

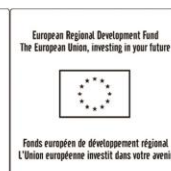


Working to develop **sustainable wetland management**

Value of **Working Wetlands**



Wetland Monitoring Framework and Manual



Contents

Introduction	1
Monitoring Themes.....	2
Biodiversity	2
Physical Processes.....	2
Land Management.....	2
Landscape Connectivity	2
Ecosystem Services	2
Economic and Social Benefits	3
Partnership Working.....	3
Table of Indicators	4
Wetland Monitoring Manual	7
Biodiversity	7
Physical Processes.....	11
Land Management.....	14
Landscape Connectivity	15
Ecosystem Services	17
Economic and Social Benefits	19
Useful References and Further Reading	23

Introduction

The partners of the Value of Working Wetlands (WOW) Project have carried out monitoring of changes in land-use, biodiversity and landscape connectivity that will allow the effect of the project to be assessed. The monitoring that the partners have implemented through the course of the project is detailed in the report which accompanies work package 3.2. *Cross Border Assessment of Current Conditions*. This document accompanies work package 3.3 *Evaluating Land Management for Biodiversity*.

This monitoring manual and framework have been produced to enable others working in wetlands elsewhere in Europe to follow the methods used by the WOW partners and set up effective monitoring of wetland health at a landscape-scale in their own project area. Additional measures to those used by the WOW partners have also been suggested, drawn from other examples of best practice for monitoring at the landscape scale which are referenced in the final section of this document.

The monitoring manual and monitoring framework sit together as one document with the manual containing all supporting information for the monitoring framework. The monitoring framework is a flexible document which allows adaptation to reflect local priorities. Through the work of the WOW project, the partners have developed an understanding of the common features of wetlands but the partners also want to recognise in this document the differences in species, habitats and land use challenges of wetlands in different regions.

Monitoring Themes

This monitoring framework has been divided into themes which will best describe the health of a wetland ecosystem. Indicators have been suggested under each theme and land managers using the framework are free to choose which of the indicators can best represent the state of the wetland they would like to monitor. With careful pairing of indicators their influence on one another can be inferred. When devising landscape-scale monitoring, it is important that biotic, abiotic and human factors are all considered. Therefore, although it is not necessary to gather data on each of the indicators included in the framework, it is recommended that at least one indicator from each theme is chosen.

Biodiversity

Biodiversity is included as an indicator of wetland health and ecosystem function. If the resources are available, both species and habitats should be monitored to give a full representation of the state of the wetland. Wetlands hold assemblages of iconic species and habitats and each wetland will have species that are considered to be locally important which should be surveyed regularly. Wetlands can be particularly susceptible to invasive non-native species which can have a damaging effect on wetland ecology and so it has been recommended that these are also monitored.

Physical Processes

Soil and hydrological conditions in a wetland shape the habitats found there and can fluctuate more than in most other habitats. They simultaneously influence and are influenced by land use and so a detailed knowledge of physical aspects such as soil type and water levels are needed to direct management. Flooding and drought will both be common features of future climates and their influence on a wetland must be monitored to determine and evaluate land management which will need to adapt in the future.

Land Management

Recording the land management that is taking place across the wetland will allow work to be coordinated and understood at a landscape scale. The data collected under this theme can be compared with that collected under other themes to reveal correlations between work carried out and the condition of the wetland ecosystem.

Landscape Connectivity

Species and habitats cannot persist in isolation and therefore the health of the wetland ecosystem depends on the degree of connectivity between habitat patches in the landscape, referred to as “Home habitat”. Indicators of structural connectivity measure physical connections between habitats which act as corridors such as ditches or hedgerows. Indicators of functional connectivity represent how easily species can move through the landscape outside of their ideal habitat.

Ecosystem Services

Wetlands have significant contributions to make to Regulating, Supporting, Provisioning and Cultural ecosystem services. The benefits of these ecosystem services can be felt at different scales, for

example wetlands have the potential to provide ecosystem services locally by contributing to flood alleviation as well as globally through carbon storage. This framework provides the means to combine data on these services to provide an evidence base for the appropriate management of wetlands which will achieve a range of additional benefits. Supporting ecosystem services which include soil formation, nutrient cycling and primary production are not explicitly included in this framework as they are difficult to measure directly but can be inferred from other indicators.

Economic and Social Benefits

Wetlands are more than important places for wildlife; they are important places for people too. Wetlands offer opportunities for business, education and leisure activities and these should be part of a suite of indicators which demonstrate the true value of a wetland. If land managers are considering applying for external funding to manage the wetland it is extremely beneficial to have this information to include in the application and then to demonstrate the impact of the work once it has begun.

Partnership Working

Wetlands often have a number of stakeholders that need to work together to ensure the management objectives of the area are met. Monitoring the success of partnership working will encourage effective collaboration and help to identify opportunities to resolve conflict.

Table of Indicators

Theme	Sub-theme	Indicator
Biodiversity		
	Species	Number of pairs of breeding waders
		Wintering bird assemblage
		Survey of locally important bird species
		Survey of locally important (aquatic) invertebrate species
		Survey of locally important plant species
	Habitat	Area of wetland habitat in favourable condition across the landscape including designated and non-designated sites
		Area of wetland habitat managed to maintain/improve its condition
		Area of wetland habitat in the process of being restored or created
		Ditch habitat quality assessment including <ul style="list-style-type: none"> a) Channel form b) Extent/composition of in-channel vegetation c) Extent/composition of bankside vegetation
	Invasive (Non-native) species	Size and extent of American mink (or other invasive mammal e.g. Muskrat <i>Ondatra zibethicus</i>) population
		Extent of issues with invasive plant species and weeds, including native and non-native species
		Extent of invasive aquatic plants e.g. <i>Crassula helmsii</i>
	Physical Processes	
	Soil	Soil structure
		Abundance of soil invertebrates
		Chemical composition of soil
	Hydrology	Water quality assessed by <ul style="list-style-type: none"> a) Water clarity b) Extent of algal dominance c) Water chemistry

Theme	Sub-theme	Indicator
Physical Processes		
	Hydrology	Measurements of hydrological inputs and outputs
		Soil water table
		Characteristics of annual flood events including <ul style="list-style-type: none"> a) Areas flooded b) Max water height c) Period and duration of immersion
	Vegetation	Terrestrial/aquatic plant communities
Land Management		
	General Management	Land use and management operations
	Water Management	Water management assessed according to <ul style="list-style-type: none"> a) Water levels in ditches b) Water table depth c) Surface water presence/depth
	Landowner Advice	Proportion of landowners advised who followed advice
Landscape Connectivity		
	Home Habitat	Area of (species-rich) home habitat
		Area of wetland habitat created to enhance landscape connectivity
	Landscape Permeability	Area of sustainable land use that is beneficial to wetland species
		Area of Farmland under environmental stewardship options
		Amphibian populations
	Structural Connectivity	Ditch invertebrate populations
Ecosystem services		
	Regulating	Carbon storage
		Water quality regulation
	Provisioning	Proportion of farmland in sustainable agricultural production

Theme	Sub-theme	Indicator	
Ecosystem Services			
	Provisioning	Forage quality and productivity	
		Non-peat fuel production	
		Amount of natural materials (reeds for thatch, osier for basket weaving etc.) used in traditional crafts	
	Cultural	Length of Public Rights of Way and Permissive Paths	
		Number of fishing/hunting permits issued	
		Number of people engaging in locally important cultural activity e.g. boating or cycling	
Economic and Social Benefits			
	Social Benefits	Number of educational visits.	
		Visitor numbers on core sites in the wetland.	
		Number of volunteer hours on wetland management activities	
	Local Attitudes	Membership of local organisations linked to the management of the wetland	
		Attendance of public events	
	Economic Value	Estimated economic value of Ecosystem services	
		Money brought into the area through agri-environment schemes	
	Partnership Working		
		Mobilisation of Resources	Project income
Number of multi-agency projects.			
Financial value of help in kind			
Efficient and Effective Delivery		Fulfilment of identified partnership goals	
Leadership and Influence		Number of publications/articles	

Wetland Monitoring Manual

Biodiversity

Indicator	Number of pairs of breeding waders		
Theme	Biodiversity	Sub-theme(s)	Species
Rationale	Special Management is undertaken on the Somerset Levels and other European wetlands to encourage populations of breeding waders. Population trends of breeding waders should be monitored to assist with the evaluation of the efficacy of this management.		
Method	<p>The RSPB have devised a method of monitoring displaying breeding wading birds. This method is outlined in The Wet Grassland Guide.</p> <p>A transect should be walked three times during the breeding season in good weather conditions within 3 hours of dawn or dusk. The species, number, behaviour and position of displaying waders should be mapped as well as the extent of any wet features and grazing animals.</p>		
Measure of Success	Repeated annual monitoring should show an increasing population trend.		

Indicator	Wintering bird assemblage		
Theme	Biodiversity	Sub-theme(s)	Species
Rationale	During the winter wetlands in the channel region host internationally important populations of migratory bird species for which they can often hold special designations.		
Method	<p>The British Trust for Ornithology (BTO) Wetland Bird Survey (WeBS) is an established method used in the UK for counting population sizes of wetland species using water bodies in the winter.</p> <p>Individual water bodies in the wetland should be visited monthly during the winter and the species and number of individuals of each species should be recorded.</p>		
Measure of Success	Repeated annual monitoring should show an increasing population trend.		

Indicator	Survey of locally important bird species		
Theme	Biodiversity	Sub-theme(s)	Species, Habitat
Rationale	<p>Each wetland will have locally important species that have specialist habitat requirements. For example, bitterns in the UK. If management is taking place to benefit these species, monitoring of their population should be established.</p> <p>Birds are very mobile species and their distribution is often determined by habitat quality. The population size and distribution of these species can be used as a proxy for habitat quality.</p>		
Method	This will depend on the species being monitored.		
Measure of Success	Repeated annual monitoring should show an increasing population trend.		

Indicator	Survey of locally important (aquatic) invertebrate species		
Theme	Biodiversity	Sub-theme(s)	Species, Habitat
Rationale	Aquatic invertebrates can be very sensitive to water quality. The population size and distribution of these species can be used as a proxy for water quality.		
Method	This will depend on the species being monitored. Methods are suggested for some species in the RSPB <i>Wet Grassland guide</i> and		
Measure of Success	Repeated annual monitoring should show an increasing population trend.		

Indicator	Survey of locally important plant species		
Theme	Biodiversity	Sub-theme(s)	Species, Habitat
Rationale	<p>Each wetland will have locally important species that have specialist habitat requirements. If management is taking place to benefit these species, monitoring of their population should be established.</p> <p>The distribution of plant species can be used as an indicator of soil conditions and hydrology. The establishment of local indicators can be used to evaluate or trigger management.</p>		
Method	This will depend on the species being monitored. It is good practice to survey sites that are a focus of management effort annually to track progress and alter management accordingly.		
Measure of Success	Repeated annual monitoring should show an increasing distribution.		

Indicator	Area of wetland habitat in favourable condition across the landscape, including designated and non-designated sites		
Theme	Biodiversity	Sub-theme(s)	Habitat
Rationale	This measure will highlight areas of poor habitat quality where work such as landowner liaison should take place or opportunities to take management control of land should be identified.		
Method	<p>Data will need to be collated from the following sources (if locally available)</p> <ul style="list-style-type: none"> • Natural England SSSI condition surveys • Agri-environment scheme surveys • Agri-environment scheme options • Local Wildlife Site surveys • Partner organisations • Specially commissioned habitat surveys <p>“Favourable condition” will need to be defined based on the measures available. It will not be possible to repeat data collection in full annually and so a reporting and analysis interval should be set based on locally available data and possible survey effort.</p>		
Measure of Success	Trend shows a greater area of habitat attaining favourable condition.		

Indicator	Area of wetland habitat managed to maintain/improve its condition		
Theme	Biodiversity	Sub-theme(s)	Habitat
Rationale	It can take many years to restore a habitat to favourable condition and so the effort that is being put into habitat management should be monitored rather than the amount of habitat that has been restored.		
Method	<p>Data will need to be collated from the following sources (if locally available)</p> <ul style="list-style-type: none"> • Natural England SSSI condition surveys • Agri-environment scheme surveys • Agri-environment scheme options • Local Wildlife Site surveys • Partner organisations • Local landowners • Specially commissioned habitat surveys <p>This information can be gathered in conjunction with information to show the condition of habitats in the project area. A proportion of land under positive management can be calculated using this data.</p>		
Measure of Success	Trend shows a greater proportion of land being managed to maintain/improve its condition.		

Indicator	Ditch habitat quality assessment including <ul style="list-style-type: none"> a) Channel form b) Extent/composition of in-channel vegetation c) Extent/composition of bankside vegetation 		
Theme	Biodiversity	Sub-theme(s)	Habitat, General Management
Rationale	<p>Ditches and drainage channels are distinctive features of wetlands and a habitat that is relied up by many wetland specialist species.</p> <p>The collection of data under this indicator will allow the hydrosereal stages of ditches across the wetland to be monitored and management to be coordinated at a landscape scale to have the greatest benefit to ditch species.</p>		
Method	These surveys should be carried out annually and follow guidelines set out in <i>Common Standards Monitoring Guidance for Ditches</i> produced by JNCC.		
Measure of Success	See success measures laid out in <i>Common Standards Monitoring Guidance for Ditches</i> produced by JNCC.		

Indicator	Size and extent of American mink (or other invasive mammal e.g. Muskrat <i>Ondatra zibethicus</i>) population.		
Theme	Biodiversity	Sub-theme(s)	Invasive (Non-native) species
Rationale	Invasive non-native mammal species can, in large numbers, have a detrimental effect on populations of breeding waders and other important wetland species.		
Method	Annual mink raft surveys or alternative method for other species.		
Measure of Success	Trend shows a decreasing population.		

Indicator	Extent of issues with invasive plants and weeds, including native and non-native species.		
Theme	Biodiversity	Sub-theme(s)	Invasive (Non-native) species
Rationale	Native weed species and non-native invasive plant species can dominate an area and pose a threat to biodiversity; they can also present a risk to the health of livestock in some cases. Their extent should be monitored to enable effective coordinated control across the landscape.		
Method	Species to be monitored under this indicator could include rushes, ragwort, hemlock water dropwort, thistles etc. Extent of species can either be measured by a count of sites affected, number of plants or area depending on what is appropriate to the species and the data available. Information should be gathered through condition surveys and also information from local land owners and partner organisations.		
Measure of Success	Reduction in the extent of issues with invasive plants and weeds, including native and non-native species. Separate targets may be necessary depending on aggressiveness of the plant.		

Indicator	Extent of invasive aquatic plants e.g. <i>Crassula helmsii</i>		
Theme	Biodiversity	Sub-theme(s)	Invasive (Non-native) species
Rationale	Invasive aquatic plants can spread easily through a wetland and threaten biodiversity.		
Method	Extent of species can either be measure by a count of sites affected or area depending on what is appropriate to the species and the data available. Information should be gathered through condition surveys and also information from local land owners and partner organisations. It is advisable to set up a mechanism for reporting and managing these species if this is not already in place.		
Measure of Success	Reduction in extent of invasive aquatic plants. Separate targets may be necessary depending on aggressiveness of the plant.		

Physical Processes

Indicator	Soil structure		
Theme	Physical Processes	Sub-theme(s)	Soils
Rationale	Soil structure can indicate problems in past management and inform future management of the wetland.		
Method	<p>The structure of the upper soil horizons should be surveyed. There is no need for regular repetition of this unless management practices or environmental conditions are known to have changed.</p> <p>The desired soil condition will need to be defined for the site and specialist interpretation of soil structure is likely to be required. This is a long-term indicator as improvement in soil structure can be a slow process.</p>		
Measure of Success	An improvement in soil structure in response to management.		

Indicator	Abundance of soil invertebrates		
Theme	Physical Processes	Sub-theme(s)	Soils
Rationale	The number and species of soil invertebrates are related to conditions in the soil such as water levels and soil chemistry.		
Method	Annual survey of soil invertebrates including surveys of red and green worms on sites that are a focus of management. See Stork & Eggleton (1992) for an introduction to soil invertebrates as indicators.		
Measure of Success	An increase in soil invertebrate diversity. Particular increases should be seen in species which indicate the soil is moving towards the desired condition.		

Indicator	Chemical composition of soil		
Theme	Physical Processes	Sub-theme(s)	Soils
Rationale	Soil chemistry should direct habitat management and restoration decisions and will also indicate if management is having the desired effect.		
Method	<p>If it is not already available, a detailed soil map should be made of the wetland as this will give an indication of likely soil chemistry and nutrient loading.</p> <p>Focus on sites where soil chemistry is thought to be an issue or it is a particular aim of management to rectify some imbalance in the soil e.g. the reduction of nutrients when restoring land which previously was of agricultural use.</p> <p>Specialist advice should be sought on the type of analysis necessary.</p>		
Measure of Success	Sites tested should have target levels to be attained which are specific to those sites.		

Indicator	Water quality assessed by a) Water clarity b) Extent of algal dominance c) Water chemistry		
Theme	Physical Processes	Sub-theme(s)	Hydrology
Rationale	Water quality in a wetland is integral to the health of the wetland. It influences the biodiversity and ecosystem services the wetland is able to support. Regular monitoring of water quality can inform changes to management that need to take place.		
Method	The recommended method for this is covered in detail in “ <i>Common Standards Monitoring Guidance for Ditches</i> ” produced in 2005 by the Joint Nature Conservation Committee (UK). Water quality should be assessed monthly between mid-June and late August. The measure of success for water quality will depend on local conditions and so should be set in line with local objectives.		
Measure of Success	a) Water not unnaturally turbid in at least 90% of channel b) Mean cover of filamentous macro-algae not more than 10% (mid-June to end August) c) Water chemistry to satisfy locally set targets.		

Indicator	Measurement of hydrological inputs/outputs		
Theme	Physical Processes	Sub-theme(s)	Hydrology, Water Management
Rationale	A basic water budget should be constructed in order to direct and evaluate management of water levels in the wetland.		
Method	If possible rain gauges should be installed across the wetland. If this is not possible data can be obtained from local weather stations. The water levels in channels which bring water on to the wetland and also drain water from the wetland should be monitored. Again, if it is not possible to collect these measurements directly the data may be available from local government agencies. Further information on siting hydrological monitoring equipment can be found in section 4 of <i>Practical Approaches to Wetland Monitoring: Guidelines for Landscape-scale Long-term Projects</i> produced by Anglia Ruskin University.		
Measure of Success	Water budget devised and followed as part of a water level management plan.		

Indicator	Soil water table		
Theme	Physical Processes	Sub-theme(s)	Hydrology, Water Management
Rationale	Dipwells can be used to measure flooding or the height of the water table. Understanding the relationship between surface water, the water levels in ditches and the soil water table is essential when managing a wetland to create the desired habitat conditions.		
Method	Dipwells should be installed across hydrological gradients on the wetland. Further information on siting hydrological monitoring equipment can be found in section 4 of <i>Practical Approaches to Wetland Monitoring: Guidelines for Landscape-scale Long-term Projects</i> produced by Anglia Ruskin University.		
Measure of Success	A water level management plan for the wetland should be devised and the water table should follow this.		

Indicator	Characteristics of annual flood events including a) Areas flooded b) Max water height c) Period and duration of emersion		
Theme	Physical Processes	Sub-theme(s)	Hydrology, Water Management
Rationale	Although the amount of water held by a wetland can be controlled to a certain extent, this measure also serves to monitor changes in flood events over time and in particular the occurrence of extreme flood events. This information also relates to ecosystem service provision and can be used when calculating the flood water storage capacity of a wetland.		
Method	Data can be collected by either by directly surveying areas during flood events or gathering telemetry data and aerial photos from partner organisations.		
Measure of Success	Where possible flooding should fall within the aims laid out in a water level management plan however, due to extreme weather events the control of flooding may not be possible.		

Indicator	Terrestrial/aquatic plant communities		
Theme	Physical Processes	Sub-theme(s)	Vegetation
Rationale	Plant communities are indicative of the soil and hydrological condition of a wetland as well as water quality; when there are not the resources available to measure these factors directly vegetation survey can act as a cost effective proxy.		
Method	Data for this indicator can be collected as part of other habitat surveys. Plant communities will vary depending on the location of the wetland and so local indicators should be set.		
Measure of Success	Repeated surveys show the development of plant communities typical of local wetlands with good soil and hydrological conditions.		

Land Management

Indicator	Land use and management operations		
Theme	Land Management	Sub-theme(s)	General Management
Rationale	Management taking place across the whole wetland landscape can have a strong influence on wetland species. By monitoring this management it will be possible to deliver more targeted land management advice and also to stagger some types of management where possible.		
Method	Walk over surveys can be carried out throughout the year, with a greater frequency during the months where most management is likely to be taking place locally. The following points should be recorded <ul style="list-style-type: none"> • Land use/crop • Harvest date • Grazing date • Number of animals • Other management operations 		
Measure of Success	Land use that will contribute to the degradation of the wetland (e.g. peat extraction, crops which will contribute to sedimentation) should decrease.		

Indicator	Water levels in ditches		
Theme	Land Management	Sub-theme(s)	Water Management, Hydrology
Rationale	Ditch water levels are an important part of wetland management and need to be monitored to ensure that management is following an agreed plan.		
Method	It may be possible to set up monitoring of ditch levels independently if the resources are available. If not data on ditch levels will be available from government agencies or the local regulatory authority such as the Internal Drainage Board on the Somerset Levels.		
Measure of Success	Water levels following agreed management plan.		

Indicator	Proportion of landowners advised who follow advice		
Theme	Land Management	Sub-theme(s)	Landowner Advice
Rationale	A large amount of effort is put into delivering advice to landowners and so to ensure this advice is realistic and actually making a difference to the way in which the landscape is managed, the success of this advice should be monitored.		
Method	Information should be gathered from advisory bodies operating in the area and can be confirmed by walk over surveys of management taking place.		
Measure of Success	A baseline should be set in the first year and annual targets for improvement should be set according to this.		

Landscape Connectivity

Indicator	Area of (species-rich) home habitat		
Theme	Landscape Connectivity	Sub-theme(s)	Home Habitat
Rationale	The term home habitat refers to areas of good wetland habitat that wetland specialists would call home. Home habitats do not have to be designated, they simply have to be habitat types characteristic of wetlands.		
Method	<p>The first step in this process is to determine which habitats are locally characteristic of wetlands. Often these will be species-rich habitat types but they can also be less species-rich habitats which have an important function in the wetland landscape e.g. botanically poor wet grassland which is important breeding habitat for wading birds.</p> <p>Once home habitats have been identified data on their extent can either be collected directly or it can be gathered from other organisations and land managers operating in the area. Annual surveys should be carried out and vulnerable sites should be resurveyed regularly.</p>		
Measure of Success	Area of species-rich habitat to remain the same or increase.		

Indicator	Area of wetland habitat created to enhance landscape connectivity		
Theme	Landscape Connectivity	Sub-theme(s)	Home habitat
Rationale	Wetlands can present opportunities for habitat creation such as flood alleviation schemes or the restoration of old peat workings. For habitat creation to have the greatest positive impact on the wetland the position of the habitat in the ecological network should be considered.		
Method	<p>The first step in this process is to determine which habitats are locally important to wetland connectivity. Often these will be species-rich habitat types but they can also be less species-rich habitats which have an important function in the wetland landscape e.g. botanically poor wet grassland which is important breeding habitat for wading birds.</p> <p>Once these habitats have been identified data on their creation can either be collected directly or it can be gathered from other organisations and land managers operating in the area.</p> <p>Habitat created can enhance the ecological network in the following ways</p> <p>Creation of new areas of home habitat which will act as stepping stones between other home habitats.</p> <p>Creation of new habitats which form a physical connection between other areas.</p>		
Measure of Success	Agree a reasonable target at the start of the project/monitoring period.		

Indicator	Area of sustainable land use that is beneficial to wetland species		
Theme	Landscape Connectivity	Sub-theme(s)	Landscape Permeability
Rationale	The permeability of the landscape outside of areas managed for nature conservation is extremely important to the functioning of an ecological network.		
Method	<p>Classify land use and habitat types that will make the landscape easier to move through for wetland species</p> <p>Data for this indicator can be collected through a combination of an annual survey and through gathering data from other organisations and land managers in the area. The frequency with which it is possible to gather data and the rate of change in land use will determine how regularly this indicator is reviewed.</p>		
Measure of Success	Area of sustainable land use that is beneficial to wetland species to remain constant or increase.		

Indicator	Area of farmland under environmental stewardship options		
Theme	Landscape Connectivity	Sub-theme(s)	Landscape Permeability
Rationale	Carefully located environmental stewardship options can make the landscape more permeable for many species.		
Method	Collate information annually from government agencies.		
Measure of Success	Area of farmland under environmental stewardship to increase or remain constant.		

Indicator	Amphibian populations		
Theme	Landscape Connectivity	Sub-theme(s)	Landscape Permeability
Rationale	Amphibian populations are sensitive to both habitat conditions and habitat fragmentation as many species prefer to move through less heavily managed areas of habitat and their populations can respond quickly to changes in local conditions.		
Method	<p>Populations and distribution of local species of amphibians can be monitored in a number of ways including pit-fall traps, larval surveys and the use of refugia.</p> <p>By working within local experts “reasonable limits” can be defined as expected responses to local events. Changes in population size and distribution should be interpreted in terms of life history, vagility and the habitats it prefers at different stages in its life cycle.</p>		
Measure of Success	Amphibian populations to increase or fluctuate within reasonable limits.		

Indicator	Ditch invertebrate populations		
Theme	Landscape Connectivity	Sub-theme(s)	Structural Connectivity, Species
Rationale	Wetland species with limited terrestrial dispersal capabilities rely on structural features in the landscape to move to new areas. These include drainage channels and flood events which allow lateral dispersal. The distribution of species that disperse in this way will not be influenced by landscape permeability and so measures that evaluate structural connectivity should be included in landscape scale monitoring.		
Method	Annual sampling should take place at nominated sites. Special attention should be paid to species with limited dispersal capabilities. Ditch management, habitat condition and flood events should be considered when analysing the distribution of aquatic invertebrate populations. Specialist advice is likely to be required during survey and analysis.		
Measure of Success	Distribution of species to follow expected patterns. No loss of established populations.		

Ecosystem Services

Indicator	Carbon Storage		
Theme	Ecosystem Services	Sub-theme(s)	Regulating
Rationale	The waterlogged conditions in wetland soils facilitate the storage of carbon through the accumulation of undecomposed plant litter. The deposition of organic sediment in ponds and lakes is also another means of carbon storage.		
Method	The storage of carbon across the whole landscape is very difficult to measure and so theoretical approaches may be more cost effective. Methods such as TESSA or the use of EcoServ GIS are recommended. This will only change if there are major changes in land use and so this will only need to be repeated at 5 yearly intervals.		
Measure of Success	No decrease in carbon storage capacity.		

Indicator	Water quality regulation		
Theme	Ecosystem Services	Sub-theme(s)	Regulating
Rationale	Freshwater systems can store, dilute and detoxify water pollutants.		
Method	The water purification capacity across the whole landscape is very difficult to measure directly and so theoretical approaches such as TESSA or the use of EcoServ GIS are recommended. This will only change if there are major changes in land use and so this will only need to be repeated at 5 yearly intervals.		
Measure of Success	No decrease in water purification capacity.		

Indicator	Proportion of farmland in sustainable agricultural production		
Theme	Ecosystem Services	Sub-theme(s)	Provisioning
Rationale	Grassland in a wetland landscape can support beef and dairy systems and their role in food production should be recognised. However care must be taken with this indicator not to encourage intensive farming methods.		
Method	Taken annually from freely available data on agri-environment scheme uptake.		
Measure of Success	Proportion to increase following the introduction of the New Environmental Land Management Scheme (UK) or similar.		

Indicator	Forage quality and productivity		
Theme	Ecosystem Services	Sub-theme(s)	Provisioning
Rationale	This indicator can establish the agricultural value of wet grassland plant communities and allow different grassland management techniques to be better understood.		
Method	<p>Regular survey sites should be established which allow for the comparison of different grassland management techniques. As a minimum, forage samples should be analysed for ;</p> <ul style="list-style-type: none"> • Dry matter • Digestible organic matter • Metabolisable energy • Neutral detergent fibre • Acid detergent fibre • Soluble nitrogen • Crude protein <p>Mineral analysis would also be beneficial if the resources are available.</p>		
Measure of Success	Overall trend in forage quality and productivity to remain constant or increase where this can be achieved without damaging wetland health.		

Indicator	Length of Public Rights of Way and Permissive Paths		
Theme	Ecosystem Services	Sub-theme(s)	Cultural
Rationale	Walking in the countryside along public rights of way is the simplest way for people to engage with the landscape, understand it and develop a passion for preserving it.		
Method	In the UK Local Authorities hold data on public footpaths. Other government organisations also hold data on permissive paths which have been opened up through agr-environment schemes or other agreements. The length of public rights of way does not change rapidly and so data only needs to be collected every 5 years.		
Measure of Success	No decrease in length of public rights of way.		

Indicator	Number of fishing/hunting permits issued		
Theme	Ecosystem Services	Sub-theme(s)	Cultural
Rationale	Wetlands traditionally provide many opportunities for fishing and hunting. These popular ways for people to enjoy wetlands should be carefully controlled to ensure that they are sustainable and have a minimum impact on wetland species and habitats.		
Method	Data obtained annually from permit issuers.		
Measure of Success	Agreed sustainable maximum number of permits issued annually.		

Indicator	Number of people engaging in locally important cultural activity e.g. boating or cycling		
Theme	Ecosystem Services	Sub-theme(s)	Cultural
Rationale	Wetlands will have locally important cultural activities which bring people to the area for example, some wetland areas may be particularly suited to boating whereas others may have an extensive cycling network. By gathering information about popular activities in the wetland it can be promoted		
Method	This will depend on the activity being monitored.		
Measure of Success	Agreed sustainable levels of activity met.		

Economic and Social Benefits

Indicator	Number of educational visits		
Theme	Economic and Social Benefits	Sub-theme(s)	Social Benefits
Rationale	Educational visits are an opportunity to communicate to children and young people the importance of wetlands.		
Method	Annual collation of data from organisations who deliver educational activities. Data should include the age of the children and types of activities.		
Measure of Success	An increase in demand and delivery (within capacity) of educational visits.		

Indicator	Visitor numbers on core sites		
Theme	Economic and Social Benefits	Sub-theme(s)	Social Benefits, Local Attitudes
Rationale	The number of people visiting a site is a gauge of local interest and enthusiasm for the landscape. A successful landscape-scale project needs buy-in from the people living in the landscape.		
Method	Visitor numbers to be counted at peak times either manually or electronically.		
Measure of Success	An increase in visitor numbers during comparable periods.		

Indicator	Number of volunteer hours on wetland management activities		
Theme	Economic and Social Benefits	Sub-theme(s)	Social benefits
Rationale	Volunteering has been shown to have a number of physical and psychological health benefits and can be used to demonstrate the positive contribution that the landscape makes to people's lives.		
Method	Annual collation of data from all organisations that run volunteer work parties in the area.		
Measure of Success	An increase in the number of volunteer hours spent on wetland management activities.		

Indicator	Membership of local organisations linked to the management of the wetland		
Theme	Economic and Social Benefits	Sub-theme(s)	Local Attitudes
Rationale	Many organisations involved in managing wetlands are membership organisations. The number of members that an organisation has demonstrates support for the work of that organisation.		
Method	Annually collate data from local membership organisations.		
Measure of Success	An increase in the membership of local organisations.		

Indicator	Attendance of public events		
Theme	Economic and Social Benefits	Sub-theme(s)	Local Attitudes
Rationale	Public events are a good way to introduce new people to the wetland and give people familiar with the area a chance to see it differently. The events can include open days, farming demonstrations or talks to local groups. Attendance at these events can be used to gauge public interest in the wetland.		
Method	Annual collation of data from all organisations holding events in the wetland. The events can also be used as opportunities to gain detailed feedback about the wetland from the public.		
Measure of Success	An increase in attendance of public events and largely positive feedback where sought.		

Indicator	Estimated value of Ecosystem services		
Theme	Economic and Social Benefits	Sub-theme(s)	Economic value
Rationale	The economic value of the ecosystem services provided by wetlands can be used to make the case for their restoration and proper management.		
Method	<p>The ecosystem services provided by particular habitats can be estimated using theoretical approaches such as TESSA or the use of EcoServ GIS. They can also be estimated using documents like the UK National Ecosystem Assessment Technical Report.</p> <p>There are a number of methods that could be used to estimate the economic value of ecosystem services which have been well summarised in the document <i>An Introductory Guide to Valuing Ecosystem Services</i>, produced by the UK Government.</p>		
Measure of Success	The estimated value of ecosystem services should remain constant or increase annually.		

Indicator	Money brought into the area through agri-environment schemes		
Theme	Economic and Social Benefit	Sub-theme(s)	Economic Value
Rationale	Money that landowners receive through agri-environment schemes is spent in the local area. Being able to illustrate this can help to increase support for landowners becoming part of these schemes.		
Method	Estimated annually from freely available data on agri-environment scheme uptake.		
Measure of Success	Trend to show an increase in the value of agri-environment schemes to the area.		

Indicator	Project income		
Theme	Partnership Working	Sub-theme(s)	Mobilisation of Resources
Rationale	Project income can be used as an indication of project work taking place and the resources being invested in the positive management of the landscape.		
Method	Annual collation of information from project partners operating in the area.		
Measure of Success	Project income to remain constant or increase.		

Indicator	Number of multi-agency projects		
Theme	Partnership Working	Sub-theme(s)	Mobilisation of Resources
Rationale	Management at a landscape scale requires multi-agency projects.		
Method	Count of active multi-agency projects on a 3 year cycle.		
Measure of Success	Number of projects to remain constant or increase.		

Indicator	Financial value of help in kind		
Theme	Partnership Working	Sub-theme(s)	Mobilisation of Resources
Rationale	In addition to project income, help in kind also has a financial value. It can be used as an indication of project work taking place in and the resources being invested in the positive management of the landscape.		
Method	<p>Collation of information from project partners operating in the area.</p> <p>Help in kind can include</p> <ul style="list-style-type: none"> • Voluntary work • Services offered by other organisations which are not charged for • Equipment donated to the project <p>This information is best summarised regularly and is often required by external funders.</p>		
Measure of Success	Help in kind to remain constant or increase.		

Indicator	Fulfilment of identified partnership goals		
Theme	Partnership Working	Sub-theme(s)	Efficient and Effective Delivery
Rationale	The success of partnership projects should be tracked throughout the project to monitor its progress.		
Method	Collation of information from project partners operating in the area. This is best done quarterly to ensure the project maintains momentum and is almost always required by external funders.		
Measure of Success	Identified goals fulfilled.		

Indicator	Number of publications/articles		
Theme	Partnership Working	Sub-theme(s)	Leadership and Influence
Rationale	This indicator monitors the commitment of organisations to communicate the work that they are doing. It can also provide an indication of the number of people who have visited the wetland or had access to information about the work that is being carried out to improve the wetland condition.		
Method	<p>Collation of information from project partners operating in the area.</p> <p>This could include</p> <ul style="list-style-type: none"> • Number of leaflets produced/taken by visitors to the area • Number of hits to a website • Articles in local publications and the readership of those publications 		
Measure of Success	Target number of articles and publications produced.		

Useful References and Further Reading

British Trust for Ornithology, The Wetland Bird Survey (WeBS) Home Page,

<http://www.bto.org/volunteer-surveys/webs>

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Department for Food and Rural Affairs, An Introductory Guide to Valuing Ecosystem Services https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/191502/Introductory_guide_to_valuing_ecosystem_services.pdf

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Stroh, P. & Hughes, F., 2010, *Practical Approaches to Wetland Monitoring: Guidelines for Landscape-scale Long-term Projects*, Anglia Ruskin University <http://www.nationaltrust.org.uk/document-1355774442659/>

UK National Ecosystem Assessment Follow-on (2014) The UK National Ecosystem Assessment Follow-on: Synthesis of the Key Findings. UNEP-WCMC, LWEC, UK. <http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx>