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# Managing Abstraction and the Water Environment

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## Foreword

A naturally functioning water environment provides space for nature, services to society that everyone relies on and resilience to climate change. Rivers, lakes, estuaries, wetlands and water under the ground provide many different benefits to society – from supplying drinking water and supporting fisheries to providing an essential resource for business and agriculture. It is essential water is used and managed in a sustainable way. By doing this, the natural environment, business and economic growth will be protected and the long-term benefits to health and wellbeing improved.

The Environment Agency and Natural Resources Wales manage water resources by regulating activities in the water environment, including abstraction from surface and ground water. This regulation aims to get the balance right between abstractor and environmental needs, meeting legal requirements. This aim remains central to the reform options ([see the consultation document](#)).

This note summarises how abstraction affects the environment, how unsustainable abstraction is identified and what is done to deal with it.

## What is unsustainable abstraction?

Abstraction and flow regulation are “significant water management issues” in England and Wales and are one of the top pressures needing to be addressed to achieve healthy ecology.

Abstraction is the removal of water, permanently or temporarily, from water bodies such as rivers, lakes, canals, reservoirs or from groundwater. Abstraction can alter the natural flow regime either directly changing surface water flows or indirectly by lowering groundwater levels and consequently affecting flows to springs, wetlands, lakes and rivers. The natural flow regime can also be changed where the flow in rivers is controlled by impounding structures, such as dams or weirs, or released from a reservoir; this is known as flow regulation.

The natural flow regime is a benchmark for a healthy environment. Altering these natural conditions, through abstraction or flow regulation, can have direct and indirect adverse impacts on the health of the environment and its ecology.

Water is abstracted to meet a wide range of uses throughout England and Wales. The effect abstraction has on the natural flow regime and the environment is influenced by the amount and timing of the abstraction, the volume that may be returned and where the water is returned after use. Many abstractions are sustainable, but this is not always the case.



**An example of unsustainable abstraction. In a damaged chalk stream in Southern England the river is almost dry in the middle and lower catchment due to groundwater abstraction. This has caused significant loss of habitats and species.**

## What is unsustainable abstraction? (cont:)

Unsustainable abstraction from rivers and groundwater can change the natural flow regime. This will result in lower flows and reduced water levels, which, in turn may, limit ecological health. Changes and reductions of river flows and groundwater levels can have the following effects:

- Reduced flows can exaggerate the impacts of barriers such as weirs, which can hinder the passage of migratory fish.
- Changes to flow dynamics can increase sedimentation rates, affecting species sensitive to sediment loadings, such as fish, and affecting spawning success.
- Reduced flows can lead to loss of habitats and changes to erosion and deposition patterns which in turn may lead to loss of in-channel geo-morphological diversity and flushing of sediment
- Channel narrowing can occur when flows are reduced
- Induce poorer quality groundwater to move - for example inducing saline intrusion from deep groundwater or from the sea.
- Allow invasive plant species to colonise exposed river sediments, such as gravel bars, temporary islands;
- Where there are increased concentrations of nutrients together with low flows algal blooms may occur
- Change the natural variability of flow. These variations are important to trigger the migration of fish

## Hydroecology

Hydroecology is an integral part of water resources management, it is;

- the scientific overlap between the fields of hydrology and ecology
- the impact of hydrology on ecosystems, or vice versa.

Understanding the relationships between hydrology and ecology helps us to protect the long-term future of the water environment and maintain a balance between the water needs of society and the environment.

Hydroecology can be impacted by:

- Abstractions
- Barriers to the movement of organisms
- Flow regulation
- Morphological alterations (e.g. navigation, flood defence)
- Drought; naturally and through interactions with human activities

Hydroecological data are used to understand what is happening in the environment. This includes detecting where and what damage is being done now and predicting future changes.

By monitoring the water environment hydroecological data is gathered that helps detect the changes to the natural flow regime and understand how this impacts on the health of ecology. Hydroecology is used to understand where abstraction and flow regulation affects the environment now and how new abstraction might affect the environment in the future.

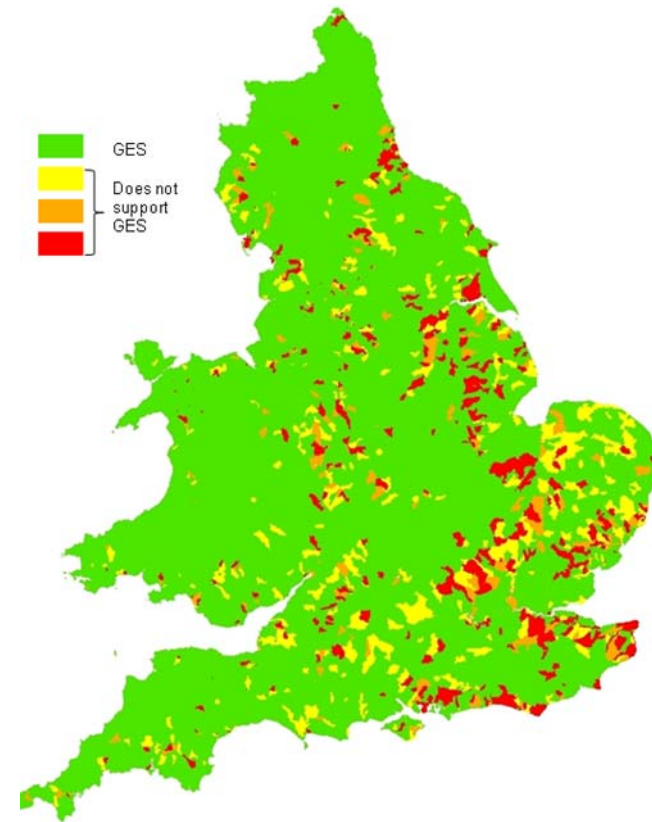
# Protecting the environment

The Environment Agency and Natural Resources Wales work with stakeholders, operators and other regulators to protect and improve the environment.

European Directives, national targets and statutory environmental obligations direct how they manage the water environment in England and Wales. These are built into the way that Environment Agency and Natural Resources Wales manage water resources. Through these drivers regulators, abstractors and stakeholders are able to ensure that abstraction and regulated flows do not compromise the ecological health of the aquatic environment. A number of these are explained in more detail below.

The Water Framework Directive (WFD) puts ecology at the centre of how they manage and protect the water environment (quality, resources and physical characteristics). The WFD works through a series of 6-year cycles of River Basin Management Planning. The first cycle will end in 2015 when, following further planning and consultation, River Basin Management Plans published in 2009 will be updated and reissued. The WFD focuses on the ecological health of the aquatic environment. The primary objectives are to prevent deterioration and, where necessary, restore good ecological status (GES) or good ecological potential (GEP) for surface water or good status for groundwater.

To understand where unsustainable abstraction stops us from meeting these objectives they have looked at abstraction in each water body. Resolving the abstraction and flow issues in England and Wales will be a key part of achieving our commitments to the environment. At the same time, water still needs to be available for people, agriculture and industry now and for future expected increases in population and climate change.



**The map shows abstraction pressure in rivers.** Red indicates water bodies that have severe levels of abstraction pressure, based on current abstraction, where the Environment Agency and Natural Resources Wales have a high level of confidence that this will be causing ecological issues and potentially a failure of GES. There is less certainty with lower levels of abstraction pressure. In yellow and orange water bodies abstraction could be causing or contributing to a failure of GES.



## Protecting the environment (cont:)

**The Habitats and Birds Directives:** aim to protect wild plants, animals, birds and habitats. It provides a high level of protection to the network of nationally and internationally important protected areas around the European Union. These European sites form a network known as Natura 2000. The Environment Agency and Natural Resources Wales have a legal duty to ensure that no authorised activity or permission results, directly or indirectly, in an adverse effect on the integrity of a Natura 2000 site, unless there are reasons of overriding public interest.

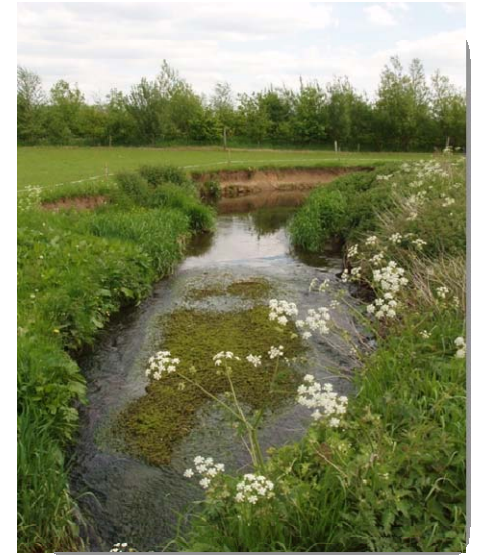
Statutory powers enable and in some cases, such as the Habitats Regulations, require the Environment Agency and Natural Resources Wales to act where abstractions are having, or potentially could have, a detrimental impact on the environment. The Environment Agency and Natural Resources Wales check if existing abstractions and licence applications risk damaging these sites and take actions to remove the risk.

**Biodiversity 2020 outcomes;** The England Biodiversity Strategy - Biodiversity 2020 - provides a commitment to return 50% of Sites of Special Scientific Interest (SSSIs) to favourable condition and to maintain 95% at recovering condition, or better. It also aims to have no net loss in priority habitats and for 90% of these habitats to be in favourable or recovering condition. All new abstraction licences are assessed for impacts to the SSSI features and priority habitats and changes to existing licences are made if needed to meet this commitment.

**An example of one of our protected areas: The River Mease is designated as a Special Area of Conservation (SAC) and SSSI and**

**comes within the protection of the Habitats Directive.**

Nationally important populations of spined loach and bullhead are found here along with white-clawed crayfish, otters and floating vegetation such as water-crowfoot. Several of the designated species in the SAC are sensitive to changes in flow. If abstraction is having a significant impact on flows in the river then the protected features could be adversely affected. Maintaining flows in the river will protect the protected features.



More information on the Habitats and Birds Directives can be found here <http://jncc.defra.gov.uk/default.aspx?page=5281> or <http://wales.gov.uk/topics/environmentcountryside/consmanagement/marinefisheries/directives/birdshabitats/?lang=en>  
More information on the Biodiversity 2020 can be found here <https://www.gov.uk/government/publications/biodiversity-2020-simple-guide-and-progress-update-july-2013>

More information on the WFD can be found here. <http://www.environment-agency.gov.uk/research/planning/33106.aspx>  
<http://naturalresourceswales.gov.uk/our-work/policy-advice-guidance/water-policy/water-framework-directive/?lang=en>

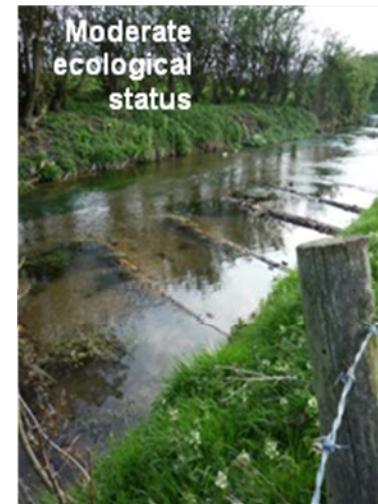
# Understanding the problem

There are a range of ways to determine if abstraction (and in some cases flow regulation) are unsustainable and impact on the environment. The Environment Agency and Natural Resources Wales look at hydroecological, biological and other data to determine what a healthy environment is for each water body. They then assess if current conditions are different to this. Where there are differences they work out what might be causing this and what solutions are needed to put it right. This includes assessing, where and by how much abstraction or flow regulation contributes to unhealthy ecology. The flow regime (hydrology) is one of the hydromorphological quality elements that affect the ecological status of a water body. There are five status classifications: High, Good, Moderate, Poor or Bad.

For a water body to be at High Ecological Status (HES) it must have virtually natural conditions. For hydrology this means that the quantity and dynamics of flow and the connection to groundwater must be very close to natural.

GES is the default objective set in RBMPs for the surface water environment and represents a good healthy ecology. For a water body to achieve GES the biology must be of a certain quality. Changes to the flow regime can compromise this. By identifying where this happens they know where to target actions to improve flows to achieve GES.

More information on classification can be found here  
<http://www.environment-agency.gov.uk/research/planning/33260.aspx>





## Flow standards

In England and Wales they identify the “hydrological status” of rivers and lakes by calculating the difference between the natural flow regime and the recent measured flow regime. Natural flow is the flow that would occur if all artificial influences (abstractions, discharges, flow regulation) were not taking place.

If the difference is greater than defined limits the flow regime may have been altered to the extent that the water body is not at high or good ecological status. If a river has less than 5% difference from natural flow for either abstraction or discharge, it can meet the standard for HES under low flow conditions. Any more difference and it will not be high status.

The standards reflect the different sensitivity to changes in flow regime in different types of rivers. In more sensitive rivers it would take less change in flow regime to impact on ecology. Each river is assigned a type which reflects that sensitivity.

To meet GES the amount of difference to natural flow depends on the time of year, the type of catchment and the flow. For example in a clay catchment at low flows natural flow can be reduced by up to 15% (April – March) whereas in salmonid spawning and nursery areas this is only 10%.

This approach was developed by UKTAG as a consistent method to be used across the UK. The standards have been set to ensure that we comply with the WFD across the UK. In England and Wales the standards for easier use in water resources management. For lakes a similar approach has been taken that considers the change in the natural water level range and the percent changes to the natural net inflow.



The UK Technical Advisory Group on the Water Framework Directive ("UKTAG") makes technical recommendations to the UK government administrations on implementing the Water Framework Directive. UKTAG is a working group of experts drawn from the UK environment agencies and conservation agencies. It also includes representatives from the Republic of Ireland.

More information on UKTAG and flow standards can be found [here](http://www.wfduk.org).  
[www.wfduk.org](http://www.wfduk.org)

# The Environmental Flow Indicator

The Environment Agency and Natural Resources Wales have adapted the flow standards and developed the “Environmental Flow Indicator” (EFI).

The EFI is calculated as a percentage deviation from the natural river flow. If a river flow is lower than the EFI it can be used to show

- where changes to the flow regime may be causing impacts to river ecology
- where the flow regime supports GES
- where water may not be available for further abstraction without risking impacts to the environment
- where there is a risk that future increased demand for water may cause deterioration

The EFI is not a target or objective, but indicates where abstraction might be unsustainable. It is used to identify water bodies where changes to the flow regime may be causing or contributing to a failure of GES - this is the “flow compliance assessment”.

If the flow is higher than the EFI at low flows, it should support GES and is classed as compliant. If the flow falls below the EFI it may not support GES and the water body is assessed as non-compliant. This is used to target further investigation of what measures are needed to achieve GES, including sustainable abstraction.

The degree of non-compliance has been split into three compliance bands.

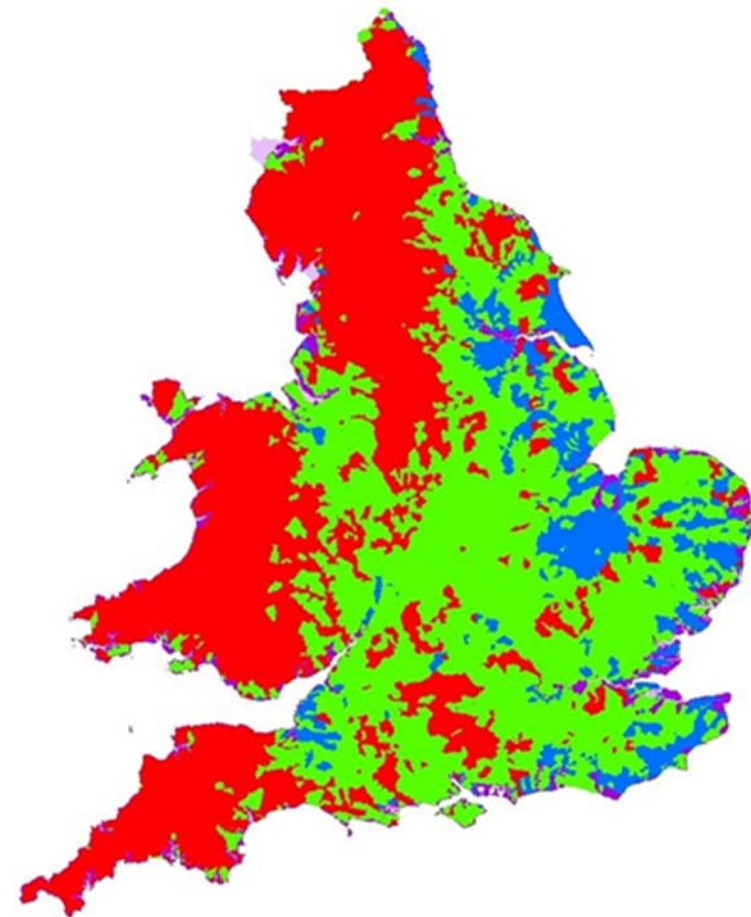
Flow adequate to support GES	Flow not adequate to support GES		
Compliant with EFI		Non-compliant	
	Band 1	Band 2	Band 3
	CONFIDENCE IN NOT SUPPORTING GES		
	Low	medium	high
	DIFFERENCE IN FLOW TO THE EFI		
	less than 25%	between 25% and 50%	greater than 50%
	INCREASED PRIORITY FOR ACTION		

## Using the Environmental Flow Indicator

Screening of all river water bodies the Environment Agency and Natural Resources Wales have identified where abstraction may be causing flows to fall below EFIs. For some rivers they used data from gauging stations which have been monitoring and recording flow for many years. For other rivers, they have predicted and modelled flows based on data from similar catchments. They will continue to improve the monitoring and data on which they make these assessments and will continually review and update compliance results.

The Environment Agency's and Natural Resources Wales' Catchment Abstraction Management Strategies (CAMS) use the EFI to indicate where and how much water is available for future abstraction.

Based on the UKTAG flow standards the EFI approach uses an overall abstraction sensitivity for each water body. Where there is a low sensitivity to abstraction it is possible to abstract more water before there is an impact on ecology than where there is high sensitivity. Similarly where there is high sensitivity smaller changes to the flow regime may result in impacts to ecology compared to low sensitivity.



**River sensitivity to abstraction; red high, green medium and blue low sensitivity**

More information on the EFI can be found here

<https://brand.environment-agency.gov.uk/mb/BMeWdb>

More information on Catchment Abstraction Management Strategies can be found here

<http://www.environment-agency.gov.uk/business/topics/water/119927.aspx>

## Different types of water bodies are assessed in different ways

### Reservoirs and regulated rivers

Surface waters where the flow or physical condition is substantially modified for a particular use (such as water supply or power generation) are designated as Heavily Modified Water Bodies (HMWB). Because of the modifications these water bodies cannot be restored to GES without compromising the specified use. In these cases rather than aiming for GES we aim to reach good ecological potential (GEP). HMWB for water resources purposes include most reservoirs and river reaches where flows are substantially managed.

Ecological potential is a balance between the use of the water body and achieving sustainable healthy ecology. To do this all the measures to mitigate against the impacts of the modifications are identified, except those that would affect the use. By putting in place these mitigation measures the water body can reach the best potential ecology – hence GEP.

### SSSI and Natura 2000 flow standards

In some circumstances evidence may show that the EFI does not provide the right level of environmental protection. In Natura 2000 sites, SSSIs and priority habitats more specific or protective flow requirements may be needed to protect the important species and habitats.

The Joint Nature Conservation Committee has recently agreed updated Common Standards for Monitoring guidelines (CSM) for flow. These form the basis of Natural England and Natural Resources Wales' advice on the flow required to protect the features of SSSI and SACs (designated under the Habitats Directive).



**Garreg-ddu and Caban-coch reservoirs, heavily modified water bodies**

More information on the designation of HMWBs and the assessment of ecological potential can be found here  
<http://www.environment-agency.gov.uk/research/planning/127810.aspx>  
<http://www.wfduk.org/resources%20guidance-defining-good-ecological-potential>



## Improving our understanding

The Environment Agency and Natural Resources Wales are committed to collecting evidence to improve our understanding of how abstraction impacts on ecology. They will use this knowledge in water resources management.

The Environment Agency, Natural Resources Wales and their partners and customers continuously look for ways to improve how they manage the environment.

The tools and standards they use in water resources management will be improved as they gather hydroecological evidence and gain more knowledge and understanding.

UKTAG facilitate the development of approaches for WFD. They have a programme of review and revision through which improvements are made. The Environment Agency and Natural Resources Wales ensure these improvements are built into operational water resources management. This, in turn, ensures that decisions are compliant with the requirements of WFD.

As part of the ongoing improvement in 2012/13 UKTAG reviewed and consulted on the evidence for the environmental flow standards. This concluded that the river flow standards for medium and high flows needed to be revised but no changes were proposed to the low flow standards or those to support GES. So following this review the EFI will continue to be used.

The EU has recognised the importance in improving the methods to determine the flows required to support a healthy ecology (“e-flows”). Guidance on e-flows will be developed in 2014. The Environment Agency and Natural Resources Wales are inputting and learning from experiences across Europe.

They are improving their understanding of hydroecology by looking at trends, responses and relationships between ecology and hydrology. Some of the work areas are:

- Using historical hydroecological data to test how the environment has responded to past changes they have made to the flow regime
- Improving the methods used to assess biological quality to make sure that they reflect how biology responds to changes in the flow regime.
- Understanding how the flow regime will change with changing environment and climate.
- Looking at how to implement the reformed abstraction management system, such as understanding the response of ecology to increased abstraction at high flows and defining ecological triggers to review abstraction.

More information on the reviewing standards can be found here.

<http://www.wfduk.org/stakeholders/stakeholder-review>

More information on the EU blueprint for water can be found here

<http://ec.europa.eu/environment/water/blueprint/>

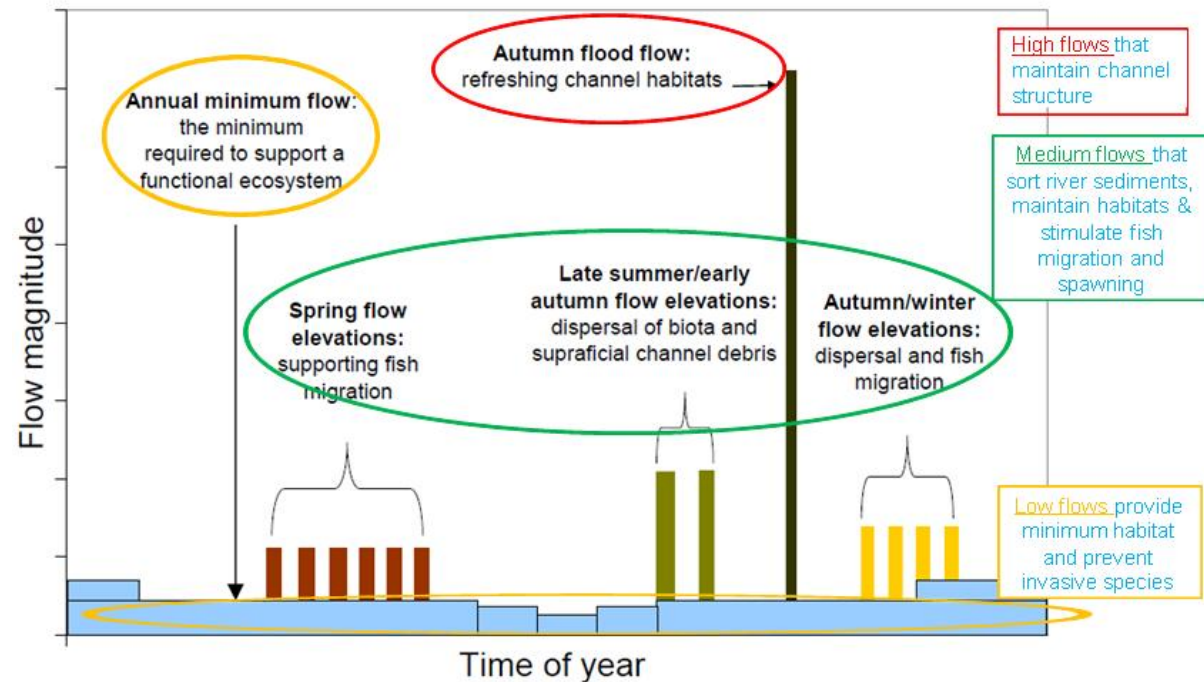
# Improving Assessment Methods: Ecological Potential

The Environment Agency and Natural Resources Wales have improved the method they use to assess if rivers downstream of impoundments are managed in the best way to support a healthy ecology.

An example of how they continuously improve their assessment approaches can be seen in the recent proposals made by UKTAG.

UKTAG first published guidance on the classification of ecological potential in 2008. A review of this guidance and other hydroecological evidence has shown that it is possible to define what a river downstream of an impoundment should be like to achieve the objective of good ecological potential.

There are times when different flows are important for ecology, such as spring flow to support fish migration. By making sure these flows happen through managing the water released from reservoirs or other impoundments we can improve and protect ecology.



**Flows at different times of the year that support a healthy ecology**

More information on the assessment of ecological potential can be found here  
<http://www.wfduk.org/stakeholders/uktag-manchester-gep-workshop-16th-july-2013-presentations>  
<http://www.wfduk.org/resources/river-flow-good-ecological-potential>

## Managing Unsustainable Abstraction

The Environment Agency and Natural Resources Wales assess abstraction licences against the level of impact they are causing, or could cause. Following this, changes may have to be made to ensure that abstraction licensing continues to balance the needs of a changing environment with those of people, business and industry.

Following publication of the 2009 RBMPs, a major programme of investigations at thousands of sites across England and Wales has given a good understanding of why waters fail to achieve healthy ecology. This evidence is being used to target action and investment to protect and improve waters, including actions to deal with unsustainable abstraction. The outcomes of the investigations will be published in the RBMPs

### **Fowlmere Watercress beds:**

With the help and support of Cambridge Water Company and the RSPB it is possible to balance the needs of the environment with the need for water for people. Following detailed investigation the Environment Agency has agreed with Cambridge Water Company that abstraction will be reduced from boreholes near the Fowlmere site. As a result this site, one of a few relic fen habitats left in an otherwise intensively farmed region of Cambridgeshire, will remain a refuge for wildlife particular to the area.





the construction of a new abstraction plant. Under a new agreement with the Environment Agency, United Utilities will ensure that water is only taken from the rivers when it is plentiful.

The scheme will also see United Utilities decommission a number of water intakes along the two rivers and refurbish those that remain. These changes will help to balance environmental benefits and public water supply by increasing the flow of water in the Ribble Valley without reducing the supply to nearby towns. The restoration of a more natural flow to these two rivers will also ensure that there is always enough water for juvenile fish and will help to protect salmon migration up the river system.

### **Brennand and Whitendale; dealing with unsustainable abstraction**

Water will be taken more sustainably from the Rivers Ribble and Brennand in the future, following changes to an abstraction licence and

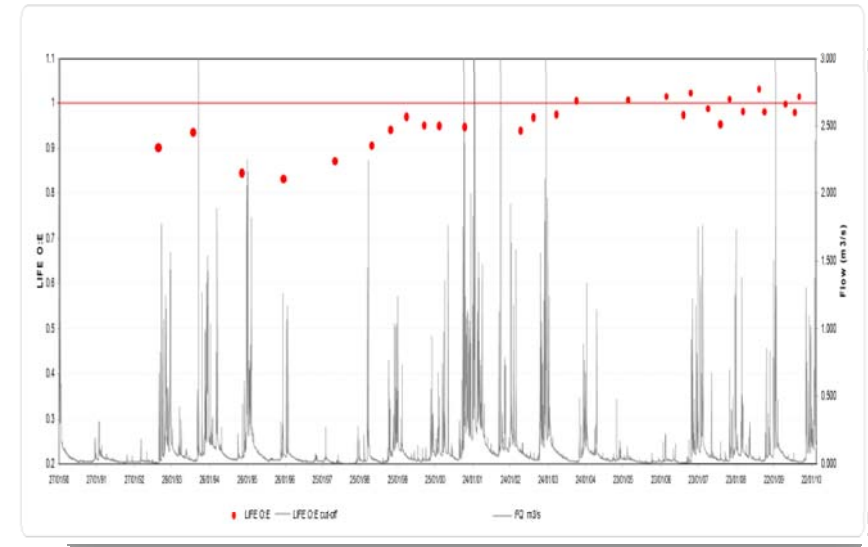


# Investigating Unsustainable Abstraction

Where the Environmental Flow Indicator is not being achieved more detailed evaluation is needed to understand why. These investigations can include the collection of ecological monitoring data, modelling responses of ecology to historical flow and other pressures, and hydraulic-habitat based approaches.

In water bodies which are not compliant with the EFI Hydroecological Validation (HEV) are used to understand in more detail how ecology responds to changes in flow. Time series of flows and macro invertebrate *Lotic Invertebrate Flow Index (LIFE)* scores are used as evidence for ecological impact due to reduced river flows. LIFE scores are used to indicate if the population of macro invertebrates is as expected for the particular river being investigated. If it is not as expected this means reduced flows may be impacting on ecology. Other macro invertebrate data is considered alongside this to provide information on whether reduced LIFE scores may be due to other pressures such as poor water quality, excess fine sediment and modifications to river morphology.

More information on *Lotic Invertebrate Flow Index (LIFE)* see Extence *et al* (1999), River flow indexing using British benthic macroinvertebrates: a framework for setting hydroecological objectives. Regul. Rivers: Res. Mgmt., 15: 545–574.



**Hydroecological Validation plot** shows the relationship between ecology and flow. The results provide evidence of where water resources activities, such as abstraction might be contributing to an ecological problem.

In the example shown above biology fails to reach the required quality for GES and the flow is non-compliant with the EFI. The LIFE scores are low in most sampling years which confirms that flow sensitive ecology is being impacted. Unsustainable abstraction may be causing this impact and further investigation to confirm this is needed.

## Achieving sustainable abstraction

The Environment Agency and Natural Resources Wales have worked with abstractors and other stakeholders to put measures in place to help get on the pathway to healthy ecology and deal with unsustainable abstraction.

Through the river basin management planning process they will identify unsustainable abstraction, set objectives and agree the cost effective measures to deal with it. The river basin management plans will be open to consultation in summer 2014 and published in final form by December 2015. The RBMPs will set out what is needed to achieve sustainable abstraction up to 2021 and if further action is required up to 2027.

Water body objectives describe the long term vision for specific parts of the water environment. To meet these objectives, in some water bodies, they will need to change and improve the flow regime. This will include dealing with unsustainable abstraction. This process will take into account the costs and benefits of taking such actions. The benefits of dealing with unsustainable abstraction on the catchment scale may take time to realise but, if effective combinations of measures can be introduced, then the number of water bodies supporting a healthy ecology by 2021 can be expected to increase.

Work to investigate and solve problems caused by unsustainable abstraction is managed through a process called **Restoring Sustainable Abstraction (RSA)**.

The RSA programme was set up in around 1999 to address sites having possible abstraction issues that were identified from a number of sources. The Environment Agency and Natural Resources Wales have enabled voluntary abstraction licence changes and made compulsory changes.

RSA is one of the routes to help deliver River Basin Management Plan objectives for sites already identified through RSA but will not deal with additional impacts raised by our investigations for the Water Framework Directive or the larger scale impacts and risks to whole water bodies. These risks will be dealt with alongside existing RSA work.

## Sustainable abstraction licensing

When granting new licences to abstract water, the Environment Agency and Natural Resources Wales reserve some water to meet the needs of the environment and protect the rights of existing abstractors. As a result, water availability depends on how much water can be safely licensed without harming the environment and without affecting water availability for existing licensed abstractions downstream. The need to safeguard the lower reaches of river catchments with abstraction or flow problems means that water is often not available in upstream areas even though there are no problems locally.

They monitor the environment and existing abstraction to understand the water balance of our catchments and what water may be available for future use through Catchment Abstraction Management Strategies (CAMS). They publish the results in our Abstraction Licensing Strategies.

The Environment Agency and Natural Resources Wales determine catchment water availability status in a consistent and objective manner. The natural flow regime and the compliance with EFI is calculated for each water body. Water availability is calculated by comparing the EFI to the recent flow conditions. If flow is below the EFI there may not be more water available to abstract.

The EFI and other hydroecological data are used to ensure new abstraction licences are sustainable and help to prevent deterioration. Ensuring sustainable abstraction may involve setting hands-off flows (flow levels at which abstraction should be reduced or stopped) and volumes for abstraction licences.

More information on RSA can be found here

<http://www.environment-agency.gov.uk/business/topics/water/32026.aspx>

<http://naturalresourceswales.gov.uk/apply-buy-report/apply-buy-grid/water/abstractions-impoundment/?lang=en>

More information on River basin planning can be found here

<http://www.environment-agency.gov.uk/research/planning/147344.aspx> or

<http://naturalresourceswales.gov.uk/our-work/policy-advice-guidance/water-policy/water-framework-directive/?lang=en>

More information on abstraction licensing can be found here

<http://www.environment-agency.gov.uk/business/topics/water/32020.aspx>

or <http://naturalresourceswales.gov.uk/apply-buy-report/apply-buy-grid/water/abstractions-impoundment/?lang=en>