

Inventory of Ecosystem Services provided by Natura 2000 in Wales: Summary report

LIFE Natura 2000 Programme for Wales

Prepared by LUC and LIFE Natura 2000 Programme

Action A9: LIFE N2K Wales: LIFE 11 NAT/UK/385

June 2015



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Project Title: Inventory of Ecosystem Services provided by Natura 2000 Sites and Features in Wales

Client: National Resources Wales

Version	Date	Version Details	Prepared by	Checked by	Approved by Director
V0.1	18/11/2014	Draft for internal circulation	Emma Deen	Robert Deane	Robert Deane
V1.1	10/11/2014	Draft final report	Emma Deen	Diana Manson	
V2	January 2015	Draft final report	Emma Deen	Shontelle Williams	Robert Deane
V3	June 2013	Final report	Kathryn Hewitt Andrew Jeffery		Kathryn Hewitt

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Crynodeb Gweithredol

Teclyn ymarferol yw Rhestr Gwasanaethau Ecosystemau Natura 2000 a ddylai fod yn ddefnyddiol i ymarferwyr a phenderfynwyr sydd â diddordeb yn Natura 2000. Bydd yn eu galluogi i amlygu'r manteision sy'n deillio i bobl Cymru o'r rhwydwaith Natura 2000.

Mae Natura 2000 yn rwydwaith Ewrop gyfan o ardaloedd gwarchod natur a'r rhwydwaith hon yw canolbwynt polisi natur a bioamrywiaeth yr Undeb Ewropeaidd. Mae gwerth cyfraniad Natura 2000 i gadwraeth bioamrywiaeth yn cael ei gydnabod yn eang (Popescu et al. 2014), fodd bynnag, ar ben hyn, daw safleoedd Natura 2000 a'u rhywogaethau a'u cynefinoedd dynodedig â chyfoeth o fuddion i bobl Cymru ar ffurf gwasanaethau ecosystemau. Er enghraifft, buddion megis ailgylchu maetholion a dŵr, rheoli hinsawdd, ansawdd dŵr, aer a phridd ac ardaloedd ar gyfer hamdden a thwristiaeth.

Daeth gwasanaethau ecosystemau a'u gwerth yn amlwg, gyda nifer o astudiaethau'n cael eu cynnal yn y maes (TEEB, 2010; NEA, 2011; GHK, 2011; Pagella et al, 2013); mae'n nhw hefyd yn elfen allweddol mewn dulliau cyfun o Reoli Adnoddau Naturiol. Fodd bynnag, mae astudiaethau wedi tueddu i ganolbwyntio ar ddarpariaeth ecosystemau yn fras ar lefel cynefinoedd yn hytrach nag ar gynefinoedd neu rywogaethau mwy penodol sydd â'r gwerth cadwraethol mwyaf.

Teclyn yw'r Rhestr Gwasanaethau Ecosystemau Natura 2000, a ddisgrifir yn yr adroddiad hwn, i helpu ymarferwyr nodi'r gwasanaethau ecosystemau sy'n cael eu darparu gan nodweddion rhywogaethau a chynefinoedd penodol Natura 2000 ac sy'n sail ar gyfer datblygu'r wybodaeth sydd ar gael ar gyfer safleoedd. Y bwriad yw y bydd yn cynnwys gwybodaeth gwaelodlin y gellir ychwanegu ato pan geir rhagor o wybodaeth. Mae'r adroddiad yn disgrifio'r dulliau o ddatblygu Rhestr Ecosystemau a chrynodeb o'r canlyniadau.

Dengys canlyniadau cyntaf y rhestr fod y rhwydwaith Natura 2000 yng Nghymru'n darparu amrywiaeth o ecosystemau ar raddfa arwyddocaol. Y rhai o'r pwysigrwydd pennaf yw'r gwasanaethau rheoleiddio, megis cadw carbon (yn enwedig mewn gwlypdiroedd a choetiroedd), lliniaru erydiad yr arfordir a pheryglon llifogydd (drwy gynefinoedd rhwng llanw, morfa heli a thwyni tywod) a chymhathu llygredd aer a dŵr (llawer o gynefinoedd). Mae safleoedd Natura 2000 hefyd yn chwarae eu rhan mewn economïau ffermio da byw traddodiadol ac yn y dwydiannau pysgod a chregyn y môr yng Nghymru.

Mae'r rhan fwyaf o gynefinoedd a rhywogaethau Natura 2000 yn darparu gwasanaethau tirluniau o ansawdd a syniad o le. Mae rhai safleoedd Natura 2000 hefyd yn atyniadau allweddol i ymwelwyr, llawer hefyd yn caniatáu amrywiaeth eang o gyfleoedd mynediad a hamdden, megis cerdded, ymweld â glan y môr, gwylio bywyd gwylt, hwylio a chwaraeon antur. Gyda'i gilydd, mae'r rhain yn cyfrannu at economi twristiaeth Cymru.

Bydd deall yn glir y gwasanaethau ecosystemau y mae Natura 2000 yn eu darparu o gymorth i gefnogi'r broses barhaus o gyfuno anghenion bioamrywiaeth gyda sectorau eraill megis amddiffyn rhag llifogydd, amaethyddiaeth, twristiaeth ac iechyd fel bod pawb ar eu hennill. Bydd hefyd o help i ddatblygu dulliau trefnus fesul ardal o reoli adnoddau naturiol sy'n ystyried cydberthynas ffactorau amgylcheddol ar lefel tirlun, dalgylch neu ranbarthol. Gall y Rhestr hefyd fod o help i ganfod arian ar gyfer Natura 2000 o ffynonellau amgen o ariannu, pan nad bioamrywiaeth yw'r maen prawf pennaf.

Executive Summary

The N2K Ecosystem Services Inventory is a practical tool, which is intended to be useful to practitioners and decision-makers with an interest in Natura 2000, to enable them to highlight the multiple benefits of the N2K network for the people of Wales.

Natura 2000 (N2K), a European-wide network of nature protection areas, is the centrepiece of EU nature and biodiversity policy. The value of Natura 2000 for its contribution to the conservation of biodiversity is well established (Popescu et al. 2014), however, in addition to this, Natura 2000 sites and their designated species and habitats, deliver a wealth of benefits to the people of Wales in the form of ecosystem services. For example they provide benefits such as nutrient and water cycling, regulation of climate, water, air and soil quality and provide areas for recreation and tourism.

Ecosystem services and their value are becoming well recognised with a number of studies undertaken in this area (TEEB, 2010; NEA, 2011; GHK, 2011; Pagella et al, 2013); they are also a key element of the integrated Natural Resource Management approach. However existing studies have tended to focus on ecosystem delivery at a broad habitat level, rather than at the level of more specific habitats of the highest conservation value or of individual species.

The Natura 2000 Ecosystem Services Inventory, described in this report, is a tool to help practitioners identify ecosystem services provided by specific Natura 2000 species and habitat features and provide the basis for developing this information for sites. It is intended to provide baseline information that can be updated in the future when more data becomes available. This report describes the approach taken to developing the Ecosystems Inventory and a brief summary of results.

Initial results from the Inventory show that the N2K network in Wales delivers a wide range of ecosystem services at a significant scale. Of primary importance are regulatory services such as carbon sequestration (delivered particularly by wetlands and woodland), amelioration of coastal erosion and flood hazard (delivered by intertidal habitats, saltmarsh and sand dunes), and assimilation of air and water pollution (many habitats). N2K also plays a part in the economies of low-intensity livestock farming and sea fish and shellfish industries of Wales.

Cultural services of landscape quality and tranquillity and sense of place are delivered by the majority of N2K habitats and species. Some N2K sites are also key tourist attractions, and many also allow for a wide diversity of access and recreational opportunities such as walking, seaside visits, wildlife watching, boating, and adventure sports. Together these contribute to the tourism economy of Wales.

A clear understanding of ecosystem services provided by N2K will help to support the ongoing process of integrating biodiversity needs into other sectors such as flood defence, agriculture, tourism and health to deliver mutual benefits. It will also aid the development of a coherent area-based approach to natural resource management which examines interrelationships of environmental factors at a landscape, catchment or regional level. The Inventory can also help source funding for N2K from alternative finance sources, where biodiversity is not the priority criteria.

Introduction

Natura 2000 (N2K) is a Europe-wide network of nature protection areas and the centrepiece of EU nature and biodiversity policy. The aim of the network is to assure the long-term survival of Europe's most threatened species and habitats. In Wales there are 112 Natura 2000 sites - 92 Special Areas of Conservation (SAC) and 20 Special Protection Areas (SPA). In Wales these sites are designated to protect 121 different habitat and species features.

The contribution of the Natura 2000 series to the conservation of biodiversity is well established (Popescu et al. 2014), however, in addition Natura 2000 sites, species and habitats deliver a wealth of other benefits to the people of Wales. They are living landscapes with farms, forestry enterprises or fisheries which contribute to the Welsh economy. They show us nature at its best and are appreciated by millions of visitors every year, supporting the tourist industry and providing the opportunity for pleasure, relaxation and outdoor exercise which boosts health and wellbeing. They also provide essential life support services, such as purification of drinking water and carbon storage. These benefits are known as ecosystem services¹.

The value of protected sites to society are increasingly recognised (Millennium Ecosystems Assessment, 2005) and there have been a number of key studies in this area. Internationally, the Economics of Ecosystems and Biodiversity (TEEB) Programme has examined the many benefits that society gains from natural systems². In the UK, The National Ecosystems Assessment (NEA) provided the first comprehensive overview of the state of the natural environment in the UK (UKNEA, 2011). Research for Defra (GHK, 2011) assessed the ecosystem services provided by Sites of Special Scientific Interest in England and Wales and work has been undertaken for the Wales Environment Hub on the provision of ecosystem services by habitats in Wales (Pagella et al., 2013). However, these and other studies have focussed on ecosystem delivery at a broad habitat level, rather than at the level of more specific habitats of the highest conservation value or of individual species. There has therefore been no formal assessment of the ecosystem services that are provided by N2K features and sites in Wales.

1.1 Aims and objectives

The primary aim of the study was to produce a practical, easy-to-use inventory that will allow the ecosystem services that are provided by features and sites in Wales to be clearly identified. It provides a baseline dataset that can be updated in the future when more information becomes available.

It is intended that the inventory will be used as a tool to supply information to promote the wider benefits of the N2K network in Wales to both the public and decision-makers.

In addition the inventory can also be used as an evidence base to help obtain funding for the conservation of N2K by aiding applications to a wider range of grant schemes, such as those aligned with ecosystem services provision. For example, a significant amount of public funds are earmarked for public

¹ Ecosystem Services are defined most concisely by the United Nations Environment Programme's Millennium Ecosystems Assessment as "the benefits people obtain from ecosystems" <http://www.unep.org/maweb/documents/document.300.aspx.pdf>

² <http://www.teebweb.org/>

goods such as flood defence, erosion control and water purification. Therefore there is potential for these funds to be integrated with N2K requirements, where the sites contribute to these services.

This report describes the approach taken to developing the Natura 2000 Ecosystems Inventory, outlines the scope and limitations of the study and summaries key findings.

1.2 Definitions and abbreviations

Ecosystem services: The benefits people gain from ecosystems. Four broad categories of services are recognised (Millennium Ecosystem Assessment 2005) as follows:

- **Supporting services** are those that are necessary for the production of all other ecosystem services and include primary production, soil formation, nutrient cycling and water cycling as well as ecological functioning.
- **Provisioning services** are the products obtained from ecosystems and include food, fibre, fuel and genetic resources.
- **Regulating services** are the benefits obtained from the regulation of ecosystem processes and include regulation of the climate, water, air, soil, diseases and pests.
- **Cultural services** are the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences and include landscape character, accessible natural space, recreation and tourism, outdoor exercise, the appreciation of nature and cultural heritage.

Natural 2000 Sites: Special Areas of Conservation are designated under the EU Habitats Directive (1992) and Special Protection Areas are designated under the EU Birds Directive (1979). Together these make up the Natura 2000 network.

Natura 2000 Features: These are the habitats and species that are of European Importance and which justify the designation of N2K sites where they are found. Annex I of the Habitats Directive lists the habitats of European importance and Annex II lists the species of European importance in relation to SACs. Annex I of the Birds Directive lists the species of European importance in relation to SPAs.

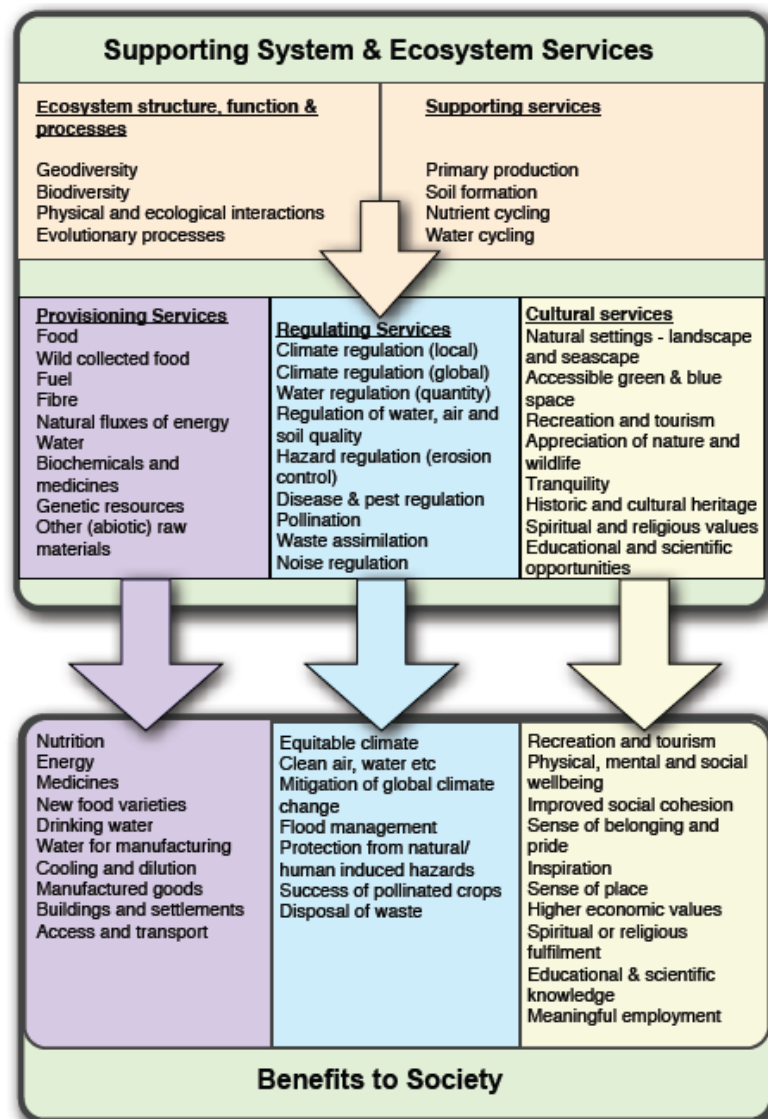
Methodology

The approach taken in this study was to undertake a desk-based review of existing evidence to identify the ecosystem services that N2K features and sites in Wales are providing, or have the potential to provide.

The method adopted for the study involved firstly data gathering and an evidence review, followed by the creation and testing of the Natura 2000 Ecosystem Services Inventory.

2.1 The ecosystem services

The initial list of ecosystem services considered in this study was based on the categorisation in Natural Resources Wales *Ecosystem Approach* document as shown below, with a focus on supporting services, provisioning services, and regulating services, with some consideration of cultural services.



In some cases, these categories were subdivided, for clarity and to facilitate data collection. In total 27 supporting, regulating and provisioning services were assessed, as shown in the table below. In part these sub-categories were based on a review of the UK National Ecosystem Assessment (UKNEA, 2011b) and the judgement of the consultancy team taking into account the services considered to be most significant on the range of habitats present on Welsh N2K sites.

Ecosystem services assessed in the N2K Ecosystem Services Inventory

Type	Broad ecosystem service category	Ecosystem service sub-category (where applicable)
Supporting	Primary production	-
	Soil formation	-
	Nutrient cycling	-
	Water cycling	-
Provisioning	Food	Meat
		Seafood and marine fish
		Freshwater fish
		Honey
		Wild collected food
	Fuel	Wood fuel (including charcoal)
		Biofuels (e.g. biodiesel and bioethanol)
	Fibre	Animal fibres (e.g. wool)
		Timber (for construction)
	Water	Drinking water
Water for industrial uses		
Water for irrigation		
Genetic resources	Plant and animal genetic material for breeding	
Regulating	Climate regulation (local)	Alteration of microclimates due to landform and vegetation
	Climate regulation (global)	Carbon sequestration in organic soils and vegetation
	Water regulation (quantity)	Mitigation of inland flood propagation
		Mitigation of inland flood generation (making space for water)
	Regulation of water and air quality	Regulation of air quality (e.g. filtering particulates)
		Regulation of water quality (e.g. water purification)
	Hazard regulation (erosion control)	Mitigation of impacts of coastal storms, flood erosion events
	Disease and pest regulation	Control of human and agricultural/forestry diseases & pests
Pollination	Habitats for pollinating insects	
Waste assimilation	-	

Cultural services have been dealt with at the broad category level in this study, due to the wide scope of the subject and subjective nature of available information. However, the following factors were taken into account.

Cultural services considered in the N2K Ecosystem Services Inventory

Type	Broad ecosystem service category	Ecosystem service sub-category
Cultural services	Natural setting – landscape and seascape	Sense of place, distinctive natural character
	Accessible green and blue space	Physical or visual access
	Recreation and tourism	Informal (self-guided) access to the natural environment
		Active organised leisure pursuits
		Visits to tourism destinations (museums, visitor centres)
	Appreciation of nature and wildlife	E.g. Bird watching, cetacean watching
	Tranquillity	Absence of man-made intrusions
	Historic and cultural heritage	Links to significant historical events
		Links to language, fiction, poetry, painting, music
Spiritual and religious values	Personal connections with the environment	
Educational/scientific opportunities	Use of the environment for learning, training and research	

Exclusions

A number of services were excluded from the analysis at the outset. Services relating to biodiversity and ecological interactions were excluded because these are inherent to the aims and objectives of the N2K series, and the purpose of the inventory is to highlight the additional services and benefits of N2K.

Other services, such as the use of peat for fuel, or the production of starch crops were excluded because of the likely negative impact on the condition of N2K features if utilised to any significant extent. Those services subject to statutory processes (e.g. renewable energy developments which are subject planning consent and Habitats Regulations Assessment) were also not included. Other services were excluded due to the difficulty of obtaining information.

The excluded services are listed below:

Type	Service not included in study
Ecosystem structure, functioning and process	Biodiversity Geodiversity Physical and ecological interactions Evolutionary processes
Provisioning	Peat Starch crops Fruit and vegetables Plant fibres (e.g. flax) Wind power Ground and water source energy Hydropower Minerals (e.g. aggregates, dimension stone, lime, metals) Medicines, biocides, food additives Buildings and settlements Access and transport
Regulating	Regulation of soil quality Noise regulation

2.2 N2K sites and features in Wales

There are 112 N2K sites in Wales comprised of 92 Special Areas of Conservation and 20 Special Protection Areas.

At the time of the analysis, the designated features on Welsh SAC sites include 54 habitats features and 28 species features and on Welsh SPA there are 39 bird features.

The location of N2K sites and a full list of N2K sites and features can be found in the LIFE Natura 2000 Programme Facts and Figures report.

2.3 Method used to assess ecosystem services provided by N2K habitat and species features

A literature review was undertaken to identify which N2K features have the potential to contribute to a given Ecosystem Service.

To aid in the literature review N2K features were brigaded into broad feature groups. These broad categories were used to make the assessment more manageable by allowing the main services that are provided by each broad group to be identified, however, specific differences between features were taken into account where possible in the final inventory. The evidence base for provision of ecosystem services, and the assumptions regarding broad feature groups is provided in the tab labelled 'Evidence base'.

In addition to identifying if the feature contributed a given ecosystem service, the relative level or scale of its contribution to the service was classified, recorded as follows:

- **Large** contribution: the potential amount of service delivery is likely to be considered significant at a sub-regional (large landscape) scale within Wales.
- **Medium** contribution: the potential amount of service delivery is not likely to register as being significant at a sub-regional scale but might be considered significant at a local (for instance community) scale.
- **Small** contribution: the potential amount of service delivery is likely to be considered relatively insignificant at a sub-regional or local scale but is significant enough at a small (site-based) scale to warrant classification.
- **Negligible** contribution: the feature does deliver this service but at a scale which can be considered insignificant compared with other sources of service provision. E.g. all N2K plant species contribute to soil formation to some extent but in the case of tiny populations of rare N2K plants such as Fen Orchid, this will be of negligible impact. This was recorded as 'No service' in the inventory.

A confidence rating was also allocated, based on the availability of evidence to support the assessment of contribution to the service, as follows:

- **High** confidence: conclusive evidence found.
- **Moderate** confidence: Some evidence found but inconclusive.

- **Low** confidence: Professional opinion of the researcher where specific research was not available.

Method used to assess cultural services for Natura 2000 habitat and species features

A different approach was applied for cultural services of N2K features. Given the more subjective and nebulous nature of cultural services and information about them, it was not possible to determine definitive rules for whether specific features contribute to specific cultural services. Instead, a general assessment on a feature-by-feature was carried out using professional judgement and expressed as a 'Yes' or 'No', with an general explanation provided in textual format.

2.4 Method used to assess ecosystem services provided by N2K sites

The feature analysis can be used as a tool to produce a guide to Ecosystem Services on a particular site. The N2K Features and Sites tab, shows the designated features on each site, with the previously identified ecosystem services displayed alongside. Clearly the actual presence or potential of a service, and its scale on a given site depends strongly on the size and specific circumstances of that site. Furthermore, some sites may deliver services beyond their component features, particularly if the site has only species features. Therefore, the analysis should be used as an initial guide only, and a final analysis should be verified and modified based on more detailed knowledge of the site.

To aid this process the Site Information worksheet provides additional information about the site as follows:-

- Size assessment (i.e. large sites will deliver a larger scale of ecosystem service)
- A brief description of the site
- A summary of cultural services

Additional evidence can be added to this sheet over time.

2.5 Method used to assess the impact of improved N2K management on ecosystem services

The study also included a brief review of how management to improve the condition of the N2K features could influence the ecosystem services being delivered by those features. This was based on the professional judgement of the consultant team. This is outlined in Section 3 of this report.

Limitations

3.1 Limitations of the Inventory

Due to the scope of the study and time and budget constraints, there are several limitations to the Inventory, which it is important to recognise and which are outlined below:

- The assumptions on provision of ecosystem services are based on a rapid review of evidence, based particularly on the UKNEA which is the most comprehensive and authoritative evaluation of ecosystem service delivery in the UK to date. However, it is not a comprehensive review of all relevant scientific literature. Therefore some of the assumptions have a low confidence level associated with them, and further evidence is required.
- Initially, all N2K features were categorised into broad habitat or taxon groups to facilitate analysis, and broad assumptions on the provision of ecosystem services were made, which may not apply fully for every component feature. Subsequently, where possible and relevant, variations to the general assumption have been incorporated, based on individual features, but this has not been exhaustive.
- The scale of ecosystem service provision allocated to each feature or site is indicative, based on a rapid review of information, and not quantified by specific ranges or thresholds. However, it does enable a broad comparison of the contribution of different features and sites.

3.2 Limitations to the delivery of ecosystems services by N2K

It is important to recognise, that for many services, over-exploitation will result in harm to the N2K feature or site. For example, while grazing is desirable on many grassland and heathland sites, overgrazing can be detrimental to the condition of the habitat. Grazing levels which are compatible with conservation objectives can be expected to produce lower yields than on other farmland. Likewise, while most sites can support recreational and access services, excessive, inappropriate or unmanaged use can cause significant harm.

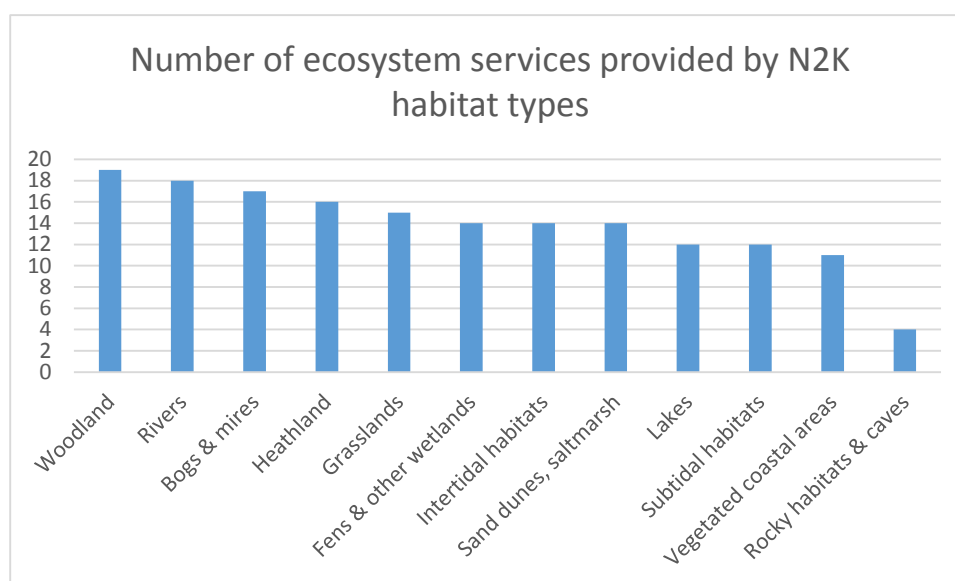
As described previously, some ecosystem services are generally not considered compatible with the sustainable management of N2K features, if carried out at any other than the smallest scale, and these have not been included in the inventory. Examples include, peat cutting, arable farming, horticulture, mineral extraction etc.

Headline results

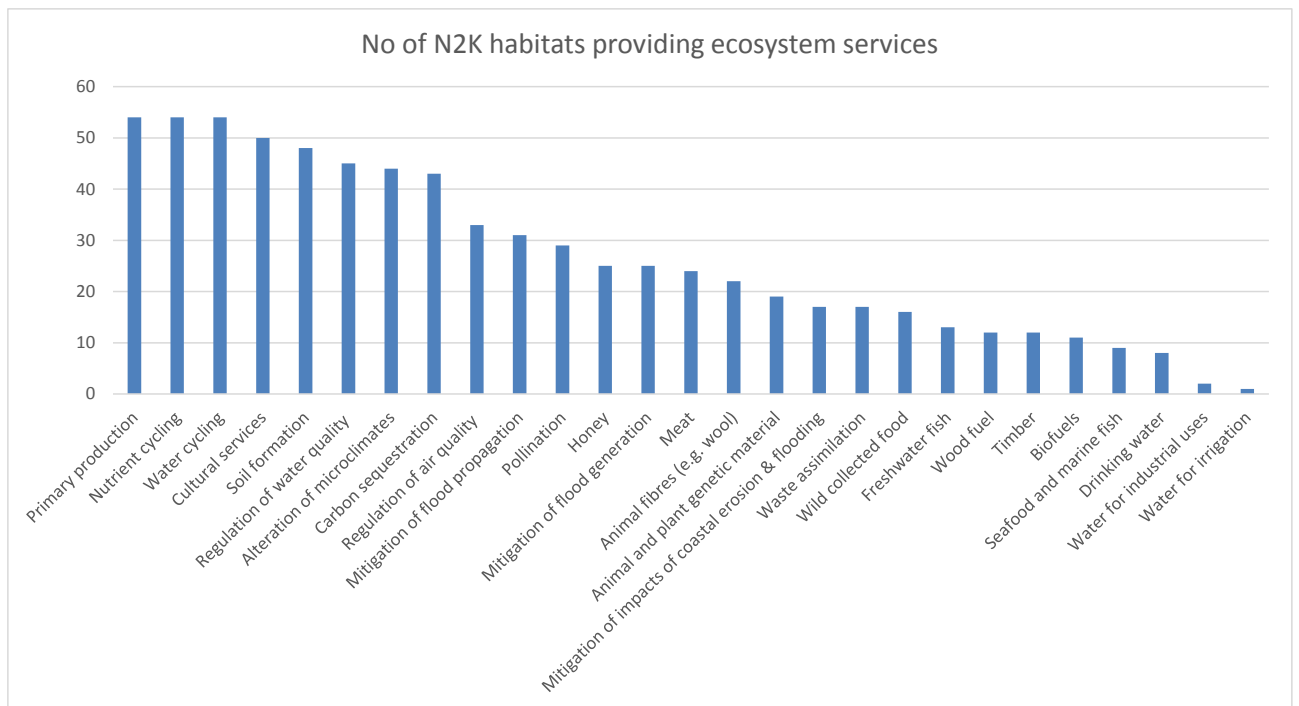
The inventory provides a classification of the potential delivery of 27 ecosystem services assessed against the 54 habitats and 67 species of European importance that are found on the 112 N2K sites in Wales. Analysis of these data reveals the following headline results.

4.1 Results for N2K habitat features

The N2K habitats are responsible for provision of the vast majority of the ecosystem services provided by the N2K features. While woodlands, rivers, bogs and mires supplied the widest range of services, all habitat types, apart from rocky habitats and caves contributed to a significant number of services. On average, each habitat contributed towards 14 different number of ecosystem services.



A wide variety of ecosystem services were provided by the N2K habitats, as shown below. The most commonly provided services related to supporting services and cultural services, with many of the regulating services also being frequently provided.



The key services are described below:

- Supporting services:** All of the N2K habitats provide at least three of the four of the core supporting services (primary production, soil formation and nutrient and water cycling), and 88% provide all four (at least at a small scale). These highly natural habitats are likely to promote higher levels of these services than can be delivered by, for example, intensively farmed land. The scale of delivery of the service is influenced by extent and type of the habitat.
- Cultural services:** The vast majority of N2K features provide a range of cultural services. Much of the tourist industry of Wales stems from the outstanding quality of the Welsh landscape and coastline and the diversity and accessibility of the countryside and shoreline. Many key visitor attractions are on or adjacent to N2K sites and the habitats of that site and its overall character is key to their ongoing appeal. For example, over 150,000 visitors a year visit South Stack³, part of the Glannau Ynys Gybi/Holy Island Coast SAC. In many cases, the cultural services are provided by the site as a whole and combination of specific habitats or species, rather than features in isolation.

Many N2K sites are used for recreational pursuits and exercise such as walking, cycling, adventure sports, boating etc. The CCW Current State of Knowledge Report (2010) calculated that 94% of terrestrial and intertidal SACs had some legal right of access, in the form of Public Rights of Way, open access land, or rights of access to the foreshore. In addition, 70% of SACs were within 5km of a town or city in Wales, allowing access to local and lower income users.

The high semi-natural quality and natural beauty of many N2K sites give significant levels of delivery of other cultural services such as sense of place, tranquillity and personal (religious and aesthetic) connections with nature.

³ <http://vscg.co.uk/case-studies/ynys-mon-south-stack-cliffs>

- **Regulating services:** Provision of regulating services is a key area for N2K habitats and sites.

Carbon sequestration: All N2K habitats are assessed as contributing to this service, however for 14 habitats (for example, bogs, fens and woodlands) the service is provided at a large scale. However, the level of sequestration can be undermined by inappropriate management.

Ameliorating air and water pollution: 85% of the habitats play a role in ameliorating air and water pollution, by trapping, assimilating and degrading pollutants. Higher levels of service are provided by rivers, wetlands, woodlands and coastal habitats.

Coastal erosion and flooding hazards: 17 coastal and intertidal habitats (for example, estuaries, salt marsh, sand dunes) are particularly important for reducing coastal erosion and flooding hazards, providing natural sea defences and dissipating wave energy.

Flood amelioration: Evidence suggests that inland flood risk is also ameliorated to some extent by natural N2K habitats, by holding back water in the uplands, or making space for flood water in the lowlands. However, the processes involved are complex and evidence is variable, and in many cases, current opportunities are not maximised.

- **Provisioning services:**

Food: 70% of the N2K habitat features are assessed as having the capacity to provide food or support food producing industries, although the scale of production is not large relative to mainstream agricultural production. The key food products from the marine environment are sea fish and shellfish which are both collected on a commercial scale. The N2K habitats provide habitable substrates (e.g. for shellfish), feeding grounds, nursery grounds and refuges. On land (grassland, wetland and heathland habitats) meat is the key food product particularly lamb, which is produced as part of the traditional upland grazing system in Wales. Beef can also be a product but this is not optimised currently on N2K sites. In some cases, such meat can be marketed with a premium due to enhanced quality and environmentally-friendly credentials. Grazing at an appropriate level, with suitable stock is an essential conservation management tool, although excessive levels of grazing can cause ecological harm.

Water for drinking and other uses: Extensive tracts of upland N2K wetlands such as blanket bog and wet heath make a significant contribution to drinking water supplies. Direct abstraction may also occur from N2K rivers and lakes. Water is also abstracted for agricultural irrigation and water in estuaries can be used for industrial purposes. In total 9 features contribute to this service.

Fuel and wood products: 12 features have potential to supply firewood or other wood products, although this is not a large scale service and currently the resource is often underutilised due to marketing and transport issues. In some cases, N2K woodland sites will benefit from an increased level of appropriate woodland management, such as coppicing, thinning or removing of non-native species. Other sites e.g. sand dunes would benefit from the removal of non-native trees.

Many N2K habitats produce excess biomass which requires removal, (e.g. scrub, invasive species, annual growth of fen vegetation), which is currently of no value, however, technologies are in

development to convert biomass to fuel or other useful products. These may provide a service in the future.

4.2 Results for N2K species features

Delivery of ecosystem services by species features is small relative to that provided by N2K habitats, overall, except for cultural services where 52 of the species make a contribution. On average species contributed to only one service, compared to the 14 provided by habitats. A notable exception is Atlantic salmon which provides (or has the potential to provide) four services.

While many of the species do technically make a contribution to services such as primary production, soil formation, carbon sequestration, waste assimilation etc, the small size of populations of what are often rare species on N2K sites, mean that in practice the contribution is generally deemed to be negligible, compared to the associated habitats.

Cultural services: 79% of species are noted as having a contribution to cultural services (and this did not include specialist academic or scientific interest). Much of the cultural service was associated with recreational activities, such as bird watching, cetacean watching, or fishing. Some tourists will be attracted to Wales specifically to see certain species, while for others a wildlife spectacle is just part of the broader natural appeal of the Welsh environment. Small businesses operate providing dolphin spotting cruises, or boat trips to island or coastal sites to see waders, nesting seabirds and grey seals, as well as specialist wildlife holidays.

Many species contribute strongly to the sense of place, and some are often seen as typically Welsh, such as the chough and red kite. Species such as the otter, grey seal, common dolphin and puffin are much-loved charismatic species which held in great affection by the public.

4.3 Results for N2K sites

The Ecosystem Inventory links the ecosystem services identified for individual features to sites (N2K Features and Sites tab). This allows practitioners to identify ecosystem services which a particular site could potentially deliver. However in each case, the results will need to be ground-truthed against the actual circumstances of that site, such as the extent of the feature on the site, whether it is the uplands or lowlands etc.

For these reasons it is not possible at this stage to provide summary results for sites.

4.4 Impact of improved N2K management on ecosystem services

In many cases, features on N2K sites in Wales are in unfavourable condition, and not subject to an optimal conservation management regime. While conservationists seek to improve management to bring the feature into favourable condition from an ecological perspective, in some cases, improved management, also has the potential to deliver enhanced ecosystem service delivery.

The table below summarises instances where the scale of ecosystem service provision could be increased through enhanced management of N2K features.

Ecosystem service	Potential to improve provision
Wood fuel	The reintroduction of coppicing in woodlands where it was historically practiced, and the removal of conifers from heathland or woodland sites would improve N2K feature condition, and would also result in wood fuel provision.
Biofuels	The harvesting of plant material arising from favourable management such as removal of invasive species (e.g. gorse or rhododendron) or the maintenance of sub-climatic ecosystems (e.g. reed cutting on wetlands). The cost and difficulty of transport and drying of the harvested material are likely to be constraints.
Climate regulation – carbon sequestration	Certain wetland habitats/sites where historic drainage has taken place have potential to enhance their levels of carbon sequestration by raising water levels, while at the same time improving the condition of the habitat.
Water regulation – mitigation of flood propagation	In the uplands, blocking drains improves the capacity of wetland habitats such as blanket bog to hold back rainfall at the same time as improving its condition. Reducing the density of grazing livestock can improve the structure of soils (reducing compaction and increasing water infiltration) as well as enhancing semi-natural floristic diversity. Increasing the width of marginal vegetation beside watercourses and other field margins can reduce the speed with which rainfall runs off land into rivers, as well as improving water quality for biodiversity.
Water regulation – mitigation of flood generation	Woodland, wetland and grassland in floodplains can provide areas for flood storage and attenuation, while also enhancing their semi-natural character and biodiversity.
Hazard regulation	Coastal habitats such as salt marsh that are in favourable condition (i.e. well-vegetated, stable and/or expanding) contribute to greater levels of protection from coastal flooding and erosion, than those which are eroding.
Pollination	Management to enhance floristic diversity and promote flowering in habitats such as semi-natural grassland, woodland and wetlands, for example, by avoiding overgrazing, should increase populations of pollinating insects.
Cultural services	Enhancing the condition of culturally valued habitats such as oak woodland and numbers of species such as puffin, dolphin and salmon may contribute to the level of cultural services provided, in terms of enjoyment and accessibility.

Conclusions and recommendations

5.1 Conclusions

The Natura 2000 network exists to protect threatened habitats and species in Europe. These features have inherent value and also support biodiversity and ecological processes both within protected sites themselves and in ecosystems beyond. While these are of high value in themselves, the study shows that a wide range of additional benefits (in some cases at a significant scale) are also provided by features of Natura 2000. These can sometimes be overlooked, yet are a key element of the integrated Natural Resource management approach.

Of particular importance are regulatory services such as carbon sequestration (delivered particularly by wetlands and woodland), amelioration of coastal erosion and flood hazard (delivered by intertidal habitats, saltmarsh and sand dunes), and assimilation of air and water pollution (many habitats). N2K also plays a part in the economies of low-intensity livestock farming and sea fish and shellfish industries of Wales.

Cultural services of landscape quality and tranquillity and sense of place are delivered by the majority of N2K habitats and species. Some N2K sites are also key tourist attractions, and many also allow for a wide diversity of access and recreational opportunities such as walking, seaside visits, wildlife watching, boating, and adventure sports. Together these contribute to the tourism economy of Wales.

The N2K Ecosystem Services Inventory offers a useful means of identifying ecosystem services provided by specific Natura 2000 features, plus and a tool to help developing this information for sites.

The Inventory is designed to be enhanced over time with improved evidence and information. It is very much a tool on which to develop understanding rather than a definitive statement of fact.

The Inventory can be used to highlight the ecosystem services provided by N2K to support the ongoing process of integrating biodiversity needs into other sectors such as flood defence, agriculture, tourism and health to deliver mutual benefits. A sound knowledge of ecosystem services provided by protected sites will also aid the development of a coherent area-based approach to natural resource management which examines interrelationships of environmental factors at a landscape, catchment or regional level. The Inventory can also help source funding from alternative finance sources, where biodiversity is not the priority criteria.

5.2 Recommendations for further development of the Inventory

The following developments are recommended to inform further research in this area.

1. Carry out a trial of the inventory, through application by the relevant users, to identify modifications and improvements.
2. Enhance the evidence base, by referencing a wider range of relevant sources to improve accuracy of the Inventory and breadth of evidence. Provide more information on specific features, rather than broad categories. Particularly, source evidence for areas currently with low confidence, and for services where there is conflicting evidence.
3. Build on the current work to develop an ecosystem service assessment for all N2K sites, taking into account specific circumstances of the site. This should include more detail on cultural services, particularly access to the site (rights of way/open access) and recreation/tourist

services, socio-economic services e.g. volunteering or educational opportunities, jobs provided, business supported etc.

4. Investigate the economic value of the services provided by features and/or sites, which could provide a useful incentive for potential investors and a stronger evidence base for policy-makers and funding applications.

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