The Second State of Natural Resources Report (SoNaRR2020)

SoNaRR2020 Register semi-natural grasslands evidence

Natural Resources Wales

Final Report

About Natural Resources Wales

Natural Resources Wales's purpose is to pursue sustainable management of natural resources. This means looking after air, land, water, wildlife, plants and soil to improve Wales's well-being, and provide a better future for everyone.

Evidence at Natural Resources Wales

Natural Resources Wales is an evidence-informed organisation. We seek to ensure that our strategy, decisions, operations and advice to Welsh Government and others are underpinned by sound and quality-assured evidence. We recognise that it is critically important to have a good understanding of our changing environment.

We will realise this vision by:

- Maintaining and developing the technical specialist skills of our staff;
- Securing our data and information;
- Having a well resourced proactive programme of evidence work;
- Continuing to review and add to our evidence to ensure it is fit for the challenges facing us; and
- Communicating our evidence in an open and transparent way.

Title: **SoNaRR2020 Register semi-natural grasslands evidence**

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The Second State of Natural Resources Report (SoNaRR2020) contents

This document is one of a group of products that make up the second State of Natural Resources Report (SoNaRR2020). The full suite of products are:

Executive Summary. Foreword, Introduction, Summary and Conclusions. Published as a series of webpages in December 2020

The Natural Resource Registers. Drivers, Pressures, Impacts and Opportunities for Action for eight Broad Ecosystems. Published as a series of PDF documents and as an interactive infographic in December 2020

Assessments against the four Aims of SMNR. Published as a series of PDF documents in December 2020:

SoNaRR2020 Aim 1. Stocks of Natural Resources are Safeguarded and Enhanced

SoNaRR2020 Aim 2. Ecosystems are Resilient to Expected and Unforeseen Change

SoNaRR2020 Aim 3. Wales has Healthy Places for People, Protected from Environmental Risks

SoNaRR2020 Aim 4. Contributing to a Regenerative Economy, Achieving Sustainable Levels of Production and Consumption

The SoNaRR2020 Assessment of Biodiversity. Published in March 2021

Assessments by Broad Ecosystem.. Published as a series of PDF documents in March 2021:

Assessment of the Achievement of SMNR: Coastal Margins

Assessment of the Achievement of SMNR: Enclosed Farmland

Assessment of the Achievement of SMNR: Freshwater

Assessment of the Achievement of SMNR: Marine

Assessment of the Achievement of SMNR: Mountains, Moorlands and Heaths

Assessment of the Achievement of SMNR: Woodlands

Assessment of the Achievement of SMNR: Urban

Assessment of the Achievement of SMNR: Semi-Natural Grassland

Assessments by Cross-cutting theme. Published as a series of PDF documents in March 2021:

Assessment of the Achievement of SMNR: Air Quality

Assessment of the Achievement of SMNR: Climate Change

Assessment of the Achievement of SMNR: Energy Efficiency

Assessment of the Achievement of SMNR: Invasive Non-native Species

Assessment of the Achievement of SMNR: Land use and Soils

Assessment of the Achievement of SMNR: Waste

Assessment of the Achievement of SMNR: Water Efficiency

Updated SoNaRR evidence needs. Published in March 2021

Acronyms and Glossary of terms. Published in December 2020 and updated in March 2021

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Semi-natural grasslands Natural Resource Register Evidence List

SoNaRR2020

The evidence below has been extracted from the semi-natural grassalnds chapter unless otherwise stated.

If the original piece of evidence is not cited within this document then it can be found in the semi-natural grasslands chapter or associated chapters, which will be published in March 2021. At that point this document will be superseded.

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Evidence List: Drivers, Pressures and Impacts Table

Climate Change

1. **Changing Weather Patterns**

   1.1 **Causing the altering of the hydrology of some wet grassland systems.**
   Climate change was given a medium threat for some grassland habitats and considered likely to have an increasing impact in the future, including from direct effects such as increasing summer droughting and altering the hydrology of some wet grassland systems (Natural England & RSPB, 2014; Stroh et al., 2019).

   1.2 **The indirect effects of climate change, including changes to land management, may be more significant.**
   The indirect effects of climate change, including changes to land management, may be more significant than direct effects (Natural England & RSPB, 2020; Stroh et al., 2019).

Pollution

2. **Air Pollution**

   2.1. **Biodiversity in grassland is severely negatively impacted by high levels of nutrient enrichment, such as from atmospheric nitrogen deposition, which can also cause soil acidification.** (Stevens et al., 2004; Stevens et al., 2010b; Van den Berg et al., 2011).
   Air pollution was listed as 'high' for all of the grassland Annex 1 habitats; this includes atmospheric deposition of nitrogen oxides (NOx), from the burning of fossil fuels by traffic and industry, and local sources of ammonia (NH_3) deposition, arising mainly from intensive poultry and dairy enterprises. These pollutants are known to cause decreased species-richness of grassland through the twin effects of eutrophication and soil acidification (Stevens et al., 2004; Stevens et al., 2010b; Van den Berg et al., 2011).

   Upland grasslands are more likely to be subjected to high levels of NOx deposition, due to generally higher rainfall levels. However, even low NOx deposition levels can detrimentally affect more sensitive species (in both upland and lowland situations), notably lichens (Stevens et al., 2012).

   Evidence from Air Quality Chapter
   Unfertilised semi-natural grassland is particularly affected by nitrogen deposition, which can change the species composition, favouring some grasses at the expense of herbs, bryophytes and lichens. Herb-poor, species-poor grassland provides fewer food sources for biodiversity and reduced nectar sources for pollinators.

2.2. **Causes decreased species-richness of grassland through the twin effects of eutrophication and soil acidification.**

Air pollution was listed as 'high' for all of the grassland Annex 1 habitats; this includes atmospheric deposition of nitrogen oxides (NOx), from the burning of fossil fuels by traffic and industry, and local sources of ammonia (NH_3) deposition, arising mainly from intensive poultry and dairy enterprises. These pollutants are known to cause decreased species-richness of grassland through the twin effects of eutrophication and soil acidification (Stevens et al., 2004; Stevens et al., 2010b; Van den Berg et al., 2011). Intensive poultry units are particularly common in parts of mid Wales, Anglesey and Pembrokeshire (Laimann & Henderson, 2018).

Evidence from Air Quality Chapter
Ammonia has similar eutrophication and acidification effects on semi-natural grassland, but impacts are closer to source, with the highest concentrations often associated with intensive poultry and dairy enterprises.

Land Use Change

3. **Insufficient Management**

3.1. **Resulting in declining species-richness and condition, over-dominance of tall, robust species and eventually loss of grassland to scrubland.**

Pressures and threats relating to level of grazing were listed as 'high' for all grassland European Protected Habitats in Wales, from under-grazing (including abandonment and succession to scrub/trees) and/or over-grazing.

Inappropriate management, such as overgrazing and undergrazing, also generally have a very detrimental effect on plant and animal diversity.

Marsh fritillary butterfly Euphydryas aurinia, a species mostly associated with lowland wet grassland, declined by 71% between 1990 and 2017 in Wales, to a large extent due to under-management, although recovery on some sites has been noted since 2007 (JNCC, 2019; Tordoff & Williams, 2018).

Undermanagement of grassland can also lead to an increase in certain invasive non-native species such as Himalayan balsam Impatiens glandulifera, but probably the greatest invasive non-native species threat to grassland condition is cotoneaster species, which are a significant issue on a number of calcareous grassland sites across Wales (Stroh et al., 2019; various site reports)

A wide range of grassland plant species have suffered significant decline or local extinctions in Wales

- Declines in bumblebee species in recent decades have been directly attributed to the loss of semi-natural grassland and grassland species.

- Corncrake Crex crex was once found in species-rich meadows in every county but has declined by 98% as a breeding bird in Wales since about 1970.

- Loss of lowland wet grasslands is considered to be the main cause of decrease in lapwing which suffered of an estimated 51% decline in Wales between 1998 and 2018.

- Curlew was widespread in lowland wet grasslands and upland habitats in Wales, but more than three-quarters of its Welsh population has been lost in the last 25 years and it is now considered the most pressing bird conservation priority in Wales.

3.2. **Undermanagement and overgrazing are both likely to deplete pollinator resources, as well as causing overall species impoverishment.**
The importance of wild pollinators is now being more widely recognised (Garibaldi et al., 2014; IPBES, 2016; Rader et al., 2016; Lucas et al., 2018) but, in addition to the decline of managed bees (Potts et al., 2010), many wild pollinator groups have endured huge declines in recent decades (Biesmeijer et al., 2006; Fox et al., 2013; Baude, 2016; Powney et al., 2019). Semi-natural grasslands are of high importance for pollinating invertebrates, with calcareous and neutral grasslands having among the highest nectar levels of all habitats (Baude, 2016); marshy grasslands had the highest density of bumblebees and butterflies of ten broad habitats assessed during Glastir Monitoring and Evaluation Programme (Alison et al., 2020). Undermanagement and overgrazing are both likely to deplete pollinator resources (Hudewenz et al., 2012; Jerrentrup et al., 2014; Vanbergen et al., 2014; Lázaro et al., 2015), as well as causing overall species impoverishment.

3.3. **Undermanagement means lower livestock production and an increased fuel loading, meaning increased fire risk.**
Management is key to reducing fire hazard in semi-natural grasslands. Suitable levels of livestock grazing and/or cutting reduces fuel loading and are also likely to have other ecosystem benefits, such as increased plant species-richness and increased agricultural productivity. Grassfires, together with a much smaller number of forest fires, have been estimated to cost South Wales Fire Service £7 million annually (Jollands et al., 2008).

4. **Agricultural Intensification**

4.1. **Loss of lowland wet grasslands is considered to be the main cause of decrease in lapwing**
Loss of lowland wet grasslands is considered to be the main cause of decrease in lapwing Vanellus vanellus (State of Nature: Hayhow et al., 2019), which suffered of an estimated 51% decline in Wales between 1998 and 2018 (RSPB unpubl.).

Declines in grassland flora and fauna are largely due to loss of species-rich grassland habitat, for example decline in traditionally managed hay meadows (corncrake and green-winged orchid) and loss of lowland wet pastures (curlew and lapwing).

4.2. **Increase soil compaction levels, which can reduce the soil's capacity to hold water and thus potentially increase flood risk.**
Overgrazing is likely to increase soil compaction levels, which can reduce the soil's

capacity to hold water and thus potentially increase flood risk (Alaoui et al., 2018; Hargreaves et al., 2019).

4.3. **High levels of fertiliser application lead to the decline in grassland diversity and condition, and eventually habitat loss**
Intensive farming practice is still resulting in loss of lowland semi-natural grassland, decline in grassland diversity and condition, and habitat patch fragmentation (Section 2.1.1; Smith et al., in prep; Fig 4; results presented in SoNaRR 2020)

Current losses of Semi-Natural Grassland are in the context of more than 90% loss in the latter part of the 20th century (Stevens et al., 2010a).

4.4. **Likely to deplete pollinator resources, as well as causing overall species impoverishment**
Stevens et al., 2010a; Stroh et al., 2019

4.5. **Leads to fragmentation - lack of ecological connectivity of semi-natural grasslands leads to isolation of less mobile species, making them at much greater risk of extinction**.
Semi-natural grasslands dominated the Welsh lowland landscape less than 100 years ago, but declined by more than 90% during the latter part of the 20th century, driven by land-use policies focused on agricultural production. Remaining areas of the ecosystem are often small and highly fragmented. (Section 2.1.1; Fig 5; Stevens et al., 2010a; SoNaRR2016).

5. I**nsufficient Management**

5.1. **Causing protected sites to not be appropriately managed, leading to poor condition.**
Recent structured condition monitoring on grassland SSSIs shows a pattern of mostly poor condition: 91 (72%) of 124 lowland semi-natural grassland SSSI features assessed between 2004 and 2017 were in unfavourable condition, with under-management flagged as the main cause (affecting 80% of features; see Fig 3). During the most recent round of SAC monitoring, all but one of the 23 lowland grassland SAC features in Wales was considered to be in unfavourable condition.

5.2. **Protected sites may become 'habitat islands', poorly connected to other habitat patches**
Habitat fragmentation has a huge effect on less mobile flora and fauna, leaving populations isolated from one another and therefore much more prone to extinction if local conditions become unfavourable for a time, and with little chance thereafter of them being restored by natural means. Connected landscapes are highly important for many butterfly species which persist as metapopulations and are at greatly increased risk of extinction in fragmented landscapes (Butterfly Conservation, 2015).

Evidence from the Climate Change Chapter
Where species are unable to disperse, either due to barriers to movement or being unable to disperse at the pace of warming, they will be at risk of localised extinctions (high confidence) (IPBES, 2019). This is likely to be a particular problem for species which have lower dispersal rates and/or face fragmented habitats.

Rarer species of conservation concern by their nature often have more specific environmental and habitat requirements that mean they face greater challenges to disperse than widespread species. For instance, lowland semi-natural grasslands in Wales are very fragmented, which could limit species' ability to move as the climate changes, increasing their risk of extinction.

5.3. **Unprotected sites may be lost, for example through fertiliser application**
Statutory site protection has been shown to greatly limit loss of semi-natural grassland habitat, for example Ridding et al. (2015) recorded a 9% loss of grassland habitat area on SSSIs in England between 1960 and 2013, compared to 73% loss on unprotected sites in the same period (see also SoNaRR2016, section 3.7). In Wales, of 26 grassland qualifying features on SACs assessed between 2005 and 2017, no cases of loss in extent were recorded, and of 124 SSSI grassland qualifying features assessed between 2004 and 2017, only 7 (5%) had been impacted by some loss of extent (mainly through scrub expansion).

A desk-based assessment of Purple Moor-grass and Rush Pasture Priority Habitat using time-series aerial imagery estimated a 22% loss of habitat area over a 22-year period (1992-2014). This study looked at around 2000 randomly-chosen, unprotected habitat patches across Wales which had been previously mapped by the Phase 1 Habitat Survey of Wales (Blackstock et al., 2010), comprising 10% of all mapped patches of the habitat. Losses of grassland habitat were recorded the whole period, including post 2013.

Revisits to 61 unprotected grassland sites between 2008 and 2017 recorded loss of grassland Priority Habitat at 27 sites (48%) since the previous site visits in the early 2000s (Smith et al., in prep). Losses were partially offset by grassland habitat expansion at 5 sites (8%), but mapped loss of the habitat was 31.7 ha and mapped gain 5.5 ha, meaning more than five times as much loss as gain.

Evidence from Aim 2: Resilient Ecosystems Chapter
The amount of lowland habitat, especially freshwater, grassland, heathland and peatland, has declined considerably due to hard engineering, water abstraction and changes in management that modify plant communities and change the type of habitat.

6. **Built Development and Infrastructure**

6.1. **Areas of semi-natural grassland outside the statutory site network are locally at greatly increased risk from land development, including new roads, quarrying and housing.**
Smith et al., in prep.

7. **Unmanaged Access, Sport and Recreational Activity**

7.1. **Recreation damage to upland calcareous and calaminarian grassland is locally significant.**
JNCC, 2019

8. **Competing Land Use**

8.1. **Small losses of SNG to afforestation have so far been recorded (High Confidence), but the threat is very likely to be greater in the future as afforestation increases to help with climate change.**

Smith et al., in prep.; JNCC, 2019

INNS, Pests and Diseases

9. **Spread of INNS**

9.1. **Species such as Cotoneaster can spread over calcareous grassland if not controlled. Undermanagement of wet grasslands may aid spread of Himalayan balsam**

Undermanagement of grassland can also lead to an increase in certain invasive non-native species such as Himalayan balsam Impatiens glandulifera, but probably the greatest invasive non-native species threat to grassland condition is cotoneaster species, which are a significant issue on a number of calcareous grassland sites across Wales (various individual site reports; Stroh et al., 2019).

Evidence from INNS Chapter

The heat map of occurrence records of INNS of interest to Wales which impact on the semi-natural grassland ecosystem in Wales (Fig 8d) shows that they are widely spread across Wales with a higher concentration of records in south east Wales, which reflects the distribution of this ecosystem and the invasion history of the INNS that affect this ecosystem, as many of the plant species have escaped from gardens and a few key species invaded south Wales first, before spreading northwards. In some places there is a correlation to water courses, which indicates that waterways can form pathways for the spread of certain species and emphasises the need to act at appropriate spatial scales to effectively tackle INNS (e.g. catchment scale). INNS of interest to Wales can affect semi-natural grassland by reducing biodiversity, largely by outcompeting or shading out native plants. On occasion, this can lead to the formation of monocultures which significantly reduce the variety and abundance of native plants and can have knock on impacts on invertebrate communities and higher trophic levels. INNS can contribute to succession, for example by restricting livestock access and thus promoting reversion to scrub and woodland, which may then be more difficult and costly to remove. Also, to a lesser extent, the species listed can affect the grazing productivity of semi-natural grassland.

Evidence List: Assessment of SMNR

Aim 1: Stocks of Natural Resources are safeguarded and enhanced

Aim 1: Progress towards meeting the aim

1.1 Semi-natural grasslands are generally better connected in the upland fringes (ffridd), and much better connected in the uplands, where patches of habitat are generally much larger (see Fig 5, section 2.1.1; Blackstock et al., 2010). Extent of SNG in the uplands and upland fringes appears broadly stable at present (section 2.1.1).

1.2 Loss of high-quality grassland habitat is continuing in the lowlands outside the protected sites network (Section 2.1.1; Fig 4; Smith et al., in prep.).

1.3 27% of all semi-natural grassland in Wales, and 10% of priority grassland habitat, is on statutory protected sites. Statutory site protection greatly limits loss of semi-natural grassland habitat (Fig 7; section 2.1; Ridding et al., 2015).

1.4 The majority of lowland semi-natural grassland SSSI features are in unfavourable condition (section 2.1.1).

1.5 19% of mapped grassland Priority Habitat has been covered by Glastir Advanced grassland options in recent years (2012 to 2019) (section 2.1.1).

1.6 EIA (Agriculture) Regulations cover all semi-natural grassland and have prevented incidents of significant damage to at least 89 high conservation value grassland sites since 2002 (Welsh Government, 2017; section 2.1.1)

Aim 1: Obstacles remaining to meeting the aim

1.7 Semi-natural grassland is the most fragmented ecosystem in the Welsh lowlands (Fig 5 & 6; section 2.1.1).

1.8 Only about 10% of grassland Priority Habitat is on protected sites (section 2.1.1)

1.9 A total of 21% of the semi-natural grassland on protected sites is currently covered by specific SSSI management agreements mostly aimed at improving grassland condition. (section 2.1.1).

1.10 81% of mapped grassland Priority Habitat has not been covered by Glastir Advanced grassland options in recent years (2012 to 2019). (section 2.1.1).

1.11 EIA (Agriculture) Regulations are unlikely to guard against gradual changes, such as incremental increase in fertiliser application, and are not designed to prevent management neglect or abandonment (section 2.1.1).

Aim 2: Resilient Ecosystems

Aim 2: Progress towards to meeting the aim

2.1 More than 90% of SNG in lowland Wales was lost in the 19th century (SoNaRR2016; Stevens et al., 2010a). Remaining habitat patches are invariably small, ranging from an average of 6.2 ha (acid grassland) to just 1.8 ha (neutral grassland). (Fig 5; SoNaRR2016; section 2.1.1).

2.2 Semi-natural grassland is the most fragmented ecosystem in the Welsh lowlands; patches are widely scattered within landscapes dominated by improved grassland. Some better-connected landscapes remain locally. (section 2.1.1; Stevens et al., 2010a; Blackstock et al., 2010).

2.3 Upland semi-natural grassland scores high on both extent and connectivity and diversity and condition is medium. (section 2.1.1; Blackstock et al., 2010). Overall resilience of upland ecosystems may be improved by conversion of some upland acid grassland to other habitats such as heathland. (section 2.1.1; Mountain, Moor & Heath chapter).

2.4 There has been very little recorded recent loss of grassland extent on SSSIs in Wales, but condition is mostly poor. (section 2.1.1; Figure 3).

2.5 Condition is mostly poor for lowland SNG outside statutory sites. Undermanagement is one of the principal causes of this. (section 2.1.1; Smith et al., in prep.).

Aim 2: Obstacles remaining to meeting the aim

2.6 Lowland SNG outside statutory protected sites is still being lost to agricultural improvement. (section 2.1.1; Smith et al., in prep.).

2.7 High Levels of atmospheric nitrogen deposition (nitrogen oxides and ammonia) is still occurring, although atmospheric N is declining slowly. These cause increased soil nutrient levels and acidification in SNG. (section 2.1.1; Stevens et al., 2004; Stevens et al., 2010b; Van den Berg et al., 2011; Air Quality chapter).

2.8 Climate change will have a direct negative impact on semi-natural grassland ecosystems, for example through increased droughting and hydrological changes, as well as indirect effects such as changes to land management. (sections 2.0, 2.1.1; Natural England & RSPB, 2020; Stroh et al., 2019).

2.9 Insufficient resources devoted to management of grassland SSSIs or targets aimed at improving site condition. (section 2.1.1)

2.10 Insufficient uptake and targeting of agri-environment schemes on SNG sites. (section 2.1.1)

2.11 90% of grassland Priority Habitat is not on protected sites. (section 2.1.1; Figure 7)

Aim 3: Healthy Places for People

Aim 3: Progress towards to meeting the aim

3.1 Despite a decline in the historic rate of loss of SNG, conversion to improved grassland is continuing (section 2.1.1; SoNaRR2016; Stevens et al., 2010a). This decreases regulating and cultural ecosystem service provision, including pollination supply, water and soil quality, sense of place and cultural provision (section 2.2.2: Baude, 2016; Alison et al., 2020; Weisser et al., 2017; Chen et al., 2018; Chen et al., 2020; Weatherhead & Howden, 2009; Bengtsson et al., 2019; Hargreaves et al., 2019; Jarvie et al., 2008, 2010; Bullock et al., 2011; Souchere et al., 2003; Bengtsson et al., 2019; Evans et al., 2019; Tsiafouli et al., 2014; Lindemann-Matthies et al., 2010; Junge et al., 2015).

3.2 Undermanagement or abandonment of SNG is still widespread within and outside statutory protected sites (section 2.1.1; Figure 3), meaning decreased provision of, for example, pollination supply and increased hazard (fire) loading (section 2.2.2; Yang et al., 2019 Moog et al., 2002; Bohner et al., 2019; Kimberly et al., 2019).

3.3 The intensification of SNG on floodplains has led to increased flood risk and water pollution (section 2.2.2; Alaoui et al., 2018; Weatherhead & Howden, 2009; Bengtsson et al., 2019; Hargreaves et al., 2019; Leip et al., 2015; Jarvie et al., 2008, 2010; Bullock et al., 2011).

Aim 3: Obstacles remaining to meeting the aim

3.4 Focus in farming is predominantly on maximising food production rather than multiple ecosystem service benefits (sections 2.2.1 & 2.3; Enclosed Farmland chapter).

3.5 Insufficient resources to tackle undermanagement on and outside statutory sites (sections 2.1.1 & 2.1.3; Figure 3; Smith et al., in prep.)

3.6 Insufficient spatial targeting of SNG restoration/creation to maximise ecosystem service benefits (sections 2.1.1, 2.1.3 & 2.4)

3.7 Evidence to be provided

3.8 Climate change is causing changes detrimental to SNG and the ES they provide and leading to land use changes harmful to SNG. This is likely to increase into the future (sections 2.0, 2.1.1, 2.1.3 & 2.2.1; Natural England & RSPB, 2020; Stroh et al., 2019; Tilman & Downing 1994; Isbell et al., 2015; De Keersmaecker et al., 2016; Volaire et al., 2014).

Aim 4: A Regenerative Ecomony

Aim 4: Progress towards to meeting the aim

4.1 SNG undermanagement and abandonment are still widespread within and outside statutory protected sites (section 2.1.1; Figure 3).

4.2 Meat produced from semi-natural grasslands typically has a higher nutrient content and lower fat levels than that produced from agriculturally improved grasslands. Meat quality is being increasingly promoted but is often regarded as less important than price. (section 2.2.1; Wood et al., 2007; Fraser et al., 2009; Bullock et al., 2011; Shellswell, 2017; McAuliffe et al., 2018).

4.3 The capital costs of farming semi-natural grassland are markedly lower than for intensive grassland management, largely due to much lower expenditure on fertilisers and farm chemicals, and also less use of farm machinery. This is now being considered more in farm economics (section 2.2.1; Enclosed Farmland chapter)

4.4 Evidence from Enclosed Farmland Chapter
The weight of pesticide active ingredients applied to land has decreased over the past 25 years (Figure 3). However, this hides the true picture as the number of hectares treated with pesticides, along with the frequency of treatments, have increased, impacting soil biodiversity. In addition, there have been increases in the toxicity of pesticides and the variety of pesticides used on a single crop (Hayhow et al., 2019).
Figure 3 Trends in Pesticide use in Wales. Total Area Treated refers to the **active substance treated area**. This is the basic area treated by each active substance, multiplied by the number of times the area was treated e.g. A field of 3 ha is treated 4 times with active X. Therefore, the area treated is 12 ha (3x4) Fera Science, 2020.
Inorganic fertiliser inputs have decreased since the late 1980’s (Figure 2) (Hayhow et al., 2019). For long-term permanent pastures this has led to a reduction in productivity without environmental gain (Ye et al., 2011). There is no information available on organic fertiliser inputs, but 20th century transitions towards livestock systems based on silage and slurry, combined with imported feeds for pigs and poultry, point towards increased organic nutrient levels across the majority of farmland. Organic manures are one of the largest contributors to ammonia emissions, which have significant implications on other ecosystems (Plantlife & Plant Link UK, 2017).
Figure 2 Total quantities of manufactured fertilisers used in the UK, 1965 to 2017 (Hayhow et al., 2019)

Aim 4: Obstacles remaining to meeting the aim

4.5 Semi-natural grasslands provide comparatively low financial returns due to low productivity, often leading to neglect and undermanagement (section 2.1.1; Bullock et al., 2011).

4.6 Focus in farming is predominantly on maximising food production rather than multiple ecosystem service benefits (sections 2.2.1 & 2.3; Enclosed Farmland chapter).

4.7 Appreciation of the greater nutritional value of meat from semi-natural habitats is likely increasing but is still largely a niche market and cost is still generally regarded as more important (section 2.2.1; Wood et al., 2007; Fraser et al., 2009; Bullock et al., 2011; Shellswell, 2017; McAuliffe et al., 2018).

4.8 The full capital costs of intensive farming are not always accounted for in farm food production, when compared with the lower costs of food production on SNG (section 2.2.1; Enclosed Farmland chapter).