland bat population at West Blean. Ongoing project that includes ringing of Natterer's and Brown Long-eared Bats.
9. KBG Greater Horseshoe Project to investigate 2020 sound recordings, locate and protect roost sites and foraging habitat, and identify status of the species in the county.

Restored habitat, site of one of the recordings of Greater Horseshoe
© John Puckett

Conclusion

Wildlife legislation has made bats among the best-protected mammals in Britain. This has substantially reduced the casual destruction of roosts. Important indirect benefits are (a) direct contact with the general public through the roost visitor licence system, and (b) contact with professional sectors such as timber treatment companies, builders and forestry. However, much more work will be required to maintain and improve diversity of this highly vulnerable group, which is itself an important indicator of the wider health of the environment.

More targeted conservation strategies are needed to aid the recovery of bat populations; for example, landscape-scale biodiverse grassland recovery and increased habitat connectivity. The less common woodland bat species are particularly at risk of over-management of woodland. Development impacts and the perception of bats need to be improved through national measures and public engagement. In both urban and rural areas, the impact on nocturnal animals of artificial lighting at night needs to be taken into consideration when planning. This should include: further research and data collection to assess trends and highlight particular problems; the continued monitoring of known sites; ensuring the needs of bats are taken into account in habitat management – especially in the case of woodland where this is increasingly well understood; and planning and delivery of habitat restoration at a landscape-scale.

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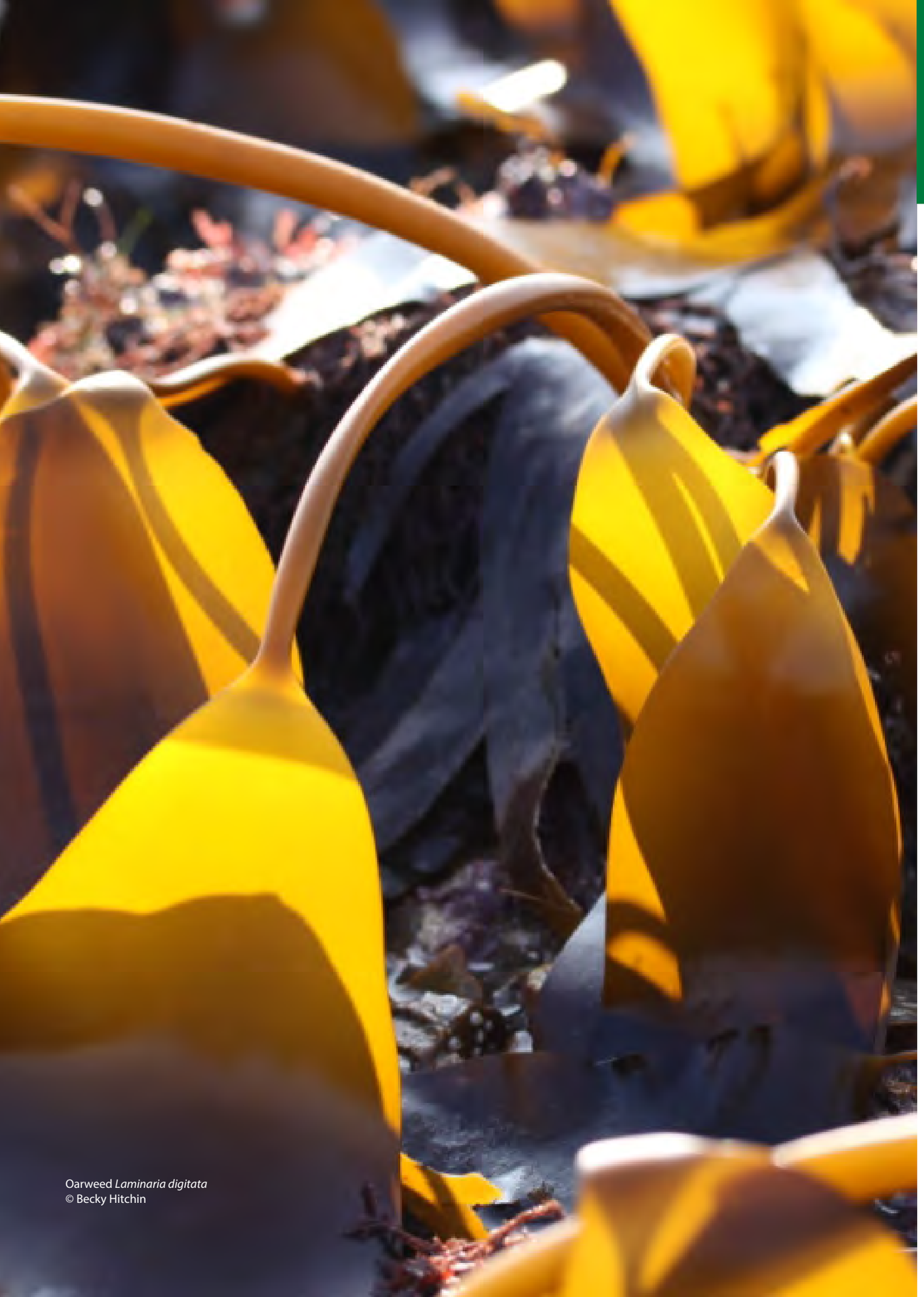

Oarweed *Laminaria digitata*
© Becky Hitchin

KENT'S MARINE SPECIES

ALANA SKILBECK, KENT WILDLIFE TRUST

Summary

- Kent has a rich and varied marine fauna, known to comprise of at least 700 species in 17 Phyla.
- Kent's marine fauna and flora includes a number of rare or threatened species which have been highlighted for protection.
- Twenty-eight of the UK's 275 marine fish are listed as Biodiversity Action Plan priority species, and 15 of these occur around Kent.
- Kent has a wide and rich variety of marine habitats, including exposed rock reefs, globally scarce coastal and marine chalk, clay, greensand, intertidal rock, offshore sandbanks, mud and fine sand, Blue Mussel beds and biogenic reefs.
- Survey data is insufficiently detailed or extensive to be able to analyse trends in populations of most marine species from the seas around Kent.
- Since 2011, 11 MCZs have been designated in Kent's waters. These sites protect important species assemblages and habitats.
- Evidencing and enforcing the protection of the marine environment will rely on adequate resourcing of survey and data science to manage and monitor MCZs and the wider marine environment.

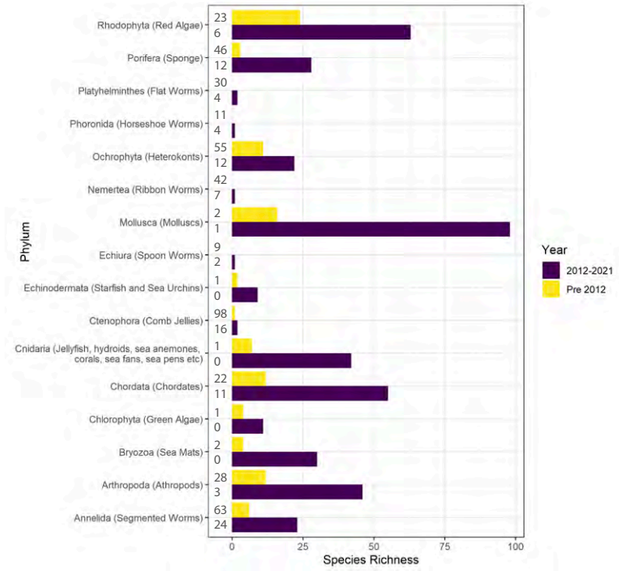

Figure 1 Species richness in each of 17 marine Phyla recorded in Kent since the publication of the State of Kent's Wildlife in 2011

Marine fauna of Kent

The marine fauna of Kent is rich and varied. Approximately 700 species of marine animals are known from Kent, from 17 different Phyla, as outlined in Figure 1. It is undoubtedly the case that most of these groups are under-recorded and that many more species occur around Kent and are yet to be recorded.

Kent's marine fauna includes a number of rare or threatened species which have been highlighted for protection. Twenty-eight of the UK's 275 marine fish are listed as Biodiversity Action Plan priority species, and 15 of these occur around Kent. UK Biodiversity Action Plan priority species found around Kent include:

- Kaleidoscope Jellyfish *Haliclystus auricula*
- Stalked Jellyfish *Lucernariopsis cruxmelitensis*
- Common European Oyster *Ostrea edulis*
- Herring *Clupea harengus*
- Cod *Gadus morhua*
- Whiting *Merlangius merlangus*
- Mackerel *Scomber scombrus*
- Horse Mackerel *Trachurus trachurus*
- Sea Monkfish *Lophius piscatorius*
- Lesser Sandeel *Ammodytes marinus*
- Short-snouted Seahorse *Hippocampus hippocampus*
- Plaice *Pleuronectes platessa*
- Sole *Solea solea*
- Common Skate *Dipturus batis*
- Undulate Ray *Raja undulata*
- Basking Shark *Cetorhinus maximus*
- Tope Shark *Galeorhinus galeus*
- Blue Shark *Prionace glauca*

Common or Harbour Seals and Grey Seals are identified as indicator species for marine ecosystems in the Kent Biodiversity Strategy, and the most notable concentrations are part of the Thames population, with haul-out sites in Sandwich, Pegwell Bay, and the Goodwin Sands. Nationally, Grey Seal population status is favourable, while there is evidence suggesting a decline in Harbour Seals (Special Committee on Seals, 2020).

Table 1 The six Marine Conservation Zone Species Features of Conservation Importance and their location around Kent

Species	Location in Kent
Kaleidoscope Jellyfish *Haliclystus auricula*	A single known site at Westgate, Thanet
Stalked Jellyfish *Lucernariopsis cruxmelitensis*	A few records around Thanet
Tentacled Lagoon Worm *Alkmaria romijni*	In the Thames and Medway
Common European Oyster *Ostrea edulis*	Records scattered all around the county
Defolin's Lagoon Snail *Caecum armoricum*	A single known site, in Lydd's lagoons
Short-snouted Seahorse *Hippocampus hippocampus*	A few scattered records around the county

Six of the 29 MCZ species FOCI are present around Kent and are shown in Table 1.

Status and trends

At the time of writing, there was insufficient resource and capacity within the marine conservation community in Kent to meaningfully update the findings of the last report of this kind for Kent's marine environment (Kent Biodiversity Partnership, 2011), which still provides the most comprehensive baseline available. This baseline is far from complete however, though key information is highlighted in the marine *Drivers of Change* and *Conservation* chapters of this report. Figure 1 provides a comparative analysis of the number of species recorded in each of the 17 marine Phyla in Kent during the current and previous reporting periods. While it would appear that species richness in most Phyla has increased, this comparison likely reflects a disparity in survey effort, far more so than it reflects real change in ecological communities, and is of very limited use for the assessment of community change.

Key habitats and their protection

Kent has a wide and rich variety of marine habitats. Its seabed features some exposed rock reefs, such as those extending out from the chalk cliffs around Thanet and Dover, and the greensand around Folkestone. On the north Kent coast, London clay is intermittently exposed, and at Reculver, blocks of tabular sandstone overlay clay. These relatively stable rock areas support algae on the intertidal and shallow subtidal zones (as far as light penetration is sufficient through the typically turbid water). Around and below low tide the rocks support rich communities of attached animal life.

Coastal and marine chalk is globally scarce, forming less than 1% of the whole UK coastline, and Kent has 35% of this UK resource. The chalk and clay support unusual assemblages of plants and animals, adapted to living on and within the soft rock. In some areas of chalk reef, deep gullies are formed, with shaded overhangs created by scouring of the soft chalk. Further habitat complexity is provided by the periodic falls from the chalk cliffs, depositing large boulders out onto the intertidal. These can support unusual and rich communities of attached animal life on the damp and shaded undersides, featuring sponges, sea squirts and bryozoans in particular.

The soft London clay of north Kent is ecologically distinct from the county's chalk as it lacks the dense canopies of fucoid and kelp algae. Nonetheless, the clay (particularly that at Studd Hill, between Hampton and Tankerton) is of moderate algal species richness. The small outcrop of lower greensand at Copt Point at Folkestone represents a single area of harder natural intertidal rock around Kent and is important in supporting algal communities and species not found on natural surfaces elsewhere around Kent.

Kent seas also hold offshore sand banks, such as those of the Goodwin Sands and Margate Sands complexes, as well as the impressively long and tall sediment formation of the Varne Bank in the Dover Strait. While sandbank sediments are often mobile, they can also harbour many invertebrates and fish, and can be consolidated by beds of mussels and reefs of Ross Worm tubes. Those sandbanks which are exposed at low tide provide remote haul out sites for seals.

Mud and fine sand sea beds occur in the estuary areas of the Thames, Medway, Swale and Pegwell, supporting high numbers of animals living within the sediment. Seagrass beds and extensive saltmarsh formations in the Medway Estuary and the Swale create habitats which support different plant and animal diversity, as well as protected nursery grounds for fish and other species. The saltmarshes of the Medway Estuary and the Swale represent an important component of the algal species and communities of the county, which are often characterised by green algae and the yellow-green algal genus Vaucheria. The saltmarshes also support the red alga *Bostrychia scorpioides*.

In Hythe Bay, stable and unusual communities occur in the subtidal mud, featuring large burrowing animals including Spoon Worms *Maxmuelleria lankesteri,* burrowing shrimps *Callianassa subterranean* and *Upogebia deltaura*, and mats of tiny *Ampelisca* crustaceans. Large areas of Kent's seabed comprise of sediments of varying coarseness overlying rock in varying thicknesses, from thin veneers to deep deposits.

In many places, the bedrock and boulders are intermittently exposed, providing a rich habitat mosaic of stable rock supporting sessile animals, with mobile and burrowing animals living on and within the sediment between. The county's seabed sediment habitats are frequently stabilised with formations of sand tubes constructed by Ross Worms *Sabellaria spinulosa*. These tubes can form a stabilising crust over the sediment seabed, or in certain conditions they can form into reef structures standing several centimetres proud of the seabed and covering large areas.

Sabellaria spinulosa reefs are usually found in subtidal and substantial reefs and have been observed off Thanet, Folkstone and Hythe Bay, but significant formations are present on intertidal chalk around Kent, at Kingsdown, Deal, Dumpton Gap and Birchington on Thanet, representing a habitat and community type not included in the national classification system. These *Sabellaria* formations are delicate, and broken sections and collections of broken tubes are frequently encountered on the seabed.

Blue Mussels are also present around the whole Kent coast, forming often long lived, stable beds on both rock and sediment on the intertidal, and sometimes more ephemeral features in the subtidal. All these types of natural 'biogenic' reef formations provide important habitat and shelter for a range of small species, which in turn provide a food source for larger animals. The many man-made structures that have been constructed and the numerous wrecks that lie around Kent create additional hard habitat features, and can increase biodiversity locally; although in some cases (notably coastal protection on chalk coasts), they can cause the loss of natural habitat and communities. Blue Mussel beds form annually off-shore of juvenile or spat mussel. These are often harvested by fishermen or predated by starfish swarms.

The Marine and Coastal Access Act 2009 presented a long-awaited opportunity to establish an ecologically coherent network of Marine Protected Areas (including new national-level designations, MCZs), to formulate regional marine plans, and to create a Marine Management Organisation and 10 Inshore Fisheries and Conservation Authorities, responsible for planning and managing our seas sustainably.

Biogenic reef habitats are among several of Kent's marine habitats which have been recognised as priority habitats in the UK Biodiversity Action Plan, and more recently for protection as habitat FOCI in the designation of MCZs under the Marine and Coastal Access Act 2009. MCZ habitat FOCI present around Kent include:

- Intertidal chalk – Thanet and Kingsdown to Folkestone
- Subtidal chalk – Thanet and Kingsdown to Folkestone
- Subtidal sands and gravels – widespread around the county
- Mud in deep water, and mud with burrowing megafauna – Hythe Bay
- Sheltered muddy gravels – scattered records, including Thames estuary
- Peat and clay exposures – Folkestone Warren, north Kent, and west of Thanet
- Fragile sponge and anthozoan communities – on subtidal greensand off Folkestone
- Intertidal under-boulder communities – Kingsdown to Folkestone
- Seagrass beds – Medway and Swale (intertidal beds only)
- Ross Worm reefs – records scattered around the county, both intertidal and subtidal
- Honeycomb Worm reefs – subtidal off Folkestone
- Native Oyster beds – north Kent
- Mussel beds – records scattered around the county

The chalk reefs of Thanet, the sand dunes of Sandwich Bay, the shingle of Dungeness, and the sandbanks in the outer Thames, each fall within Special Areas of Conservation under the European Habitats Directive. The Swale, Medway Estuary and Marshes, Outer Thames Estuary, Thanet Coast and Sandwich Bay, and from Dungeness to Pett Level each fall within Special Protection Areas under the European Birds Directive. Sites around Thanet, at Folkestone, and in the Thames, have been identified as Important Plant Areas (Plantlife, 2007). Further detail about MCZs is found in the *Drivers of Change* chapter of this report.

Recording, monitoring and research

Multiple citizen science programmes have been conducted by local marine enthusiasts and conservation organisations to collect data on marine species and habitats in Kent. The Seasearch and Shoresearch projects are coordinated by KWTs marine team, delivered in Kent as part of the Guardians of the Deep project.

Seasearch is a project for volunteer recreational scuba divers who have an interest in what they're seeing under water, and want to learn more about and help protect the marine environment around the coasts of Britain and Ireland. Kent Seasearch was developed

to find out more about the marine wildlife of Kent, as well as to learn more about the various types of seabed habitat.

Shoresearch is The Wildlife Trusts' national citizen science survey of the intertidal shore, and up until 2020, KWT ran a Shoresearch programme. This was a series of survey events throughout the year where a group of volunteers visited selected intertidal sites around the Kent coast to record all the species and habitats they could find. Shoresearch surveys collect vital baseline data and help to achieve The Wildlife Trust's charitable objectives: to promote the conservation and study of nature, educate the public to understand, appreciate and value nature and the need for conservation. The data can be used as evidence in the designation process for MPAs, as well as providing opportunities for monitoring long-term changes in the marine environment, such as the effects of pollution, climate change, and invasive species. It is anticipated that Shoresearch will continue to run in the future.

Another long running survey is the Thames Marine Mammal Survey. Members of the public are encouraged to submit their sightings of marine mammals from the Thames and its tributaries to ZSL to help them better understand their distribution. Alongside these surveys, ZSL conducts annual seal population surveys using aerial, boat and land based transects. These annual surveys have allowed ZSL to map critical habitat for the seals and follow trends in the seal population numbers (ZSL, 2021). Detailed surveys have also been conducted around the coast for major developments, including offshore wind farms.

Figure 2 shows survey coverage of Kent's marine environment between 2011 and 2021. Although there is a fairly focused concentration of surveys in the South East, it is evident that there is an incomplete coverage, and therefore the records likely provide an incomplete inventory of the marine environment.

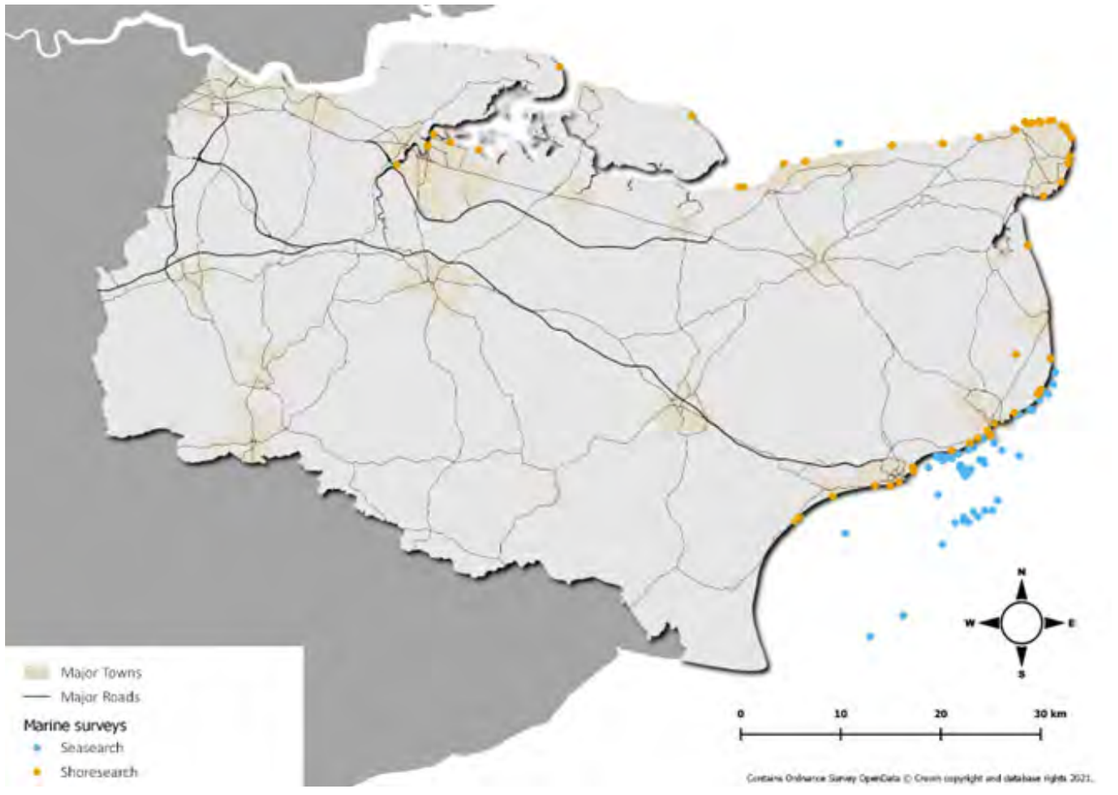

Figure 2 Marine survey coverage in Kent between 2011-2021. Each point represents a survey, though multiple surveys have occurred in some locations and are not reflected in the figure

Conclusion

The compilation of the marine species section of this report was one of the greatest challenges to the editors. The relative infancy of marine biological recording compared to terrestrial biological recording and survey, the relative paucity of data as a consequence, and the recent absence of specialists with sufficient oversight of the overall marine picture of the county, have made updating information on the state of Kent's marine species difficult to achieve. The key message is that while significant developments in marine policy that now provide a framework for designation and protection are encouraging, evidencing and enforcing these will rely on adequate resourcing of survey and data science. Addressing this will be key to the restoration and protection of Kent's coasts and seas for the future.

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KENT'S SEAWEEDS

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Summary

- The Kent coast hosts a moderately rich seaweed flora with 256 brown, green, and red algae of the 650 known for the British flora after removal of 56 uncertain species records; of the 256 species 215 have been confirmed present since 2000. In addition, 9 Xanthophyceae and 2 Prymnesiophyceae, ecologically important, occur in the county.
- Specialist attention is needed to identify many of the microscopic, small, and crustose forms not recorded recently. According to the 2021 Red Data List (RDL) for British seaweeds only <1% are 'Critically Endangered' (CR), 2% are 'Endangered' (EN), 4% are 'Vulnerable' (VU), and 11% are 'Near Threatened' (NT); most (43%) are of 'Least Concern' (LC) whilst 36% are 'Data Deficient' (DD).
- Non-native species form 4% of the Kent seaweed flora. Of 12 non-native seaweeds in Kent, two are causing major changes in community structure; their eradication is near impossible.
- The Thanet, South Foreland to Dover, and Folkestone seashores are the most species-rich and thus the key habitats for seaweeds in Kent with the South Foreland to Dover coast having the most threatened species in Kent.
- Whilst historical evidence shows that most rocky shore seaweed communities have long been present, there is concern that climate change and raised sea temperatures may bring about changes in species dominance.
- Natural and anthropogenic processes are the main drivers of change with increased sea temperature and sea-level rise exerting impacts now and into the future.
- Physical changes to the Kent coast have had negative and positive impacts with the loss of natural habitats and their algal communities but the gain of man-made habitats and increased seaweed biodiversity.
- Continuing floristic and ecological study, whether by professionals or by citizen scientists, is essential to monitor the state of Kent's seaweeds and changes that may occur around the coast and reduce the extent of data deficiency in our knowledge of Kent's seaweed flora.

Seaweed flora of Kent

Seaweeds or marine algae are photosynthetic eukaryotic organisms that vary in morphology from microscopic single cells and simple filaments to large and more structurally complex forms. Seaweeds as primary producers are important in sea water oxygenation, carbon capture, structuring habitats for marine fauna as well as providing ecosystem services for humankind.

Table 1 Algal phyla

Phylum		
Rhodophyta		Red algae
Chlorophyta		Green algae
Ochrophyta	Phaeophyceae	Brown algae
	Xanthophyceae	Yellow green algae
	Prymnesiophyceae	

Botany Bay Keystone species *Prymnesiophyceae*

Channelled wrack *Pelvetia canaliculata*

The *New Atlas of the Seaweeds of Kent* (Tittley, 2016) itemised 306 species (since increased to 312) of brown, green, and red algae for Kent (almost half of the British flora) and two Prymnesiophyceae; nine Xanthophyceae were not included; the changed total reflects new discoveries and revised taxonomy. Two hundred and fifteen species have been confirmed since 2000; those missed are the small or microscopic forms which are often ephemeral, easily overlooked, and difficult to identify. Of the 215 species recorded since the millennium, most are temperate occurring widely in the UK.

A consensus map of the Kent seaweed flora (Figure 1) shows increasing species richness from the low salinity reaches of the Thames and Medway estuaries to greatest richness on the open-sea coasts of Thanet and Dover/South Foreland and Folkestone. The geologically soft North Kent coast to the west of Thanet supports fewer species whilst the sand and shingle coasts are too mobile for algal settlement. Man-made structures are habitats that enhance algal richness and facilitate dispersal.

Historical, doubtful, and provisional records account for 56 of the 312 species listed for the county. Assignment of Red Data List (RDL) threat categories for the seaweeds of Britain (Brodie et al., 2021) to the remaining 256 in Kent reveals that only <1% are 'Critically Endangered', 1.5% are 'Endangered', 3.5% are 'Vulnerable' and 11% are 'Near Threatened'. The majority are of 'Least Concern' (43%) although 36% of the flora is 'Data Deficient' (Figure 2). Fourteen algae (excluding Prymnesiophyceae and Xanthophyceae for which there is no RDL data) are keystone community characterising species. Fifty-four 'faithful' species are consistently present among the keystone communities of which 11% are in the more threatened RDL categories (CR, EN, VU, NT; Figure 3) whilst three-quarters are 'Least Concern'. Based on area of occupation (4, 2.25% coastal tetrads or less) 92 species have been provisionally assessed as priority rare or restricted in Kent but only 7 (7.5%) are nationally in the most threatened RDL categories (CR, EN, VU); most species are 'Data Deficient' (57%) and the remainder are 'Near Threatened' (10%) and 'Least Concern' (25%) (Figure 4).

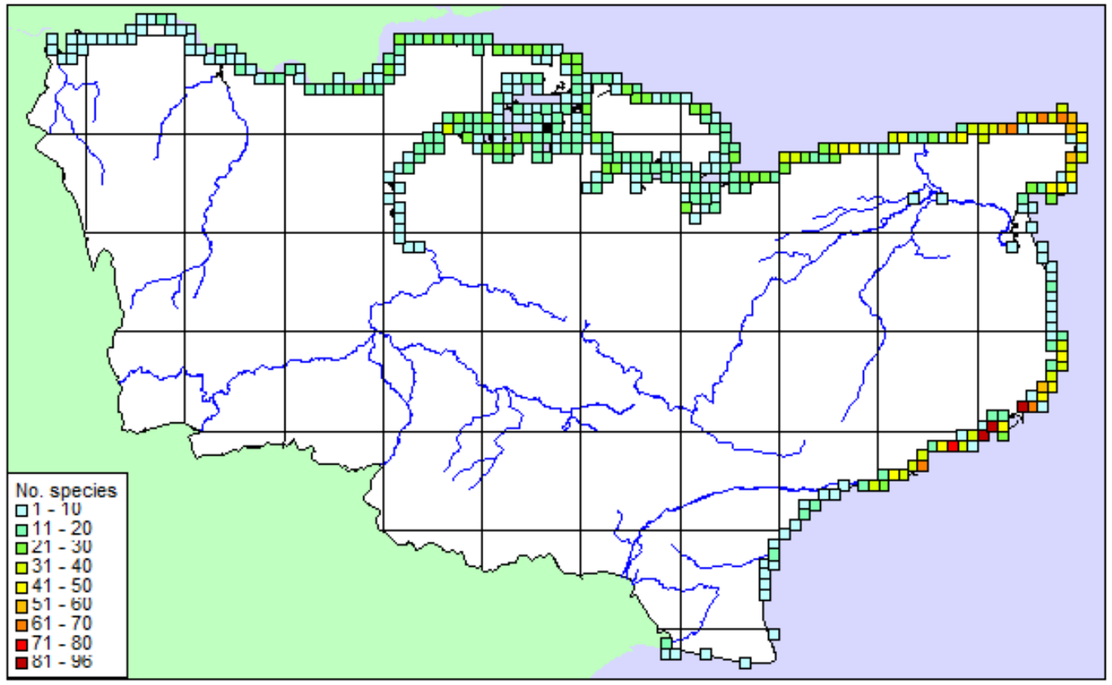

Figure 1 Species richness of seaweeds in Kent by monad (from Tittley, 2016)

Status and trends

Species lost

Forty-six species recorded in the 20th Century have not been found since 2000; most (38) are rarities. Their absence reflects sampling and identification challenges rather than environmental or habitat change although perhaps the absence of *Feldmannia irregularis* and *Kuetzingiella holmesii* may be due to the loss of chalk cliff habitats on Thanet.

Species gained

Since the millennium, 25 species have been found new to Kent (Table 2), with others awaiting confirmation. Of these, two are 'Endangered' and one 'Vulnerable', the majority are of 'Least Concern' and 'Data Deficient'. Many species show eastward extensions in range along the south coast *(cf. Hardy & Guiry, 2006)*. The appearance of occasional *Himanthalia elongata* may be due to fertile drift material washed on to Kent shores underlining the importance of drift as a vector in dispersal. Man-made structures create environments for species, e.g., the nationally 'Endangered' red alga *Dasya ocellata*, otherwise absent on natural shores.

Keystone community characterising species

Five of the keystone species listed in Table 3 are 'Near Threatened' and the remainder 'Least Concern' and 'Data Deficient'. Keystone species have long been present on the Kent coast; Tittley (2016, Figure16) showed that the earliest seaweed records for Kent at Margate almost 400 years ago are those that today characterise the intertidal communities. These will persist providing natural coastal processes continue and the sites are not seriously disturbed by human activities. Seawalls and promenades, now enclosing 80% of the Thanet coastline (Fowler & Tittley, 1993), have restricted the chalk cliff and cave inhabiting communities to a few sites. Table 3 shows that despite concern for some keystone species, all listed remain present in Kent since 2000.

The Channel Wrack *Pelvetia canaliculata* (nationally 'Near Threatened') is rare in Kent and south-east England although widespread in Britain; it occurs only on Lower Greensand rocks at Copt Point, Folkestone. *Ascophyllum nodosum* nationally 'Least Concern' on natural rocky shores, is restricted to Copt Point but is spreading widely in North Kent colonising man-made habitats (Tittley, 2016 Figure 17; Tittley, 2018, 2019). At Copt Point only, it hosts an obligate algal

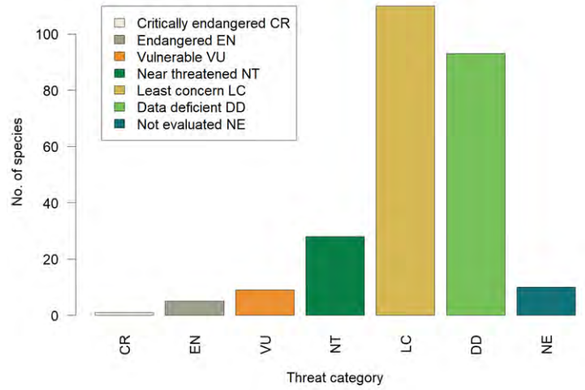

Figure 2 Frequency of Kent's seaweed species in Red Data List categories. CR = Critically endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern; DD = Data Deficient; NN = Non-native.

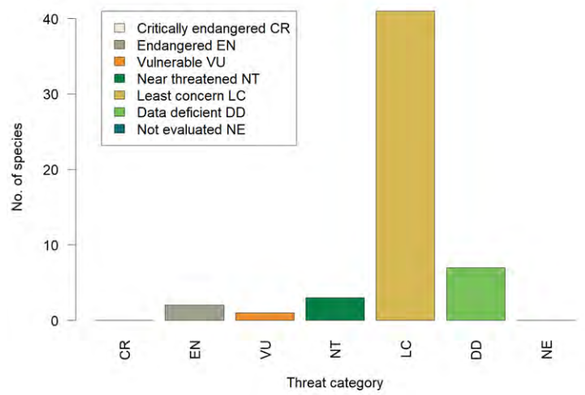

Figure 3 Frequency of Kent's seaweed species in Red Data List categories for 'faithful species' (those consistently present among keystone communities) of the Kent seaweed flora


Oarweed *Laminaria digitata*, South Foreland

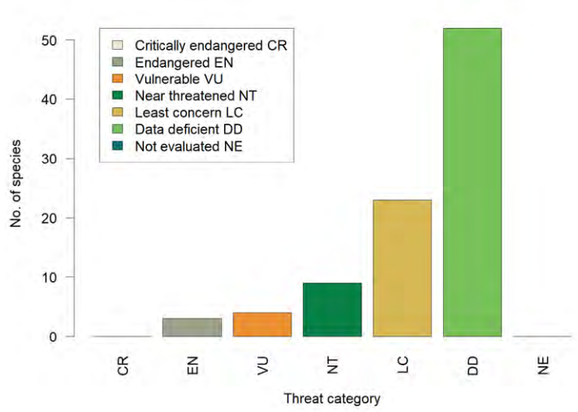

Figure 4 Frequency of Kent's seaweed species in Red Data List categories for priority rare species

Table 2 Seaweeds species new to Kent since 2000

Species R = Rhodophyta [red algae] C = Chlorophyta [green algae] P = Phaeophyceae [brown algae]	No. of tetrads	Comment and distribution	GB Red Data List status
R: *Acrochaetium corymbiferum*	4	Few UK records, first for SE England	DD
R: *Aglaothamnion pseudobyssoides*	8	Few UK records, first for SE England	DD
R: *Antithmnion villosum*	4	East extension in range along the south coast	LC
R: *Ceramium cimbricum*	8	East extension in range along the south coast	DD
R: *Ceramium secundatum*	3	East extension in range along the south coast	NT
R: *Corallina caespitosa*	2	Only recently recognised as a species separate from C. officinalis; few UK records, first for SE England	LC
R: *Dasya ocellata*	1	East extension in range along the south coast	EN
R: *Griffithsia devoniensis*	1	East extension in range along the south coast	NT
R: *Lomentaria orcadensis*	1	East extension in range along the south coast	LC
R: *Peyssonnelia harveyana*	2	East extension in range along the south coast	DD
R: *Plocamium lyngbyanum*	1	Only recently recognised as a species separate from P. cartilagineum; widespread in UK	DD
R: *Spyridia griffithsiana*	1	East extension in range along the south coast	DD
C: *Rosenvingea radicans*	7	First records for SE England; widespread in UK	LC
C: *Ulothrix implexa*	14	First records for SE England; widespread in UK	LC
C: *Ulothrix subflaccida*	12	First records for SE England; widespread in UK	LC
C: *Ulva pseudocurvata*	2	First records for SE England; poorly known in UK	DD
P: *Chilionema ocellatum*	1	First record for SE England; poorly known in UK	DD
P: *Desmarestia aculeata*	1	East extension in range along the south coast; first record for SE England	VU
P: *Desmarestia ligulata*	4	East extension in range along the south coast; first records for SE England	LC
P: *Himanthalia elongata*	2	East extension in range along the south coast; first records for SE England	LC
P: *Leptonematella fasciculata*	1	First record on the south coast	DD
P: *Microspongium globosum*	1	First record for SE England	DD
P: *Stictyosiphon griffithsianus*	1	East extension in range along the south coast; first record for SE England	DD
P: *Stilophora tenella*	1	East extension in range along the south coast; first record for SE and E England	LC
P: Tilopteris mertensii	1	East extension in range along the south coast; first record for SE and E England	EN

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epiphyte, *Vertebrata lanosa*, which in turn bears an obligate algal parasite *Choreocolax polysiphoniae,* both priority rare species in Kent. The status of canopy forming *Fucus serratus* is unclear; Yesson *et al.* (2015) detected its decrease in the eastern English Channel over the past four decades and Tittley (2020) revealed its disappearance over the past half century at Botany Bay, Thanet. By contrast, data for Margate have demonstrated its presence for four centuries (Tittley, 2016) and monitoring near Dover revealed an increase in cover (Tittley *et al.*, 2017). There is a long historical record of kelp (principally *Laminaria digitata)* on Kent's chalk and Lower Greensand shores at low tide level to 10 m depth; populations remain stable (Yesson *et al.*, 2015) but nonetheless nationally considered 'Near Threatened'.


Sea Mare's-tail *Halurus equisetifolius*, Shakespeare Cliff

Table 3 Keystone community characterising species present in Kent before and after 2000

Species	Habitat	Presence 2000 to date	Presence pre-2000	Kent Concern	GB red Data List status
Prymnesiophyceae *(Chrysotila stipitata; Ruttnera lamellosa)*	Upper intertidal fringe chalk cliffs and caves	√	√	High	---
Pilinia rimosa	Upper intertidal fringe chalk cliff caves	√	√	High	DD
Pelvetia canaliculata	Upper intertidal Lower Greensand rocks	√	√	Medium	NT
Fucus spiralis	Upper intertidal rocks and sea walls	√	√	Low	LC
Fucus guiryi	Upper intertidal rocks and sea walls		√	Low	LC
Fucus vesiculosus	Middle shore rocks and sea walls	√	√	Low	LC
Ascophyllum nodosum	Middle intertidal lower greensand rocks* and sea walls	√	√	High* Low	LC
Fucus serratus	Middle and lower intertidal rocks	√	√	Low	LC
Osmundea pinnatifida	Middle intertidal wave-exposed chalk shores turf forming	√	√	Low	LC
Gelidium pusillum	Middle intertidal wave-exposed chalk shores turf forming	√	√	Low	LC
Corallina officinalis	Mid shore pools	√	√	Low	NT
Halidrys siliquosa	Middle and low intertidal deep pools	√	√	Medium	NT
Rhodothamniella floridula	Lower intertidal chalk shores, silt and sand binding and cushion forming	√	√	Low	LC
Palmaria palmata	Low intertidal, subtidal fringe	√	√	Low	LC
Laminaria digitata	Low intertidal fringe, subtidal	√	√	Low	NT
Bostrychia scorpioides	Middle intertidal saltmarsh, and estuary sea walls	√	√	Medium	NT
Xanthophyceae *(Vaucheria spp,)*	Middle intertidal saltmarsh and estuary sea walls	√	√	Medium	---

As elsewhere in Britain saline wetlands historically formed much of the coastline of North Kent but which have been drained and claimed or lost through erosion. Channels in the remaining saltmarsh continue to be lined by *Vaucheria* spp whilst green algae grow in damp areas between halophytes. The nationally 'Near Threatened' red alga *Bostrychia scorpioides* characterises a community mostly epiphytic on halophytes; in the Thames estuary it also occurs on halophytes growing on sea walls.

Non-native and invasive species

The spread of non-native seaweeds into Kent is of national concern (Tittley, 2015). Eleven have been found in the county, mostly since 2000 (Table 4), having spread from neighbouring areas. Eight have had little impact and have been recorded only on a few occasions. Management of the most impactful species is impractical, although attempts have been made to clear *Sargassum muticum*.

Grateloupia turuturu, was first found on harbour marinas but is now common along the coast of North Kent and continues to spread. Plants over 1 m long are washed ashore while smaller plants grow in pools and standing water. Its impact on marine communities requires further study; Irvine & Farnham (1983) noted that *G. turuturu* flourishes in high water temperatures (to 25^{0}C) and near sites of organic pollution. The mossy *Caulcanthus okamurae* has become a constituent of the algal turf community and locally dominant. *Sargassum muticum,* the most obvious non-native seaweed in the Kent coast, is now the dominant species in pools and lagoons as blanketing growths. Both *Caulacanthus okamurae* and *Sargassum muticum* crowd out native species. The kelp-like *Undaria pinnatifida* is known only on harbour marinas and a navigation buoy.

Herne Bay Neptune's Arm breakwater Habitat gain

Table 4 Non-native seaweed species known to occur in Kent

Species	First recorded in Kent	Habitat	Kent Impact
R: *Antithamnionella spirographidis*	1926	Low intertidal and subtidal; on harbour marinas, buoys and other substrata	Low
R: *Asparagopsis armata (tetrasporophyte)*	2006	Low intertidal; epiphytic	Low
R: *Bonnemaisonia hamifera (tetrasporophyte)*	2007	Subtidal; epihytic, tidal swimming pool	Low
R: *Caulacanthus okamurae*	2009	Intertidal; turf forming in wave washed locations, cliffs and artificial structures, epiphytic on Fucus	High
R: *Grateloupia turuturu*	2006	Intertidal pools and lagoons. subtidal, harbour marinas, buoys, sea-bed stones and cobbles	Medium
R: *Melanothamnus harveyi*	post 2000	Mid shore pools. epiphytic and epilithic	Low
R: *Neopyropia leucosticta*	2007	Middle to low lintertidal	Low
C : *Codium fragile ssp. Fragile*	1985 c.2010	Drift (1985); tidal swimming pool (c.2010)	Low
P: *Colpomenia peregrina*	2012	Drift; epiphytic	Low
P: *Sargassum muticum*	1988	Middle to low intertidal pools and lagoons; subtidal, rafting attached to stones and shells	High
P: *Scytosiphon dotyi*	Before 1987	Upper intertidal, vertical rock faces	Low
P: *Undaria pinnatifida*	2004	Subtidal harbour marinas, buoys	Low

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Key habitats and their protection

Three locations and their habitats are of importance as the most species rich in Kent, where most rare species occur, and the best of their kind in the region: intertidal and subtidal chalk on Thanet; intertidal and subtidal chalk around the Dover area; intertidal and subtidal Lower Greensand around Folkestone. They are recognised as Important Plant Areas (Brodie *et al.*, 2007) and Sites of Special Scientific Interest (SSSI) (Thanet Coast SSSI, Dover to Kingsdown Cliffs SSSI, Folkestone Warren SSSI). Chalk reefs and cliffs are key features of the Thanet Coast Special Area of Conservation (SAC); the proposal for the Thanet coast to be a Highly Protected Marine Area (HPMA) would ensure greater habitat protection. Intertidal and subtidal chalk is a 'Feature of Conservation Importance' (FOCI) for Marine Coastal Zone (MCZ) recognition (Natural England & Joint Nature Conservation Committee, 2010) although subtidal chalk was not included as a protected feature in the Dover to Folkestone MCZ whilst recognised in the Folkestone Warren SSSI designation. Intertidal Lower Greensand habitats are protected as the 'Broad-scale habitats' (NE & JNCC, 2010) 'High energy intertidal rock' and 'Moderate energy intertidal rock' whilst, as for chalk, subtidal Lower Greensand is not protected by the MCZ although recognised a SSSI feature. According to Brodie *et al.* (2021), the hectad (10 x 10 km grid square) encompassing the South Foreland and Dover stretch of coast contains the most threatened ('Critical', 'Endangered', 'Vulnerable') species in Kent. Intertidal and subtidal chalk, and intertidal mudflats and coastal saltmarsh are priority habitats listed in the *Kent Nature Partnership Biodiversity Strategy*.

Table 5 Key habitats for seaweeds in Kent

Habitat	Species	Reference study sites	MCZ	SAC	SSSI
Chalk cliffs	*Chrysotila stipitata* *Ruttnera lamellosa*	Epple Bay (SAC) Botany Bay (SAC) Kingsgate Bay (SAC) Pegwell (SAC)	Thanet Coast	√	Thanet Coast
Chalk caves	*Pilinia rimosa*	Botany Bay (SAC) Kingsgate Bay (SAC)	Thanet coast	√	Thanet Coast
Intertidal chalk	*Fucus vesiculosus* *Fucus serratus* *Halidrys siliquosa* *Gelidium pusillum* *Osmundea pinnatifida* *Rhodothamniella floridula* *Palmaria palmata*	Epple Bay (SAC) Fulsam Rock (SAC) White Ness (SAC) Dumpton Gap (SAC) Hackemdown Point St Margaret's Bay Langdon Bay (DHB) Shakespeare Cliff (DHB) Abbot's Cliff	Thanet Coast Dover to Deal Dover to Deal Dover to Folkestone Dover to Folkestone	√	Thanet Coast Dover to Kingsdown Dover to Kingsdown Folkestone Warren Folkestone Warren
Subtidal chalk	*Laminaria digitata* *Laminaria hyperborea*	St Margaret's Bay	Dover to Deal		Dover to Kingsdown
Intertidal Lower Greensand rock	*Pelvetia canaiculata* *Ascophyllum nodosum*	Copt Point	Dover to Folkestone		Folkestone Warren
Subtidal Lower Greensand rock	*Laminaria digitata* *Chorda filum* *Desmarestia aculeata* *Desmarestia ligulata*	Copt Point/East Wear Bay	Dover to Folkestone		Folkestone Warren
Saltmarsh	*Bostrychia scorpioides* *Vaucheria spp*		Swale Estuary Medway Estuary		

Drivers of change

Habitat loss

Natural and anthropogenic processes have altered the Kent coast. Most noticeable has been the loss of saline wetland and its associated algal communities. Significant habitat loss has occurred on Thanet where the chalk coastline has been enclosed by sea walls and promenades with the loss of cliff and cave habitats.

Habitat gain

Man-made habitats are now of algal biodiversity significance and have contributed to an increase in species occurrence and widened species distributions. Over half of the seaweed flora recorded since 2000 occurs in man-made habitats with floating habitats the most species rich (Table 6). The post-glacial sinking of south-east England has facilitated the upriver spread of marine algae along sea and river walls along the Thames Estuary (Tittley, 2014). Offshore wind farms around Kent are also habitats for marine algae but remain un-investigated.

Climate

Sea temperature has increased by around 1°C during the past half century and is likely to be the cause of the decrease in abundance of *Chorda filum*, *Fucus serratus*, *Laminaria hyperborea* and *Saccharina latissima* in the eastern English Channel (Yesson *et al*. 2015). The eastward extension of species range along the south coast to Kent may reflect elevated sea temperature.

Sea-level rise

Sea-level has risen around the Kent cost due to the land sinking caused by isostatic rebound. Today, climate change is adding to sea-level rise and causing coastal squeeze and reduction in extent of communities. Tittley (2020) estimated that during 50 years of study at Botany Bay sea-level has risen 150-225 mm and that by 2066 there will be 16-25% less intertidal area.

Ocean acidification

Increased amounts of carbon dioxide in the atmosphere are causing the oceans to become more acidic and therefore the coralline algae to be corroded and outcompeted and could disappear (Brodie *et al.*, 2014); particularly sensitive are juvenile stages and the delicate epiphytes on sea grasses and larger algae.

Non-native species

Eleven non-natives have spread to Kent mostly since the millennium. Of these two have exerted a major impact on intertidal communities with *Sargassum muticum* now the dominant species in rock pools, lagoons and standing water and mossy growths of *Caulacanthus okamurae* now a component of the algal turf and in places the dominant species.

Table 6 Seaweed species recorded in man-made habitats in Kent (Tittley, 2016)

Man-made habitat	Total
Floating pontoons and harbour marinas	73
Buoys	45
Tidal swimming and boating pools	55
Groynes	32
Sea walls	43
TOTAL all habitats	114

Public pressure and concerns

Seaweed foraging is a fashionable activity with professionals harvesting seaweed under licence in a non-damaging and sustainable manner; of more concern is uncontrolled foraging for personal consumption.

Macroscopic species of Chlorophyta in dense blooms ('Green-tides') that occur in sheltered parts of the Medway estuary are the result excess nutrient loading in inshore waters and constitute an ecological problem. Methods have been developed recently that predict where and when green algal blooms will occur (Aldridge & Trimmer, 2009). The decay of blanketing algal mats over soft intertidal sediments impacts the local ecosystem by causing anoxic conditions to the detriment of underlying sediment dwelling invertebrate communities.

Drift seaweed washed on to Kent's beaches is perceived by residents and visitors as unsightly and unpleasant when decaying and local authorities clear it from beaches during the holiday season. Drift weed, however, is ecologically important by harbouring flies and other invertebrates that are an important food source for Turnstones and other sea-shore birds and is left to remain during the winter period (cf. Natural England, 2010).

Gutweed and Sea Lettuce *Porphyra umbilicalis* Nayland Rock

Recording, monitoring and research

Algae have been recorded continuously since the late 16th Century creating a historical record and glimpses of the past flora (Tittley, 2016). More recently, national museums and universities have undertaken floristic, taxonomic, and ecological research in the county. In the 1980s the Kent Wildlife Trust set up the 'Kent Marine Group' for volunteer recorders that later morphed into 'Shoresearch' and 'Seasearch' whose remit was in part to train volunteers in the identification of the key seaweeds. Data gathered during regular field meetings have been deposited at the Kent and Medway Biological Records Centre. From the mid-1990s to 2011 regular field monitoring was undertaken in the Thanet coast SAC at key reference study sites (Tittley *et al.*, 2012) whilst from 2006 Dover Harbour Board has undertaken monitoring at key reference study sites in the Dover area (Tittley *et al*., 2017). The author, an algal specialist at the Natural History Museum, has conducted research since the 1960s, culminating in an atlas of historical and post millennium data based on 14,000 seaweed records. The maps reveal changes in occurrence and distribution.

Taxonomic research and changes to the Kent seaweed flora

The relatively recent advent of molecular taxonomic studies has led to a revolution in the understanding of the processes for the maintenance, transmission, and expression of genetic information. For the Kent seaweed flora this has resulted in some major changes at various taxonomic levels. Examples can be shown for all shore levels. At the upper intertidal fringe on chalk cliffs and in caves the six formerly recognised species of Prymnesiphyceae have been reduced to two. The larger brown alga *Fucus spiralis* which grows on upper intertidal rocks and sea walls encompasses two species *F. spiralis* and *F. guiryi*; the former inhabits the uppermost shore level whilst the latter grows at lower levels on the upper shore. At middle shore levels until recently Purple and Black Laver (*Porphyra purpurea, P. dioica*) were identified as a single species whilst the rock-pool characterising *Corallina officinalis* has been shown to be two species (*Corallina officinalis* and now *C. caespitosa*). At low shore and subtidal levels, the genus *Plocamium* in Britain has increased from one to three species two of which *P. cartilagineum*, and now also *P. lyngbyanum,* occur in the county. Further changes are to be expected as research progresses.

Conclusion

The Kent coast hosts a moderately rich seaweed flora of 256 accepted species. Although only a small proportion of the Kent seaweed flora is of high national Red Data List status, careful management of the coast and its inshore waters is required to ensure these species survive in the county and to ensure that the Thanet, Dover, and Folkestone areas remain important areas for algal biodiversity. Man-made structures on and around the coast create habitat for seaweeds, enhancing algal biodiversity and facilitating dispersal. Accompanying the marine transgression into the Thames and Medway estuaries a continuing inward spread of seaweeds is expected and increased species richness. Unfortunately, climate change and increased water temperature and rise in sea level will exert a significant impact on intertidal areas and associated seaweed communities as will increased sea temperature with the spread of warm water to Kent from the west. Stormier seas may cause a shift in community structure from brown algal canopies to an algal turf. These concerns and our still data deficient knowledge of Kent's seaweed flora demonstrate the need for continued monitoring and study.

Ramsgate Chalk cliff and caves
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Copt Point Folkestone, Lower Greensand reef
© Ian Tittley

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