



**Cyfoeth
Naturiol
Cymru
Natural
Resources
Wales**

Opportunities for sustainably managing the Dyfi's natural resources...to benefit people, the economy and the environment

Vol.1 - September 2016



Contents

Purpose and status of this document

Vol 1.

1 Introduction and background

1.1 What is the issue

1.2 What area does the Opportunities Document cover

1.2.1 The legislation

1.3 Why has the Opportunities Document been produced

1.4 How has the Opportunities Document been produced

2 Benefits

2.1 How our natural resources support the economy

2.1.1 Agriculture

2.1.2 Forestry

2.1.3 Outdoor activities

2.1.4 Renewable energy

2.1.5 Mineral resources

2.2 How our natural resources protect us

2.3 How our natural resources support recreation, culture, wildlife and health

3 Challenges & Issues

Vol 1 Maps

Map No	Topic
1	Location of the Dyfi Catchment
2	Productivity of Agricultural land
3	Areas of 'productive' woodland
4	Number and variety of businesses related to fishing around the estuary
5	Geology of the Dyfi
6	Areas of land that help prevent flooding
7	The extensive range of habitats in the estuary
8	The contribution of land to preventing sedimentation and erosion
9	The carbon stock contained within soils and vegetation combined
10	Extensive Rights of Way network
10a	Scheduled Ancient Monument sites
10b	Landscape areas
11	SSSI and Special Area of Conservation sites (SAC) in the Dyfi
12	Communities most at risk of flooding
13	Areas that are storing and emitting carbon
14	Areas generating phosphorous
15	Condition of rivers in the Dyfi

Vol 1 Appendices

- Appendix 1 Existing Plans and strategies related to the natural resources of the area**
- Appendix 2 Important 'ecosystem services' in Dyfi**
- Appendix 3 Land Use Capability (LUCI) model**

Vol 2. (separate document)

“Vision, aims & Opportunity Maps”

“Mae Cynladwyaeth amdano abnabod sut mae ein cynefin yn cyfrannu tuag at ein cynhalaieth. Ac yn sgil hynny, i drin y pridd fel ei bod yn medru cynnal fy ngwreiddiau i a'n nghymdogion, gwreiddiau'n plant a gwreiddiau'n hwyron.”

“Sustainability is about understanding how our 'habitat/home/ sustains us (physically and emotionally). And working the soil so that it can sustain my roots and my neighbours, our children's roots, and the roots of our grandchildren.”

T Llew Jones

The Purpose of this document

Wales' natural resources provide our basic needs and give us energy, prosperity and security. They protect us and make us healthier and our lives better. A healthy resilient environment creates the conditions for a thriving and sustainable society. But evidence shows that our natural resources continue to be put under pressure from a variety of sources. We need to think and act differently, to manage our natural resources in Wales in a way which values and enhances them and the many benefits they provide. The Environment (Wales) Act and the Well-being of Future Generations (Wales) Act together create a modern legislative framework to bring this about. NRW is at the forefront of this with a new purpose under the Environment (Wales) Act to seek to achieve the sustainable management of natural resources (SMNR) and apply the SMNR principles in exercising all our functions.

To help Wales prepare for this new legislation, in 2014 Natural Resources Wales set up three natural resource management trials; the Rhondda and Tawe in South Wales and **Dyfi** in Mid Wales. Trialling the application of SMNR allowed us to:

- Learn how to apply SMNR and the nine principles at a local scale;
- Explore Wales' emerging natural resources priorities, described in Welsh Government's Natural Resources Policy statement;
- Test engagement, evidence and planning approaches which might be used to develop Area Statements, which are a key element of the natural resources planning framework and a requirement of the Environment Act;
- By sharing our learning, inform the developing Environment Bill and NRW's ways of working.

We deliberately took an open and flexible approach. From the outset, we involved the people who live and work in these places to identify priorities, risks, and opportunities for better management of the area. Generally people responded positively to our approach because they felt part of developing solutions. The trials led us into working with partners on some of the significant issues, which in the past were considered either too challenging or not within our remit. Each trial was based on a river catchment and, to maximise learning, was selected because of its different environmental, economic and societal circumstances. Whilst the scale of Area Statements remains to be decided it is now expected that they will cover a larger area than those of the individual trials.

In the Dyfi, we produced this document to outline the priorities for sustainably managing the natural resources in the trial area. This information is based on two years of working with organisations, community groups and residents in the area, extensive evidence gathering and knowledge sharing.

These documents are not Area Statements and are non-statutory (as the work preceded the Environment (Wales) Act). However, they **provide a local framework for the Public Service Board, organisations, community groups, local business** and people to use and refer to. They can be **used by communities and organisations to work better together** and deliver outcomes which deliver multiple benefits. They can **encourage better working between partners by focussing resources on clearly identified opportunities** and can also be **used to support both local and landscape scale proposals for funding**.

1. Introduction

The Dyfi has an outstanding natural environment and is one of the most scenic areas in Wales. It is home to around 12,000 people and many more visitors, who rely on and use the natural resources of the area for enjoyment and to make a living. We have fantastic beaches which attract tourists from the UK and wider afield; some of the best recreational fishing in the country; and our farmers produce quality products, such as Welsh Lamb, that is enjoyed throughout the world. We can surf at Borth; walk in the Aran mountain's'; ride horses or mountain bikes in the Dyfi forest; visit the historic town of Machynlleth and go dolphin watching in Cardigan Bay. We can buy local produce in the market in Machynlleth; learn about the latest developments in green technology at the Centre for Alternative technology; or visit fantastic raised bog at Cors Fochno - one of the largest in the UK and Europe. The Dyfi is also home to the only UNESCO Biosphere in Wales. Biosphere reserves are areas of terrestrial and coastal ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use.

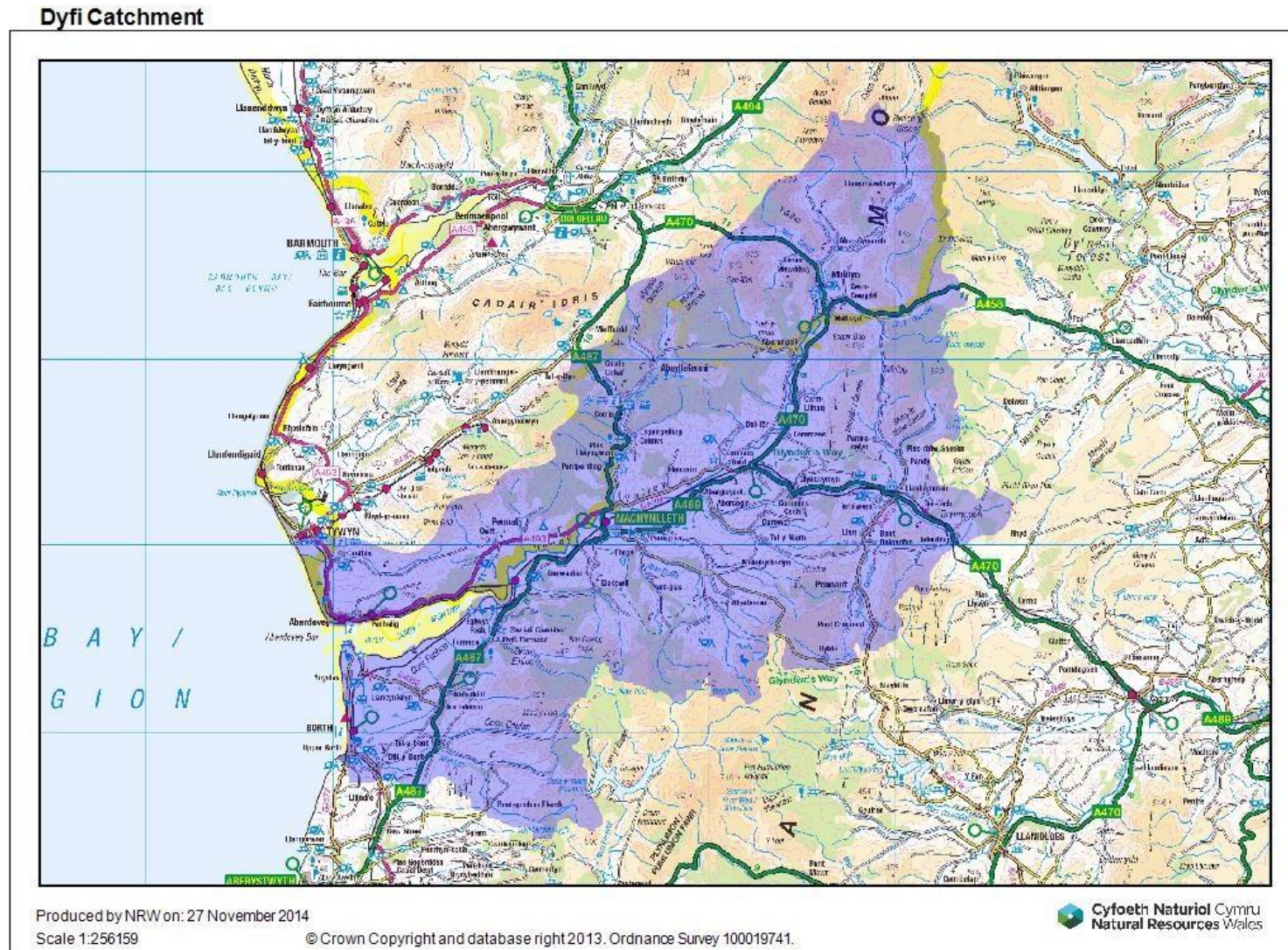
The geography of the area ranges from the mountains of Aran Fawddwy in south Snowdonia, to sea level and beaches at Borth and Aberdyfi. The area has a rich cultural and industrial heritage and was once an important for lead mining. The main economic activities are farming, forestry, tourism and a vibrant service sector. Renewable energy also plays an increasingly important role – particularly hydropower. The area is dominated by the Afon Dyfi itself and its many tributaries, which provides floodplain grazing areas, recreational opportunities as well as spawning grounds for fish – such as salmon and sea trout. The main soils of the Dyfi valley are podzolic soils, ground water gleys and peat soils.

Table 1: Key facts and figures

Population	c 13,000
Area of the Dyfi Catchment	c 68,000 ha
Road and rail network	1.1%
Rainfall range	1000 mm-2000 mm per annum
Urban infrastructure	4.2%
Snowdonia National Park	29%
Grade 3 Agricultural land	1.1%
National Conservation designations	10.6 %
Existing Woodland - 17942ha	26.5%
Welsh Government Woodlands (managed by NRW) - 7761ha	11.4%
Native Woodland (Ancient Semi Natural Woodland) – 1365 ha	2.0%
Land above the treeline	9.8%
Heath moors and mires	7.7%
Open Water including Estuary	5.6%



Map 1: Location of the Dyfi Catchment¹



1.1 What is the issue?

Our environment provides us a wealth of goods and services for free, including clean air; clean water; and places to enjoy. However, in the past, because there is no a price tag attached to these resources, we have often not managed them carefully - leading to overuse and degradation. Like many areas in Wales and the rest of the UK - the Dyfi has seen major changes over the centuries - from conversion of natural vegetation to improved farmland and commercial forestry; wetland and peatland drainage; road and rail infrastructure and housing development; canalisation and the building of sea defences.

The Dyfi still has significant social, economic and environmental problems which could be improved through better management of our natural resources. For example, we have a legacy of historic mine and diffuse pollution in many of our rivers, some of our beaches have failed to make European standards, we suffer from flooding in some of our villages, we have some social deprivation in our towns, agricultural incomes continue to be variable and are often reliant on EU subsidy, some of our best sites for wildlife are in poor condition and our young people often need to leave the area to find work. In addition, we will also face major changes as the climate warms and weather patterns change. As the HM Government White Paper on the Natural Environment (2011) stated:

“Nature is sometimes taken for granted and undervalued. But people cannot flourish without the benefits and services our natural environment provides.”

And through our local consultation – local people are saying similar things too...

“A healthy natural environment ... it's critical to our local economy as well as to our future.” Dyfi Stakeholder

“Fel un yn byw yn yr ardal erioed ag yn poeni am yr amgylchedd, iaith a diwylliant, ag bywoliaeth pobl ifanc lleol. Datblygu cymunedau mewn perthynas a'r amgylchedd, cydweithio a'r economi [As one who has lived in the area all my life, and cares about the environment, language and culture, and providing livelihoods for young people. Communities need to develop. Keep community needs in mind as well as the environment, and work with the economy.” Dyfi Stakeholder

¹ The trial also considers the estuary and the marine environment (to 1 nautical mile).

1.2 What area does the Opportunities Document cover?

The Opportunities cover the whole of the Dyfi catchment, the estuary, and the marine environment to 1 nautical mile.

1.2.1 The legislation

In order to achieve a more resilient environment and one that supports the people and economy of Wales, the Welsh Government has recently passed two pieces of important legislation.

Legislative background

Three recent pieces of legislation passed in Wales have placed a duty on public bodies to try to plan and manage the environment for long-term, multiple benefits with people, the environment, and the economy, firmly in mind.

Firstly, the **Well Being of Future Generations (Wales) Act (2015)** is about improving the social, economic, environmental and cultural well-being of Wales. It will require public bodies² to plan for the long-term, work better with people and communities and each other, look to prevent problems and take a more joined-up approach.

The Environment (Wales) Act 2016 puts in place the legislation needed to plan and manage Wales' natural resources in a more and joined-up way that helps to tackle the challenges we face. A key part of the Bill is focused on the opportunities our natural resources provide for people, the economy and the environment of Wales. From 2017, the Bill requires Natural Resources Wales (NRW) to produce 'area statements'³ setting out the vision, priorities, and opportunities for the sustainable management of natural resources at a local level.

Planning Policy Wales 17 (PPW) outlines the Welsh Government's policy in Wales and includes biodiversity and landscape as important elements of the design process.

² Public bodies listed in the Act include: Welsh Government, Local Authorities; Local Health Boards ; Public Health Wales NHS Trust; Velindre NHS Trust; National Park Authorities; Fire and Rescue Authorities; Natural Resources Wales; The Higher Education Funding Council for Wales; Arts Council of Wales; Sports Council of Wales; National Library of Wales; National Museum of Wales.

³ Area statements are designed to inform the 'Needs Assessment' and 'Wellbeing Plans' set out in the *Wellbeing of Future Generations Act*. The statements will also inform other existing plans, such as local development plans. Further information about the Environment Bill and Natural Resource Management is available at: <http://gov.wales/environmentbill>

1.3 Why has the Opportunities Document been produced?

This document has been prepared to try to address some of the issues outlined above, make the most of the opportunities, and test a new approach to managing natural resources. The proposals are about what we want to work towards and how we think we can work together to achieve it. We are not proposing detail or suggesting targets but rather setting the direction, principles and opportunities to meet the challenge.

A key principle is that no one organisation can, on its own, secure a profitable and prosperous future for our natural resources. The scale of the task is beyond the scope and remit of any organisation. Most of Wales' natural resources are looked after by private landowners and it is clear that the vision will need to be understood and supported by them, as well as members of the public, if it is to be implemented. Policy makers will need to ensure that suitable incentive mechanisms' are in place to allow landowners to take up opportunities; the public sector will also need to play its part by being an exemplary land and water manager, providing guidance support and advice, and using regulation wisely. In the marine environment the need for co-ordinated policies and regulation is perhaps even more important given the shared nature of the resource.

We can only achieve real results through communities, businesses and government working together. While none of us can predict the future, by improving our environment, we will be able to secure the social & economic benefits the benefits the natural environment produces for future generations.



The Dyfi was chosen as one of three areas in Wales to trial this new approach. The document has been produced following engagement with a wide range of stakeholders (see below) and using the most recent evidence available. As well as outlining how we can work together to improve the area, this document will also help in preparing for 'area statements' when they are introduced under the Environment Bill in 2017. The Opportunities document:

- Outlines a long term vision for the Dyfi.
- Gathers information on benefits we currently get from the area and risks to these benefits.
- Identifies priorities that we need to tackle to maintain and enhance our natural resources.
- Presents opportunities to enhance our environment and provide multiple benefits.

1.4 How has the Opportunities document been produced?

The document has been produced through engagement with a wide range of individuals and organisations both on a one to one basis and during two public stakeholder events which took place in July 2015, October 2015. These events were open to any member of the public or representative organisations that wished to attend. They were facilitated by an independent professional facilitator. The reports of these events can be found here (in both Welsh & English) www.naturalresources.wales/Dyfi

We have also produced a You Tube video. <https://youtu.be/ZLvsO366wKE> and several project updates to inform people about the progression of the project. We set up a website www.naturalresources.wales/Dyfi that has further information about the project and reports.

We have had conversations, meetings and exchanged information with the following organisations to find out what issues and opportunities are important to them

Landowning and environmental groups:

Afon Leri 'Future Farmers'⁴

Tilhill Forestry

National Trust

RSPB

FWAG Cymru

NFU Cymru

Centre for Alternative Technology

Outward Bound Trust Wales

Dyfi Outdoor recreation providers

Dyfi Landswap/ Edible Mach

Aberystwyth University

Local Authorities:

- Gwynedd County Council
- Ceredigion County Council
- Powys County Council
- Snowdonia National Park
- Powys LAG



The project team also presented at a number of specialist groups on individual subjects including:

Conservation (NRW, RSPB, Montgomeryshire Wildlife Trust, Snowdonia National Park, Eco Dyfi, Plantlife)

Access (LAG chairs, Snowdonia National Park, NRW, Ceredigion CC, Gwynedd CC)

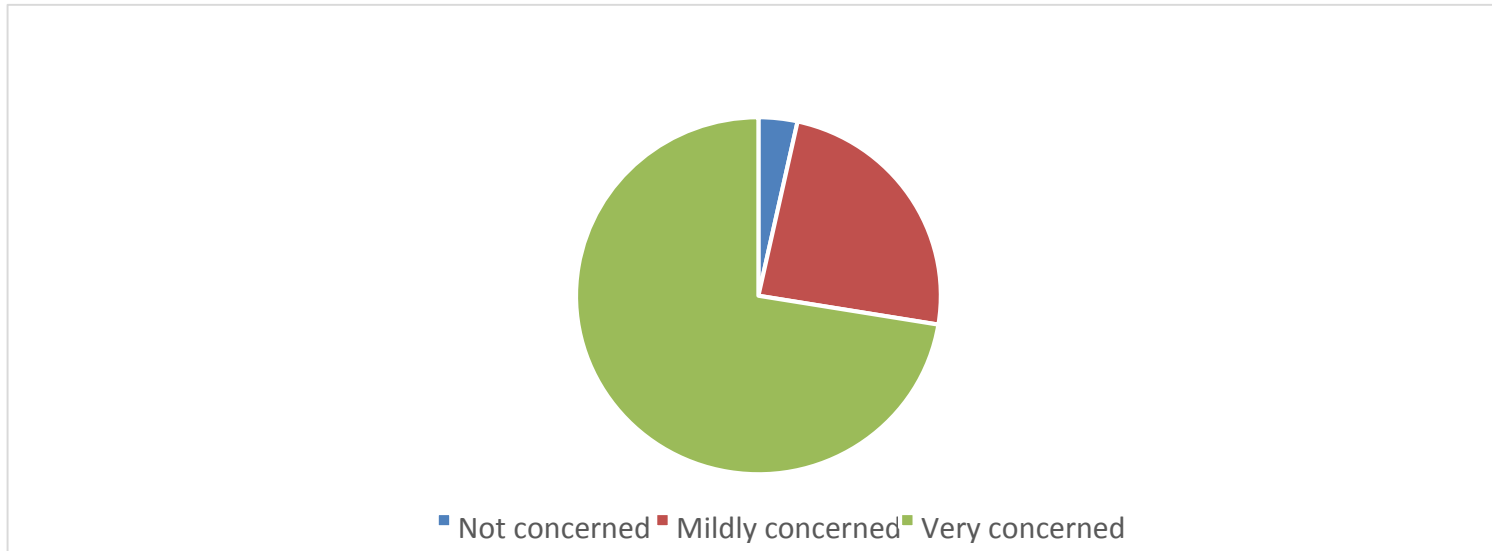
Dyfi Biosphere Tourism group – Aberystwyth University, Eco Dyfi, CAT, Ceredigion CC, Montgomeryshire WildlifeTrust, Ceredigion museum, National Library of Wales, Corris Mine Explorers, Visit Wales, Machynlleth CC, Dyfi Outdoor Recreation providers – Snowdonia Active, Ecodyfi, 20 local outdoor recreation providers.

⁴ A group of 7 farmers from the Afon Leri, all under the age of 40, who first came together under the Cambrian Mountains initiative to explore how they could manage their farms more sustainably and better deliver public benefits.

Over 90% of stakeholders agreed that they wanted Challenges and Risks to be addressed and that we need to capitalise on opportunities.

As well as asking people’s opinions – we have also gathered evidence and identified gaps from existing strategies, plans, and research evidence. We have also commissioned new research evidence specifically relevant to the Dyfi that has been referenced throughout the document. We have also tried new mapping approaches to help us make informed decisions about how we manage our natural resources. We have also delivered a range of projects that will add to our evidence base.

Figure 1 How concerned are Dyfi stakeholders regarding the management & use of natural resources



2. Benefits provided by the Dyfi’s natural environment

A key aim of the project was to develop a picture of what ‘services’ or ‘benefits’ the natural environment of the Dyfi provides and what are the challenges. We receive many benefits from the land, rivers and coastline that surrounds us. By understanding the benefits we get from the environment, we will be better able to plan future management to ensure we continue to maintain and enhance these benefits. This approach should also allow more integrated management of our natural resources.

As expected, during our stakeholder engagement, there were differences of opinion on what the balance between ‘preserving’ and ‘using’ the natural environment should be. For example, some stakeholders said that there can be too much focus on ‘conservation’ to the detriment of Welsh culture, language and jobs. However, most stakeholders valued the environment, understood the benefits it provides and wanted to work to make it better. An ‘economic’ benefit that could not be quantified but emerged from stakeholder engagement is that the environment itself (beaches, mountains, scenery, wildlife and historic environment) provide a great place to live and work thereby retaining talent/ attracting new talent to the area. The section below, sets out some of the main benefits that the environment provides and lists some key risks and challenges to maintaining and improving those benefits.

2.1 How our natural resources support the economy

Key benefits

- **Food production**
- **Timber / fuelwood production**
- **Supports the tourism/ outdoor industry**
- **Renewable energy**
- **Fishing, game and wildlife**
- **A great environment to live and work**

The land, landscape, rivers and coastline of the Dyfi are what sustains our economy. In the past, metal mining was a major economic activity with large mines, such as the mine at Dylife producing over 2500 tons of lead per annum at its peak in the mid-19th century. However, today the main land based economic activities are farming, forestry, tourism and increasingly renewable energy. The **soil, water and natural environment** supports and maintains these activities.

2.1.1 Agriculture

By far the largest land based economic activity in the Dyfi is farming with over 70% of the Dyfi being farmed - mainly for sheep. Dairy farming is also locally important on the fertile floodplain and in the river valleys. Market gardening and aqua-culture are also practiced though at a small scale. Game and wildlife management is also a small but important sector locally. The agriculture industry of Wales currently contributes £2441 million per annum in Gross Value Added to the Welsh economy and also has strong linkages with the important food and drink sector.

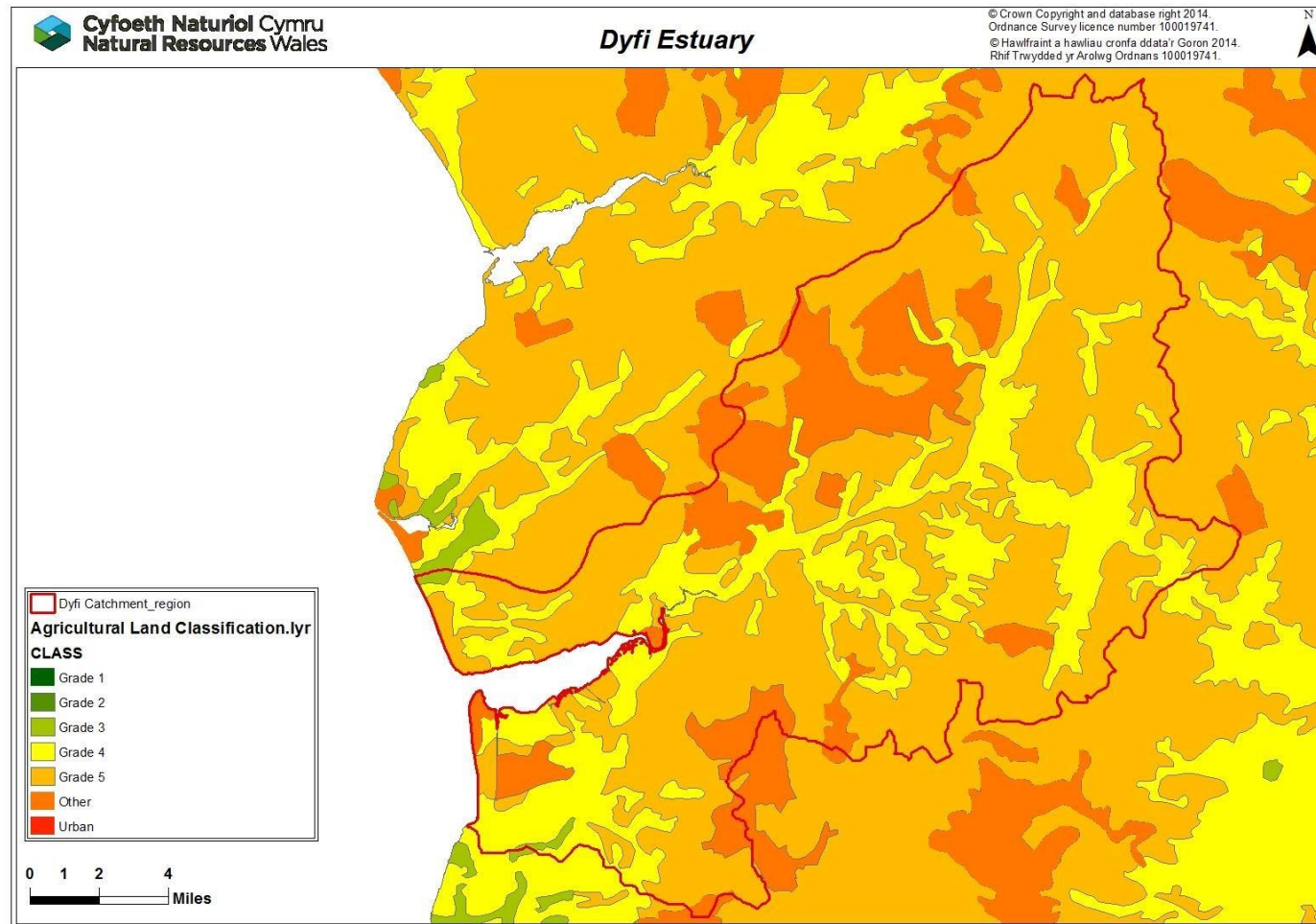
In terms of land capability, over 98% of the Dyfi is grade 4 & 5 agricultural land which restricts the types of agriculture that the land can support. The mild climate and high rainfall of the area make it well suited to livestock farming – particularly in the river valleys. The nature of the landscape, poor infrastructure and distance from centres of population mean that opportunities for diversification can be limited. Though some farmers have developed other income sources such as holiday accommodation and renewable energy (particularly hydro-power). Though agriculture is practiced throughout the catchment - Map 2 shows the relative productivity of the agricultural land in the Dyfi (based on soils, geology and aspect/ slope and vegetation cover & rainfall/ climate) and, as expected, shows that the better soils (grade 4) and lower lying land is more suited to agricultural production. Predictions suggest a 14% increase in mean winter rainfall and a decrease of 17% in mean summer rainfall which may affect the ability of the land to maintain grazing at current levels.

As well as providing food, the farming industry supports many other businesses – such as feed merchants, local agricultural contractors and vets surgeries. Recent research indicates that family farms in Wales procure over 80% of goods and services from within a 25 mile radius of the holding⁵, making a wider contribution to local economies and communities. The Dyfi has a long history of farming and many landscape features associated with agriculture, such as dry stone walls, droving roads and agricultural buildings, contribute the ‘sense of place’ and help support the tourist industry.



⁵ Wales Rural Observatory (2013) An Analysis of the Socio-Economic Impact of CAP Reforms on Rural Wales Phase 3, 4, and 5 Report: Impact on Rural Society and Economy. The full report can be found at: <http://www.walesruralobservatory.org.uk>

Map 2: Productivity of agricultural land



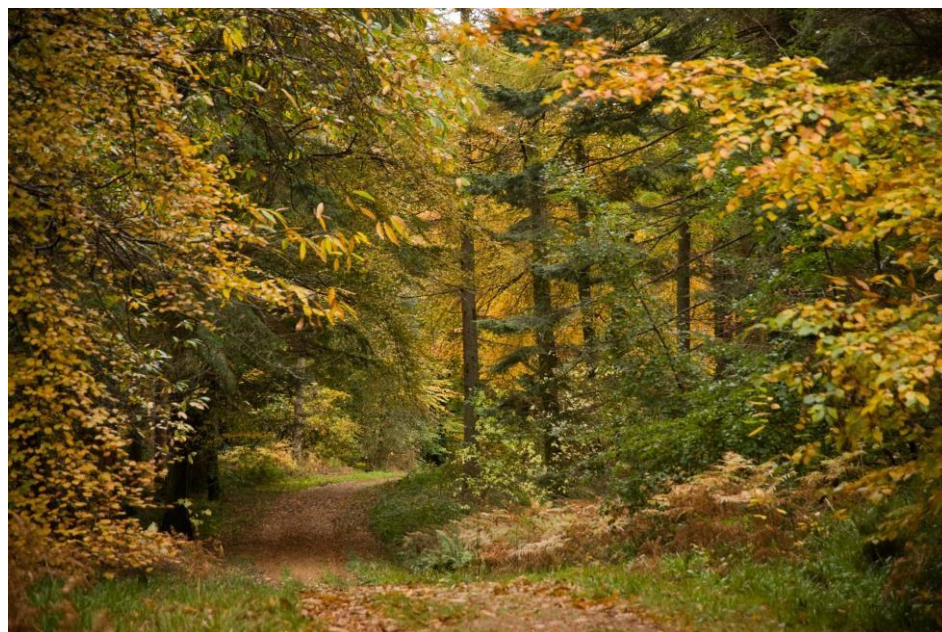
Map 2 shows the relative quality of agricultural land (Grade 1 being most productive). The lower lying land and river valleys currently provide the best areas for agriculture while the steeper upland areas on poorer soils are less well suited to agricultural production but still currently support hill grazing.

2.1.2 Forestry

Our forests provide a range of benefits to the economy, including producing **quality timber and biofuel**, providing **employment for contractors/forest managers** and providing an **important** backdrop for tourism and recreational activities such as mountain biking, wildlife tourism, rallying, horse riding and the outdoor activities sector. The forestry sector directly supports over 11,000 jobs and is worth over £400 million to the Welsh economy(2015). Private woodland management makes up £31 million; Welsh Assembly Government Woodlands contribute £30.5 million; and £338 million is generated from secondary processing.

Many of these jobs are linked to rural areas and are significant contributors to local economies. Across the UK, only 58% of woodlands are currently managed and we still import 63% of our softwood timber and 94% of our hardwood timber ⁶. By replacing imported timber with local produce, we are also helping Wales achieve a better **carbon balance**.

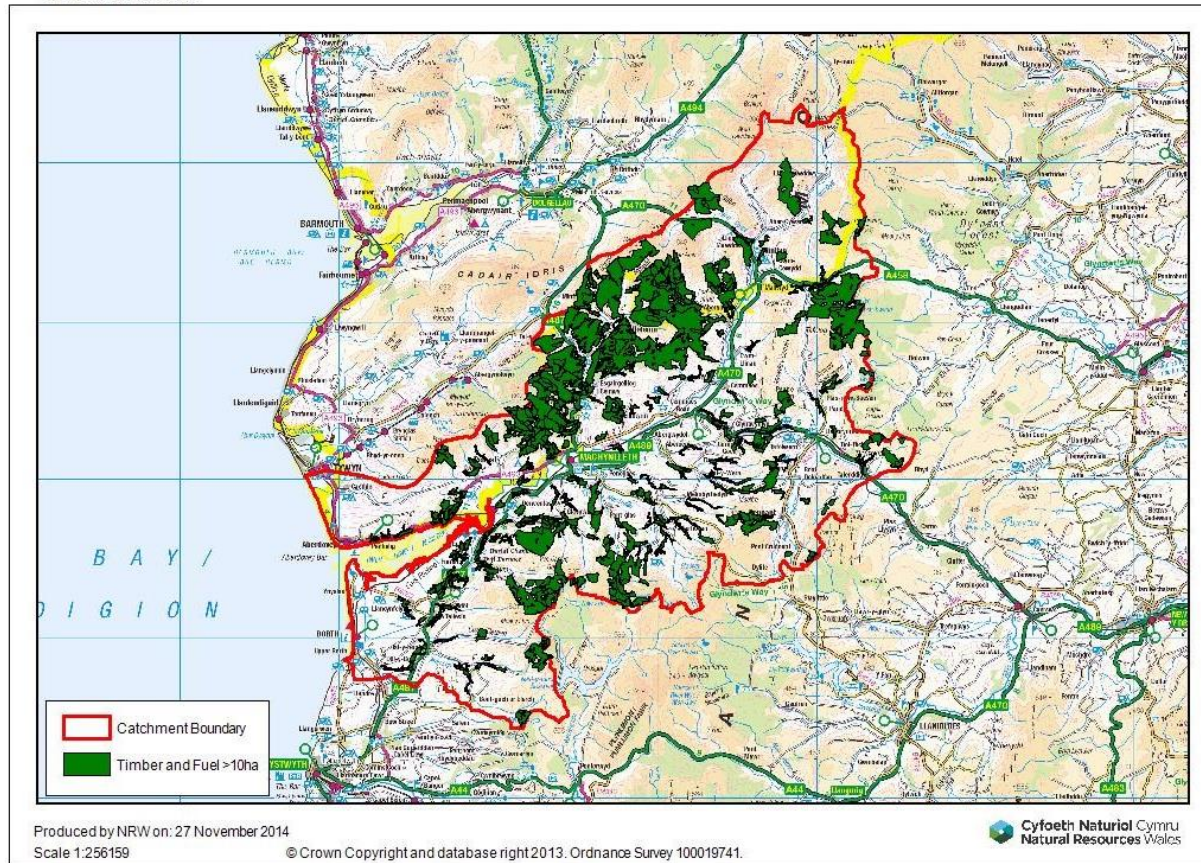
The Dyfi currently has 26 % woodland cover – the majority of which is conifer forest. In postglacial times, the Dyfi would have been almost completely covered in native woodland but from the Neolithic times onward it was greatly reduced. Today, native woodland survives in the valleys and on the lower hillsides but makes up only 2% of the area. Large areas of upland, were planted with commercial conifer species – mainly sitka spruce - in the 1930s. These forests are now planted with a wider variety of **productive tree species**, including Douglas fir, Larch, Western Red Cedar and broadleaves. The forests of the Dyfi benefit from the high rainfall of the area and can grow successfully on shallower upland soils and land less suited to pasture.



⁶ Timber trade federation Statistical review 2015

Map 3: Areas of 'productive'⁷ woodland

Timber and Fuel



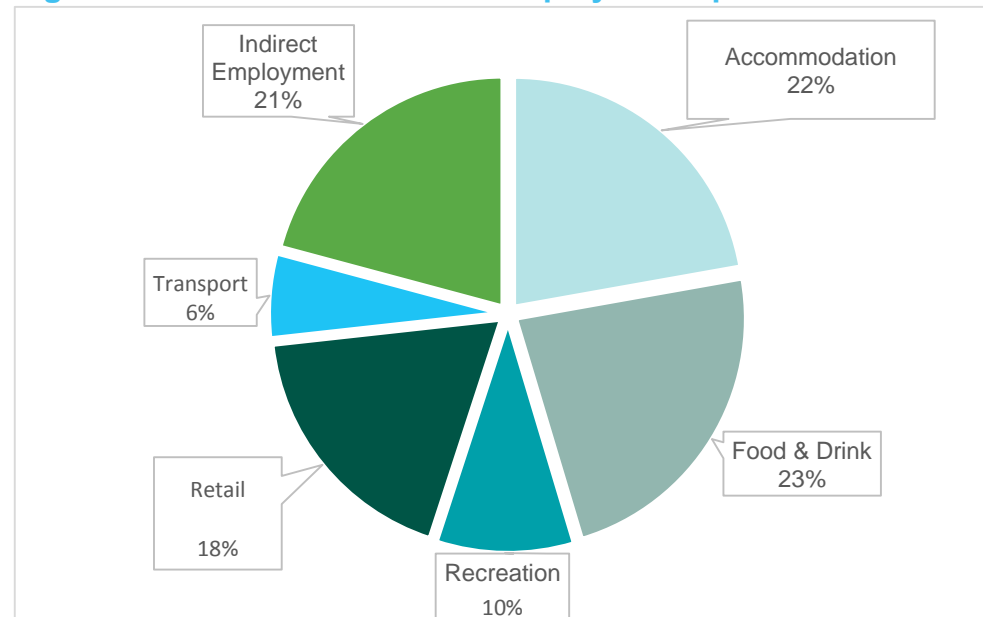
⁷ Woodlands of over 10ha (Note: smaller woodland can also be 'productive' as well but 10 ha is generally considered the scale at which woodland becomes a more commercial proposition)

Case study – Restoring ancient woodland at Cwm Glesyrwrch, Dyfi forest

The project used GIS information, modelling work, and local knowledge to identify the best sites that would, due to their strategic location, contribute the most to a wider network of resilient broadleaved woodland within the Dyfi. The site chosen at Cwm Glesyrwrch is under NRW management. Woodland provides a range of ecosystem services including flood regulation, erosion control, carbon capture/ storage and biodiversity. Broadleaved woodland is known to provide a broader range of ecological niches and is more suited to our native wildlife than conifers and therefore has greater biodiversity benefits (though reduced timber production benefits). The project aimed to begin the transition of a 78 hectare plantation on an ancient woodland site (PAWS), back to mixed broadleaved woodland as part of a wider effort to build a more resilient woodland network in the Dyfi.

As well as very steep ground, the main practical problem to overcome was the presence of the highly invasive conifer tree species, Western Hemlock as well as Rhododendron Ponticum. Research has shown that the presence of Western Hemlock significantly slows the establishment of native broadleaved trees. This is in part due to the dense canopy that these species produce. In early 2015, contractors removed Western Hemlock and rhododendron from the site over a 2 month period. This significantly opened up the canopy and lead to improved recreation and amenity too.

Figure 2 Direct and indirect employment split between sectors ('Full Time Equivalent' jobs)



Though we do not have specific figures for the Dyfi - outdoor activity tourism in Wales contributes £481m to the Welsh economy which in turn helps support the equivalent of 8,243 full time jobs. The Dyfi has a vibrant outdoor activity tourism sector ranging from large providers such as Outward Bound in Aberdyfi, to mountain biking in the Dyfi forest to surfing, canoeing and paddle board guiding on the estuary. The sector also helps support accommodation and local food providers by bringing people into the area and supporting the economy. Similarly, recent research shows wildlife tourism is also an important and growing sector with sites such as Ynys Hir, Cors Dyfi, Cors Fochno and the Dyfi estuary itself attracting many visitors. The Osprey centre alone attracts 35,000 visitors each year.

Fishing in the rivers, estuary and out at sea is also a very important part of the economy, tourism and outdoor

recreation. The Dyfi estuary supports important, **salmon & sea trout** populations both inside the estuary and out in the marine area of Cardigan Bay and the Irish Sea¹⁰. The Dyfi is one of the 80 main salmon rivers in England and Wales (Cefas, 2013) though it is now more noted for its **sea trout** recording a ten year average catch (to 2009) of 1544 sea trout per season. Mussels are also harvested from natural beds in the Dyfi. Saltmarsh in particular is an important nursery area for the **fisheries resource**¹¹

There are several fishing clubs operating in the area – the New Dyfi Fishery Association being the longest established. There are also several commercial sea fishing tourism operators working from Aberdyfi. The **fisheries resource is also of very high cultural value** expressed by both the tourists and locals surveyed.

¹⁰ The Dyfi Estuary fisheries project (2015) did not find evidence for direct overfishing occurring within the estuary. It was not within the scope of this project to evaluate fisheries activities beyond the estuary.

¹¹ Ecosystem service provision (Fisheries Resource) in the Dyfi Estuary System (2015) E.K. Naumann et al. (Environment Systems Ltd and Newcastle University)

Map 4: Number and variety of businesses related to fishing around the estuary

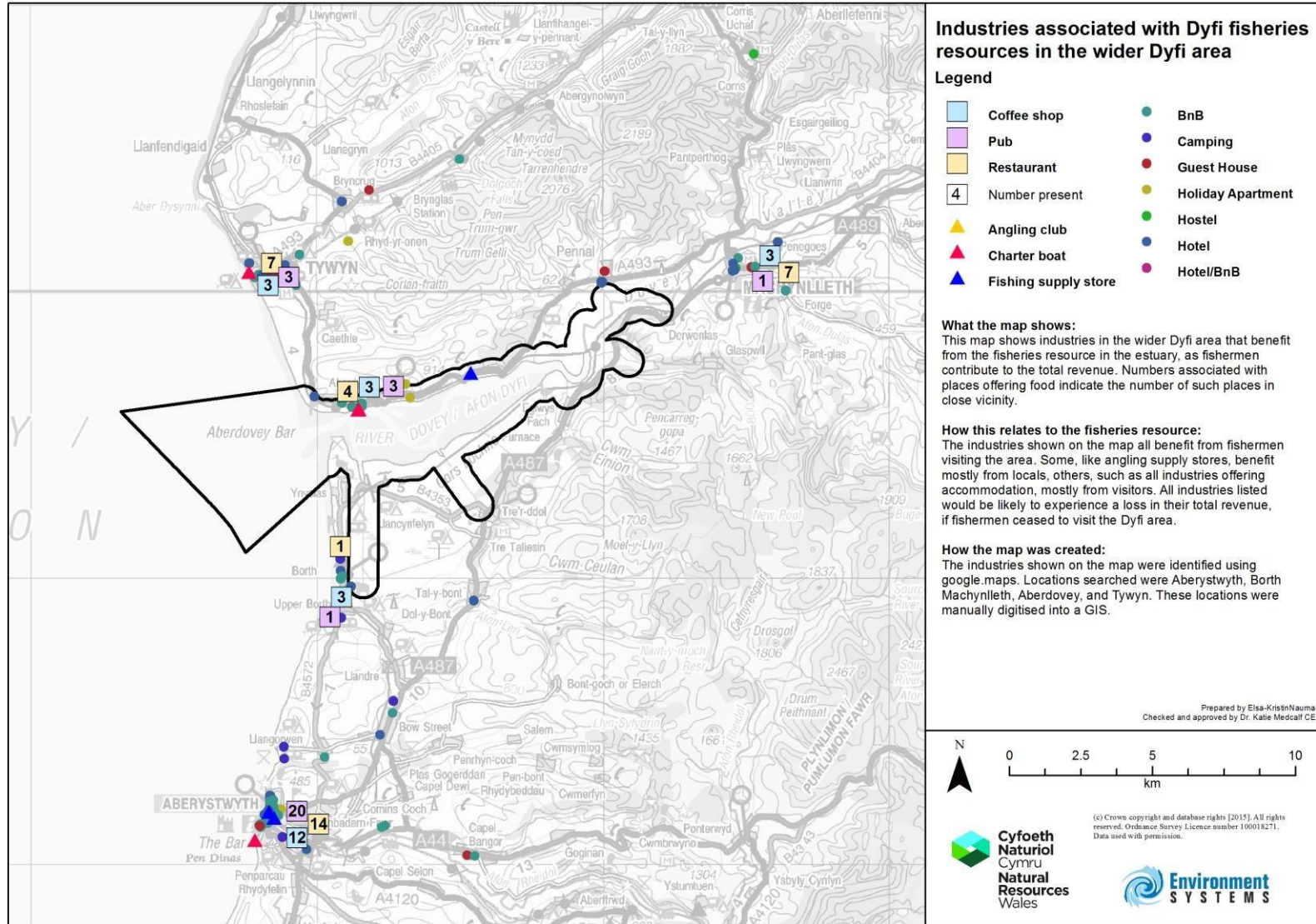
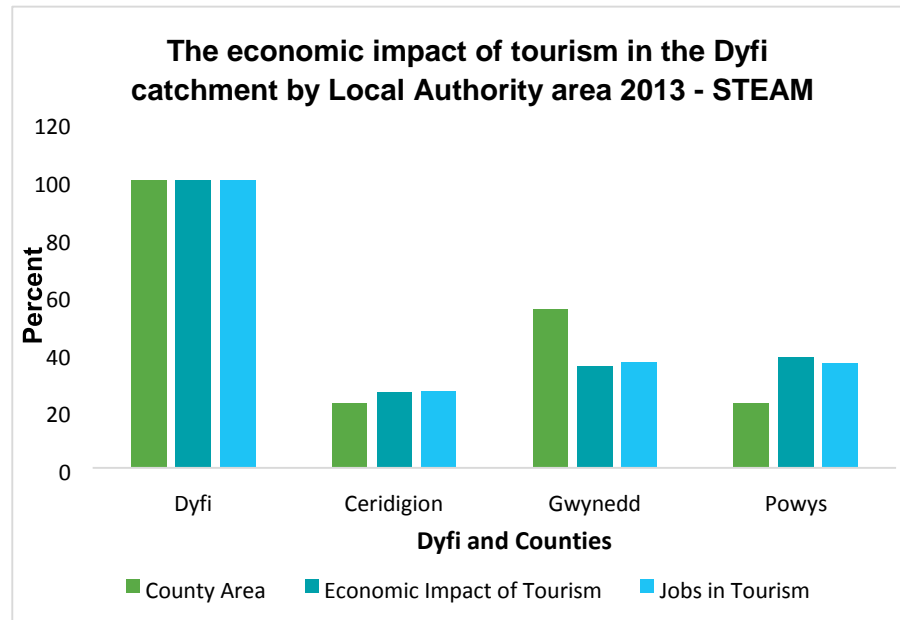


Figure 3 Geographical area, economic impact and jobs created by county



2.1.4 Renewable energy

The Dyfi has a long history of harnessing wind, hydropower, solar and biomass, including innovative community run schemes (Bro Dyfi Community Renewables - <http://communityenergywales.org.uk/profile/bro-dyficommunity-renewables>). Due to its steep terrain, high rainfall, upland character, extensive woodlands, rivers and coast- the Dyfi still has many renewable energy opportunities.

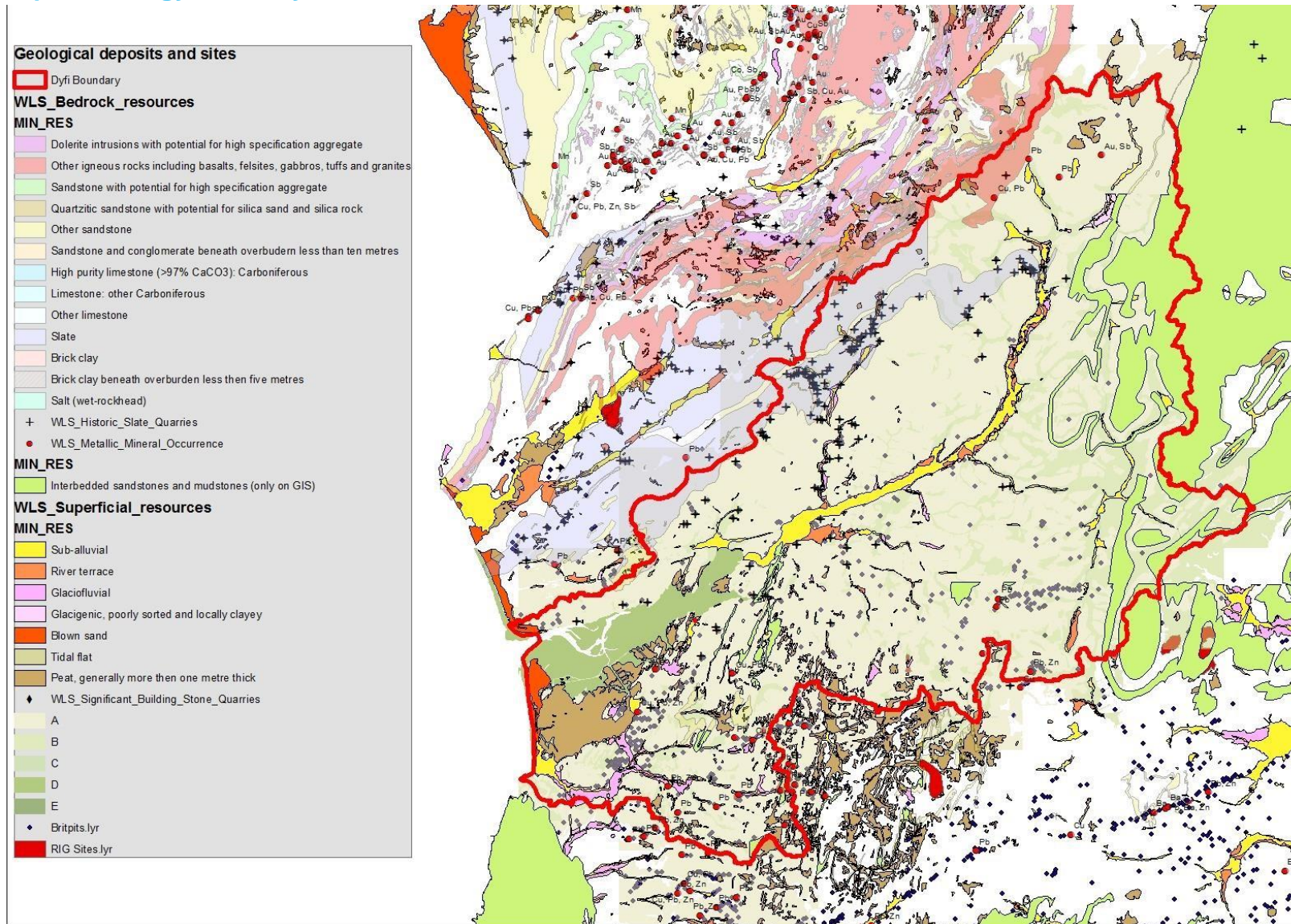
***‘Renewable energy must be considered as a must, there must be a “proper” Wales wide [renewable] energy policy.’
Dyfi Stakeholder***

The area also has specialist organisations such as the Centre for Alternative Technology and renewable energy consultancies that are able to provide advice. In recent years, the high feed in tariffs have driven renewable schemes but this has slowed with a reduction in the government feed in tariffs (FITS). This **case study** looks at Bro Dyfi Community Renewables - <http://www.ecodyfi.org.uk/pdf/CAfEcasestudy8.pdf> one of the first community renewables schemes in the UK.

2.1.5 Mineral resources

Though mining has now ceased, future technologies and metal markets might make some mines in the Dyfi economically viable again in future. Some old mines such as Braich Goch slate mine in Corris (Corris Mine Explorers) are also an important tourism attraction. Other mines are of historic, geological, scientific and recreational value.

Map 5: Geology of the Dyfi

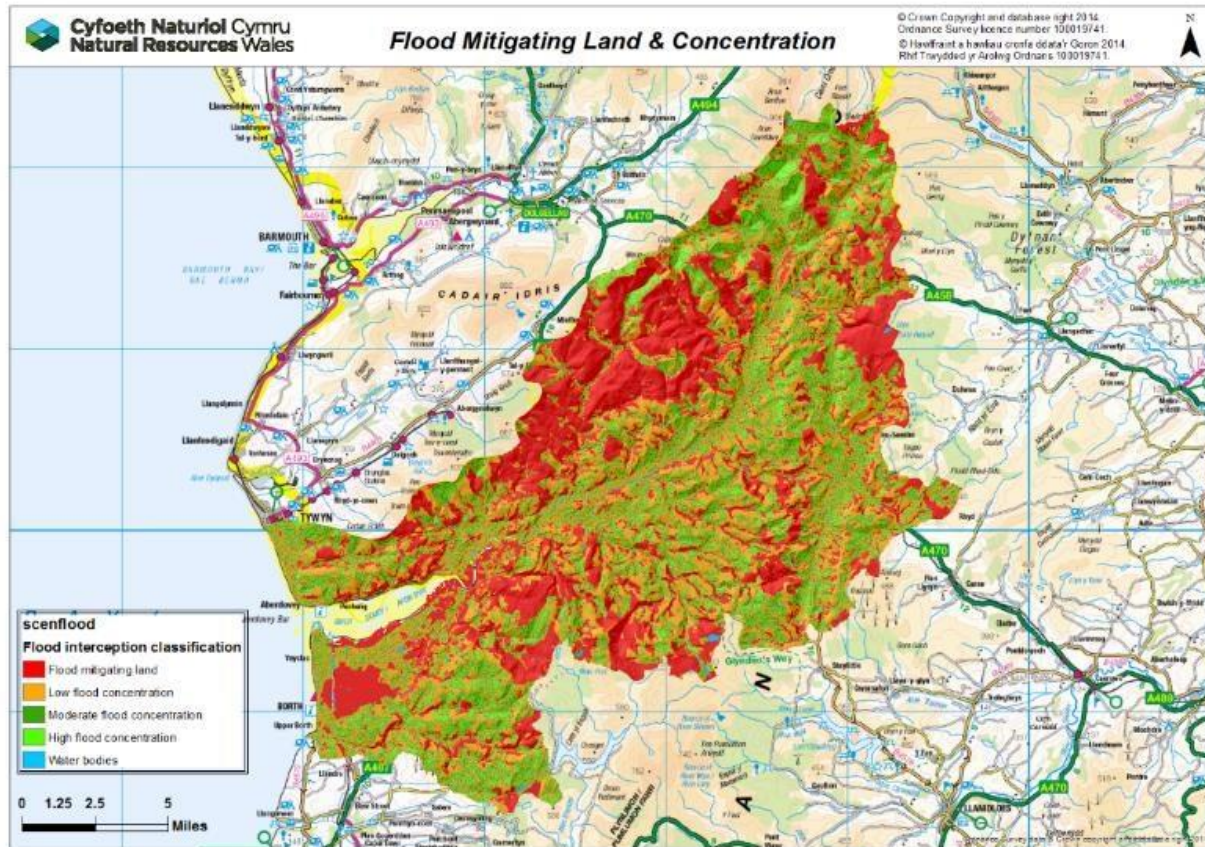


2.2 How our natural resources protect us

Key Benefits:

- Flood defence
- Drinking water
- Good air quality
- Prevention of erosion and sedimentation
- Carbon storage
- Safe bathing beaches

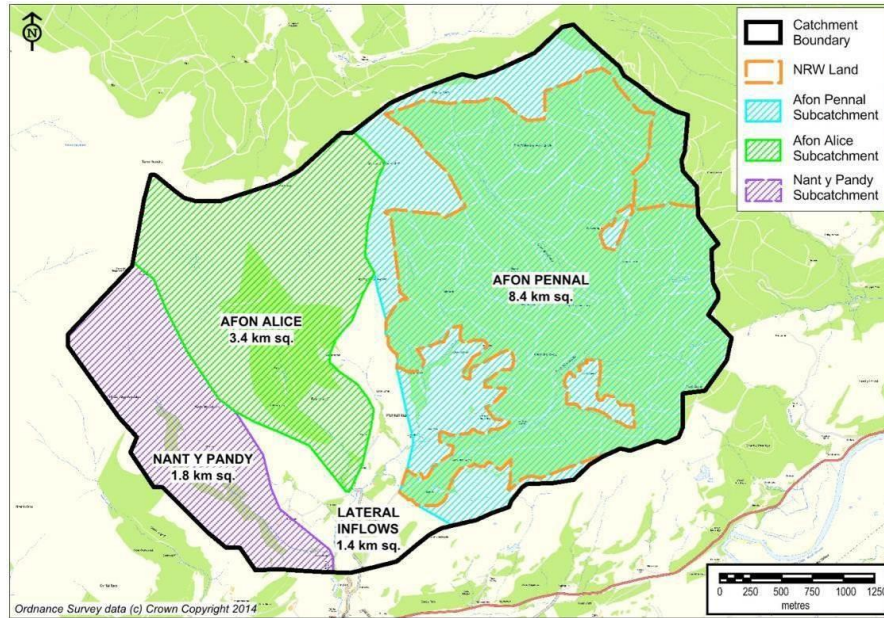
Map 6 Areas of land that help prevent flooding¹²



¹² (based 'LUCI' model – see appendix 3 of vegetation, soils, geology and slope)

Case study Modelling Natural Flood Risk management at Pennal

The study considered the potential benefits of applying Natural Flood Risk Management (NFRM) measures in the Pennal catchment. A short list of potential NFRM options were developed including: options for the floodplain, use of woody debris and planting shelterbelts. Drainage re-alignment and installing J-drains in the forest emerged from the study as the best option in this catchment.



Example of a J-drain in operation – holding water in the forest.



It is clear from Map6 that our forests, peatlands, unimproved grassland, wetlands and shrub are particularly important in helping to prevent flooding. The natural environment protects our health, homes and livelihoods in a number of ways. The Dyfi provides **good air quality** - with very low levels of pollution from particulates and NO₂. Saltmarshes, dunes and other coastal habitats on both the Aberdovey and the Ynyslas side of the estuary substantially reduce the cost of **coastal flood defence** as they form a natural barrier to wave and tidal energy¹³.

Salt marsh reduced the height of large waves in deep water by 18%, making them an effective tool for reducing the risk of coastal erosion and flooding. 60% of this reduction is due to the presence of marsh plants alone¹⁴.

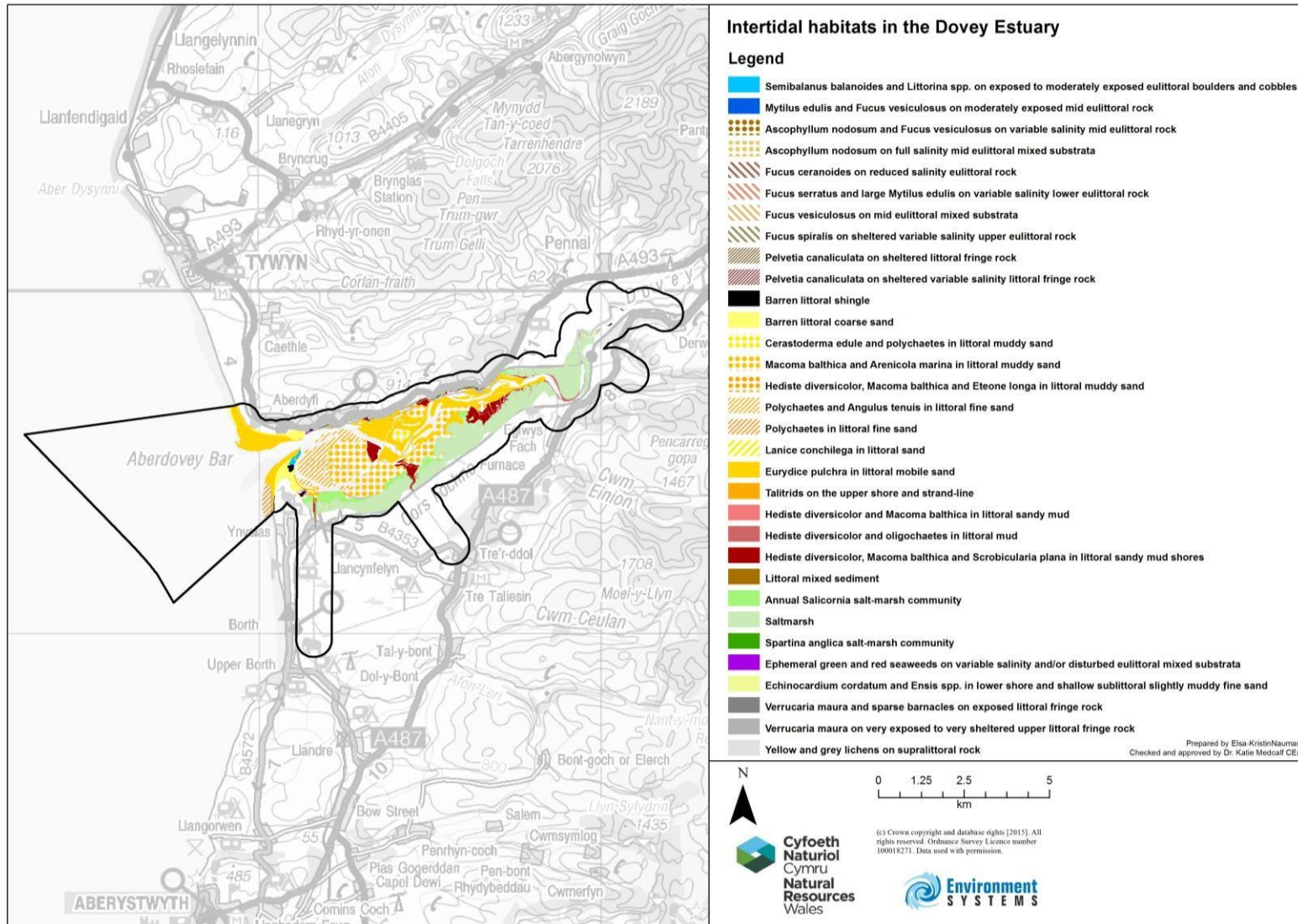
The map below shows the extensive saltmarsh on the south side of the estuary. The Dyfi contains large areas of woodlands, peatland (extensive lowland peatland in particular), grasslands and coastal habitats also help prevent fluvial (river) **flooding; prevent erosion and sedimentation** (see map 8); help **pollination** and **store carbon** (see map 9) in soils and water.



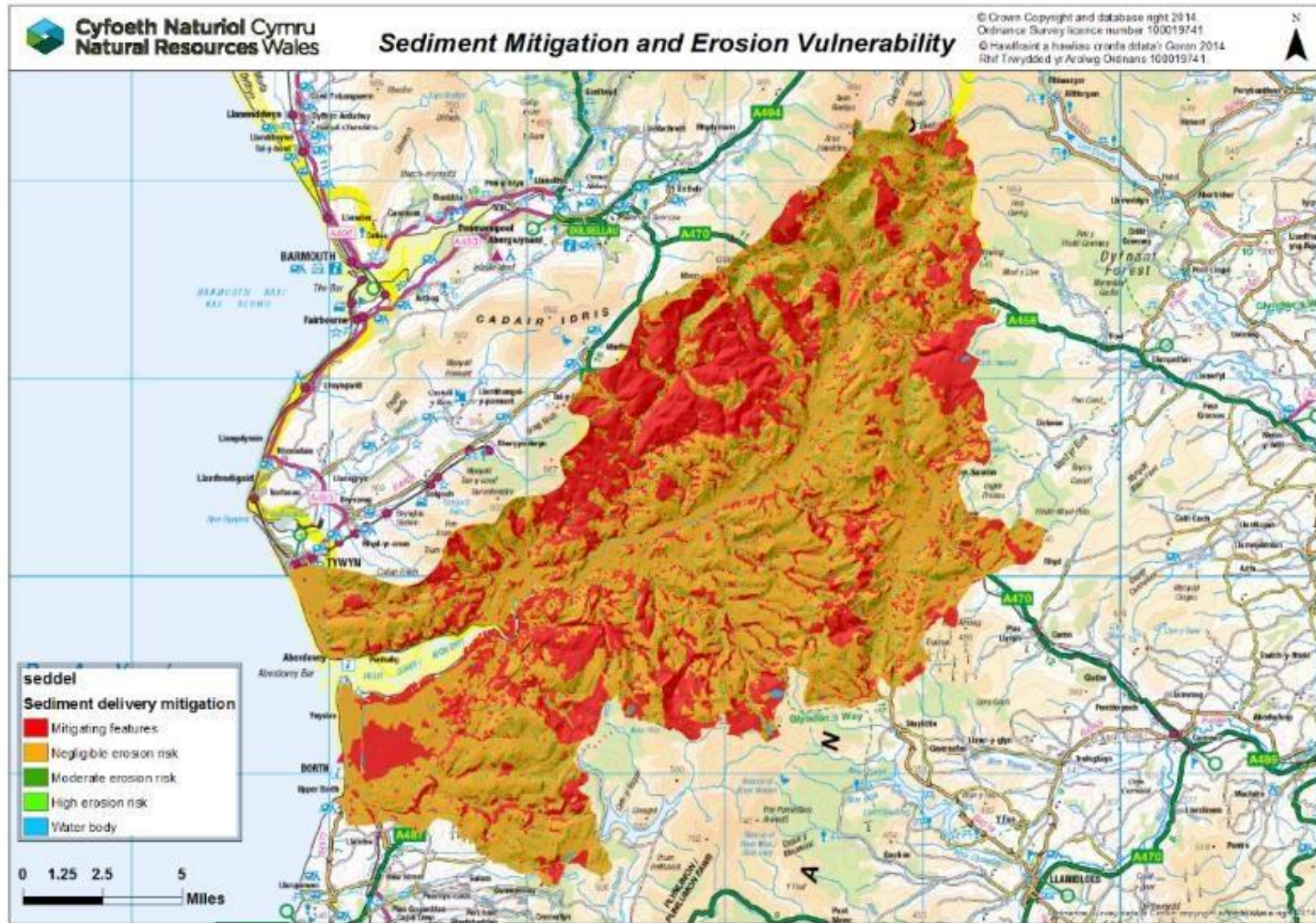
¹³ The Eco-geomorphology of Tidal Marshes – Morris et al 2004

¹⁴ Wave attenuation over coastal salt marshes under storm conditions. Moller et al. Nature Geoscience 7, 727–731 (2014)

Map 7: The extensive range of habitats in the estuary

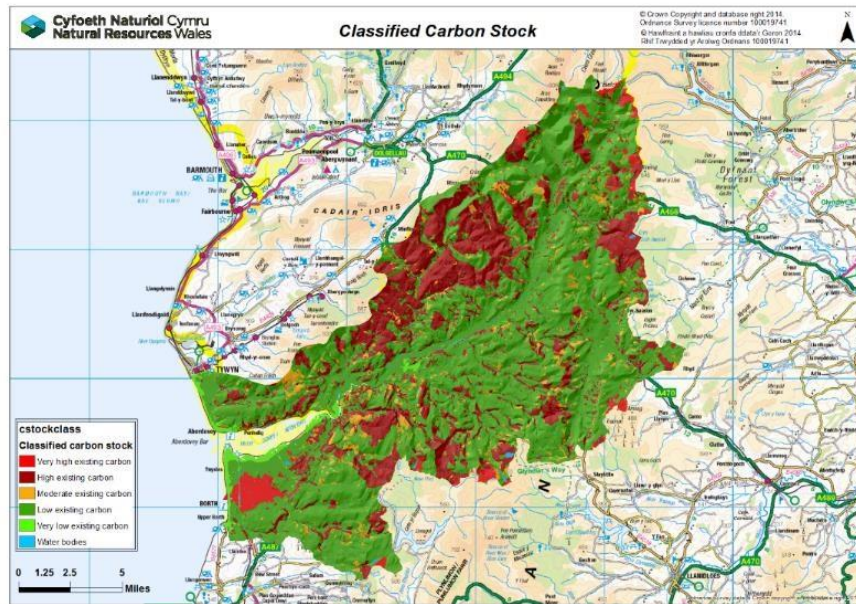


Map 8 The contribution of land to preventing sedimentation and erosion.



Woodlands and peatlands in particular, increase infiltration of water into the soil thereby slowing the flow of water and helping to prevent flooding (see map 6). Drain re-alignment, drain blocking and introducing woody debris to streams can further enhance flood protection. The photograph below shows Cors Fochno – an Special Area of Conservation and extensive raised bog. Cors Fochno not only provides habitat for some of our rarest wildlife – it also stores carbon and helps mitigate flooding.

Map 9 The carbon stock contained within soils and vegetation combined



Cors Fochno – one of the largest areas of raised bog in Europe



Installation of 6 large woody debris structures in a headstream near Belford, Northumberland - more than doubled the travel time for the peak of the flood 1km downstream.

These habitats also offer protection against the effects of atmospheric/diffuse pollutants by **reducing runoff** (the overland flow of water) by reducing the amount of water reaching the water course unfiltered. There are many benefits of **good water quality** beyond drinking water – good quality water ensures **safe bathing beaches**, such as Borth and Aberdyfi, with obvious benefits for tourism and health. The waste processing and purification services provided by the marine environment also ensures our seas provide **safe food**, such as the fish and shellfish, (2two beds at Aberdyfi East and West), collected from the Dyfi and attract recreational and commercial fishermen. The catchment also provides fresh **drinking water** via two water supply reservoirs.

The peatlands, both in the uplands and particularly the lowland areas of the Dyfi (such as the raised bog at Cors Fochno), provide **carbon storage** which helps guard against the effects of climate change, and provide a number of other biodiversity, educational, scientific and cultural benefits. Peatland restoration (250 ha) in Pumlumon is reported to have made a contribution to the UK carbon balance of 1347 tonnes of CO₂ stored each year¹⁵.

Saltmarshes are both a buffer and a link between the marine and the terrestrial. The plants growing on mudflats trap sediment and pollutants, which contributes to the maintenance of water quality by **preventing eutrophication** (Deegan, 2002; Rountree and Able, 2007).

2.3 How our natural resources support recreation, culture, wildlife and health

Key Benefits

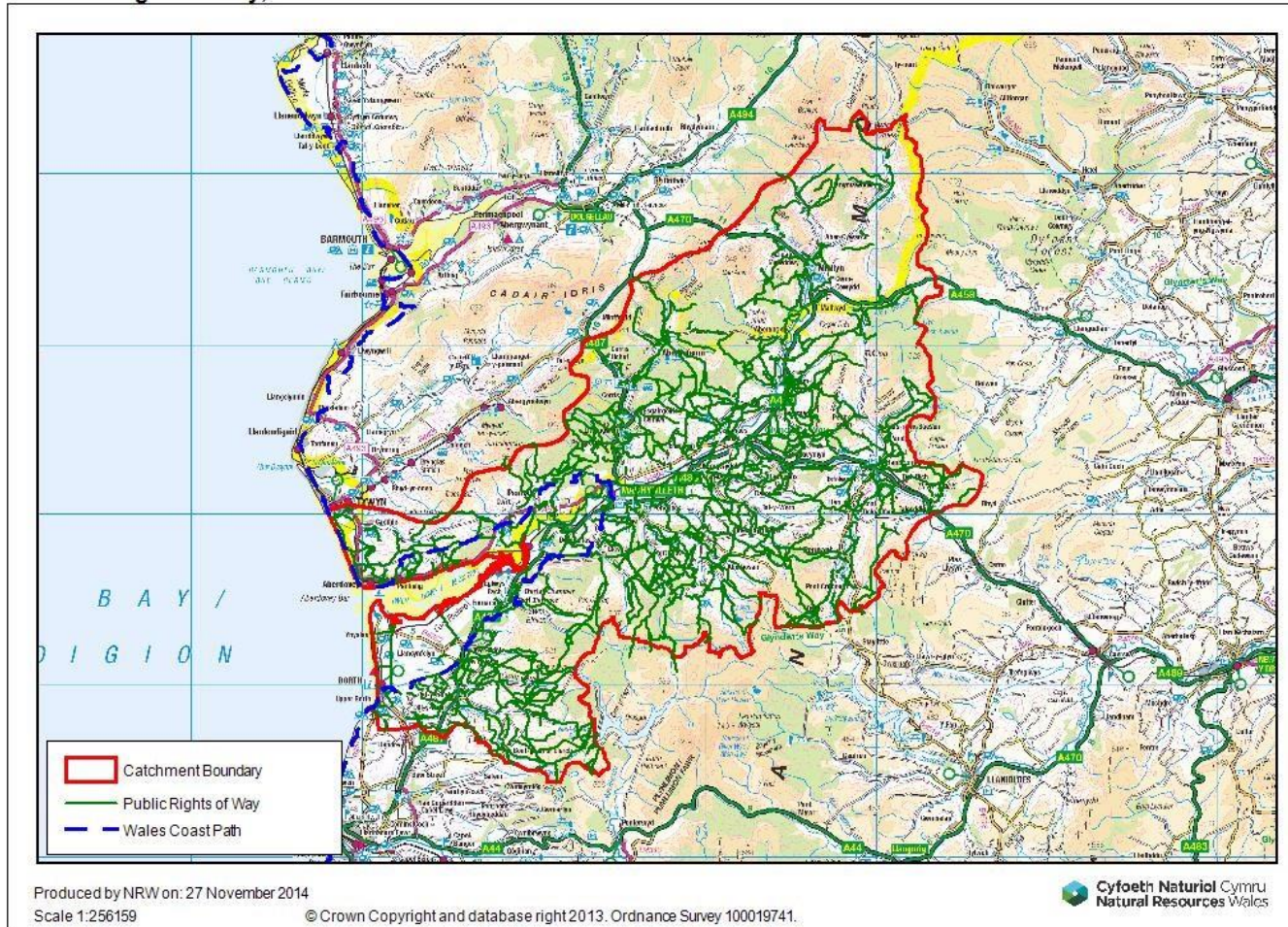
- **Easy access to 'green' & 'blue' space**
- **Extensive outdoor recreation opportunities**
- **Healthy environment to live and work**
- **Historic environment and 'Sense of Place'**
- **Internationally important conservation habitat**
- **Iconic wildlife**

¹⁵ Invest in the Pumlumon Project – Wildlife Trusts Brochure for Green Investors.

The unique scenery and the natural and historic environment of the Dyfi not only attracts thousands of visitors to the area every year but also provide a great place to live and work. The combined rate of **unemployment and economic inactivity is relatively low** across the Dyfi catchment area. **Health deprivation is also generally low**, and (with the exception of Machynlleth) - levels of adult physical activity are high. The **estuary and beaches** at Aberdyfi and Borth, the **mountains** and the presence of an extensive network of Public Rights of Way and the Wales Coastal Footpath provide significant tourism and recreational benefits as described above. ***"Across the physical activity sector, we need to build on the diversity of opportunities to be active including... exercising in a natural environment." Chief Medical officers for England, Wales, Scotland and Northern Ireland (2011)***

Map 10: Extensive Rights of Way network

Public Rights of Way, Wales Coast Path

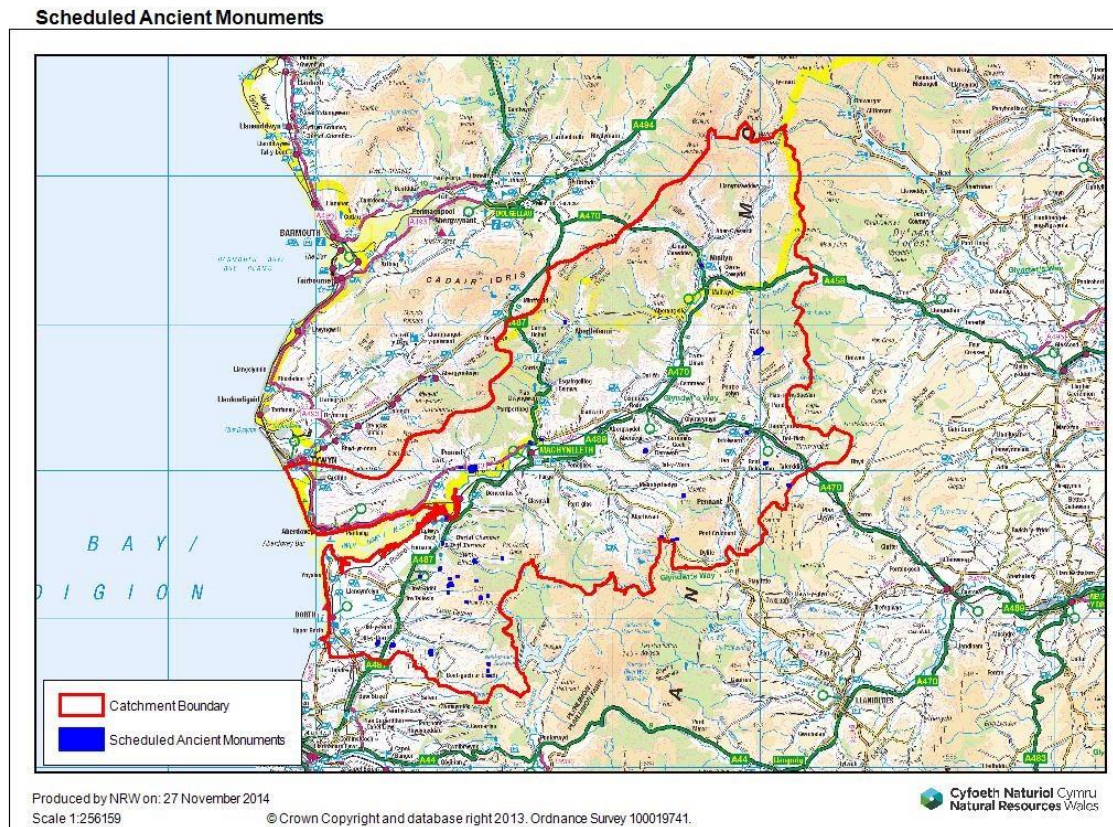


The rivers provide excellent fishing and also excellent kayaking opportunities with the Dulas', Twymyn and upper Dyfi being some of the classic rivers of Wales for Kayaking. In the historic environment, it is the historic components of our landscapes; field systems and boundaries, traditional features, ancient monuments and archaeological sites that contribute to their value and the benefits provided. Over 80% of the Welsh historic landscape is evaluated as being of High or Outstanding quality in

LANDMAP 20% of tourism expenditure can be attributed to the historic environment and attracting visitors to Wales. ¹⁶

The area has an extensive range of historic sites such as Scheduled Ancient Monuments (SAM) and Historic Environment Record' sites - Dyfi Furnace, for example, is one of Britain's best preserved mid-18th century charcoal burning furnaces. Such sites are an important part of attracting visitors to the area. The **historic environment** also provides us with a 'sense of place'; is an important **educational resource**; and can provide **important places for wildlife** within structures like old railway lines and canals.

Map 10a Scheduled Ancient Monument sites

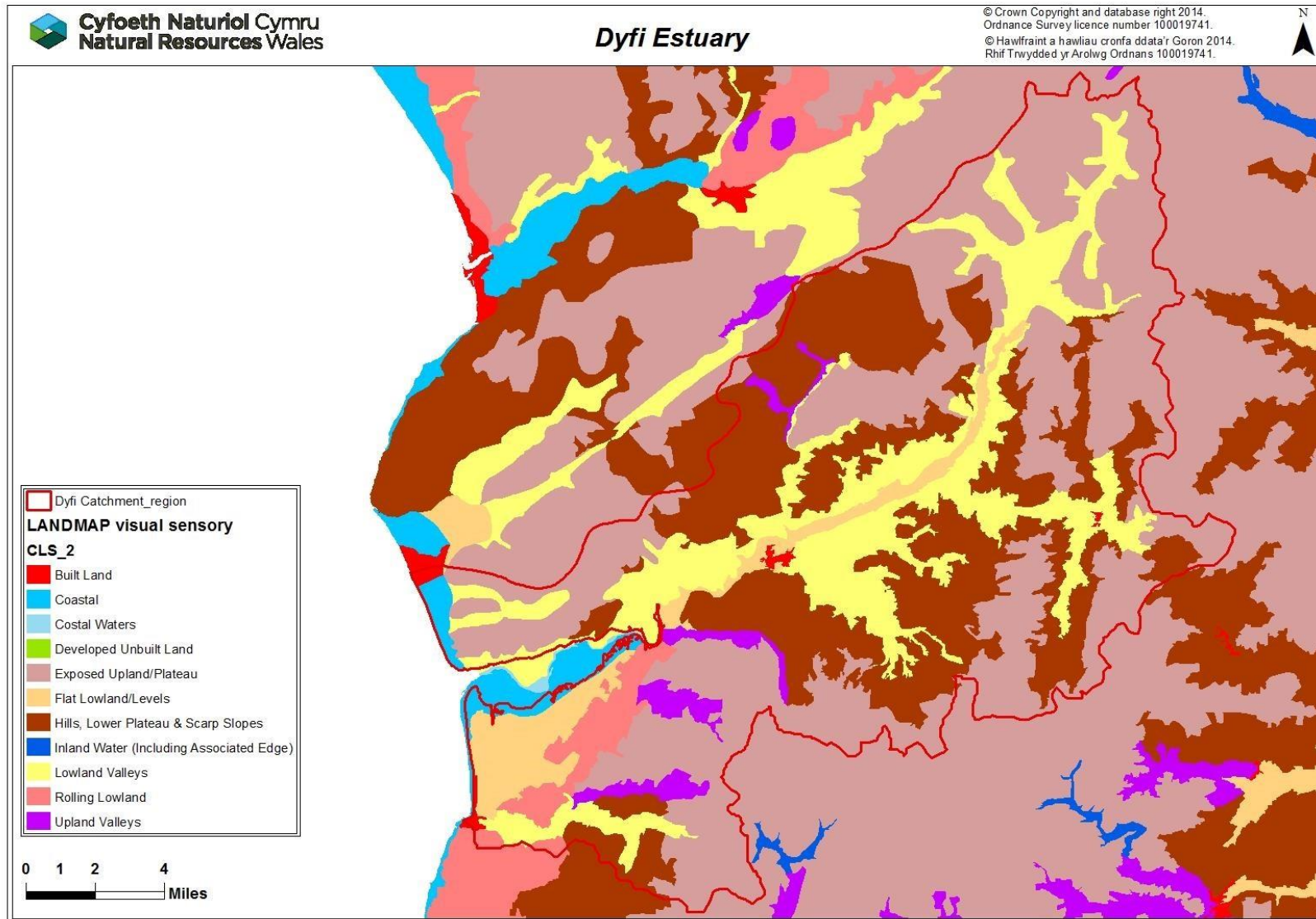


¹⁶ Valuing the Welsh Historic Environment (CADW - 2011)

There is extensive recreational use in the **forests and woodland** from local dog walkers and cyclists and a specialist **mountain bike trail** - Dyfi ClimachX in the northern Dyfi forest - which complements the Mach 1,2,& 3 mtb trails . The forest is also used more formally by Outward Bound, **Wales Rally GB** and other organised events as well as **horse riding** (there are 11,000 horses in Ceredigion alone - National Equine Database 2011). In Coed Ty Gwyn woodland, an NRW managed woodland near Machynlleth, 'Coetiroedd/ Dyfi Woodlands' a team of outdoor educators - help **connect people with woodlands and the outdoors** through education and practical learning of woodland and forest skills.

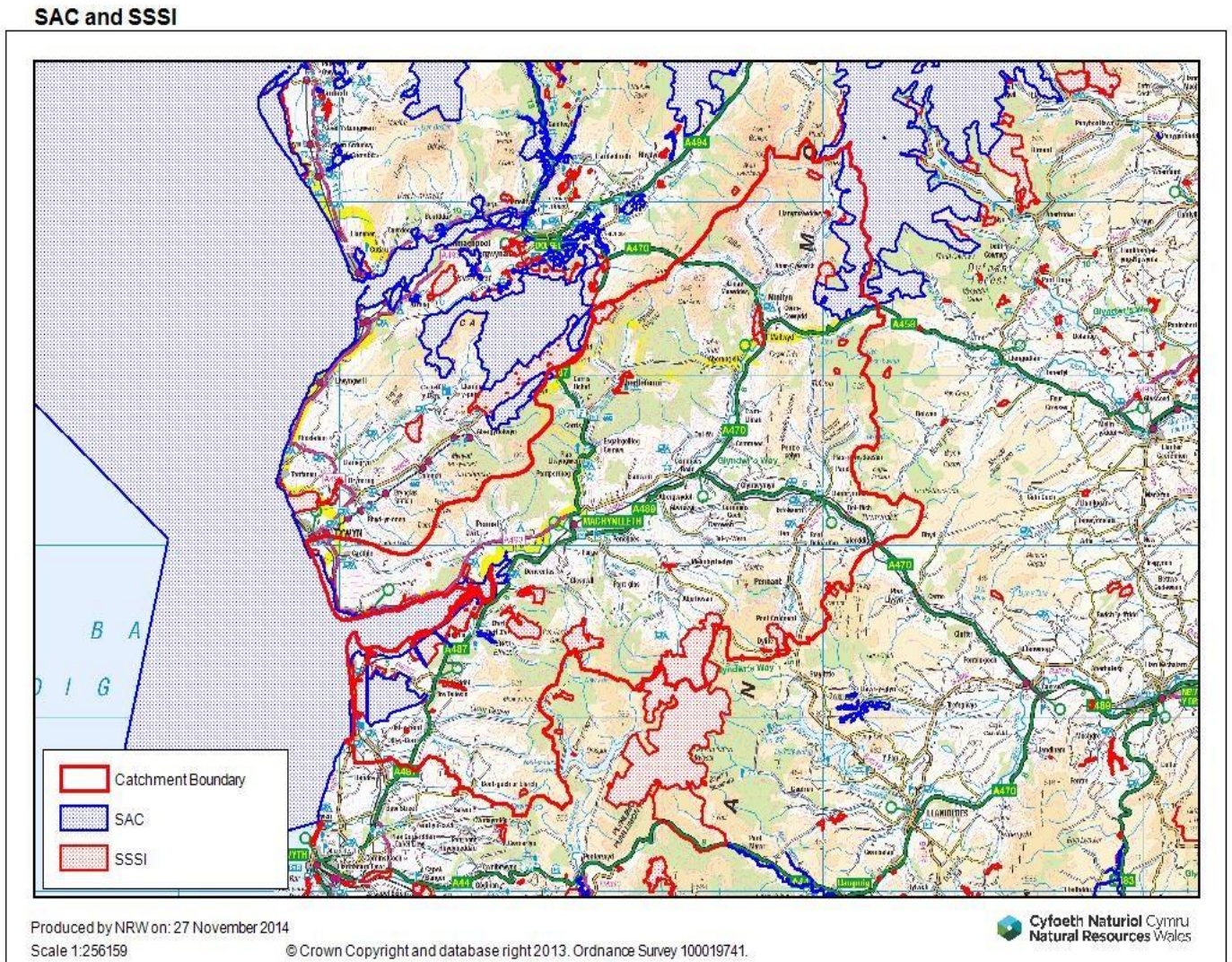
“more could be made of the sea and river as a resource, both for food and for recreation.” Dyfi stakeholder

Map 10b Landscape areas



Map 11 SSSI and Special Area of Conservation sites (SAC) in the Dyfi

Our 'best wildlife sites' such as Ynys Hir, Ynys Las, Cors Fochno, Cors Dyfi, Cwm Einion and Pen Lyn a'r Sarnau are not only important in supporting the economy and protecting us as described above but also for education purposes and their intrinsic worth as some of the best wildlife sites in the UK . For example: the saltmarsh that borders the estuary hosts over 100 Greenland white-fronted geese ; Ynys Hir Reserve and Cors Fochno host an important Welsh population of Lapwing as well as adders, hen harrier and rare species of invertebrates and other wildlife; the woodland at Cwm Einion and Cwm Clettwr host rare lichens and bryophytes. Pen Lyn a'r Sarnau not only has outstanding marine and coastal habitats but also hosts iconic wildlife such as bottlenose dolphins, grey seals and otter. On the economic side, one pair of Ospreys breeding at the Montgomery Wildlife Trust Cors Dyfi reserve in Wales, have attracted 35,000 extra visits to the area bringing in an estimated £350,000 a year locally.¹⁷



¹⁷ Invest in the Pumlumon Project – Wildlife Trusts Brochure for Green Investors

High Nature Value farming can offer significant benefits for biodiversity as well as helping to support local breeds, conserving genetic diversity and enhancing the resilience of the sector. It can deliver sustainable farming that doesn't come at the expense of animal welfare, soil and water quality, as well as safeguarding and restoring habitats.



Unimproved Grasslands, have traditionally been managed through grazing or cutting and include some of the most species-rich habitats in Europe with the richest soil biodiversity. They are the source of a wide range of ecosystem services, ranging from meat and dairy products to recreational and tourism opportunities, and they also act as carbon sinks. A recent lowland grassland survey of the Dyfi catchment (Wynderush Consultancy 2015) confirmed that the lowland semi natural grasslands in the Dyfi catchment are very fragmented and often in poor condition. There is a strong likelihood that we may lose some of these sites if management action is not taken.

3. Challenges to the sustainable management of our natural resources

Having considered the benefits that the natural environment provides, the project worked with stakeholders and looked at evidence to establish the key challenges faced by the Dyfi now and in the future. The Challenges range from those associated with climate change, changing demographics and the threats of pests and diseases.

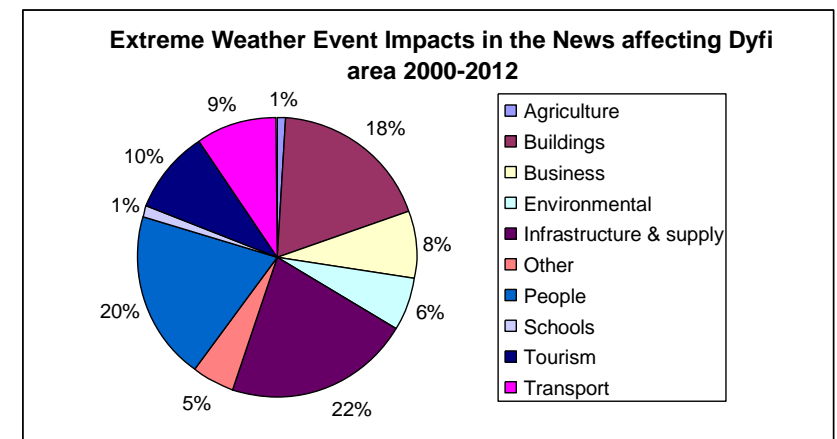
- Retaining young people and providing employment opportunities:** The Dyfi has experienced rural depopulation / changing rural demographic with local young people often needing to move away to gain employment. There is a perceived / real lack of opportunities, particularly for younger people and people without limited / specific types of professional skills. The above will also help maintain thriving communities and retain the language and culture. Machynlleth and the rural south east corner of the catchment area have relatively high proportions of adults with no formal qualifications

We need to retain our young people and provide a means for them to support themselves and therefore remain in the area.

Dyfi Stakeholder

- Potential decrease in capacity to produce food:** Though climate change may result in a longer growing season – it is likely that any benefits will be offset by difficulties associated with a changing climate and weather patterns. Increased soil moisture, erosion and compaction of soils could lead to soil loss and damage and fewer ‘field days’ (i.e. days when livestock can be kept out on the fields);
- Increased susceptibility to pests and diseases and windblow** (trees blown over) in our forests as the climate changes.
- Difficulty of expanding woodland cover.** Current agricultural land values often prohibits the establishment of new woodlands.
- Potential changes to the tourist season.** Warmer but wetter summers and competition from elsewhere may change the attractiveness of the area for the more traditional beach holiday maker using the Dyfi

Figure 4 Sectors most affected by extreme weather events (2000-2-12)

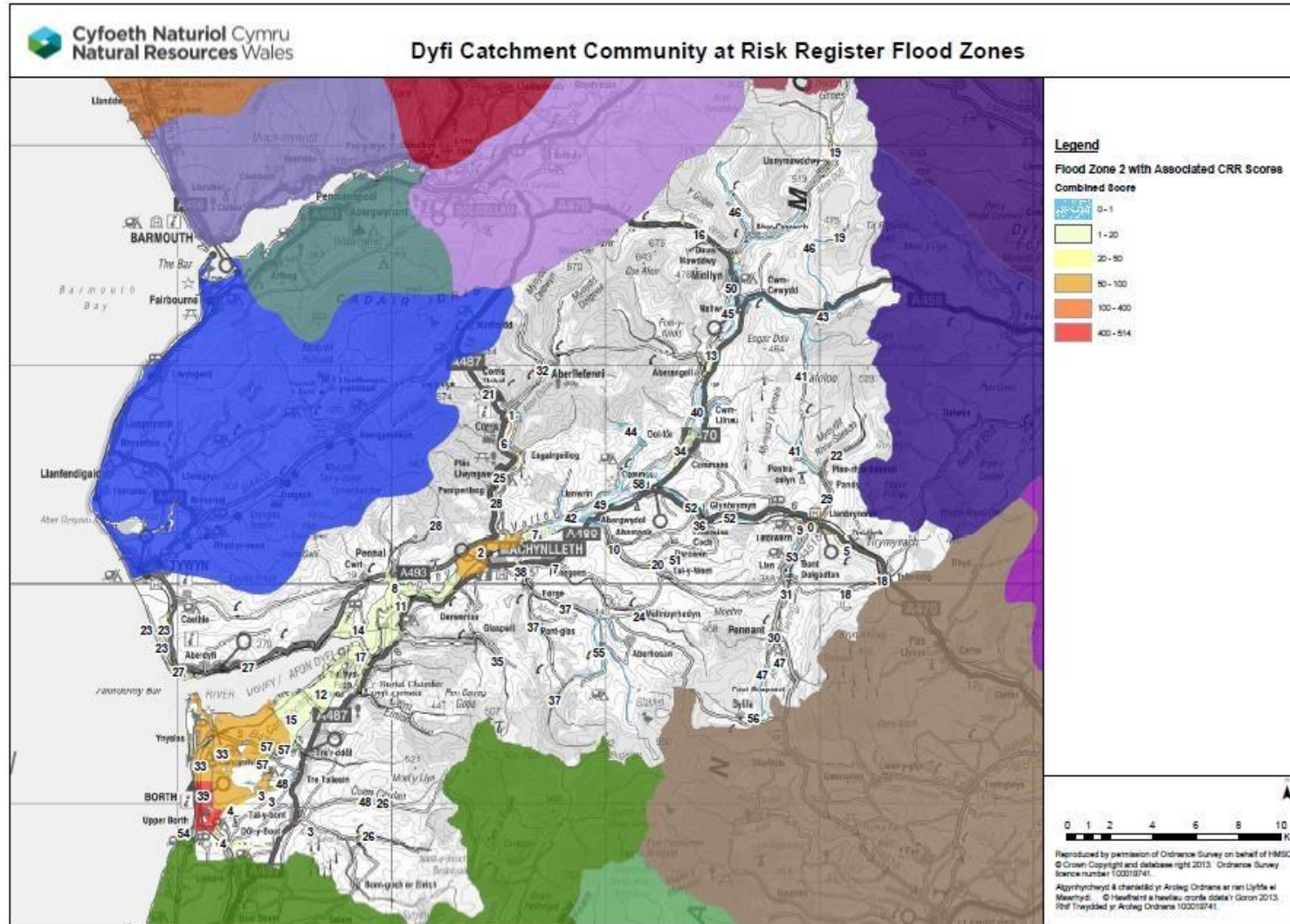


- **Less active land management** - The farming population is also getting older with only 12% in the 16-24 age group in Wales (over 30% of the workforce is 55 years of age or older) – this has implications for long term viability of farm businesses as well as potentially, the appeal of the landscape.
- **Potential declines in farm income.** Farm gate prices and farm incomes have seen declines over the last decade. Possible decreases in EU ‘direct support CAP payments after 2020 or more funds moved into agri- environment, could affect the viability of hill farming in particular if businesses are not able to access agri- environment support.
- **Ability to harness renewables** – challenges include poor phase 3 electricity infrastructure in more remote areas; declining feed in tariffs (FITS) , difficulty in gaining planning, public opposition (particularly to wind), and high initial costs.
- **Potential declines in the fisheries resources¹⁸ and natural flood protection** due to the constrained nature of the estuary. Estuarine habitat, particularly the saltmarshes and dunes of the Dyfi are currently constrained by man-made structures including flood banks and the railway line. This means that these natural defences are not able to expand and provide natural flood protection and replace habitat for fish and other wildlife that is being lost as the estuary changes and sea level rises.
- **Flooding.** There are currently 487 properties in the Dyfi at risk of flooding. (see map 12)¹⁹. Increases in winter rainfall, sea level rise are likely to cause more flooding in future. Factors such as upland drainage, compaction of soils by livestock; lack of vegetation cover and drainage of wetlands, floodplains and peatlands are thought to contribute to downstream flood risk.

¹⁸ The Dyfi Estuary fisheries project (2015) did not find evidence for direct overfishing occurring within the estuary. It was not within the scope of this project to evaluate fisheries activities beyond the estuary.

¹⁹ In the current Shoreline Management Plan (2) - Cors Fochno, Afon Leri, Borth Golf course and Borth itself are currently treated as ‘Managed realignment’ in the long term (> 40 years) i.e. after this period – these areas will not be defended from sea level rise.

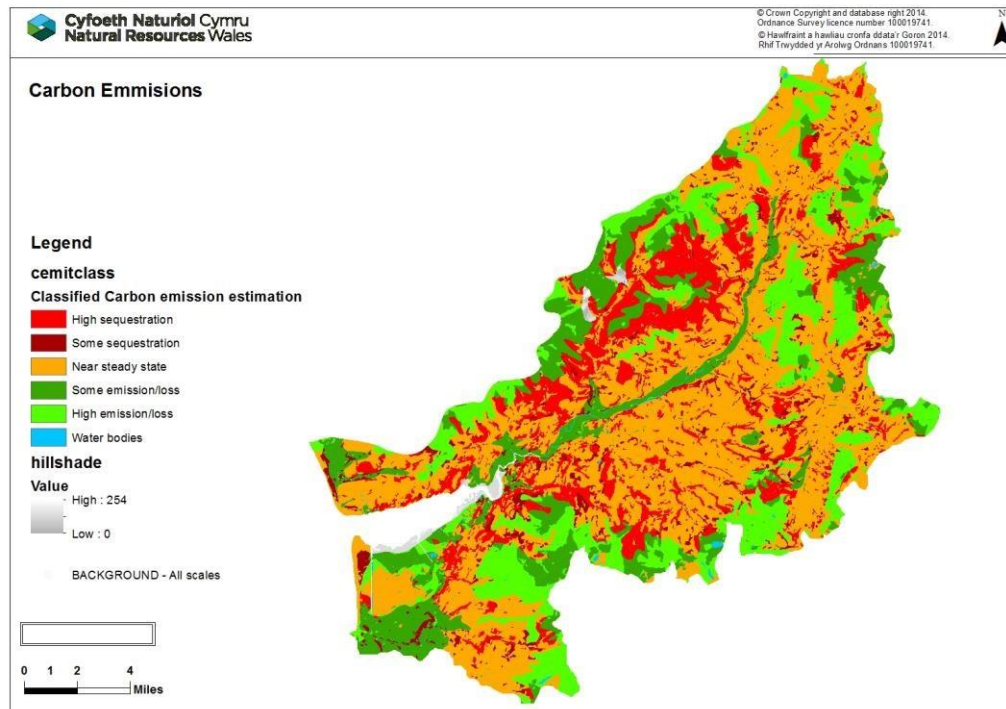
Map 12 Communities most at risk of flooding (red most at risk)



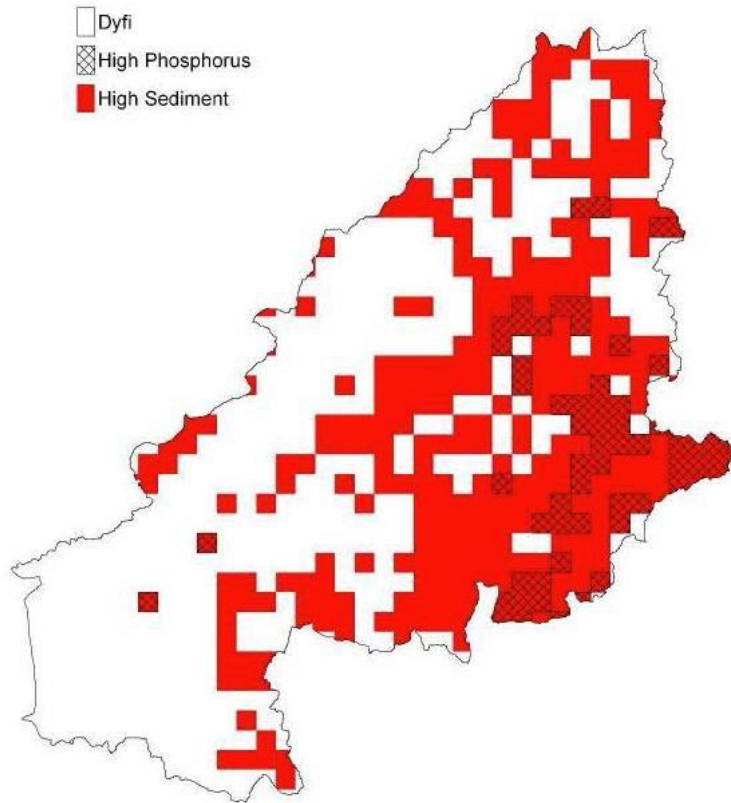
- **Water quality issues** affect estuarine and freshwater biodiversity and fisheries, shell fisheries and bathing beaches, such as Aberdyfi. There are currently 13 water bodies (rivers, lakes & streams) that are failing the EU 'Water Framework Directive' standards. The main causes of poor water quality in the Dyfi are: **livestock management; land management; mine waters; and barriers to fish migration.**

Diffuse pollution from livestock and land management - surface water run-off from fields and yards containing animal waste, nutrients and sediment pollutes watercourses and reduces ecological value. High stock numbers, leads to surface compaction of the soil (field poaching) leading to more run-off and increased flood risk and sedimentation. The main areas of sedimentation and phosphorous largely correspond to the more intensively farmed areas – see map 14. The Einion has also suffered from acidification due to the forestry in the past. All of the above affects water quality at our bathing beaches, such as Aberdovey and the shellfish beds in the estuary.

Map 13 Areas that are storing and emitting carbon



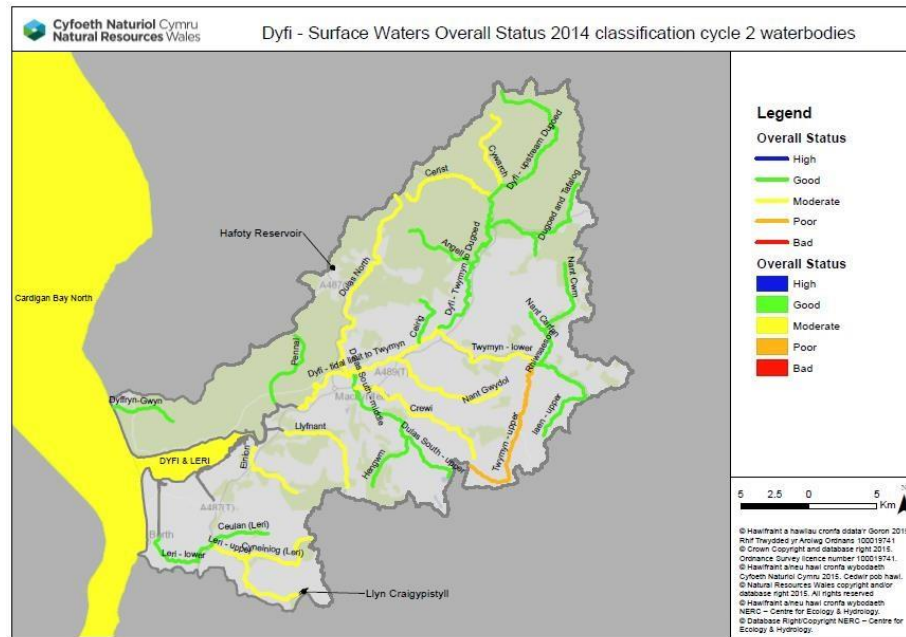
Map 14 Areas generating phosphorous and overgrazed riverside that has been poached by sediment livestock.



- **Mine water pollution** – Several rivers in the Dyfi, such as the Twymyn, Crewi, Leri are failing to meet Water Framework Directive Standards due to heavy metal contamination). Dylife mine alone is the largest source of zinc²⁰ in the catchment and impacts approximately 40km of river.

²⁰ Zinc is toxic to algae which then impacts the rest of the food of chain.

Map 15 Condition of the rivers in the Dyfi



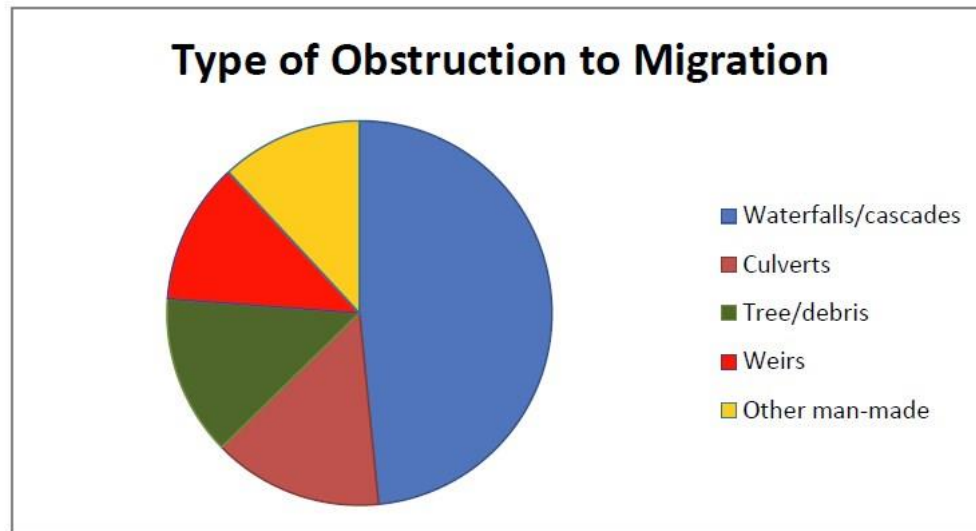
Pollution from Dylife mine affects 15km of river



- **Barriers to Fish Migration** – though work has been ongoing over many years to remove barriers to fish migration are – barriers are still a significant issue – particularly given the recreational & economic importance of fishing in the catchment. As part of the Dyfi NRM trial, Arfonnydd Cymru mapped fish barriers throughout the catchment²¹ The work showed that there was 126 obstructions, 44 of which were total barriers to fish migration. Around 80% of total barriers were natural features such as waterfalls. Other types of barrier are shown below.

²¹ Mapping barriers to fish migration in the Dyfi catchment – DY5: Afonydd Cymru 2015.

Figure 5 Type of fish barriers present in the Dyfi catchment



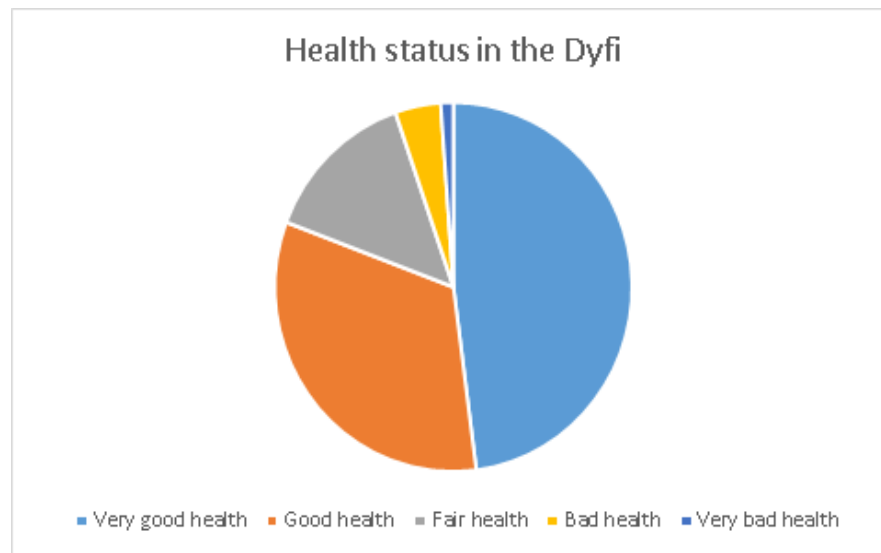
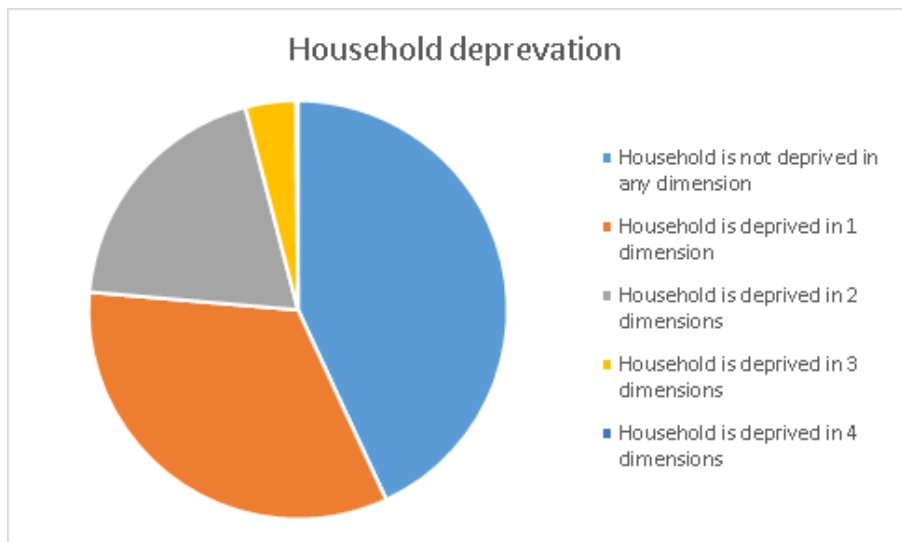
Fish barrier on the Afon Crewi



- **Pockets of health deprivation and low levels of physical activity** amongst deprived communities. The proportion of children aged 4-15 who undertake one hour or more of physical activity a day is low, in communities in the north and west of the catchment, which are among the 20% most deprived in Wales. In comparison to other rural areas - the rate of health deprivation in and around Machynlleth is among the 20% most deprived in rural Wales.

Figure 6 Household deprivation in the Dyfi 2015 (Office for National Statistics) 2015 Statistics)

Figure 7 Health status in the Dyfi (Office for National (Office for National Statistics) 2015 Statistics)



- **Lack of activities/ access close to where people live** including (flat) 'active travel' routes between settlements.
- **Lack of integrated information on what to do and where to go in the outdoors.** More use of technology (a member of the Dyfi Biosphere tourism association for example, suggested a series of "selfie spots" as a way to interpret and share the views that are on offer in the Dyfi.)

Flat easy cycling routes with good commuting or leisure attractions (cafes/pubs), like the Morfa Mawddach trail, are lacking in the Dyfi Area. Dyfi stakeholder

- **Poor access to inland waters and the estuary** due to conflict with fishing and landowning interests. The estuary is a key attraction of the area but there is difficulty accessing it for water sports, particularly on the south side, as inland waters are under private ownership. Though voluntary access agreements have been successful in some places, the Evaluation of SPLASH ²²Grant Scheme 2008 – 2012 stated that '*few [voluntary] arrangements have provided meaningful new access.*'²³
- **Impact of the changing climate on the historic environment** features. Climate change could adversely affect these features and landscapes due to erosion, increased vegetation etc.
- **Fragmentation & reduction in biodiversity of habitat** such as peatland, wetlands, grassland and broadleaved woodland due to factors such as changing agricultural & forestry practices, intensification and development. Though some wildlife species, such as those associated with woodland, are doing well others associated with open conditions and farmland, such as butterflies have declined (down 13%). Between 1970 and 1990, twice as many bird species suffered contractions to their Welsh ranges, compared to species whose ranges increased²⁴. Farmland bird species such as curlew, lapwing, which have important populations in the Dyfi are declining. In terms of lowland waders - the condition and extent of habitat and lack of predator control are thought to likely causes.
- **Changes to the life cycles of plants and animals-** changes in weather patterns are likely to cause changes in the life cycles of plants and animals.
- **Water level management at Cors Fochno:** The raised bog at Cors Fochno SAC is a site of international importance for conservation and is also within the Dyfi Ramsar and Dyfi Biosphere. The bog is sensitive to changes in water levels within the underlying peat and is currently in 'unfavourable condition'. A number of drains remain on agricultural land around the periphery of the site and are known to be lowering water levels within the bog and affecting its condition. Lower water levels are required on these fields to make them suitable for agricultural use.
- **Invasive species** potentially contributing to pollution and erosion risk.

²² SPLASH – the 'water recreation' grant scheme for Wales 2008-12

²³ University of Brighton and G & L Hughes Ltd Jan 2013. Evaluation of SPLASH Grant Scheme Voluntary Access Arrangements 2008 -2012: A Report to Welsh Government and the Environment Agency Wales. January 2013

²⁴ State of Nature report 2013

Appendix 1 – Existing Plans and strategies related to natural resources

Issue	Plan/strategy title	Lead body
Flooding and coastal erosion	Flood Risk Management Plans	Natural Resources Wales
	National Flood and Coastal Erosion Risk Management Strategy	Welsh Government
	Shoreline Management Plans	Coastal Groups, which are local authority-led
	Catchment Flood Management Plans	Natural Resources Wales
	Local Flood Risk Management Strategies	Local authorities
	National Habitat Creation Programme	Natural Resources Wales
Climate change	Climate Change Strategy for Wales (2010)	Welsh Government
	UK National Climate Adaptation Strategy and Adaptation Plan	Government's Committee on Climate Change, Public bodies and utility companies
Water	Water Strategy for Wales and associated Action Plan	Welsh Government
	Water Resource Management Plans	Water Companies
	Drought plans	Water Companies
Biodiversity	Nature Recovery Plan (under development)	Welsh Government
	Special Areas for Conservation/Special Protection Area core management plans	Natural Resources Wales
	SSSI management plans	Natural Resources Wales
	Life + Natura 2000 Project Thematic Plans Natura 2000 Prioritised Improvement Plans (PIPs)	Natural Resources Wales
	Local Biodiversity Action Plan	Local Authorities/Local partnership
Invasive nonnative species	The INNS framework strategy for Great Britain	Great Britain non-native invasive species programme board
Agriculture	Common Agricultural Policy/ Rural Development Plan/ Glastir agreement plans	Welsh Government
Forestry	Wales Woodland Strategy	Welsh Government
	Forest Resource Plans/ Design Plans	Natural Resources Wales
Recreation	Rights of Way Improvement Plans, Active Travel Act	Local authority

Landscape	National Park Management Plans	National Park Authority
	AONB Management Plans	Local authorities
Marine	Welsh National Marine Plan(proposed)	Welsh Government
	Bathing Water Priorities	Natural Resources Wales

Appendix 2 Important 'ecosystem services' in Dyfi

	Ecosystem service
Cultural/ recreational	cultural heritage, recreation/ access, tourism, landscape, biodiversity
Economic	food, timber & fuel, fishing & shooting, renewable energy
Regulating/ protection	flood regulation, water quality, erosion control, and carbon storage
Supporting	geodiversity, biodiversity

Appendix 3 Land Use Capability (LUCI) model

The Land Utilisation and Capability Indicator (LUCI) model allows the mapping of ecosystem services from the sub-field to national scale, the impact of management services on these services, likely trade-offs, and opportunities for spatially optimising interventions. Currently services include agricultural productivity, flood risk, erosion, nitrogen, phosphorus loss to rivers, carbon storage and emission rates, habitat diversity, and connectivity for broadleaved woodland species. All are available as colour coded maps highlighting low to high current levels of service delivery. In contrast to simple mapping approaches, LUCI is 'process-based' and includes our best scientific understanding. It can thus generate outputs beyond current data availability and report changes in meaningful units (e.g. kg of carbon, m³ of river flow etc).

All LUCI calculations and valuations are produced at the resolution of the input digital elevation model (DEM) - 5m x 5m within the UK. This is the obvious choice for water and diffuse pollution services and allows for sub-field management changes e.g. riparian strips and field boundaries as well as sub-catchment and catchment changes to be assessed. This resolution is continued for all services to ensure each service valuation is produced at a resolution consistent (identical) with the other service valuations. This common scale is also necessary to allow trade-offs and synergies to be meaningfully calculated. LUCI is a second generation extension and software implementation of the Polyscape framework described in Jackson et al (2013). Jackson, B., Pagella, T., Sinclair, F., Orellana, B., Henshaw, A., Reynolds, B., McIntyre, N., Wheeler, H. and Eycott, A. (2013) Polyscape: A GIS mapping framework providing efficiency and spatially explicit landscape-scale valuation of multiple ecosystem services. *Landscape and Urban Planning*, 112, 74-88.