A review of the status of the sawflies of Great Britain

Phase 2: The Athaliidae and the Tenthredinidae (excluding Nematinae)

Andy Musgrove, March 2023

Summary

Data pertaining to the occurrence of 224 species of sawflies in Britain were collated and assessed against IUCN Red List criteria in order to categorise each species in terms of national threat status. The species included all species of the family Tenthredinidae with the exception of the subfamily Nematinae, and the recently constituted family Athaliidae.

Of the species under consideration, five were assessed as being Regionally Extinct, five Critically Endangered, six Endangered and 11 Vulnerable. The GB Rarity Status of the same species was assessed at the same time, with 18 species classed as Nationally Rare and seven as Nationally Scarce. A full justification of the conclusions reached is provided, alongside discussion of the methodology used and a rationale for the assessment of each individual species.

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1 Introduction

1.1 GB-level IUCN Red Lists for GB invertebrates

The UK government's 25 Year Environment Plan includes commitments to:

- take 'action to recover threatened … species of animals, plants and fungi'
- 'where possible to prevent human-induced extinction or loss of known threatened species'
- 'improve the overall status of declining species groups'

Moreover, the Plan notes that a relevant indicator for measuring its impact is one based on 'status and trends of wild species' and it is now agreed that a GB Red List Index will be one of indices used to track the effect of implementing the 25 Year Plan.

These commitments clearly require a sound understanding of the status of all species in GB, including an understanding of which species are threatened. The internationally recognised, objective approach to describing threat is by assigning each species to one of the International Union for the Conservation of Nature (IUCN) threat categories and collating these into a 'Red List'. Red Lists can be compiled at global or regional/national levels. Categorisation is a strictly defined process, in order to ensure traceability, comparability and repeatability. The current categories and criteria as well as guidelines for assigning species to the threat categories were set out in 2001 and are published by IUCN (2012a, 2012b, 2019).

Webb & Brown (2016) describe work by then undertaken to assess the extinction risk faced by some 3768 British invertebrates (about 10% of the total number of terrestrial and freshwater invertebrate species in Britain). Since then, further reviews have been published embracing approximately 3,500 more species, but there remain some significant gaps in coverage. Of the 'better-known groups' of British invertebrates, Webb & Brown (2016) noted that the most species-rich group that had never had a conservation status review undertaken (IUCN or otherwise) was the sawflies or 'Symphyta'.

Although sawflies were traditionally considered one of the two suborders of the Hymenoptera, they are now generally considered to comprise a paraphyletic grouping. For example, Peters *et al*. (2017) designates a clade of Eusymphyta comprising the majority of the sawflies, whilst including the endophagous groups (Xiphydriidae, Siricidae, Cephidae, Orussidae) within the larger Unicalcarida clade alongside all other Hymenoptera. Despite this, 'Symphyta' is still a useful and widely recognised term to refer to the group known as sawflies. British sawflies are divided into 13 families, with about 80% of species in the largest single family Tenthredinidae. A recent published British & Irish checklist of sawflies (Liston *et al.* 2014) lists 537 species, and a few more have been found subsequently, bringing the total now to over 550 with more likely to appear in the years to come. This species total is similar to that for the far-better studied aculeate Hymenoptera.

There has been virtually no conservation policy or action in the UK directed at sawflies, apart from a few mentions as interest features on some Sites of Special Scientific Interest in Wales and Scotland. Yet many sawflies appear to be rare, range-restricted and declining whilst others are of immense economic concern, notably those which are regarded as pests of trees and arable crops. No sawflies are listed on the widely used and definitive JNCC spreadsheet of species conservation designations. A GB-level IUCN Red List for sawflies will alter our understanding and appreciation of this group and enable us to identify those for which we ought to have conservation concern, alongside other better-known insect groups.

The process of undertaking IUCN Red List assessments is well covered elsewhere (e.g. IUCN 2012a, 2012b, 2019). In short, available data are collated, summarised to produce standard metrics and compared against strictly defined criteria in order to determine which Red List category a species should have assigned to it. Issues that arose relating to assessing the available sawfly data within this framework are fully discussed below.

1.2 GB Rarity Status for invertebrates

It is important to recognise that threat and rarity are not the same thing. Whilst IUCN threat assessments are now the most important means of describing the conservation status of GB invertebrate (and all other) species, it remains useful to identify species with a restricted geographic distribution within Great Britain; species apparently occurring between 1-15 hectads of the national grid are defined as Nationally Rare whilst species occurring between 16-100 hectads are defined as Nationally Scarce. These measures are not IUCN categories, but they can be determined most readily during the data collation and analyses required for IUCN assessments and so most recent GB Red List reviews also identify those which are Nationally Rare and Nationally Scarce.

1.3 Phases of the Review

Phase 1 of the review has previously been published (Musgrove 2022). Data pertaining to the occurrence of sawflies (excluding the families Tenthredinidae and Athaliidae) in Britain were collated and assessed against IUCN Red List criteria in order to categorise each species in terms of national threat status. Of 111 species under consideration, six were assessed as being Regionally Extinct, three Critically Endangered, three Endangered and six Vulnerable. In addition, the GB Rarity Status of the same species was assessed at the same time, with 24 species classed as Nationally Rare and 11 as Nationally Scarce. A full justification of the conclusions reached was provided, alongside discussion of the methodology used.

The current document describes phase 2 of the review, covering the family Athaliidae and all of the family Tenthredinidae save only for the subfamily Nematinae. Phase 3 is intended to cover the Nematinae.

2 Methods

2.1 Data collation and management

2.1.1 Data sources

At the outset of work for the review there was no active recording scheme nor complete national dataset for sawflies. Hence, data pertaining to the relevant groups of sawflies were sought from iRecord, the National Biodiversity Network (NBN) Atlas, all Local Environmental Records Centres, county sawfly recorders and key individual recorders, the latter being contacted directly and/or alerted to the project through social media and printed newsletters and journals. These data were added to a compiled dataset collated about ten years previously by Guy Knight.

It should be noted that a number of data contributors made available records relevant to phase 2 when providing phase 1 data. All such contributors were invited to contribute any updated datasets for phase 2 and many did so.

Museum collections would be a very valuable source of (mostly) older data. However, most museum collections remain uncatalogued and the time/resource to undertake such a task was not within the scope of the current review.

2.1.2 Data verification and deduplication

It was recognised from the outset that establishing the veracity of each individual sawfly record was never going to be possible. Many records are old and are provided 'as is', with no means of verification. Whilst many older records may still be supported by extant specimens in collections around Britain, it was not practical to visit collections to check every specimen. On the other hand, many recent records have been provided via online channels with accompanying photographs of sufficient quality as to be able to verify identification. In practice, a mixed approach had to be adopted.

Firstly, any descriptions of verification status that had been provided along with the record were considered carefully and for the most part followed. In particular, records from iRecord that had been assessed as 'not accepted' were not incorporated, whilst those that were 'plausible' or 'not reviewed' were considered on a species-by-species basis.

Secondly, a proportionate approach was taken to checking and deduplicating individual records, based on the volume of data per species. For example, it was impractical (and indeed unnecessary) to examine closely over 5,000 records of *Athalia rosae*, but it was entirely feasible (and indeed important) to look over every individual record of those species with only a small number of records. In the end, 68 species were examined and deduplicated more carefully.

However, for the purposes of IUCN and GB rarity status assessments, deduplication of widespread species is not required, given that the key metrics rely on 'distinct' combinations of grid squares over time (e.g. five records from the same place in the same year will only 'count' as one). The same could be said for the rarer species also, but in those cases, the extra attention to detail was deemed

important, given that assigning different categories can be strongly influenced by just a handful of records in some cases.

In terms of applying a level of verification assessment to individual records of the rarer species, a case-by-case assessment had to be made, based on a combination of location (compared to the range represented by other records), identification difficulty, changes in taxonomic opinion over time (which can be very significant), experience of the recorder and/or determiner, and so on. Such assessments will never be perfect, but were considered sufficient as to enable a robust assessment of status.

2.1.3 Data management

Particular attention was given to constructing a robust system of data management. This was because it was recognised that data would continue to be provided late into the process and it would not be possible to wait for all data to be provided before embarking on analyses and assessments. The steps required to generate the metrics necessary for undertaking the review are relatively complex and would be laborious to repeat in a manual way, hence as much of the process as possible was coded to enable rapid repetition when new data was received. The current second phase of the review benefited from re-using the data management system originally constructed for phase 1, updated where required.

The process was broadly as follows:

Individual datasets were mostly received as Excel files. No (or absolute minimal) manipulation of these files was undertaken, to avoid carrying out actions that might be missed in future should the dataset need re-loading. The datasets were saved as comma-separated text files.

The open source database system MySQL (version 8.0) was used to create a data management environment. Each dataset was loaded into the database, into an individual 'pre' table (e.g. pre_irecord, pre_norfolk, etc). Retaining each dataset as a separate table at this point enabled the wide variety of different data fields used for different systems to be retained easily for future use, without manual manipulation within Excel each time.

Initial data cleaning steps were undertaken for each dataset, to leave each with a consistent set of fields for date_from, date_to, date_type, year2use and gridref. All data cleaning steps were written as SQL statements to enable re-use in a consistent manner.

For each dataset, the scientific names used for the taxa were compared with a definitive checklist and used to continually build up a 'translation' table. This meant that taxon names could be retained in the 'pre' tables but that it was always then possible to map them onto their currently recognised taxonomic units.

For each dataset, a 'working' table was then created which included only the following fields: taxon, year, location_name, gridref, grid10km, grid2km, grid1km. The last three of these fields were constructed from the original grid reference where the resolution of the latter made it possible.

The 'working' tables for each dataset were then combined into a single 'working_combined' table. The source of each record was retained in the combined dataset. Two further fields were also created at this point. Firstly, for every record, a 'pseudotetrad' field was populated (preferentially) with the actual tetrad (2-km square) where this was possible (i.e if the spatial resolution of the

record was 2-km or finer) or, where this was not possible, with the middle tetrad of the relevant 10-km square (e.g. TM29M). The pseudotetrad approach was developed in order to enable certain important metrics to be generated for assessment against IUCN criteria (see below). Secondly, the grid references were compared against a lookup table to determine the best match in terms of country – i.e. England, Wales, Scotland, or where necessary, cross border England_Wales or England_Scotland.

Standard extracts were then produced for importing into QGIS for the determination of some area measurements, notably the calculation of Extent of Occurrence (EOO) over shorter time periods, requiring the construction of an 'alpha hull' concave polygon. For each combination of taxon and period (e.g. 'Athalia_rosae_07_21'), every associated pseudotetrad (see above) was extracted. A similar extraction was made for the purpose of deriving adjusted GB rarity status measures.

To enable investigation of the effect of shifting the precise time periods over which assessments were made, separate extracts were made up to the end of 2020, 2021 and 2022.

The use of QGIS (version 3.16.10) for the construction of the alpha-hulls and calculation of their areas, for all taxon/period combinations, involved a combination of standard geometry processing tools plus a bespoke plugin created by the Field Studies Council for the purposes of mapping biological records. Multiple scenarios involving different alpha-parameters were computed, in order to investigate the effect of varying this parameter, which was felt likely to be particularly important for smaller datasets. More detailed notes on using QGIS for this purpose were provided in Appendix 1 of the phase 1 report (Musgrove 2022) in the hope they would be useful to other workers.

The area measurements per taxon/period/alpha-parameter produced from QGIS were then imported back into a table in the MySQL database.

Finally, SQL code was used to extract all of the relevant metrics for the assessments of IUCN status and GB rarity status, forming the basis of the final data table. Importantly, because most of the above steps were retained as code, the entire process could be repeated easily, as and when additional (or updated) datasets arrived.

2.2 Undertaking the IUCN Red List Assessment

Regional assessments are carried out in a three-step process. First, assessors must determine which taxa and which regional populations to assess (step one). Next, the regional population for each taxon is evaluated according to the IUCN Red List Categories and Criteria (IUCN 2012), and a preliminary status category is assigned (step two). The effect of populations of the same taxon in neighbouring regions on the regional population is then considered, and the preliminary category is up- or down-listed if appropriate (step three). Thus, the final categorization reflects the extinction risk for the taxon within the region being evaluated, having considered potential interactions with populations outside that region.

2.2.1 Determining which taxa and which regional populations to assess

The first stage of the IUCN Red List GB assessment is to determine which taxa will be assessed at the level of Great Britain. This question has two main components. Firstly, it is necessary to decide on a taxonomic authority to follow, to determine species limits, list sequence and so on. Secondly, it is necessary to consider which species may need to be given the status Not Applicable (NA), meaning that whilst records of the species exist, there are good reasons not to allocate a further Red List status to them.

2.2.1.1 Taxonomic treatment

As is the case for many groups, sawfly taxonomy is in a state of considerable flux and subject to ongoing revision and development. The most recent published British (and Irish) checklist is by Liston et al. (2014), as part of a series of papers covering all British and Irish Hymenoptera. It is several years out of date now, however. New taxonomic studies are regularly published, and these have been incorporated where possible. More recent updates have been obtained via the online world checklist 'ecatsym' (https://sdei.de/ecatsym/), hosted by the Senckenberg Deutsches Entomologisches Institut. This electronic catalogue (Taeger et al. 2018) was checked throughout this review in cases of taxonomic uncertainty.

For phase 2 of this review, the most significant difference in higher level classification compared to Liston et al. (2014) is that the subfamily Athaliinae has been 'promoted' to family level (Athaliidae), following the work of Niu et al. (2022) who showed this to be more distantly related to the remaining Tenthredinidae than the already-recognised families of Cimbicidae, Diprionidae and Heptamelidae. Sadly, this was not appreciated in time to include the Athaliidae in phase 1 of the review, hence they are included in phase 2.

There have been a number of changes to species-level taxonomy since Liston et al. (2014). The key changes since then have been:

- The former *Claremontia confusa* (used by Benson 1952) was renamed as *C. brevicornis* in Liston et al. (2014) but has reverted to *C. confusa* (Liston et al. 2022). At the same time, the former *C. puncticeps* has now taken over the name *C. brevicornis*.
- *Eutomostethus nigrans* is now lumped within *E. ephippium*.
- *Paracharactus gracilicornis* is now *Phymatoceropsis gracilicornis*
- *Kaliofenusa ulmi* and *K. altenhoferi* are lumped and treated as *Fenusa ulmi*.
- *Heterarthrus aceris* is now *Heterarthrus fiora*
- *Dolerus cothurnatus* is now *Dolerus junci*
- Three species of the genus *Cytisogaster* (*chambersi, genistae, picta*) have returned to the genus *Rhogogaster*
- *Rhogogaster dryas* is now called *R. viridis*, a name already in use but this former *R. viridis* is now called *R. scalaris*.

There have been very many more taxonomic changes since Benson (1952). Due to the relative dearth of available works on sawflies, most observers still rely heavily on this key reference, and so careful consideration of subsequent name changes has been required when assessing records. These are discussed where required in the species accounts in the main data table.

For two species (*Empria improba, Dolerus uliginosus*), the first records have only become known since the publication of the 2014 checklist (the latter as a result of undertaking this review).

Records purportedly referring to two unexpected extralimital species were found during the data collation phase, but were quickly ruled out. For reference, these were:

- *Macrophya mixta* – a Nearctic species, with a record from Gloucester. Further investigation showed that this was Gloucester in Canada, not the English town.
- *Tenthredo campestris* – a record from Wicken Fen of this widespread European species was found in a submitted dataset, but further investigation showed it to be a transcription error for *Tenthredopsis campestris*, itself a synonym of *Tenthredopsis nassata*.

Finally, it should be noted that the work for this review was finalised in early 2023. It is inevitable that taxonomic understanding will continue to develop, and use of this review should take into account further changes in nomenclature and species limits.

2.2.1.2 Assessing whether Not Applicable (NA) is the correct status

Not Applicable (NA) is a status that can be used within regional Red List assessments (but not global ones) and is defined as a 'category for a taxon deemed to be ineligible for assessment at a regional level. A taxon may be NA because it is not a wild population or is not within its natural range in the region, or because it is a vagrant to the region.' Moreover, 'a regional Red List categorization process should be applied only to wild populations inside their natural range and to populations resulting from benign introductions'. However, 'in contrast to other Red List Categories, it is not mandatory to use NA for all taxa to which it applies; but is recommended for taxa where its use is informative.' Therefore, there would appear to be a degree of leeway open regarding the use of NA in regional assessments, although it seems important that a clear rationale should be set out to justify the way in which the NA status has been deployed.

For phase 1 of the review, there were many species for which the wild/introduced question was not straightforward, many involving conifer-feeding species. For phase 2, this has been far less of an issue, with no species using conifers and most species clearly feeding on native plants. Some are strongly associated with gardens, such as *Phymatocera aterrima* feeding on Solomon's-seal *Polygonatum* species, but in all such cases the species is also present in the wider environment.

In the event, the status NA was only used for two species, one where it seemed the species was in the early stages of a colonisation in a suburban setting (*Cladardis elongatula*), and the other where there remains a reasonable degree of doubt over the identification of the only known specimens (*Empria minuta*).

2.2.2 Evaluation of each taxon according to IUCN Red List Categories and Criteria

The process for evaluating data against criteria is well set out by the IUCN's documents and guidelines. However, the following notes discuss the particular issues encountered relating to the implementation of this process against the British sawfly dataset.

Phase 1 of the sawfly review was mostly based on records made up to the end of the year 2020. For phase 2, all analyses were initially run using end-years of 2020, 2021 and 2022, to examine the effect this would have on the final outputs, and particularly to investigate the sensitivity of the resulting

status values arising from small changes in the underlying data. In the end, despite the potential benefits of retaining a consistent time period with phase 1, it was decided better to move the time periods forward a year to the end of 2021. This was because the volume of sawfly recording data has increased strongly in recent years and hence much useful information on the phase 2 species would not be utilised otherwise. In a small number of cases, records from the year 2022 and 2023 were also incorporated, where they would have a material effect on the IUCN status; these are indicated and fully discussed in the species accounts.

2.2.2.1 Assessing status under Criterion A

Criterion A relates to a reduction in population size. Population size reduction needs to be assessed over the longer of 10 years or three generations. Sawflies all have generation lengths of less than three years, and hence a 10 year period is the appropriate duration for the assessment of all species.

The Guidelines allow for predicted population change into the future to be used for assessments (subcriteria A3 and A4). However, data of sufficient quantity or quality do not exist for any British sawflies to make this a realistic proposition.

Subcriteria A1 and A2 differ based on whether 'the causes of the reduction are clearly reversible AND understood AND have ceased' (for A1) or whether at least one of those three provisos is incorrect (for A2). Again, the nature of the available data for sawflies at present means that A1 is not a realistic prospect. Hence, A2 is the only remaining subcriterion.

Population size reduction measures need to be based on at least one of,

(a) direct observation [except A3]

(b) an index of abundance appropriate to the taxon

(c) a decline in area of occupancy (AOO), extent of occurrence (EOO) and/or habitat quality

(d) actual or potential levels of exploitation

(e) effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

In effect, the only usable metrics that can be deployed for British sawflies relate to changes in distribution and range – i.e. in AOO and EOO, i.e. A2c. In reality we do not know the precise EOO or AOO in a given year, and instead have to try to derive an estimate of these measures by using data consolidated across longer time periods. The following approach was taken.

1) Records were combined across 1992-2006 and were all assigned to relate nominally to 1999; likewise, records were combined across 2007-2021 and were assigned nominally to 2014.
2) For each species and for each of the two time periods, the EOO was calculated via the construction of alpha-hull concave polygons. The polygons were constructed using the open-source desktop application QGIS using an alpha-hull threshold parameter value of 0.75.
    a. Note that this value differs from the value of 0.5 used for phase 1. It is noted that the guidance in IUCN (2019) does not specify a definitive value for this parameter, nor does it say that the same value is necessarily used for every species. Varying the parameter operates by selectively removing outlying points to leave a smaller core from which to construct a concave polygon. This becomes increasingly problematic as numbers of points decline to low numbers, as the 'outliers' become a

proportionally larger part of the dataset. Because of this concern, a range of scenarios were examined by creating concave polygons using a range of alpha-hull threshold parameters in QGIS (0.3, 0.5, 0.75, 0.9, 1). On examination of the results, it was felt that a value of 0.75 resulted in a good compromise in excluding unrealistic outliers whilst creating realistic EOO polygons from which to calculate area measurements. However, in a small number of cases, the alpha-parameter was relaxed further to 0.9 to enable to construction of sensible concave polygons. The data table makes clear which value of alpha has been used for each species.

3) The AOO was also calculated for each species and time-period, by assigning every record to a 2 x 2 km square (using a nominal central 'pseudotetrad' (see 2.1.3) for any records that were only defined to a 10 x 10 km resolution), and then summing the areas of the distinct squares.
4) For each species, and for each of EOO and AOO, the values assigned to the nominal years 1999 and 2014 were used to construct an exponential curve, from which the estimated change between the years 2011 and 2021 was calculated, following the approach discussed in section 4.5 of the Red List Guidelines (and underpinning the Criterion A tool downloadable from https://www.iucnredlist.org/resources/grid). In the absence of evidence to the contrary, exponential change (indicating a constant rate of change) was felt more likely to be a better fit than linear change (indicating a constant loss/gain of absolute numbers). We might expect to observe exponential decline as a result of a degradation of habitat quality/suitability which reduced the reproductive rate of a species to below the replacement rate. In contrast, linear decline might be expected when an equal area of (similar quality) habitat was entirely lost per year. In reality, the true nature of population changes and underlying influences are seldom known for insects such as sawflies, but exponential decline feels the more appropriate model to be used.
5) The calculated change measures were then compared against the threshold values for A2 of -30% (VU), -50% (EN) and -80% (CR). For 'near-misses' (where the change was -20 to -29%), the potential for assigning the category NT was considered.

Note that the IUCN guidelines state that only records of adults, not immatures, should be used for direct assessment of population size under Criterion A. However, there is no such restriction for the purposes of calculating range measures (AOO, EOO), so records of sawfly larvae have been retained as their presence clearly indicates the recent presence of adults of the species. For many species of insects, including some sawflies, the vast majority of records will relate to the detection of larvae.

2.2.2.2 Assessing status under Criterion B

Criterion B relates broadly to an assessment of geographic range. Either EOO and/or AOO need to be below certain threshold values, AND at least two of three further conditions need to apply. However, one of these latter relates to demonstrating 'extreme fluctuations', which the sawfly dataset is not sufficiently detailed to enable. Therefore, to qualify under Criterion B, the range needs to be both

a) Severely fragmented OR with a low number of locations
b) Continuing decline observed, estimated, inferred or projected in any of i) EOO, ii) AOO, iii) area, extent and/or quality of habitats, iv) number of locations or subpopulations; v) number of mature individuals.

Severe fragmentation (within a) is defined as such: ‘A taxon can be considered to be severely fragmented if most (>50%) of its total area of occupancy is in habitat patches that are (1) smaller than would be required to support a viable population, and (2) separated from other habitat patches by a large distance.’ There is insufficient knowledge available to say how big a habitat patch is required to support a viable population for any species, and hence the severe fragmentation is not usable within this review.

The remaining metrics were considered as follows:

Extent of Occurrence (EOO) was assessed by finding the area of a minimum convex polygon that contained the ‘pseudotetrad’ (see 2.1.3) relating to every record of a species over the 30 year period 1992-2021. This value was calculable via in-built functions in MySQL and was compared to the threshold values for VU (<20,000 km^2), EN (<5,000 km^2) and CR (<100 km^2).

Area of Occupancy (AOO) was assessed by summing the area of all distinct ‘pseudotetrads’ (see 2.1.3) relating to every record of a species over the 30 year period 1992-2021, and was compared to the threshold values for VU (<2,000 km^2), EN (<500 km^2) and CR (<10 km^2).

‘Number of locations’ was assessed in the context of the IUCN definition of a ‘location’ relating to ‘a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present’. For terrestrial insects, such an area would be quite small. For the purposes of this review, a location was defined as a 2 x 2 km square (tetrad), so making use of the same units as for the AOO calculations. Again, ‘pseudotetrads’ were used when records were only defined to a 10 x 10 km level of precision.

Note that using pseudotetrads (which are 4 km^2) as the same measure for Locations and AOO calculation simply places a tighter constraint on the AOO requirement under criterion B2. That is, whilst AOO needs to be below 2,000 km^2 for a threatened status, there is also a need for there to be ten or fewer locations, which means that actually one needs an AOO of 40 km^2 or fewer. As it happens, because of the low level of recording of sawflies, almost all species currently have an AOO of below 2,000 km^2.

Finally, there is a need to assess whether there is "a continuing decline inferred in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals". Options (iii) and (v) are not calculable from the data available. Moreover, given that we are basing locations and AOO on the same pseudotetrad measure, (ii) and (iv) are entirely equivalent to each other.

For the purposes of the review, continuing decline was assessed over the 30 year period 1992 to 2021. This allowed for two overlapping assessments, looking at three 10-year blocks and two 15-year blocks, which it was intended would smooth over irregularities in a patchy dataset. For each of these five time-periods, EOO was calculated via the use of alpha hulls (where datasets were large enough to allow this), whilst AOO (and number of locations) was calculated from the distinct pseudotetrads. Continuing decline was assessed as occurring if:

2007-2021 < 1992-2006 – i.e. decline between two 15-year blocks

or

2012-2021 < 2002-2011 – i.e. decline between two most recent 10-year blocks

or

2002-2011 < 1992-2001 alongside 2012-2021 not > 2002-2011 – i.e. decline from the 1990's to 2000's and no increase in 2010's.

In reality, the level of sawfly recording has increased greatly in the last decade (Figure 3, see Results) which in itself may be masking further real declines. For species to have seen a recent continuing decline is therefore especially noteworthy.

2.2.2.3 Assessing status under Criterion C

Criterion C requires a knowledge of the number of mature individuals in a population. This is not known for any British sawflies and hence Criterion C could not be used in the assessment.

2.2.2.4 Assessing status under Criterion D

Criterion D relates to very small or restricted populations. For a species to qualify under D1 a knowledge of the number of mature individuals is required, but we do not have this information for sawflies. However, qualification as Vulnerable under Criterion D2 is possible if there is a restricted area of occupancy (typically AOO < 20 km^2 or number of locations <=5), coupled with a 'plausible future threat that could drive the taxon to CR or EX in a very short time.'

For the current review, sawflies were identified as potentially qualifying for D2 if they had been recorded from between one and five pseudotetrads between 1992 and 2021. For each of these, the question of a plausible future threat was considered. In practice, there were relatively few cases in which a plausible future threat could be suggested that would operate over more than one location. However, in cases where a species had been reported from just one site since 1992 it was considered plausible that a threat could drive that species to Critically Endangered or Extinct in a short time. The status Near Threatened was also considered as an option where a plausible threat could not be suggested.

2.2.2.5 Assessing status under Criterion E

Criterion E requires a quantitative analysis to be undertaken that indicates the probability of future extinction in the wild over a set time-period. No such analyses have been undertaken for British sawflies (and these are unlikely at present given the nature of the available dataset) and hence Criterion E could not be used in the assessment.

2.2.2.6 Assessing whether a Near Threatened (NT) status is appropriate

A taxon can be classed as Near Threatened (NT) when it has been evaluated against all possible criteria and does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future. The Guidelines note

that NT is appropriate 'especially when there is a high degree of uncertainty', which certainly applies to many British sawflies.

A taxon may also qualify for NT if it is the focus of a continuing taxon-specific or habitat-specific conservation or management programme targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories within a period of five years. However, this is not the case for any British sawflies to date.

The regional guidelines also note that NT could be appropriate if a Vulnerable species were deemed appropriate for 'downlisting' if it was felt that it could be 'rescued' by populations in neighbouring regions (i.e. mainland Europe). However, there is insufficient information available concerning either the status of sawflies in Europe, or their dispersal capabilities, with which to make such an assessment at present.

For taxa listed as Near Threatened on the IUCN Red List, assessors are asked to indicate which criteria were nearly met as part of the justification.

For the current review, all cases were carefully considered where metrics were close to threshold values (and in particular when some but not all subcriteria were met), noting particularly the upsurge in recording effort in recent years that may well mask actual declines.

2.2.2.7 Assessing whether a Data Deficient (DD) status is appropriate

Data Deficient is a status which can be allocated in cases where there is little available information (direct or indirect) with which to make an assessment. However, over-use of DD is discouraged, and even very limited data can be sufficient to draw conclusions regarding an IUCN Red List status.

If a taxon is known, but there is no direct or indirect information about its current status or possible threats, then it is obviously DD. The issue becomes more complex when there is very little information known about a taxon, but the available information indicates that the taxon may be threatened. The question then becomes how far is it acceptable to take inference and projection.

For the category of DD to be assigned, it must be demonstrable that data are inadequate to determine a threat category. If the data are so uncertain that both CR and LC are plausible categories, the taxon can be listed as DD. However, if plausible categories range from NT to threatened categories, DD is not the appropriate category.

A significant reason for assigning a status of DD with sawflies species relates to taxonomic uncertainty. As per the IUCN guidelines, it is not that DD should be used for taxa that simply have uncertainty around their taxonomy, but rather that the taxonomic uncertainty impacts on the potential to assess records of that taxon. In practice, this is quite often the case for sawflies, given that the main identification source underpinning most records (Benson (1952)) does not represent the currently-understood taxonomic situation for many species, and hence many records involve a degree of uncertainty as to which taxon they should be referred to.

2.2.2.8 Assessing whether a Regionally Extinct (RE) or Critically Endangered (Possibly Extinct) (CR(PE)) status is appropriate

The Regional Guidelines define RE as a 'category for a taxon when there is no reasonable doubt that the last individual potentially capable of reproduction within the region has died.' They further note that 'it is not possible to set any general rules for a time period since the last observation before taxa are classified as RE. This will depend on how much effort has been devoted to searches for the taxon, which in turn will vary, both with organism and region. If the regional authority decides to adopt any time frames for RE assessments, these should be clearly specified.'

The term 'no reasonable doubt' is important for poorly recorded taxa like sawflies. Even apparently common and widespread species are relatively poorly recorded, compared to many other taxonomic groups. Moreover, little or (usually) no effort would appear to have been devoted to searches for most rare species. Therefore, it is difficult to say that there is not a reasonable level of doubt as to whether a species remains extant or not in Britain, even many years after being last recorded.

Having said this, there are some species with no recent records where one might reasonably expect detections to have been made. The general level of interest in sawfly recording has increased strongly in the last decade, and a number of species have been rediscovered through a combination of digital photography, social media and online biological recording applications. Therefore, a continuing absence by some species does give significant cause for concern, although this does need to be assessed on a species-by-species basis, based on distributional, habitat and behavioural factors, as well as distinctiveness from an identification point of view.

For this review, the approach that has been taken is that species that have not been recorded reliably since the beginning of 1991 have been considered as candidates for RE, with other factors then being taken into account.

Additionally, the tag of 'Possibly Extinct' has been developed by IUCN to identify those Critically Endangered species that are, on the balance of evidence, likely to be extinct, but for which there is a small chance that they may be extant. Therefore, the potential for using CR(PE) has also been considered for species that have not been recorded since 1992. There is a particular difficulty in deciding how best to provide criteria to back up an assessment of CR(PE), given that there are no recent data on which to assess Criterion A (i.e. a decline from zero to zero in the last ten years) and Criterion B (similar issue for assessing 'continuing decline' and there is a requirement for one location). Criterion D could apply (very small area and plausible future threat) but that is only able to lead to a status of VU, not CR.

The Guidelines (IUCN 2012, p82) do note 'there are many species for which extinction is a possibility, but for which the declines or disappearances took place more than 10 years or three generations ago (whichever is longer), and for which the EOO and AOO are too large for listing as CR, and/or at least two subcriteria for CR B are not met. In such instances, the species should be listed as CR C2a(i), CR C2a(ii), and/or CR D, whichever seems more plausible. Such an assessment therefore implies an estimated population size of fewer than 250 mature individuals (for C2) or 50 mature individuals (for D). Even though it is impossible to know whether or not such an assumption is correct, it is a reasonable one for a species that could be Extinct.'

2.2.3 Consideration of the effect of populations in neighbouring regions

In step three of a regional IUCN Red List assessment, the existence and status of any conspecific populations outside the region that may affect the risk of extinction within the region should be investigated.

If the taxon is endemic to the region or the regional population is isolated, the Red List Category defined by the criteria should be adopted unaltered. However, none of the species covered during the current review are endemic or especially isolated.

If conspecific populations outside the region are judged to affect the regional extinction risk, the regional Red List Category should be changed to a more appropriate level that reflects the extinction risk. In most cases, this will mean downlisting the category obtained in step two, because populations within the region may experience a "rescue effect" from populations outside the region. In other words, immigration from outside the region will tend to decrease extinction risk within the region. Conversely, if the population within the region is a demographic sink that is unable to sustain itself without immigration from populations outside the region, and if the extra-regional source is expected to decrease, the extinction risk of the regional population may be underestimated by the criteria. In such exceptional cases, an uplisting of the category may be appropriate. If it is unknown whether or not extra-regional populations influence the extinction risk of the regional population, the category from step two should be kept unaltered.

There are no conservation reviews of sawflies in neighbouring European countries, nor is there sufficient information available concerning dispersal potential of sawflies. Therefore, it is hard to see on what basis one would alter a British assessment from this perspective. Therefore, none of the statuses have been altered as a result of Step 3.

2.3 Assessing GB rarity status

Threat, as described by the IUCN Red List process, is not the same thing as rarity. For example, a species may be common but threatened, or rare and stable. Whilst IUCN threat assessments are now the most important means of describing the conservation status of GB invertebrate species, it has also been found valuable to describe how restricted in geographic distribution a species is within Great Britain. These measures are not IUCN categories, but they can be determined through essentially the same data analysis process required for IUCN and so most recent GB IUCN Red List reviews have produced these GB rarity status categorisations at the same time.

GB Rarity has traditionally been assessed by counting the number of hectads (10 x 10 km squares) from where a species has been recorded. Most recent invertebrate status reviews have used a definition along the following lines:

Nationally Rare (NR): species recorded from between 1-15 hectads of the Ordnance Survey national grid in Great Britain in the last 30 years and where there is reasonable confidence that exhaustive recording would not find them in more than 15 hectads. Broadly speaking, the Nationally Rare category is equivalent to the Red Data Book categories used by Hyman (revised Parsons) (1992, 1994), namely: Endangered (RDB1), Vulnerable (RDB2), Rare (RDB3), Insufficiently Known (RDBK), Indeterminate (RDBI) and Extinct.

Nationally Scarce (NS): species recorded from between 16-100 hectads of the Ordnance Survey national grid in Great Britain in the last 30 years and where there is reasonable confidence that exhaustive recording would not find them in more than 100 hectads. The Nationally Scarce category

is directly equivalent to the combined 'Notable', Nationally Notable A (Na) and Nationally Notable B (Nb) categories used in the assessment of various taxonomic groups by Hyman (revised Parsons) (1992, 1994).

Missing, but implied from these definitions is that a species recorded in 15 or fewer hectads, but where there is reasonable confidence that exhaustive recording would find them in 16-100, would be defined as Nationally Scarce. Likewise, any species where there is reasonable confidence that exhaustive recording would find them in over 100 squares would be defined as having no GB rarity status.

Note that the same time periods have been used for GB Rarity Status calculations as for the IUCN Status calculations. That is, most are based on the 30-year period 1992-2021, except for the few cases where shifting this forward to include records from 2022 or 2023 made a material difference to the IUCN status (as indicated in the data table).

The definitions imply a degree of subjectivity around what ***exhaustive recording*** could reasonably be expected to turn up. To some extent this makes sense, as this may vary from taxonomic group to group. For example, one group may be well-recorded and known to include many habitat specialists, and hence it would be relatively surprising to find them away from existing sites. Conversely, other groups may be poorly recorded but include many species that appear to be widely distributed in fairly 'common' habitats, and hence it would be reasonable to expect that exhaustive recording would uncover many more hectads. Sawflies fall clearly into the latter group.

For the purposes of phase 1 of this review, it was decided that it would be beneficial to develop an objective approach to estimating a likely number of expected hectads to assess against the GB rarity thresholds. The same approach was followed for phase 2, i.e.

1) Derive a list of hectads per species for the 30-year period 1992 to 2021
2) To produce a broadly representative range map per species, use QGIS to produce an alpha-hull with threshold value 0.75. Note that for some species this will exclude some outlier records. For some species present in very few hectads then no alpha hull will be calculable and the unadjusted hectad count will simply need to be retained.
    a. Note that this value differs from the value of 0.3 used for phase 1. As with the IUCN status calculations (see 2.2.2.1), a range of scenarios were examined by creating concave polygons using a range of alpha-hull threshold parameters in QGIS (0.3, 0.5, 0.75, 0.9, 1). On examination of the results, it was felt that a value of 0.75 resulted in a good compromise in excluding unrealistic outliers whilst creating realistic EOO polygons from which to calculate area measurements. However, in a small number of cases, the alpha-parameter was relaxed further to 0.9 to enable to construction of sensible concave polygons. The data table makes clear which value of alpha has been used for each species.
3) It is unlikely that all sites on the periphery of the range represent the absolute limit of the distribution, and so buffer the resulting shapes by 20 km.
4) Clip the resulting shape by the coastline.
5) Calculate the area of the clipped shape in km^2 and then divide by 100 to give an equivalent in hectads.
6) In recognition that species may not always be evenly distributed across the countryside, and to retain an element of precaution, take the mean of the actual recorded hectads and the calculated hectads, to give a final estimated value of hectads to compare against the GB Rarity thresholds.

7) Consider the results carefully in terms of any understanding of the habitat preferences and detectability of each species.
8) GB Rarity status is presented based on the estimated hectads, but clearly labelled so as to show the extent of any upgrading from the status that would have been achieved from simply relying on raw hectad counts.
9) For any species where the IUCN Red List category is Regionally Extinct, then a GB Rarity Status of 'Extinct' is given.
10) For any species where the IUCN Red List category is Not Applicable, for reasons of either a) lack of occurrence in the wild or b) doubt over provenance, then a GB Rarity status of 'n/a' is indicated. However, for localised recent colonists, the GB Rarity status is calculated as normal.
11) For any species where the IUCN Red List category is Data Deficient, then a GB Rarity status may still be calculable (particularly where a minimum range size is apparent), but where not (particularly in cases of taxonomic uncertainty) then 'unclear' is indicated.
12) Note that the broad operation of QGIS is broadly similar to that described in Appendix 1 of the phase 1 report (Musgrove 2022) for the IUCN calculations.

3 Results

3.1 Datasets obtained

Publicly available datasets

The Biological Records Centre enabled access to sawfly data within iRecord, which was downloaded on 13/02/2023 and again on 20/03/2023, comprising almost 33,000 records from across Britain. Of these, about 20,000 records were of species relating to phase 2.

Data from the NBN Atlas was downloaded on 10/02/2023, comprising over 55,000 records from across Britain, although this included duplicates of the iRecord dataset. About 33,000 of these related to phase 2 species.

Prior compilation exercise

Guy Knight kindly made available a dataset he had been compiling, mostly involving data up to 2012. This included data digitised by the Biological Records Centre as well as many contributions from individual recorders, some Local Environmental Records Centres and some museums. Following extensive reformatting work, this dataset comprised over 40,000 records from across Britain, including about 29,000 relating to phase 2 species.

Local Environmental Records Centres and other county datasets

Requests for data were sent to all Local Environmental Records Centres (LERCs) in Britain. Datasets were provided by 37 LERCs, with data from four LERCs not made available by the project deadline. For one of the missing counties, a very active local recorder had made direct submissions anyway (see below). In addition, for several counties (Norfolk, Lincolnshire, Yorkshire, Kent), active county recorders were in place who made their datasets available directly. The LERC/County datasets collectively totalled about 67,000 records of which 46,500 related to phase 2 species. There were inevitably significant levels of duplication between these datasets and the national compiled datasets.

Individual recorders

Requests for data for the review were distributed through both social media (key Facebook discussion groups, plus Twitter) and print media channels, the latter being

- British Journal of Entomology and Natural History
- The Entomologist's Record
- Bulletin of the Dipterists Forum
- Newsletter of the Bees, Wasps and Ants Recording Society
- British Wildlife

In response, datasets totalling about nearly 13,000 records (10,000 of phase 2 species) were received from 20 individuals, including many of the most active British sawfly recorders of recent years. Other individuals confirmed that their records were available via iRecord.

Other sources

The Royal Horticultural Society made available 1,500 records originating from queries made to their entomologists over many years.

The Senckenberg Deutsches Entomologisches Institut undertakes an extensive programme of research into phylogenetic systematics of sawflies, and kindly made available about 900 British records it had compiled as a result of their researches.

The Herbert Art Gallery & Museum in Coventry has an extensive collection of sawflies, which had been catalogued by Adam Wright in 1985. The current curator Ali Wells kindly scanned a remaining hardcopy of the catalogue from which over 3,000 records of phase 2 species were extracted for the purposes of this review.

3.2 Overall dataset metrics

To date, over 215,000 sawfly records have been made available, including species for all three phases of the planned review. Reducing the dataset to the species under consideration in the current phase of the review leaves about 140,000 records.

This total included many duplicates. In particular, verified iRecord records are made available through the NBN Atlas; many county datasets have obtained data from other sources (like iRecord); and Guy Knight's prior compilation exercise also obtained many records that were submitted separately for the purposes of the current review.

Determining the number of overall number of duplicate records is not straightforward. For 68 of the 224 species under consideration, records were carefuly de-duplicated, but this was not possible in the time available for the more widespread species. Moreover, such a task is also not strictly necessary for most of the analyses required for a Red List (or GB Rarity) assessment, as most statistics are built upon counts of distinct grid squares, which does away with the duplicates automatically. However, for the 68 rarer species, it was informative to consider all of the records in detail, and in those cases, a detailed de-deduplication exercise was undertaken. For the species concerned, de-duplication removed 43% of the records, and so if a similar pattern was seen for the more widespread species, we might expect that the overall dataset would be reduced to approximately 80,000 records following full de-duplication. The number of records per species (original and actual/estimated deduplicated totals) are listed in Appendix 1.

Figure 1 maps the records that were used, in terms of numbers of records and numbers of species. Records came from much of Britain, although were more sparse in the northern half of Britain, inland Wales and the south-west of England.

Figure 2 illustrates the distribution of records through time. There has been a significant upturn in recent years (albeit relative, as overall data volumes are still low). This is a pattern typical of the records of many taxonomic groups, as changes in information technology have made it easier to collate and share data. Note that the declines in 2021 and 2022 are likely to be as a result of incomplete data submission at time of access.

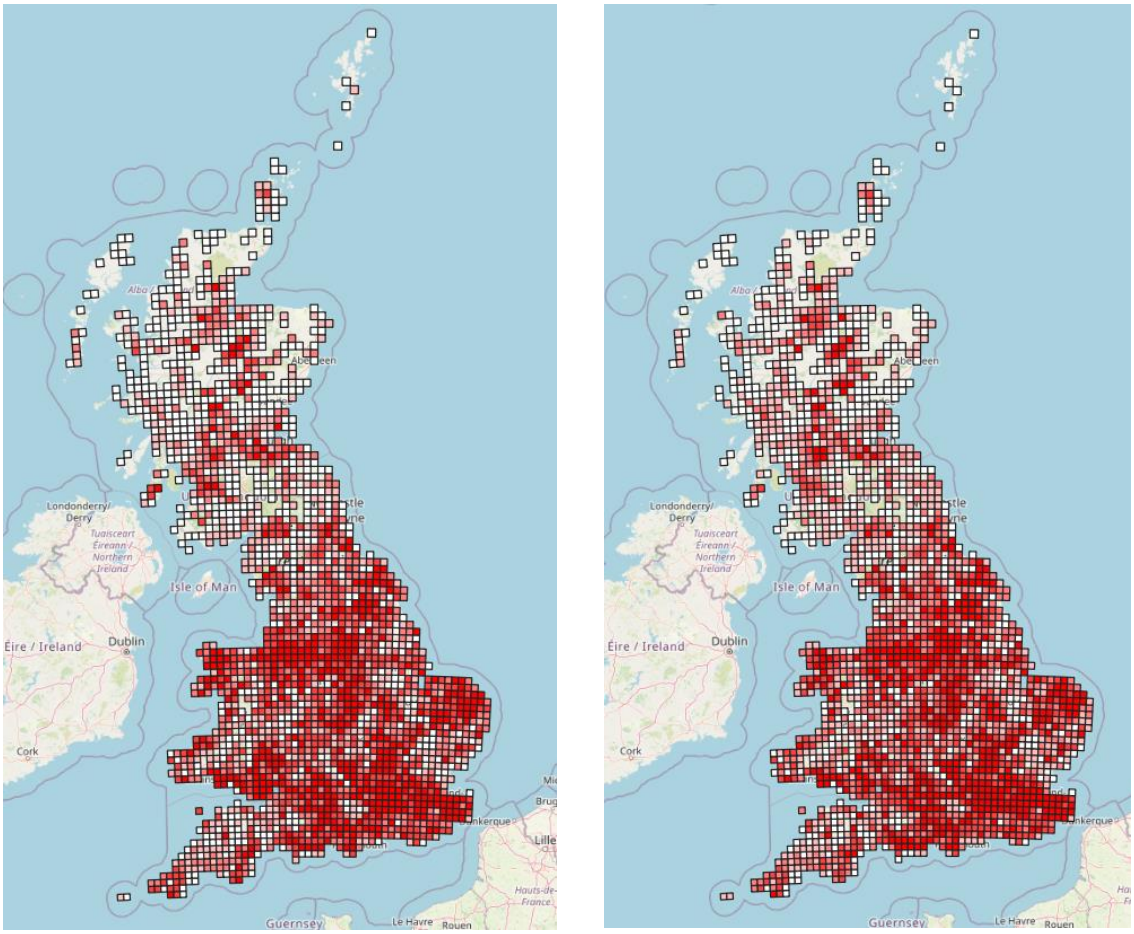

Figure 1: Relative numbers of records (left) and species richness (right) of phase 2 sawflies per 10 km square

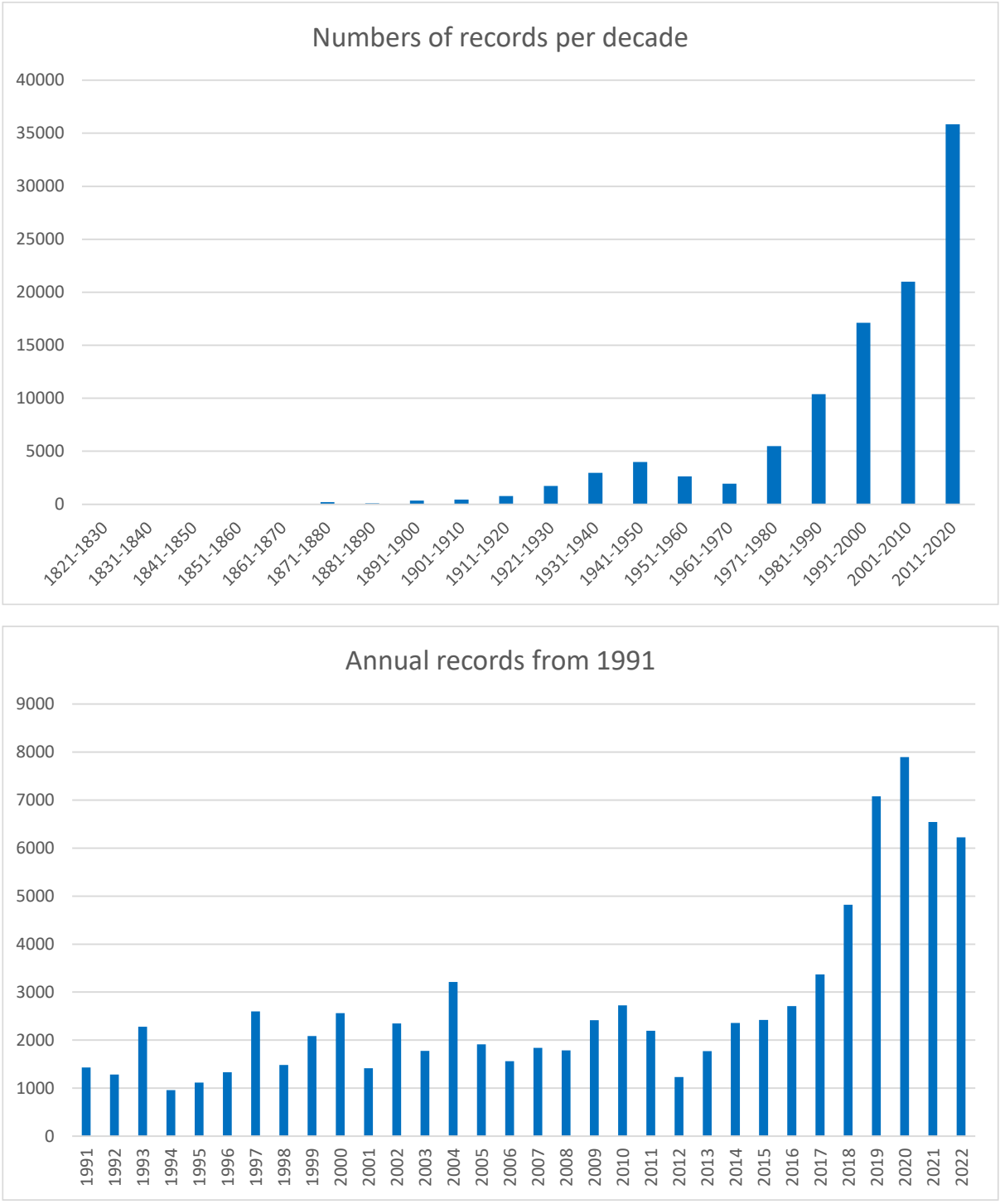

Figure 2: Numbers of records of phase 2 sawflies per decade and per recent year.

3.3 IUCN Red List Status

The data table accompanying this report sets out the IUCN Red List Status for each species, along with the qualifying criteria, associated metrics and a commentary providing a rationale in support of the categorisation..

Table 1 summarises the number of phase 2 sawfly species assigned each IUCN Red List Status following the assessment:

IUCN Red List Status	No. of species
Least Concern	170
Near Threatened	9
Vulnerable	11
Endangered	6
Critically Endangered	5
Regionally Extinct	5
Extinct in the Wild	0
Extinct	0
Data Deficient	16
Not Applicable	2
Not Evaluated	0
Total	**224**

3.4. GB Rarity Status

The data table accompanying this report sets out the GB Rarity Status for each species, along with raw and estimated numbers of hectads from the most recent 30-year period (mostly 1992-2021), on which the statuses were based.

Table 2 summarises the number of phase 2 sawfly species assigned each GB Rarity Status following the assessment:

GB Rarity Status (final)	No. of species
None	187
Not adjusted	[77]
Upgraded from NS	[91]
Upgraded from NR	[19]
Nationally Scarce	7
Not adjusted	[0]
Upgraded from NR	[7]
Nationally Rare	18
Extinct	5
Unclear	6
n/a	1
Total	**224**

4 Discussion

This is the second phase of the first published review of the status of British sawflies, following Musgrove (2022) which covered all families except for Tenthredinidae and Athaliidae. A third phase is anticipated to cover the subfamily Nematinae.

Many phase 2 species appear to be common and widespread, the five most frequently recorded being *Athalia rosae, A. cordata, Tenthredo mesomela, Blennocampa phyllocolpa* (this mostly detected through larval feeding signs) and *Tenthredopsis nassata*. However, most sawflies are fairly unobtrusive and even amongst those of Least Concern there are many species that are little known and seldom-recorded. Within the current phase 2 review, of those species with sufficiently robust data to undertake a full assessment (i.e. not Data Deficient or Not Applicable), 83% were classed as being of Least Concern. The other 17% of the fully-assessed species were deemed either threatened (Vulnerable, Endangered, Critically Endangered), Near Threatened or considered to be actually Regionally Extinct. This proportion is significantly lower than the 33% for the same categories for the species covered in phase 1. It is unclear why this should be, but many groups of sawflies covered in phase 2 have very widespread and abundant foodplants, e.g. grasses, brambles, roses, common trees, etc.

Just five species (2.4%) were assessed as being Regionally Extinct, compared with six (7.8%) in phase 1. There is nothing that immediately links the extinct species. *Allantus coryli* is known from a single record from Surrey in 1928; *Dolerus harwoodi* was recorded in Speyside on multiple occasions in the 1940s but not since; *Strongylogaster filicis* has only one confirmed record from Northumberland in 1873; *Pachyprotasis nigronotata* was recorded twice in Wales in the 20th century, although widely separated temporally and geographically; and *Tenthredo neobesa* has not been recorded since an occurrence at Wicken Fen over 100 years ago.

It is plausible that some of these species assessed as Regionally Extinct might be rediscovered given targeted attention, effort and/or luck. It is worth noting that one of the 'extinct' phase 1 species (*Arge enodis*) was located in Bedfordshire in 2022. Moreover, eight phase 2 species were discovered new to Britain since the year 2000, and so the potential for further discoveries or rediscoveries remains high.

A total of 16 species were assessed as being too Data Deficient to be able to categorise them otherwise. This was a much lower percentage compared to phase 1 of the review (7% vs 14%), in part because of the particularly difficult genus *Trichiosoma* in phase 1. Taxonomic challenges were responsible for many of the data deficient assessments, as newly understood species limits often make it impossible to assign old records to a modern taxon without the laborious task of visiting numerous museum collections. The pace of taxonomic reassessment shows little sign of abating either, and it is likely that revisions of sawfly status assessments in future years will find new challenges amongst species that may currently seem well-defined.

There were only two phase 2 species for which an IUCN status was deemed 'not applicable', these being *Clardardis elongatula* – an apparent recent suburban introduction – and *Empria minuta* – for which there appears to remain some uncertainty regarding the identification of the few specimens to date (this genus being particularly challenging to identify). The issue of native or non-native origin was far less a consideration for phase 2 than phase 1, in large part because no phase 2 species are make use of conifers or imported timber.

As was noted for phase 1, there is little opportunity for recognising historical decline. Whilst this may not be strictly necessary for assessing extinction risk, a consideration of older data can certainly bring important context and during this review, older records were found to be instructive in consideration of the patterns of occurrence of recent taxonomic splits, and questions over when/whether a species should be considered to be Regionally Extinct. Having said that, the volume of (and biases in) older data are often such that their use for any standardised metric would be impractical. The sparsity of older records would be remedied somewhat, however, if museums were able to digitise the data behind their important collections.

Finally, in addition to the IUCN Red List assessment, the GB Rarity Status of individual species was assessed. Of the 224 species under consideration, only seven were assessed as being Nationally Scarce and a further 18 as Nationally Rare. These seem relatively low proportions and most species have broad British ranges. To a large extent, this is a factor of the method used here to extrapolate range from what can often be quite scant data. Whilst this may not be entirely consistent with the approach used for other groups, equally it is true that most sawflies are not as sensitive to wet or cool conditions as, say, aculeate Hymenoptera, and many can indeed be found across most of Britain.

Priorities for further work are suggested to be as follows:

- Undertake the third phase of the review, covering the subfamily Nematinae, recognising that there may be significant issues regarding low data volumes and taxonomic uncertainty for many species.
- Following the completion of phase 3, complete the de-duplication of the combined dataset and establish clear permissions with all data providers surrounding the onwards use of the data, with the aim of establishing a national Sawfly Recording Scheme.
- Encourage targeted fieldwork to clarify the status of some particularly data-poor species, with a particular focus on some of the apparent extreme rarities. More focused work looking at upland habitats would also be particularly valuable as many questions remain regarding the sawfly fauna of these areas. Any upland Malaise trapping for Diptera, for example, should aim to retain any sawfly material alongside.
- Encourage the production of electronic catalogues of museum collections of British sawflies.
- Encourage similar regional IUCN reviews in other parts of Europe, helping generate wider context to understand the international significance (if any) of populations of sawflies in Britain.

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Appendix 1: Records per species

The total number of records obtained per species are listed below, along with totals [or estimated totals] following de-duplication (and some verification). Estimates are based on assumption of consistent 43% of records being duplicates (as found for the scarcer species for which detailed assessment was undertaken).

Species	Records obtained	De-duplicated [or estimate]
Athalia ancilla	355	[202]
Athalia bicolor	795	[453]
Athalia circularis	2702	[1540]
Athalia cordata	4570	[2604]
Athalia cornubiae	63	36
Athalia liberta	969	[552]
Athalia lugens	1061	[604]
Athalia rosae	5073	[2891]
Athalia scutellariae	425	[242]
Allantus basalis	30	12
Allantus calceatus	719	[409]
Allantus cinctus	1054	[600]
Allantus cingulatus	427	[243]
Allantus coryli	4	1
Allantus laticinctus	105	5
Allantus melanarius	40	19
Allantus rufocinctus	466	[265]
Allantus togatus	131	[74]
Allantus truncatus	148	[84]
Apethymus filiformis	203	[115]
Apethymus serotinus	203	[115]
Taxonus agrorum	80	41
Ametastegia albipes	271	[154]
Ametastegia carpini	586	[334]
Ametastegia equiseti	654	[372]
Ametastegia glabrata	912	[519]
Ametastegia pallipes	263	[149]
Ametastegia perla	39	22
Ametastegia tenera	529	[301]
Empria alector	175	[99]
Empria alpina	3	2
Empria basalis	18	7
Empria candidata	66	39
Empria excisa	268	[152]
Empria fletcheri	24	7
Empria immersa	122	[69]
Empria improba	1	1
Empria liturata	418	[238]

Empria longicornis	63	34
Empria minuta	4	0
Empria pallimacula	520	[296]
Empria parvula	51	32
Empria pumila	242	[137]
Empria sexpunctata	321	[182]
Empria tridens	518	[295]
Harpiphorus lepidus	82	36
Monostegia abdominalis	277	[157]
Monsoma pulveratum	287	[163]
Eriocampa ovata	1463	[833]
Ardis pallipes	79	44
Ardis sulcata	75	37
Blennocampa phyllocolpa	3737	[2130]
Cladardis elongatula	7	3
Claremontia alchemillae	119	[67]
Claremontia alternipes	201	[114]
Claremontia confusa	202	104
Claremontia brevicornis	145	[82]
Claremontia tenuicornis	12	[6]
Claremontia uncta	39	14
Claremontia waldheimii	177	[100]
Monardis plana	11	2
Monophadnoides rubi	322	[183]
Monophadnoides ruficruris	139	[79]
Pareophora pruni	73	44
Periclista albida	188	[107]
Periclista lineolata	118	[67]
Periclista pubescens	156	[88]
Eutomostethus ephippium	1383	[788]
Eutomostethus gagathinus	124	[70]
Eutomostethus luteiventris	1254	[714]
Eutomostethus punctatus	94	55
Monophadnus pallescens	580	[330]
Phymatocera aterrima	2278	[1298]
Phymatoceropsis gracilicornis	27	14
Rhadinoceraea micans	1532	[873]
Stethomostus fuliginosus	736	[419]
Stethomostus funereus	23	19
Tomostethus nigritus	208	[118]
Halidamia affinis	700	[399]
Caliroa annulipes	443	[252]
Caliroa cerasi	759	[432]
Caliroa cinxia	128	[72]
Caliroa tremulae	17	12
Caliroa varipes	100	71
Endelomyia aethiops	678	[386]
Fenella monilicornis	5	4

Fenella nigrita	306	[174]
Fenusa dohrnii	1727	[984]
Fenusa pumila	663	[377]
Fenusa ulmi	700	[399]
Fenusella glaucopis	50	21
Fenusella hortulana	33	18
Fenusella nana	384	[218]
Metallus albipes	224	[127]
Metallus lanceolatus	426	[242]
Metallus pumilus	203	[115]
Parna apicalis	104	54
Parna tenella	83	55
Profenusa pygmaea	1755	[1000]
Profenusa thomsoni	84	42
Scolioneura betuleti	645	[367]
Heterarthrus cuneifrons	34	13
Heterarthrus fiora	1110	[632]
Heterarthrus microcephalus	302	[172]
Heterarthrus nemoratus	272	[155]
Heterarthrus ochropoda	92	47
Heterarthrus vagans	856	[487]
Heterarthrus wuestneii	265	[151]
Aneugmenus coronatus	107	60
Aneugmenus fuerstenbergensis	109	61
Aneugmenus padi	1586	[904]
Aneugmenus temporalis	218	[124]
Dolerus aeneus	3237	[1845]
Dolerus aericeps	1784	[1016]
Dolerus anthracinus	104	65
Dolerus anticus	85	45
Dolerus asper	276	[157]
Dolerus bimaculatus	211	[120]
Dolerus brevicornis	125	[71]
Dolerus coracinus	18	13
Dolerus eversmanni	327	[186]
Dolerus ferrugatus	643	[366]
Dolerus fumosus	1404	[800]
Dolerus germanicus	965	[550]
Dolerus gessneri	103	52
Dolerus gilvipes	9	5
Dolerus gonager	1472	[839]
Dolerus haematodes	744	[424]
Dolerus harwoodi	19	12
Dolerus junci	702	[400]
Dolerus liogaster	537	[306]
Dolerus madidus	609	[347]
Dolerus niger	1215	[692]
Dolerus nigratus	2290	[1305]

Dolerus nitens	244	[139]
Dolerus pachycerus	55	12
Dolerus picipes	1814	[1033]
Dolerus possilensis	227	[129]
Dolerus pratensis	174	[99]
Dolerus pratorum	14	7
Dolerus puncticollis	526	[299]
Dolerus schmidti	13	6
Dolerus stygius	118	[67]
Dolerus triplicatus	275	[156]
Dolerus uliginosus	1	1
Dolerus varispinus	680	[387]
Dolerus vestigialis	1231	[701]
Dolerus yukonensis	125	[71]
Birka cinereipes	520	[296]
Nesoselandria morio	769	[438]
Brachythops flavens	298	[169]
Brachythops wuestneii	23	14
Selandria melanosterna	325	[185]
Selandria serva	3269	[1863]
Pseudohemitaxonus sharpi	12	10
Stromboceros delicatulus	1553	[885]
Strongylogaster filicis	9	1
Strongylogaster macula	171	[97]
Strongylogaster mixta	101	54
Strongylogaster multifasciata	1891	[1077]
Strongylogaster xanthocera	156	[88]
Macrophya albicincta	20	20
Macrophya albipuncta	145	[82]
Macrophya alboannulata	542	[308]
Macrophya annulata	2407	[1371]
Macrophya blanda	247	[140]
Macrophya duodecimpunctata	1133	[645]
Macrophya montana	796	[453]
Macrophya punctumalbum	563	[320]
Macrophya ribis	978	[557]
Macrophya rufipes	486	[277]
Pachyprotasis antennata	415	[236]
Pachyprotasis nigronotata	7	2
Pachyprotasis rapae	3157	[1799]
Pachyprotasis simulans	45	34
Pachyprotasis variegata	160	[91]
Aglaostigma aucupariae	2657	[1514]
Aglaostigma fulvipes	2231	[1271]
Perineura rubi	157	[89]
Tenthredopsis coquebertii	737	[420]
Tenthredopsis friesei	76	56
Tenthredopsis litterata	1077	[613]

Tenthredopsis nassata	3296	[1878]
Tenthredopsis ornata	221	[125]
Tenthredopsis scutellaris	62	45
Rhogogaster chambersi	173	[98]
Rhogogaster chlorosoma	789	[449]
Rhogogaster genistae	136	[77]
Rhogogaster picta	121	[68]
Rhogogaster punctulata	534	[304]
Rhogogaster scalaris	1701	[969]
Rhogogaster viridis	379	[216]
Sciapteryx consobrina	12	5
Sciapteryx soror	54	28
Tenthredo amoena	400	[228]
Tenthredo arcuata	2431	[1385]
Tenthredo atra	975	[555]
Tenthredo baetica	45	24
Tenthredo balteata	310	[176]
Tenthredo brevicornis	1378	[785]
Tenthredo colon	519	[295]
Tenthredo distinguenda	90	64
Tenthredo fagi	19	13
Tenthredo ferruginea	471	[268]
Tenthredo ignobilis	24	3
Tenthredo livida	2719	[1549]
Tenthredo maculata	613	[349]
Tenthredo mandibularis	165	[94]
Tenthredo mesomela	4349	[2478]
Tenthredo mioceras	70	41
Tenthredo moniliata	120	[68]
Tenthredo neobesa	50	5
Tenthredo notha	1862	[1061]
Tenthredo obsoleta	31	18
Tenthredo olivacea	338	[192]
Tenthredo omissa	336	[191]
Tenthredo schaefferi	435	[247]
Tenthredo scrophulariae	2356	[1342]
Tenthredo semicolon	8	6
Tenthredo temula	1978	[1127]
Tenthredo thompsoni	881	[502]
Tenthredo velox	93	59
Tenthredo vespa	143	[81]
Tenthredo zona	155	[88]