Environment and Rural Affairs Monitoring & Modelling Programme

ERAMMP Year 1 Report 16TA1: NRW & ERAMMP Monitoring Activities Review Technical Annexes

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Centre for Ecology & Hydrology

Programme/Project	Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP)
Title	ERAMMP Year 1 Report 16TA1: NRW & ERAMMP Monitoring Activities Review Technical Annexes
Client	Welsh Government
Reference	C210/2016/2017 NEC06297 Task 8.1
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How to cite (long)	Emmett, B.A., Maskell, L., Read, D., Robinson, D.A., Smart, S.M., Garbutt, R.A. & Williams, B. (2019) Environment and Rural Affairs Monitoring & Modelling Programme - **ERAMMP Year 1 Report 16TA1: NRW & ERAMMP Monitoring Activities Review Technical Annexes.** Report to Welsh Government (Contract C210/2016/2017). Centre for Ecology & Hydrology Project NEC06297.
How to cite (short)	Emmett, B.A. et al. (2019) **ERAMMP Report 16TA1: NRW & ERAMMP Monitoring Activities Review Technical Annexes.** Report to Welsh Government (Contract C210/2016/2017)(CEH NEC06297)
Approved by	James Skates
Signed	

Version History

Version	Updated By	Date	Changes
0.1	PMO	30/4/19	Initial draft.
0.11	PMO	8/5/19	Mainly formatting edits – draft for SG
0.12-0.13	PMO	23/9/19	Formatting edits
0.14	PMO	27/9/19	Approved for publication
1.0	PMO	30/9/2019	As published

This document has been formatted to print on A3 paper (landscape).

Contents

Abbreviations and some of the technical terms used in this report are expanded in the project glossary:
https://erammp.wales/en/glossary (English) and https://erammp.cymru/geirfa (Welsh)

1 Technical Annex 1 - Monitoring Activities in Wales Suitable for National Reporting Mapped Against SoNaRR Reporting Categories

ID	Monitoring Activity	Monitoring Org.	DPSIR Category	Mountains, Moorlands and Heaths	Semi-Natural Grassland	Enclosed Farmland	Wood-land	Urban	Fresh-water	Coastal Margins
20	CEH/Predatory Bird Monitoring Scheme for current and emerging contaminants (CEH).	CEH						X		
21	Pests and Disease: (CEH GMEP) Woodland plots and standard trees – recording signs of tree disease was an option to record. Landscape ecology of UK mosquito vectors.	CEH		X	X	X	X			X
101	Pollinator Monitoring Scheme, PoMS (CEH funded by Defra/SG/WG etc.).	CEH		X	X	X	X			
9	CEH/Predatory Bird Monitoring Scheme for current and emerging contaminants (CEH).	CEH	Pressure	X	X	X	X			
10	National River Flow Archive (CEH).	CEH	Pressure						X	
11	Hydrological outlooks (CEH).	CEH	Pressure						X	
12	Flood risk modelling (CEH).	CEH	Pressure						X	
13	Land use change via EO (CEH).	CEH	Pressure	X	X	X	X		X	X
14	Apportionment modelling by agriculture of nutrients and contaminants to rivers (GMEP).	CEH	Pressure						X	
15	Saltwater inundation risk maps: SALTMED model field scale tool for integrated management of water, soils, crops and N- fertilizers (CEH).	CEH	Pressure							X
16	Farmer Practice Survey (resilience, adaptation and change in practices (GMEP).	CEH	Pressure	X	X	X	X			
17	Land use change via EO (CEH)	CEH	Pressure							
18	Inventory of non-native species through the GB Non-Native Species Information Portal (partnership between Defra, CEH, BTO, BSBI and MBA).	CEH	Pressure	X	X	X	X		X	X
19	Occurrence, trends in status and predicted distribution of, non-native species, reported through expert naturalist networks, co-ordinated through the Biological Records Centre, the National Biodiversity Network and Wales LERCs.	CEH	Pressure							
22	Landscape ecology of UK mosquito vectors and risk from climate change etc. (CEH).	CEH	Pressure	X	X	X				X
23	UK Air quality monitoring network at rural sites UKEAP - UK Eutrophying and Acidifying atmospheric Pollutants (CEH), including precipitation network (Precip-Net), National Ammonia Monitoring Network – NAMN (CEH), Acid Gas and Aerosol Network – AGANET (CEH), NO$_2$Net and EMEP supersites (CEH, Scotland).	CEH	Pressure	X	X	X	X			X
A07	Met Office climate data	Met Office	Pressure	X	X	X	X	X	X	X
1	Land use/cover change incl development (via EO)	NRW	Pressure	X	X	X	X			X

ID	Monitoring Activity	Monitoring Org.	DPSIR Category	Mountains, Moorlands and Heaths	Semi-Natural Grassland	Enclosed Farmland	Wood-land	Urban	Fresh-water	Coastal Margins
2	Waste?	NRW	Pressure					X		
3	Abstraction and Discharge data (e.g. CAMS)	NRW	Pressure						X	
4	OSPAR	NRW	Pressure						X	
5	Tree disease surveillance	NRW	Pressure				X			
6	Land management. e.g. burning (via EO)	NRW	Pressure	X	X	X	X			
7	River flow and level network	NRW	Pressure						X	
8	MarClim (climate change impacts on intertidal systems)	NRW	Pressure							X
A06	State of Seas report	NRW?	Pressure							X
A08	Planning Application data	NRW?	Pressure	*X*	*X*	*X*	*X*	*X*		*X*
A10	Pollution/WFD data	NRW?	Pressure	*X*	*X*	*X*	*X*	*X*	*X*	*X*
A11	Flood incidents reports	NRW?	Pressure	*X*	*X*	*X*	*X*	*X*	*X*	*X*
A12	Waste monitoring facilities	NRW?	Pressure		*X*	*X*		*X*		*X*
A13	WFD nutrient data	NRW?	Pressure	*X*	*X*	*X*	*X*	*X*		*X*
A14	INNS data	NRW?	Pressure	*X*	*X*	*X*	*X*	*X*	*X*	*X*
A15	Protected sites - loss/damage	NRW?	Pressure	*X*	*X*	*X*	*X*	*X*		*X*
36	Wider countryside plant species including CSM and composition of linear features habitat dominant plants that deliver disproportionate amount of ecosystem function (CS/GMEP/ERAMMP).	CEH	State - Condition	X	X	X	X	X		X
37	Occurrence, trends in status and predicted distribution of species reported through expert naturalist networks, co-ordinated through the Marine Biological Association, the Biological Records Centre, the National Biodiversity Network and Wales LERCs.	CEH	State - Condition	X	X	X	X	X	X	X
38	Plant species including habitat indictors, plus condition measures (NPMS).	CEH	State - Condition	X	X	X	X	X	X	X
39	Topsoil condition (CS/GMEP/ERAMMP)	CEH	State - Condition	X	X	X		X		X
40	Pollinators (GMEP)	CEH	State - Condition	X	X	X	X			
41	UKpollinator abundance and diversity (Pollinator Monitoring Scheme, PoMs).	CEH	State - Condition	X	X	X	X			
42	Bird and pollinator linkages to land use and veg composition (CS/GMEP/ERAMMP).	CEH	State - Condition	X						
43	Predatory bird Monitoring Scheme (contaminant levels) (CEH)	CEH	State - Condition	X	X	X	X	X	X	X
44	UK Butterfly Monitoring Scheme, incorporating the Wider Countryside Butterfly Survey (UKBMS, partnership between CEH, Butterfly Conservation and JNCC).	CEH	State - Condition	X	X	X	X	X		X
45	Headwaters physical (RHS), chemical and biological indicators (CS/GMEP/ERAMMP).	CEH	State - Condition						X	
46	Ponds physical, chemical and biological indicators (CS/GMEP/ERAMMP).	CEH	State - Condition						X	
47	UK Lake portal (CEH)	CEH	State - Condition						X	
48	Wales unified peat map and GHG emissions map (CEH/GMEP).	CEH	State - Condition						X	
49	CEH long term catchment/landscape platforms (Conwy, Plynlimon) – water quality / flow.	CEH	State - Condition						X	

ID	Monitoring Activity	Monitoring Org.	DPSIR Category	Mountains, Moorlands and Heaths	Semi-Natural Grassland	Enclosed Farmland	Wood-land	Urban	Fresh-water	Coastal Margins
50	Saltmarsh and sand dune historical datasets (CEH).	CEH	State - Condition							X
24	EO-derived habitat maps	NRW	State - Condition	X	X	X	X		X	
25	Protected sites monitoring (CSM)	NRW	State - Condition	X	X		X		X	X
26	Phase 2 survey (archive)	NRW	State - Condition		X					
27	Grassland evidence & strategic conservation	NRW	State - Condition		X					
28	WFD suite (chemicals, phys-chem, ecology, hydromorph)	NRW	State - Condition						X	
29	Wetlands (WFD GWDTE)	NRW	State - Condition						X	
30	Fish monitoring (mainly salmonids)	NRW	State - Condition						X	
31	River Habitat Survey	NRW	State - Condition						X	
32	Bathing Waters	NRW	State - Condition							X
33	OSPAR River Monitoring Programme – contaminant and effluent loads.	NRW	State - Condition						X	
34	EC Bathing Waters Directive 2006/7/EC – monitoring for *Escherichia coli* and intestinal enterococci.	NRW	State - Condition							
35	Indicative feature condition assessments for European marine sites (EMS) SAC and SPA.	NRW	State - Condition							
A26	Habitat Connectivity /network maps	NRW?	State - Condition	*X*	*X*	*X*	*X*			*X*
51	EU LUCAS Soil Monitoring network (JRC)	OTHER	State - Condition	X	X	X	X			
52	National Forest Inventory (NFI – Forest Research)	OTHER	State - Condition				X			
53	ICP Level II forest monitoring sites (Forest Research)	OTHER	State - Condition				X			
54	Forest Biosoil network (no current funding) (Forest Research).	OTHER	State - Condition				X			
55	UK Acid Water Monitoring Network (external – CEH lead)	OTHER	State - Condition						X	
73	EO-derived habitat maps (CEH)	CEH	State - Extent	X	X	X	X	X	X	
74	EO-derived crops map (CEH)	CEH	State - Extent			X				
75	Field survey habitat maps (300 1km2) (CS/GMEP/ERAMMP)	CEH	State - Extent	X	X	X	X	X	X	
76	New method combining EO(LCM) and restricted field validation due end 2019 (ERAMMP).	CEH	State - Extent	X	X	X	X	X	X	
56	Phase 1 Survey (archive)	NRW	State - Extent	X	X	X	X		X	X
57	EO-derived habitat maps	NRW	State - Extent	X	X	X	X	X	X	X
58	Phase 2 Peatland survey + ongoing peatland survey	NRW	State - Extent	X					X	
59	Phase 2 Lowland heathland survey	NRW	State - Extent	X						
60	Phase 2 survey (archive)	NRW	State - Extent		X					
61	Grassland evidence & strategic conservation	NRW	State - Extent		X					
62	i-tree (urban forest measurement) – archive	NRW	State - Extent				X	X		
63	River flow and level network	NRW	State - Extent							
64	Saltmarsh (WFD)	NRW	State - Extent							X
65	National Habitat Creation Programme (linked to coastal flood management)	NRW	State - Extent							X
66	British Oceanographic Data Centre (BODC) - Marine Environmental Data & Information Network (MEDIN)	NRW	State - Extent							

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67	Habitat Mapping for Conservation and Management of the Southern Irish Sea (HABMAP) - seabed habitat maps that could be used for conservation and management.	NRW	State - Extent							
68	Intertidal Phase 1 Biotope Mapping Survey	NRW	State - Extent							
69	Marine Article 17 Habitats Features (Habitat Directive mapping)	NRW	State - Extent							
70	Marine Biodiversity Action Plan (BAP) spatial datasets	NRW	State - Extent							
71	Marine Biodiversity Action Plan (BAP) Species in Wales – spatial datasets of Bap species.	NRW	State - Extent							
72	Seabirds at Sea – distribution of seabirds in Welsh waters.	NRW	State - Extent							
A27	Phase I/Phase II (Habitats)	NRW	State - Extent	X	X	X	X			X
77	National Forest Inventory (NFI)	OTHER	State - Extent				X			
78	Stock and condition of linear features (hedges, walls etc) (CS/GMEP/ERAMMP).	CEH	State - Connectivity	X	X	X	X			
79	Connectivity metric for habitats which contributed to resilience metrics (GMEP).	CEH	State - Connectivity	X	X	X	X			
80	Population synchrony of butterflies as a measure of connectivity. Analysis of UKBMS.	CEH	State - Connectivity	X	X	X	X	X		X
81	National woodland connectivity extent opportunity assessment (GMEP).	CEH	State - Connectivity				X			
82	Mapping of barriers to fish movement.	NRW	State - Connectivity						X	
83	National Forest Inventory (NFI)	OTHER	State - Connectivity				X			
88	Species diversity status and trends, data through expert naturalist networks, co-ordinated through the Biological Records Centre, the National Biodiversity Network and Wales LERCs.	CEH	State - Diversity	X	X	X	X	X		X
89	Plant, bird, soil and pollinator species data from CS/GMEP/ERAMMP squares.	CEH	State - Diversity	X	X	X	X	X		X
90	Priority birds species index (GMEP - BTO)	CEH	State - Diversity	X	X	X	X	X		
91	Under-recorded species index (GMEP-BRC)	CEH	State - Diversity	X	X	X	X	X		
92	Pollinator Monitoring Scheme, PoMS (CEH funded by Defra/SG/WG etc)	CEH	State - Diversity	X	X	X	X	X		
94	Plant diversity in >400 quadrats across 10 Welsh sand dunes. (>4 sand dune surveys & monitoring platforms) (CEH).	CEH	State - Diversity							X
84	UK species surveillance schemes (stock & trend) e.g. UKBMS, NPMS, NBMP. (external)	NRW	State - Diversity	X	X	X	X	X		X
85	Ad-hoc Terrestrial species evidence programmes.	NRW	State - Diversity	X	X	X	X			X
86	Some species diversity metrics in WFD (analytical task).	NRW	State - Diversity						X	
87	Seabirds at Sea – abundance of seabirds in Welsh Waters.	NRW	State - Diversity							
A29	Genetic diversity data	NRW	State - Diversity	X	X	X	X		X	X
A33	Topographical data	NRW	State - Diversity	X	X	X	X	X	X	X
93	National Forest Inventory (NFI)	OTHER	State - Diversity				X			
95	BTO Coastal Birds WEBS	OTHER	State - Diversity							X

ID	Monitoring Activity	Monitoring Org.	DPSIR Category	Mountains, Moorlands and Heaths	Semi-Natural Grassland	Enclosed Farmland	Wood-land	Urban	Fresh-water	Coastal Margins
98	EO x field survey derived ANPP national map (GMEP)	CEH	State - Supporting Services	X	X	X	X			X
99	ECN data coordination centre (CEH)	CEH	State - Supporting Services	X	X	X	X			
100	Upland Water Monitoring Network (CEH manage – funding from Defra)	CEH	State - Supporting Services					X		
102	Nature paper national map of change in pollinator services based on CS/EO/lab work.	CEH	State - Supporting Services	X	X	X	X			
103	National scale soil potential for nitrogen cycling and carbon decomposition (CS/CEH).	CEH	State - Supporting Services	X	X	X	X			
104	Soil carbon and nutrients in >100 quadrats across 8 Welsh sand dunes. (>4 sand dune surveys & monitoring platforms) (CEH).	CEH	State - Supporting Services							X
105	Groundwater levels in sand dunes. Data from 4 sand dune sites in Wales (CEH).	CEH	State - Supporting Services							X
96	ECN Snowdon	NRW	State - Supporting Services	X					X	
97	ECN Wye	NRW	State - Supporting Services						X	
107	UK GHG flux monitoring network (CEH)	CEH	Impact - Regulating Services	X	X	X	X			
108	Vegetation reductions of air quality (CEH funded by Defra).	CEH	Impact - Regulating Services					X		
106	ECN Snowdon – soil solution	NRW	Impact - Regulating Services	X						
A42	Flood protection (scheme names?)	NRW	Impact - Regulating Services	X	X	X	X	X	X	X
A44	Regulating services data sources: flood protection, woodland yield, disease, minerals, national borehole network, tree cover, fish yield.	NRW	Impact - Regulating Services	X	X	X	X	X	X	X
110	UK Air quality monitoring networks (CEH)	CEH	Impact - Provisioning Services	X	X	X	X			
111	National Honey Monitoring Scheme (CEH)	CEH	Impact - Provisioning Services	X	X	X	X	X		X
112	Loss of production due to ozone (CEH)	CEH	Impact - Provisioning Services				X			
109	ECN Snowdon (incl. UKEAP & Welsh Air quality, AEA)	NRW	Impact - Provisioning Services	X						
114	National River Flow Archive (NRFA)	NRW	Impact - Provisioning Services						X	

ID	Monitoring Activity	Monitoring Org.	DPSIR Category	Mountains, Moorlands and Heaths	Semi-Natural Grassland	Enclosed Farmland	Wood-land	Urban	Fresh-water	Coastal Margins
115	Cockle fisheries (Burry Inlet and Dee Estuary)	NRW	Impact - Provisioning Services							X
113	Timber production	OTHER	Impact - Provisioning Services				X			
118	Landscape visual quality indicator (VQI) (GMEP/ERAMMP)	CEH	Impact - Cultural Services	X	X	X	X		X	X
119	Condition and threats of Historic Environment Features (GMEP/ERAMMP	CEH	Impact - Cultural Services	X	X	X	X		X	
120	Footpath condition (GMEP/ERAMMP)	CEH	Impact - Cultural Services	X	X	X	X		X	
116	Landscape (LANDMAP)	NRW	Impact - Cultural Services	X	X	X	X		X	X
117	Seascape?	NRW	Impact - Cultural Services							X
132	National Parks, Some categories of Priority Habitats and other protected/designated sites for status and change in general condition metrics (CSM, soil etc.) relative to national average (ERAMMP exploiting CS/GMEP baselines).	CEH	Response	X	X	X	X		X	X
133	Farmer Practice Survey (GMEP/ERAMMP)	CEH	Response	X	X	X	X			
134	Post-Brexit and AES (legacy and Glastir) modelling and monitoring.	CEH	Response	X	X	X	X			
135	Farm carbon footprinting (GMEP/ERAMMP)	CEH	Response	X	X	X	X			
136	Critical load and level mapping and assessment for air pollution (CEH).	CEH	Response	X	X		X		X	X
137	CEH/Predatory Bird Monitoring Scheme for current and emerging contaminants (CEH).	CEH	Response	X	X	X	X			
138	UK Grid-2Grid / Hydrojules Flood Forecasting (CEH)	CEH	Response					X		
121	Protected sites monitoring (CSM)	NRW	Response	X	X		X		X	X
122	Protected sites monitoring (SACs)	NRW	Response							
123	Forest monitoring (for timber production)	NRW	Response				X			
124	PAWS (Ancient Woodlands restoration)	NRW	Response				X			
125	WFD Investigative monitoring	NRW	Response						X	
126	Fish movement at barriers	NRW	Response						X	
127	LiDaR (flood risk)	NRW	Response					X	X	X
128	Bathing Waters	NRW	Response							X
129	Intertidal survey	NRW	Response							X
130	Sand dune survey	NRW	Response							X
131	Skomer MCZ monitoring	NRW	Response							
A45	SSSI's Action database	NRW	Response	X	X	X	X	X	X	X

2 Technical Annex 2 - What, Where, How and Why of National Monitoring in Wales

Organisation/Programme	What	Why	How	When
CS/GMEP/ERAMMP	Soil	One of our natural resources. No other ongoing soil monitoring programme. WFG indicator. Evidence of both decline (e.g. carbon in arable and habitat land) and improvement (e.g. reversal of acidification).	Co-located cores (0-15cm only) taken in 5 random locations in 300 1km GMEP squares stratified according to ITE LandClass across Wales as part of GMEP. Builds on 25 to 100 km squares in Countryside Survey depending on year. Wide range of physical, chemical and biological measurements available.	1978; 1998; 2007; 2012-2016 Proposed continuation in ERAMMP
CS/GMEP/ERAMMP	Botanical diversity	To track ongoing change as evidence of homogenisation of the countryside.	UP to 26 permanent quadrats in 300 1km GMEP squares depending on complexity / heterogeneity of the habitat/vegetation.	1978; 1990, 1998; 2007; 2012-2016
CS/GMEP/ERAMMP	Ponds	Important refugia. Stepping stones between water bodies for many taxa; High social interest. Frequently included in AES schemes for funding.	1 selected in each of 300 1km square.	1998, 2007, 2012-2016
CS/GMEP/ERAMMP	Headwaters streams	Not recorded as part of other monitoring schemes – receptors of point and diffuse sources of pollutants and nutrients affecting water quality. Refugia for biodiversity.	One stream selected per square. Water quality samples, diatoms, freshwater invertebrates (RIVPACS), River Habitat Survey.	1998, 2007, 2012-2016
GMEP	Pollinators	Effects of Glastir impacts; biodiversity interest in wider countryside. Sustain our natural resources by aiding plant reproduction and underpin food supply through pollination of food resources.	Pollinator groups recorded using Wider Countryside Butterfly methodology in 300 1km squares. Line transects within 1km squares. Timed floral observation.	GMEP – 2012-2016
CS/GMEP/ERAMMP	Birds	Effects of Glastir impacts; biodiversity interest in wider countryside. Indicators of change in condition of the wider countryside.	GMEP - Territory mapping. Walk within 200m of all areas of each 1km2 recording all species seen/heard. Four visits, April-July. Compatible with Breeding Bird Survey.	2000, 2012-2016 Subset of 335 GB-wide CS squares in 2000; all GMEP baseline 1km squares in 2013-'16
BTO / RSPB monitoring schemes	Birds	Indicators of change in condition of the wider countryside.	Range of data available including Breeding Bird Survey; Bird Atlas; range of data on rare species etc.	
GMEP/ERAMMP	Public footpaths	Walking improves mental and physical health, bringing people into the countryside and outdoor spaces and contributing to local economies.	Status and length of all footpaths in 300 1km squares.	2012-2016
GMEP/ERAMMP	Historic Environment Features	Contributes to cultural identity, sense of place and local economies.	Condition assessment and potential threats to longer term viability of the feature.	2012-2016
GMEP/ERAMMP	Landscape Visual Quality	An important resource for quality of life, local identity, wellbeing, tourism and tourism.	Photographic preference surveys undertaken online through multiple nodes (urban forums, rural forums, youth groups, outdoor etc.). Landscape photos from 300 1km squares.	2012-2016
CS/ GMEP	Linear features	Important landscape features in their own right, refugia for biodiversity, buffers for water flow. Connectivity of linear features critical as component of resilience; hedgerows as section 7 habitat (Environment (Wales) Act).	Census map of extent, attributes and condition in stratified random sample of 300 1km squares. National metric also developed using combined field, data analytics and EO in 2016.	1978; 1990, 1998; 2007; 2012-2016
CS/ GMEP	Habitat extent (field)	Captures the complexity of ecological conditions and dynamics on the ground.	Habitat areas (>20m x 20m) are mapped and attributes recorded.	1978; 1990, 1998; 2007; 2012-2016
CS/ GMEP	Point features	Important landscape features in their own right, refugia for biodiversity.	Point features are individual landscape elements that occupy less than an area of 20x20m.	1978; 1990, 1998; 2007; 2012-2016
ERAMMP	Habitat extent (field x EO)	In development. New consistently estimated time series of habitat extent that will support a) estimation of condition measures across the Welsh countryside, b) efficient use of reduced field survey effort in ERAMMP/CS squares to.	Modelling of the confusion matrix between LCM coverages for 1km survey squares and field surveyed locations of vegetation plots.	Expected to be retrospectively applied to 1990, 1998, 2000, 2007, GMEP baseline and then ongoing
CS/ GMEP	Woodland mapping	Important landscape features in their own right, refugia for biodiversity, climate mitigation.	Woodland areas (>20m x 20m) are mapped and attributes recorded:	1978; 1990, 1998; 2007; 2012-2016

Organisation/Programme	What	Why	How	When
			Broad/Priority Habitat, Belt of scrub, Belt of trees, Clump of trees, Dead lying trees, Standing dead trees, Scattered scrub/trees, Modal DBH; species; species cover.	
CEH National Capability	Habitat extent (EO) and crop cover	Provides rapid, large scale assessment of land use type and broad scale understanding of the environment. LCM Crops map plus also produced.	Parcel-based land cover map for the UK, created by classifying satellite data into 21 land cover classes based on the UK. Biodiversity Action Plan Broad Habitat definitions	1990, 2000, 2007, 2015
CEH National Capability; UK Lakes Portal	Habitat extent	GIS-based inventory of lakes for Great Britain.	The inventory includes more than 40000 water bodies in England, Scotland, Wales and the Isle of Man and catchment data for all water bodies with a surface area >1 ha.	2004 onwards
CEH National Capability	Flood risk modelling	Flood models improve warning times of national flood forecasting systems and support flood management and incident response.	State-of-the-art models that have been extensively validated against historical flood records across the UK and overseas.	?
CEH National Capability ; National River Flow Archive	Freshwater Flows	The NRFA underpins hydrological research and water-management activities in the UK, and delivers data and expertise to UK Government and international organisations.	The NRFA acts as the main focal point for hydrometric data in the UK, providing stewardship of, and access to, daily, monthly and flood peak river flow data from over 1,500 gauging stations across the UK.	1930's – on-going
CEH National Capability;	Water resource modelling	Improving water productivity and water use efficiency, saline intrusion, irrigation and drainage management, agricultural water management, soil physics/soil hydrology, remote sensing application in hydrology, hydrological modelling at catchment scale, quantifying the impact of climate and land use changes on water resources, identifying the gap between water supply and demand and suggest management solutions to narrow the gap, and water, soil, and fertilizers management modelling and experimentation at field scale.	Multiple projects and methods.	?
CEH National Capability	Catchment Platforms (Conwy, Plynlimon)	Series of long term catchment studies exploring impact of air pollution, land management and ongoing global change. Various focus and measurements over time which has contributed to e.g. reports on impacts of afforestation on water resources; effects of air pollution; impacts of land-management (forestry, peat restoration, grassland management); transfers of carbon, nutrient and contaminants from land to coastal seas etc.	Mix of water quality, hydrology, climate, air and terrestrial measurements.	Various from 1970s onwards (Plylimon) and 1990s Conwy)
CEH National Capability	ECN data management	The ECN Data Centre manages data for five UK integrated environmental monitoring networks: 1. The UK Environmental Change Network 2. The UK Environmental Change Biodiversity Network 3. The UK Uplands Waters Monitoring Network 4. The UK Lake Ecological Observatory Network 5. Habitats Monitoring Network	Together these networks cover 137 sites where a variety of physical, chemical and biological measurements are made, using a variety of data collection methods - from field sampling to automated telemetry.	Since 1990's
CEH National Capability, co-funding in Wales from Welsh Government, NRW, Forestry Commission and Woodland Trust	Upland Waters Monitoring network (headwater streams, lakes)	Impacts of changing atmospheric deposition, climate and land-use (rough grazing, plantation forestry) on freshwater chemistry (e.g. acidity, nitrogen, dissolved organic carbon, aluminium) and biota (salmonid fish, invertebrates, diatoms, aquatic macrophytes). Relevant to upland fisheries and aquatic habitats, drinking water supplies (rising DOC concentrations) and as a measure of catchment-scale land-use impacts (e.g. forest management, conifer-to-broadleaf transition).	Six sites in Wales – Paired forest/moorland streams at Plynlimon (Hafren, Gwy) and Beddgelert, moorland and forest lakes in Snowdonia (Llyn Llagi, Llyn Cwm Mynach). The Woodland Trust also support monitoring of two tributary streams at Llyn Cwm Mynach. Part of a UK-wide network.	Since 1988 at most sites (quarterly lake monitoring, monthly stream monitoring), 1985 at Beddgelert.
CEH National Capability and various funders…	Other freshwater monitoring	Impacts of changing climate and land-use on freshwater chemistry and biota.	Llyn Brianne catchment study (University of Cardiff); Forestry Commission's forest/moorland paired catchment study, which began in the 1990s; 12 years of consistent monthly monitoring for something like 10 sites in the Conwy; the non-UWMN Plynlimon streams go back to 1980 and some are still going. (Added together Wales probably has the most comprehensive set of headwater catchment monitoring sites anywhere in the UK, but this hasn't really been exploited in any sort of joined up way).	1980's onwards

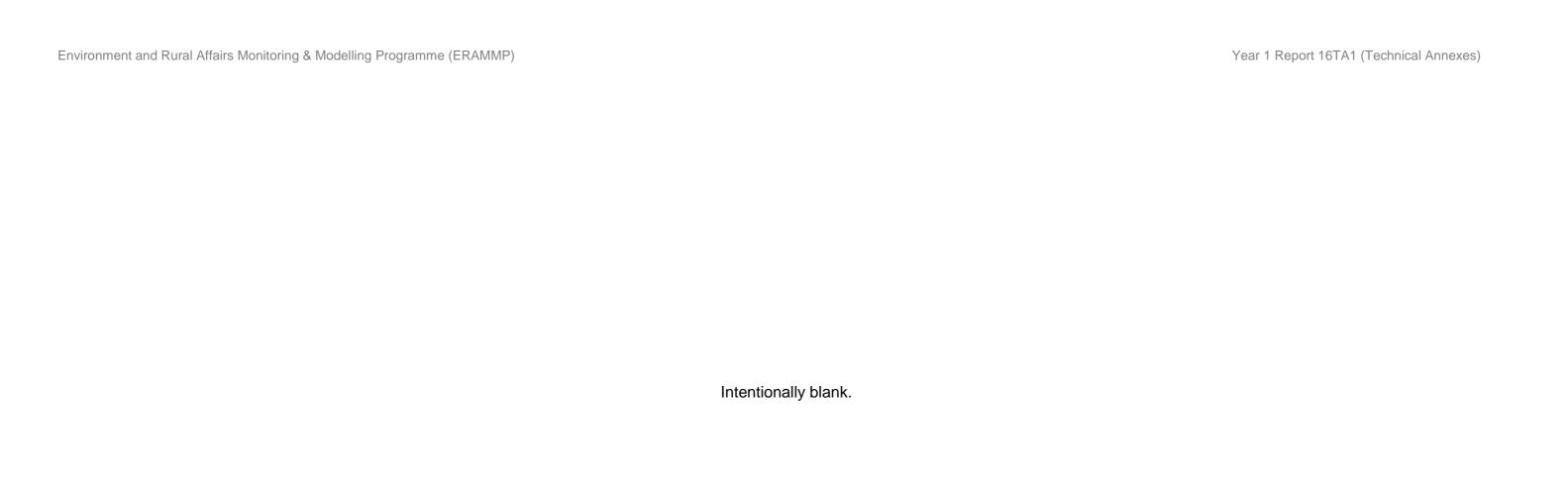| Organisation/Programme	What	Why	How	When
CEH National Capability	Hydrological Outlook	The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.	The Hydrological Outlook is based on a combination of observed data and projections into the future using models.	?
CEH National Capability	GHG Flux network (UK-SCaPE)	LTSS project measuring GHG fluxes off peatlands to look at land management effects (including bog and fen restoration) which can feed into national and international GHG emissions reporting (e.g. UNFCCC, Kyoto Protocol). The work also supports Welsh Government and Defra policy on land-use for climate change mitigation.	Carbon dioxide and methane trace gas measurements at 12 sites across the UK (currently 3 in Wales in Conwy catchment and on Anglesey).	Since 2012 in the network (longer under individual projects) – on going
Defra/WG (CEH lead)	Pollinator Monitoring Scheme (PoMs)	Status of wild bees, honey bees and hoverflies. Sustain our natural resources by aiding plant reproduction and underpin food supply through pollination of food resources.	Combination of methods. Traps and line transects within 1km squares, monitored each year. Timed floral observation aimed at wider participation.	Established in 2017 – on going
National Plant Monitoring Scheme (CEH lead)	Plant species abundance, within habitats	The status of plants within habitats, complements wider countryside surveys.	Statistically designed survey with randomly allocated 1km squares. Sampling involves recording plant 'indicator species' in plots, recorded each year. 100-150 1km squares monitored in Wales per year.	Established in 2015 – on going
UK Butterfly Monitoring Scheme	Butterfly population abundance	Indicators of butterfly trends.	Fixed transects (1-3km) walked throughout the butterfly season (26 weeks in total). Currently ~90 locations in Wales monitoring each year.	1976 onwards
Biological Records Centre (CEH lead)	Species distribution and trends in occurrence	Estimated trends for a wide range of species groups, beyond those with structured schemes. Indicators for priority species, invasive species, pollinating insects.	Observations from expert naturalist. Quality controlled and analysed to estimate trends in occurrence for thousands of species.	Trends from ~1980 onwards for Wales
National Honey Monitoring Scheme	Pollen diversity in honey, levels of pollutants (e.g. insecticides)	Estimate of flowers in the landscape. Indirect measure of exposure of pollutants to honey bees.	Collection of honey sample from beekeepers, analysis by molecular techniques and chemical analysis.	Established in 2017
Multiple sand dune surveys (CEH)	Soil	Georeferenced locations surveyed across 11 Welsh dune sites in total. The only consistent dune soil sampling we know of.	Co-located cores (0-15cm only) Basic measurements of pH, Organic Matter content, soil thickness. Carbon and Nitrogen content, & available nutrients in a subset.	Different sites in different years: 2002-2017. Repeat surveys not done, but are possible.
Dune Groundwater Monitoring (CEH)	Vegetation	Georeferenced locations surveyed across 11 Welsh dune sites in total. Initial work conducted to assess condition related to nitrogen deposition.	Co-located quadrats of 2x2m, percentage cover of all species including bryophytes and lichens.	Different sites in different years: 2002-2017. Repeat quadrat data at some sites.
Dune Groundwater Monitoring (CEH)	Groundwater levels (& chemistry)	Dipwell data on water levels available from 7 Welsh dune sites in total. Initial work conducted to assess condition related to climate change and management pressures on water tables.	Network of dipwells, some sites heavily instrumented (Newborough, Aberffraw, Harlech, Morfa Dyffryn). Some wells installed and monitored by NRW, some by CEH. Combination of monthly manual measurements and automated data loggers.	Data range from ~1985 onwards, depending on site
Multiple saltmarsh surveys (CEH)	Soil	Saltmarshes store 'Blue carbon'	Geo-referenced locations surveyed across Welsh marshes. Co-located cores (0-15cm only) Basic measurements of Organic Matter content.	Different sites in different years: 2008 - 2017
Multiple saltmarsh surveys (CEH)	Vegetation	Biodiversity and grazing management	Georeferenced locations surveyed across Welsh marshes. Co-located quadrats of 2x2m, percentage cover of all species.	Different sites in different years: 2008 - 2017
Pollution removal (ONS/CEH)	Ecosystem Service (Air pollution removal by vegetation)	GB-wide assessment of benefits of air pollution removal by vegetation (tonnes pollutants removed, health impacts and avoided medical costs). Mapped and summary data can be extracted for Wales.	Combination of atmospheric chemistry transport modelling and health economics.	2007, 2011, 2015, 2030
Noise mitigation (Defra/CEH)	Ecosystem Service (Noise mitigation by urban trees)	UK-wide assessment of benefits of noise mitigation by urban trees (number of households mitigated, economic benefit from avoided health impacts). Mapped and summary data can be extracted for Wales.	Spatial modelling combining noise mapping and location of urban trees, and dwellings.	2011
Urban heat mitigation (Defra/CEH)I	Ecosystem Service (Urban heat mitigation by urban green and blue space)	GB-wide assessment of benefits of urban heat mitigation by urban green and blue space. Data calculated for GB city regions, including Cardiff.	Spatial modelling combining days above temperature thresholds, urban green and blue space, and economics GVA data.	Approx. 2015

Organisation/Programme	What	Why	How	When
UKEAP (CEH/Ricardo Energy & Environment for Defra)	UK air quality at rural sites	Monitoring of acid gases and aerosols, ammonia, precipitation and NO_2 and 2 supersites (Harwell - mixed land use and Auchencorth Moss - upland deep peat), including coverage in Wales.	Different frequencies in four component networks, some co-location with ICP Forests Level II, UWMN, ECN and LTMN. Date used for CBED model (Concentration Based Estimated Deposition).	Some component networks date back to the 1980s, network aligned in 2009 - ongoing
Critical loads and levels modelling (CEH)	Critical load exceedance for nutrient nitrogen, acidity and heavy metals, critical level exceedance for ammonia	UK reporting to Defra and UNECE on critical loads and levels exceedance. Data can be extracted for Wales.	Nitrogen, acidity deposition modelling, and assessment of critical load exceedance by habitat.	2007-ongoing
Viruses in the aquatic environment and vector born infections (CEH National Capability and grant funded	Human Viruses	The Viraqua project studies the behaviour of human enteric viruses in aquatic environment and monitors their seasonal and diurnal concentration changes in treated and raw wastewater, river and estuarine water, sediment and shellfish. PHYTOTHREATS: Global Threats from *Phytophthora* species, EDENext: the biology and control of vector-borne infections in Europe. VMERGE: understanding midge-borne disease transmission by modelling and mapping interactions between midge vectors and their wild and domestic hosts at the landscape level.	pH, conductivity, turbidity and virus concentration data from field and experimental measurements. Mapping and modelling the distribution of vectors.	2015 – 2018 2007 - ongoing
CEH/Predatory Bird Monitoring Scheme (PBMS/CEH)	Biota (predatory birds)	The PBMS is a long-term, national-scale monitoring scheme, the aim of which is to detect and quantify current and emerging chemical threats to the environment. It achieves this by monitoring the concentrations of contaminants in sentinel predatory bird species. This provides information on (i) the extent of risk to vertebrate wildlife (and potentially Man); (ii) how this varies temporally and spatially and (iii) the effectiveness of mitigation measures, such as those incorporated into national and international regulatory directives.	300-400 bird of prey carcasses collected through citizen science (members of the public send in dead birds that they find). Most birds are from England and Wales. Failed eggs collected by specially licensed collectors. Contaminant concentrations in carcasses and eggs are quantified and spatial and temporal trends reported.	Ongoing collections made since mid 1960s
WG, Ian Rugg, Aberystwyth	Determine agricultural land class	Soil profile measurements containing georeferenced information for 15,000 auger boring profiles and 900 pit descriptions; of which, 6700 profiles were recorded prior to 1988. The remainder were recorded and captured under the current recording system. Data has been captured since 1969 and is still being captured through survey work.	Profile information is captured up to 1.2m but it may be less in places. Data captured includes: Texture, Depth, Mottles, Colour, Wetness (post 1988. Drainage pre-1988), Stone content, Droughtiness (post 1988), Structure, Porosity, Rooting, Worms, Particle Size Analysis, Organic Matter Content, Gradient, at a 100 – 200m Grid sample density. (PSD and organic matter content recorded since 1982 mainly in pit locations but not at every site).	1969 to present
EU LUCAS survey http://ec.europa.eu/eurostat/web/lucas **Land Use and Coverage Area frame Survey**	SOIL Analytes included particle size distribution, pH, carbon, nutrients, cation exchange capacity, multispectral properties and heavy metals	EU soil and land change survey. LUCAS stands for the Land Use and Coverage Area frame Survey. To identify changes in the European Union in: land use Meaning the socioeconomic use of land (for instance, agriculture, forestry, recreation or residential use). land cover: For instance crops, grass, broad-leaved forest, or built-up area.	Point samples ~20cm deep. Based on a randomized survey across EU, with emphasis on arable agricultural land and no land above 600m. 51 sample points in Wales, 840 in GB.	2009, 2015, 2021
Farming connect	Soil Farm data: Farming Connect (FC) hold a variety of data but not in an immediately useful format under the current programme, there are 622 completed Nutrient Management Plans (NMPs), with an additional 654 approved to be completed.	Helping farmers with nutrient management plans.	RB209 approach? All of these include soil analysis, and tend to be identifiable by field number.	tbd

Organisation/Programme	What	Why	How	When
Wales soil moisture network https://www.aber.ac.uk/en/dges/research/earth-observation-laboratory/research/wsmn/	4 sites in wales where soil moisture is measured with sensors		4 sites with in situ soil moisture sensors.	
NRW Soil Temperature measurement network https://businesswales.gov.wales/farmingconnect/information-hub/soil-temperature	Soil temperature		10 sites across Wales	
NRW	-Land use/cover change incl development (via EO). -Land management. e.g. burning (via EO). - EO-derived habitat maps	Knowledge of habitat distribution is important resource supporting strategic as well as operational uses. Detection of changes in habitat/land cover/land use supports targeting of both monitoring and operational interventions.	Current focus is on use of imagery available from Sentinel satellites; methods vary depending on specific application.	Most recent Wales-wide habitat map used imagery from 2003-6. More recent analysis of semi-natural habitat extent has used imagery from 2016 and 2017 (and may include 2018).
NRW	Protected sites monitoring (CSM) of SSSIs, European sites and Ramsars. In Wales focus is on SACs based around a 6 year monitoring cycle. The SAC programme covers a total of 407 features (90 from freshwater, 70 from marine and 247 from the terrestrial environment). Resource constraints have meant the current programme cycle has been reduced byc.60-70%.	Site Condition Monitoring is the assessment of the condition of interest features on protected sites (SSSI, N2K, Ramsar sites) based on Common Standards Monitoring Guidance. CSM is not a network exactly, it is a common approach to monitoring SSSIs, European sites and Ramsars. (see: http://lle.gov.wales/catalogue/item/SACSPAMonitoringProgrammeResults/?lang=en).	The monitoring is undertaken by each of the Country Conservation Bodies and as such is owned by them. (Process is currently under review by JNCC). In Wales the SAC programme aims to assess condition of each feature once in each 6 year cycle. Though resources have significantly reduced this level of delivery. In Wales programme development is now looking to incorporate a formal SSSI monitoring programme (addressing >1000 sites and c.4200 features) into a wider risk base protected sites monitoring programme.	Since 2004, although some sites have data going back further. CSM guidelines were first published in 2004. Programme aims at a 6 year cycle.
NRW	- Grassland evidence & strategic conservation	Extent and state of targeted lowland grassland sites.	Field based Phase 2 targeted grassland NVC mapping. See: Stevens, D.P., Smith, S.L.N., Blackstock, T.H., Bosanquet, S.D.S. & Stevens, J.P. 2010. *Grasslands of Wales. A survey of lowland species-rich grasslands, 1987–2004.* Cardiff: University of Wales Press. And: Smith, S.L.N., Sutton, M. & Turner, A. In prep. *An assessment of non-designated lowland grassland sites in Wales.* NRW Evidence Report No. 105.	Phase II grassland survey now as an archive 1987 - 2004. Prioritised site targeting - ongoing.
NRW	- Phase 1 Survey (archive)	Characterisation and extent of habitats in Wales.	Field based Phase 1 mapping of habitats in Wales. See: Blackstock, T.H, Howe, E.A., Stevens, J.P., Burrows, C.R., Jones, P.S. 2010 Habitats of Wales : a comprehensive field study, 1979-1997. Cardiff: University of Wales Press.	Archived – 1979 - 1997
NRW	- Phase 2 Peatland survey + ongoing peatland survey - Phase 2 Lowland heathland survey	The Lowland Peatland Survey of Wales is a strategic conservation assessment of the Welsh lowland peatland resource based on the characterisation, mapping and evaluation of plant communities. In most cases the survey is providing the first comprehensive	Field based NVC level targeted survey & mapping.	Peatland survey – 2004 - ongoing Lowland heathland survey – 1993-2002

Organisation/Programme	What	Why	How	When
		assessment of high quality wetlands protected through SSSI and international SAC designations in Wales.		
JNCC	- UK species surveillance schemes (stock & trend) e.g. UKBMS, NBMP. (external)	See JNCC – NRW sits on a range of steering or advisory groups for these schemes (e.g. NBMP http://jncc.defra.gov.uk/page-6857#bats), and associated supporting programmes such as Terrestrial Surveillance and Development etc.	See JNCC - http://jncc.defra.gov.uk/page-6873	Ongoing.
NRW	- Ad-hoc Terrestrial species evidence programmes.	To inform policy and site relevant actions.	Ad-hoc data generation. NRW acts as both a generator of targeted site based data generated though operational work and as a user of data from other schemes and citizen science activity.	Ongoing
NRW (&CEH at network-level)	- ECN Snowdon (incl. UKEAP & Welsh Air quality, AEA) -ECN river Wye	Long-term ecosystem change surveillance. See: http://www.ecn.ac.uk/	Standardised & structured surveillance. NRW runs and resources the Snowdon site in addition to the running of a range of addition surveillance schemes based on the ECN platform. Suite of biological and chemical parameters sampled at river Wye site together with flow gauging.	Ongoing
NRW	Tree disease surveillance	Monitoring to assess tree health and track the spread of tree disease (e.g. phytophthora).	Annual helicopter-based aerial surveys of public and private forests. Field surveys.	Ongoing
NRW	Operational surveys of Welsh Government Woodland Estate	Strategic, operational and tactical surveys and monitoring to: • Inform site management planning and contract management of forest management interventions (e.g. felling) to meet site objectives of long term Forest Resource Plans. • Deliver policy outcomes for improved woodland ecological condition, water quality, tree health etc. E.g. i. Plantation on Ancient Woodlands Sites (PAWS) survey ii. Riparian zone surveys (river walks) iii. Growing stock damage (mammal impact surveys) iv. *Hylobius* beetle survey v. Protected Zone (PZ) surveys covering things like *Ips typographus*, pinewood nematode, Asian longhorn beetle Coupe surveys at FMU level. These are directly related to delivery of forest management activities (felling, restocking, and civil engineering), management of health and safety, meeting legal obligations for protected sites, species and habitats etc. and other liabilities such as drinking water supplies, utilities and forest users.		Ongoing
NRW / Permit holders	Abstraction and Discharge Data	Permit compliance; water resources assessment; catchment loadings.	Flowmeter at point of abstraction; water sample at point of discharge.	Ongoing
NRW	Ospar (Oslo-Paris Convention) riverine contaminant Monitoring	Common programme of marine and estuarine monitoring across NE Atlantic region using a suite of common indicators and assessments. Purpose of this particular monitoring is to assess contaminant load inputs from rivers.	Sampling of contaminant loadings (organics, metals) in rivers immediately above upstream limit of estuaries across Wales. Also sampling of direct discharges to estuaries and sea.	Monthly / quarterly sampling above major estuaries across Wales. Ongoing
NRW	River flows and levels	Short-term flood and drought assessments; abstraction conditions; reservoir releases; water resources position. Longer-term water resource assessments eg. CAMS, WFD.	Continuous recording at fixed network of weirs/gauging stations/level gauges; supported by current meter gauging.	Ongoing
Marine Biological Assoc/NRW/Natural England	MarClim	To investigate the effects of climate change on marine biodiversity.	Surveys of intertidal indicator species – abundance, range, population.	2001 onwards
NRW	WFD suite (chemicals, physio-chem, ecology, fish)	To classify river and lake water bodies in terms of ecological and chemical status; groundwater bodies in terms of chemical and quantitative status (and trends). Also to inform on pressures and impacts.	WQ samples, kick samples, electro-fishing surveys etc. WFD surveillance monitoring – whole suite of chemical, physico-chemical parameters, and ecological indicator species at c.10% of water bodies across Wales. WFD operational monitoring – targeted monitoring of specific determinands and water bodies related to pressure, status, change etc.	Monthly or quarterly WQ samples Twice yearly ecological surveys Based on 3 or 6 yearly cycles from

Organisation/Programme	What	Why	How	When
				2007 to current. Ongoing
NRW	WFD Wetlands (GWDTE)	Monitoring of groundwater dependent wetlands as part of groundwater classification for WFD.	9 wetland sites monitored across Wales twice annually. Water chemistry sampling and water level monitoring.	Ongoing
NRW	Bathing Waters	To determine bathing water quality at designated bathing waters based on bacteriological indicators. Statutory requirement of EC Bathing Waters Directive.	WQ sample collection at bathing waters.	5-16 samples collected at each bathing water during bathing water season (May-Sept) + 1 pre-season sample. Sample nos based on risk of failing directive standards. Ongoing
NRW	WFD TraC (transitional and Coastal, inc. saltmarsh)	Water chemistry, habitat and biological indicator monitoring to classify estuarine and coastal water for WFD.	Various – water chemistry and physiochemical sampling, biological field and aerial survey.	Ongoing
Forest Research	i-Tree	Urban tree sample survey to assess natural capital value of urban tree stock. Surveys undertaken in Swansea, Bridgend and Wrexham.	Location, species, size and health; ecosystem services provided.	Specific surveys Wrexham-2013
NRW (on behalf of WG)	National Habitat Creation Programme	To assess coastal habitat gains and losses (primarily saltmarsh and intertidal habitats) in relation to flood and coastal erosion risk management work. Likely to involve monitoring of extent and condition of Habitats Directive designated feature at coastal margin.	To be determined	Proposed monitoring programme not yet operational
NRW	Seabed mapping / HabMap	Predictive habitat maps of the seabed around Wales using a combination of survey data and predictive modelling techniques.	See NRW website - HabMap[1]	
NRW	Cockle fisheries stock assessment	Annual survey of cockle stock at Dee Estuary and Burry Inlet cockle beds.		Ongoing
NRW	LANDMAP	All-Wales mapping and evaluation of landscape characteristics, qualities and influences on the landscape to support natural resources planning.	Incorporates 5 spatial datasets on Geological Landscape, Landscape Habitats, Visual and Sensory. Historic Landscape, Cultural Landscape. See NRW website - Landmap[2]	Current datasets 2011-13
NRW	LiDAR	Primarily to inform flood-risk mapping and assessment, but increasingly also for forest and landscape structure mapping, and coastal management.	Commissioned aerial surveys; possible all-Wales canopy on and canopy off surveys proposed.	Specific commissioned surveys. Most of lowland Wales and main river valleys covered
NRW	Skomer Marine Conservation Zone	Extensive monitoring and survey of species, communities and habitats in relation to the MCZ.	Varied	Ongoing

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[1] https://naturalresources.wales/about-us/our-projects/marine-projects/habmap/?lang=en
[2] https://naturalresources.wales/guidance-and-advice/business-sectors/planning-and-development/evidence-to-inform-development-planning/landmap-the-welsh-landscape-baseline/?lang=en

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