Cyfoeth Naturiol Cymru
Natural Resources Wales

Review of the Current Conservation Status (CCS) of the Great Crested Newt in Wales, with specific references to its long term prospects and within its stronghold in North-East Wales

Karen Haysom, Dorothy Driver, Mandy Cartwright, John Wilkinson and Jim Foster

Amphibian and Reptile Conservation Trust

Report No. 259

About Natural Resources Wales

Natural Resources Wales' purpose is to pursue sustainable management of natural resources. This means looking after air, land, water, wildlife, plants and soil to improve Wales' well-being, and provide a better future for everyone.

Evidence at Natural Resources Wales

Natural Resources Wales is an evidence based organisation. We seek to ensure that our strategy, decisions, operations and advice to Welsh Government and others are underpinned by sound and quality-assured evidence. We recognise that it is critically important to have a good understanding of our changing environment.

We will realise this vision by:

- Maintaining and developing the technical specialist skills of our staff;
- Securing our data and information;
- Having a well resourced proactive programme of evidence work;
- Continuing to review and add to our evidence to ensure it is fit for the challenges facing us; and
- Communicating our evidence in an open and transparent way.

This Evidence Report series serves as a record of work carried out or commissioned by Natural Resources Wales. It also helps us to share and promote use of our evidence by others and develop future collaborations. However, the views and recommendations presented in this report are not necessarily those of NRW and should, therefore, not be attributed to NRW.

Report series:	NRW Science Report
Report number:	259
Publication date:	September 2018
Contract number:	8018973
Contractor:	Amphibian and Reptile Conservation Trust
Contract Manager:	Matthew Ellis
Title:	Review of the Current Conservation Status (CCS) of the Great Crested Newt in Wales, with specific references to its long-term prospects and within its stronghold in North-East Wales.
Author(s):	**K Haysom, D Driver, M Cartwright, J Wilkinson and J Foster**
Technical Editor:	M.Ellis
Peer Reviewer(s)	
Approved By:	Dr E.A.Howe
Restrictions:	None

Distribution List (core)

NRW Library, Bangor	2
National Library of Wales	1
British Library	1
Welsh Government Library	1
Scottish Natural Heritage Library	1
Natural England Library (Electronic Only)	1

Distribution List (others)

Amphibian and Reptile Conservation Trust, Bournemouth	3
Paul Edgar, Natural England	1
John McKinnell, Scottish Natural Heritage	1
Rob Raynor, Scottish Natural Heritage	1
Wrexham County Borough Council	1
Flintshire County Council	1
Denbighshire County Council	1

Recommended citation for this volume:

K Haysom, D Driver, M Cartwright, J Wilkinson and J Foster. 2018. Great Crested Newt in Wales, with specific references to its long-term prospects and within its stronghold in North-East Wales. NRW Science Report Series. Report No: 259. pp 113, Natural Resources Wales, Bangor

Contents

List of Figures

List of Tables

1. Crynodeb Gweithredol

Y fadfall ddŵr gribog Triturus cristatus yw madfall fwyaf Prydain a'r fadfall ddŵr sydd yn y perygl mwyaf. Mae'r boblogaeth sydd ym Mhrydain o bwysigrwydd Ewropeaidd a byd-eang, gan yr ystyrir ei chynefin ym Mhrydain yn gadarnle i rywogaeth sy'n endemig i Ewrop. Mae'r rhywogaeth wedi mynd trwy ddirywiadau difrifol dros y ganrif ddiwethaf ym Mhrydain ac Ewrop ar nifer o lefelau. Bu i gydnabod y pwysau sy'n effeithio ar y rhywogaeth arwain at y fadfall ddŵr gribog yn cael ei rhestru fel Rhywogaeth a Warchodir gan Ewrop; mae wedi'i rhestru yn Atodiad II a IV Cyfarwyddeb Cynefinoedd yr UE ac yn Atodiad II Confensiwn Bern.
Comisiynwyd yr adroddiad hwn gan Cyfoeth Naturiol Cymru i adolygu amryw elfennau sy'n berthnasol i'r gwaith o asesu statws cadwraeth madfallod dŵr cribog ar lefelau gwahanol (safle, rhanbarth, gwlad), fel rhagflaenydd i'r cylch adrodd Erthygl 17 nesaf y bydd data'n cael ei gasglu ar ei gyfer i adrodd ar yr holl gyfres o rywogaethau a chynefinoedd sy'n cael eu gwarchod gan y Gyfarwyddeb Cynefinoedd ar lefel y DU.
Nod yr adroddiad hwn yw asesu statws cadwraeth cyfredol y fadfall ddŵr gribog ar lefel gwlad a lefel sir yng Nghymru, gan ystyried ei statws hanesyddol tebygol.
Ffocws penodol yr adroddiad yw cadarnle'r rhywogaeth yng ngogledd-ddwyrain Cymru. Mae gan yr adroddiad chwe amcan clir:
Darparu asesiad o statws cadwraeth cyfredol y boblogaeth o fadfallod dŵr cribog yng Nghymru, a chysylltu hwn â'r statws cadwraeth hanesyddol a ragfynegir ar ei chyfer
Darparu asesiad o statws cadwraeth cyfredol y rhywogaeth ar lefel sir a chysylltu hwn â'r statws cadwraeth hanesyddol a ragfynegir ar ei chyfer. Bydd angen rhoi pwyslais penodol ar bwysigrwydd poblogaethau a leolir o fewn gogledd-ddwyrain Cymru
Ar gyfer safleoedd dethol, gan gynnwys y rhai sy'n gysylltiedig â mesurau lliniaru, adolygu newidiadau i'r boblogaeth leol ac awgrymu rhesymau tebygol pam mae newid wedi digwydd
Rhoi cyngor ynglŷn â methodolegau a dulliau sydd eu hangen i gynnal gwyliadwriaeth yn y tymor hir. Rhagwelir y bydd hyn yn cynnwys dulliau integredig ar gyfer gwyliadwriaeth, adnoddau, a defnyddio adrodd CLYFAR
Rhoi cyngor ynghylch y rhagolygon tymor hir ar gyfer y rhywogaeth mewn ardaloedd gwledig a threfol, yn enwedig o fewn cadarnleoedd hysbys y rhywogaeth
Cynnig a llunio'r sail resymegol ar gyfer dangosyddion perfformiad allweddol ar gyfer rhagolygon tymor hir

Roedd y gwaith yr ymgymerwyd ag ef yn cynnwys coladu ac adolygu deunyddiau ysgrifenedig ymchwil ddiweddar ac adroddiadau llwyd, gan gynnwys yr adroddiadau terfynol o ganlyniad i gyfres o brosiectau a gomisiynwyd gan Cyfoeth Naturiol Cymru, neu ei ragflaenydd Cyngor Cefn Gwlad Cymru, i bennu statws cadwraeth cyfredol y rhywogaeth ar amryw lefelau daearyddol ac i wella'r seilwaith ar gyfer monitro ei statws a llywio gweithgareddau cadwraeth. Gwnaethom hefyd archwilio'r cynlluniau rheoli craidd a phrotocolau monitro ar gyfer Ardaloedd Cadwraeth Arbennig dethol a safleoedd eraill.
Archwiliwyd data o gronfa ddata madfallod dŵr cribog, sef Cronfa Ddata Monitro GCN Cymru Ar-lein, a chynhaliwyd rhai dadansoddiadau archwiliadol. Dylid ystyried mai'r rhain yw profion cyntaf systemau rheoli data a ddatblygwyd yn ddiweddar, a'u

bod yn dangos y dylid archwilio llwybrau ymchwilio ymhellach wrth i ddata ac adnoddau gwell ganiatáu. Mae allbynnau'r contract hwn, felly, yn cynnwys gwybodaeth wedi'i choladu, casgliadau, sylwadau ar y graddau y gellir ystyried y data sydd ar gael ar hyn o bryd yn gadarn, ac argymhellion ar gyfer rhagor o ddadansoddiadau, meysydd gwaith a datblygu systemau.

Mae amcangyfrifon diweddar o gynefin a phoblogaeth y fadfall ddŵr gribog ar gael ar gyfer Cymru, a'r siroedd sydd â'r poblogaethau pwysicach o fadfallod dŵr cribog, trwy gyfres o adroddiadau a gomisiynwyd gan Cyfoeth Naturiol Cymru rhwng 2014 a 2017. Mae'n rhesymol dod i'r casgliad fod y boblogaeth bresennol o fadfallod dŵr cribog ledled Cymru, er ei bod yn cynrychioli cadarnle Ewropeaidd, yn is na lefelau hanesyddol o gryn dipyn. Mae'r rhywogaeth yn agored i fygythiadau a phwysau sy'n parhau ac yn debygol o fodoli yn y dyfodol megis newid y ffordd y defnyddir tir, newid yn yr hinsawdd a dilyniant hydroseral. Mewn rhai lleoliadau, mae'r cyfleoedd ar gyfer creu cynefinoedd newydd i estyn a chysylltu poblogaethau eisoes yn gyfyngedig o ganlyniad i faint mae'r ffordd mae tir yn cael ei ddefnyddio wedi newid. Bu i werthusiad o ddynodiadau safleoedd, amcanion rheoli a phrotocolau monitro ar gyfer detholiad o Ardaloedd Cadwraeth Arbennig ganfod gwahaniaethau rhwng y fethodoleg a ddefnyddir yng Nghymru a chanllawiau Monitro Safonau Cyffredin Cyd-bwyllgor Cadwraeth Natur, yn ogystal â rhywfaint o anghysondeb rhwng Ardaloedd Cadwraeth Arbennig gwahanol. Cafodd addasrwydd a'r defnydd o amryw ddangosyddion perfformiad eu hystyried. Cynigir argymhellion i gryfhau asesiadau statws cadwraeth, y fframwaith monitro rhywogaethau a chynefinoedd, y defnydd o ddangosyddion perfformiad ar safleoedd dynodedig, a rheoli data.

1. Executive Summary

The great crested newt *Triturus cristatus* is Britain’s largest and most threatened newt. The British population is of European and global importance, as the British range is regarded as the stronghold of a species that is endemic to Europe. The species has undergone serious declines over the last century in Britain and Europe at a number of scales. Recognition of the pressures acting on the species led to the great crested newt being listed as a European Protected Species; it is listed on Annex II and IV of the EC Habitats Directive and Appendix II of the Bern Convention.

This report was commissioned by Natural Resources Wales to review various elements relevant to the assessment of the conservation status of great crested newts at different scales (site, region, country), as a precursor to the next Article 17 reporting cycle, for which data will be gathered to report on the full suite of species and habitats protected by the Habitats Directive at UK scale.

This aim of this report is to assess the current conservation status of great crested newt at country and county levels in Wales, with regard to its likely historic status. A

particular focus of the report, is the species stronghold in north-east Wales. The report has six explicit objectives:

- To provide an assessment of the current conservation status of the Welsh population of great crested newts and relate this to its predicted Historic Conservation Status;
- To provide an assessment of the current conservation status of the species at county levels and relate this to its predicted historic conservation status. Particular emphasis will need to be given to the importance of populations located within north east Wales;
- For selected sites, including those associated with mitigation, to review local population changes and suggest likely reasons why change has occurred;
- To advise on methodologies and approaches required to sustain long term surveillance. It is envisaged that this will include consideration of integrated approaches to surveillance, resources, and utilization of "SMART" (Single-entry Multiple Applications for Reporting Trends) reporting;
- To advise on the long term prospects for the species within both rural and urban areas, particularly within known strongholds for the species; and
- To propose and articulate the rationale for long term prospects Key Performance Indicators (KPI's).

The work undertaken involved collation and review of recent research literature and grey reports, including the final reports resulting from a suite of projects that were commissioned by NRW or its predecessor CCW to determine the current conservation status of the species at various geographical scales and to improve the infrastructure for monitoring its status and informing conservation activity. We also examined the core management plans and monitoring protocols for selected SACs and other sites. Data downloaded from the Online Wales GCN Monitoring Database was examined and some exploratory analyses were undertaken. These should be regarded as first tests of recently developed data management systems and illustrative of avenues of investigation that should be further explored as improved data and resources allow. The outputs of this contract therefore comprise collated information, conclusions, comments on the degree to which data available at present may be considered robust, and recommendations for further analyses, work areas and system development.

Recent estimates of range, population and habitat for great crested newt are available for Wales and the counties with the most important populations of great crested newt through a series of reports commissioned by NRW between 2014 and 2017. It is reasonable to conclude that the present population of great crested newts across Wales, while representing a European stronghold, is significantly below historic levels. The species is vulnerable to ongoing and likely future threats and pressures such as land-use change, climate change and hydroseral succession; in some localities there is already limited scope to create new habitat to extend and connect populations due to the extent of land-use change. Evaluation of site designation, management objectives and monitoring protocols for a selection of SACs found differences between Welsh methodology and the JNCC Common Standards Monitoring guidance, as well as some inconsistency between different SACs. The suitability, and application, of various performance indicators was considered. Recommendations to strengthen conservation status assessment, the species and habitat monitoring framework, use of performance indicators at designated sites and management of data are proposed.

1. Introduction

The great crested newt *Triturus cristatus* is Britain's largest and most threatened newt (Gleed-Owen 2007). The British population is of European and global importance, as the British range is regarded as the stronghold of a species that is endemic to Europe (Gleed-Owen 2007). Although it is nationally widespread, in some areas it is localised, influenced by the availability of suitable breeding ponds, water and habitat quality and the connectivity between breeding sites. In Wales the most significant populations occur in the north-east (French *et al*. 2014), where the density of ponds is higher than in many other areas (Gleed-Owen 2007).

Serious declines over the last century have been reported in its range and population in Britain and Europe at a number of scales. In Britain, Beebee (1975) estimated 50% loss of populations in the 1960s. Later evidence from local case study information suggested that losses had continued at around 2% every five years (Nicholson & Oldham 1986). Recognition of the pressures acting on this species led to it being designated as a European Protected Species; it is listed on Annex II and IV of the EC Habitats Directive and Appendix II of the Bern Convention. It is also protected under UK domestic legislation where it is listed on schedule 2 of the Conservation of Habitats and Species Regulations 2017 and on schedule 5 of the Wildlife and Countryside Act 1981 (as amended). In Wales it is listed under the provisions of section 7 of the Environment (Wales) Act 2016. Under the UK Biodiversity Action Plan which operated between 1994 and 2012 (see JNCC.defra.gov.uk/ukbap); it was one of the original species to be assigned a Species Action Plan, for which it qualified as a species listed on the Habitats Directive, Bern Convention and Wildlife & Countryside Act 1981. The importance of the UK population as a proportion of the European population, and the reported significant decline would also have been important factors leading to its designation as a UK BAP species. The UK Biodiversity Action Plan considered it to be a species likely to benefit from enhanced site protection, implementation of reintroductions, and implementation of wetland or pond restoration (Plowman, 1995). ARC took on the role of one of the lead partners for the species in 1995, and has continued in its lead role voluntarily beyond the term of the original UK Biodiversity Strategy.

Gleed-Owen (2007) considered the greatest on-going threat to the great crested newt in Britain to be the deterioration and loss of suitable breeding ponds driven by human action e.g. agricultural intensification and urban development and natural processes e.g. seral succession. In northeast Wales, Gleed-Owen (2007) identified several explicit threats namely: terrestrial and aquatic habitat loss, degradation and isolation; agricultural intensification and inappropriate land management; urbanisation; introduction and colonisation by fish, waterfowl and non-native invasive plant species. There are now five Special Areas of Conservation (SAC) in Wales where important populations of great crested newt were the primary driver for site designation or a key interest feature (Halkyn Mountain SAC, Johnstown Newt Sites SAC, Deeside and Buckley Newt Sites SAC, Glan-traeth SAC and Granllyn SAC). The species is also listed as an interest feature on eight SSSIs, most of which underpin the SACs. Some populations are on land owned or managed by heritage or conservation organisations such as National Trust, county wildlife trusts, ARC or local government and set aside for the conservation of habitats or species. While protected sites make a contribution to species protection, and are also important in demonstrating appropriate habitat management, the status of comparatively widespread species, such as great crested newt is, however, ultimately dictated by factors operating in the wider countryside, *i.e.* land outside the protected area network.

This report was commissioned by Natural Resources Wales to review various elements relevant to the assessment of the conservation status of great crested newts at different scales (site, region, country), as a precursor to the next Article 17 reporting cycle, for which data will be gathered to report on the full suite of species and habitats protected by the Habitats Directive at UK scale (see http://jncc.defra.gov.uk/page-4060 for details of previous reports and approaches). The concept of conservation status, and an evaluation of when this is considered to be at a favourable level, is a key element underpinning the implementation of the Habitats Directive and the reporting requirements therein. Its definition has been largely based around the approach provided in Article 1 of the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention 1979); this convention also included a reference to the restoration of historic distributions and abundance. The concept of conservation status is valuable in supporting outcome focused approaches to conservation management. It is anticipated that after the UK

leaves the European Union, international obligations will remain in place for great crested newt conservation and for the reporting of their status, due to their being listed on Appendix II of the Bern Convention 1979 and noting the increasing convergence between Habitats Directive and Bern convention reporting approaches; in particular, the decision of the Standing Committee to the Bern Convention to report on the conservation status of species and habitats under Resolution 8(2012) (see https://rm.coe.int/1680746515).

This project comes at a time when, the availability of new technologies (e.g. Biggs *et al.* 2015) has expanded rapidly the options for monitoring this species (e.g. Ewald et al. (2018)) and political, business and nature protection drivers have resulted in a significant amount of interest in the species and a diversification of approaches to its assessment across the UK.

An early attempt to quantify changes in great crested newt status in Wales, employing approaches including assessment of historical pond loss and spatial (GIS) modelling approaches, was carried out by Gleed-Owen (2007) in conjunction with Forest Research. This was further developed by ARC and Cofnod (2010), who first investigated the use of Biomapper GIS software and its application to Favourable Conservation Status (FCS) and Favourable Reference Value (FRV) concepts. This work was funded by the Countryside Council for Wales (CCW), now NRW.

NRW and the Welsh Government (WG) have all seen the potential value and application of spatial techniques to elaborating great crested newt status in the context of a policy and planning environment where the location, population trajectory and overall status of every great crested newt population is not wholly known due to finite resources. Various developments of the modelling of great crested newt status in the key areas of Wales (i.e. those areas considered to host the natural distribution of great crested newts in the country; broadly Anglesey, NE Wales, Powys and S Wales east to Gower) have therefore been carried out, resulting in further modelling based on Maxent (Maximum Entropy) GIS software and employing the approach to historical pond losses developed by Gleed-Owen (2007). This has led to reports covering Powys and the Brecon Beacons (Arnell and Wilkinson 2013a), Anglesey and the North East (Arnell and Wilkinson 2013b) and South Wales (Fletcher *et al*. 2014a), culminating in

a report combining these model outputs that covers the species Welsh range (French *et al*. 2014b). The latter included methods for deriving FCS metrics from the modelling that have application to EU Article 17 reporting, as well as suggestions for developing the utility of modelling-derived metrics to guide other assessments of status and subsequent target setting.

These approaches have been yet further explored by examination of the contemporary collection of field survey data and its application and suitability for generating data to derive a comprehensive and integrated suite of repeatable metrics on which to base assessment of status at scales from population ("pond") to country (Wilkinson *et al*., 2015a; Wilkinson *et al*., 2015b). These authors recognised the wealth of data arising from great crested newt surveys coming out of (especially) North East Wales but noted that, though several approaches (such as aggregating scores on population trajectory and HSI etc. to produce overall positive or negative scores for any given scale) showed promise, comprehensive assessment was impossible due to the range of ways in which field data was supplied and recorded. Wilkinson *et al*. (2015b) suggested a spreadsheet-based recording remedy for this issue, whereby all recorders would add data to a spreadsheet employing "forced-choice" responses to create consistency. This, however, was considered cumbersome by likely users and a more elegant solution in the form of an on-line recording system designed specifically for recording great crested newts (and other amphibians) in Wales was developed by Cofnod, in consultation with ARC and NRW staff based on the earlier work (*ibid.*). The implementation of this system was funded by WG and has currently attracted over 24,000 contemporary and historical amphibian records from more than 1,000 ponds in North East and Mid-Wales. The ponds in the database are a selection of long-term monitoring sites and include post development mitigation sites.

This aim of this report is to assess the current conservation status of great crested newt at country and county levels in Wales, with regard to its likely historic status. A particular focus of the report, is the species stronghold in north-east Wales. The report has six explicit objectives:

- To provide an assessment of the current conservation status of the Welsh population of great crested newts and relate this to its predicted Historic Conservation Status;

- To provide an assessment of the current conservation status of the species at county levels and relate this to its predicted historic conservation status. Particular emphasis will need to be given to the importance of populations located within north east Wales;

- For selected sites, including those associated with mitigation, to review local population changes and suggest likely reasons why change has occurred;

- To advise on methodologies and approaches required to sustain long term surveillance. It is envisaged that this will include consideration of integrated approaches to surveillance, resources, and utilization of “SMART” (Single-entry Multiple Applications for Reporting Trends) reporting;

- To advise on the long term prospects for the species within both rural and urban areas, particularly within known strongholds for the species; and

- To propose and articulate the rationale for long term prospects Key Performance Indicators (KPI’s).

The assessments made in this report have been undertaken through collation and review of recent research literature and grey reports, including the final reports resulting from a suite of projects that were commissioned by NRW or its predecessor CCW to determine the current conservation status of the species at various geographical scales and to improve the infrastructure for monitoring its status and informing conservation activity. As a short contract, time limits the scope for primary research, but where relevant and where data allowed, some new exploratory analyses have been undertaken. These should in the main be regarded as first tests of recently developed data management systems and illustrative of avenues of investigation that should be further explored as improved data and resources allow. The outputs of this contract therefore comprise collated information, conclusions, comments on the degree to which data available at present may be considered robust, and recommendations for further analyses, work areas and system development.

3. Current conservation status of the Great Crested Newt in Wales

Objective: To provide an assessment of the current conservation status of the Welsh population of great crested newts and relate this to its predicted Historic Conservation Status

3.1 Introduction and method overview

The most recent attempt to quantify the conservation status of the great crested newt at country level in Wales was undertaken by Fletcher *et al*. (2014b) under contract to Natural Resources Wales. The work was commissioned as a step to enhancing the quality of information submitted by the UK in the EC Habitats Directive Article 17 reporting cycle that is mandatory to Member States; in the second Article 17 status assessment which covered the period 2007 - 2012 great crested newt had been assigned the status "Unknown XX" due to uncertainty regarding the population, habitat and future prospects components of the assessment. Fletcher *et al*. (2014b) deployed fine-scale Geographical Information Systems (GIS) approaches to determine quantitative and spatially referenced metrics of features relevant to great crested newt range, population, habitat and future prospects. Fletcher *et al.* (2014b) aggregated the results of several other recent studies that had used fine-scale modelling to generate 25 m resolution spatial outputs relevant to species status measures at regional scale. The main tool used was Maximum Entropy Modelling, (MaxEnt or Multinomial Logistic Regression), which when provided with a training set of species record map coordinates and relevant geographical and habitat GIS layers, may be used to predict areas where habitat appears likely to be suitable for a species. Sub-sampling and re-apportioning records between training and testing datasets allows the fit of such spatial models to be examined, and also has the advantage of being a repeatable methodology capable of being applied after time has elapsed to assess change.

The short time-frame and broader scope of the current contract did not permit a repeat of the data analyses undertaken by French *et al*. (2014b). It was also considered unlikely that sufficient time had elapsed for any change to be detectable, particularly as the majority of species records available currently, would also have been used in the earlier study. We therefore draw predominantly on the findings of these or other

recent studies to summarise status parameters at Wales scale. However, a search of the ARC Living ARCive amphibian and reptile records database was undertaken to ensure that new data gathered since the previous studies could be taken into consideration, at least to the extent of evaluating whether the results of these previous reports were likely still to apply. A data request was also submitted to Freshwater Habitats Trust for recent species records generated by the PondNet eDNA monitoring programme (Ewald *et al*. 2018).

Table 1 . Estimated status metrics for great crest newt in Wales according to French et al. (2014). These estimates were derived using Maximum Entropy Modelling (Max Ent) aka Multinomial Logistic Regression approaches and were based on a total Wales area of 20,761 km2, a total number of ponds of 30,056, a number of ponds in size range typically used by great crested newts of 19,899 and a regional HSI >0.7 of 24.75%.

FCS Criterion	**Measure**	**Estimate**
RANGE (extent of occupancy)	Total km^2	7312
	Proportion of Wales	35.2%
POPULATION	No. of occupied ponds	3271
	Ponds occupied by GCN as a proportion of total ponds in Wales	11%
	Ponds occupied by GCN as a proportion of ponds in Wales that are a typical size for GCN use	16%
	No. high quality ponds (HSI >0.7*)	810*
HABITAT(extent of suitable habitat)	Total km^2	2170
	Proportional to Wales	10.5%
	Proportional to range	29.7%

* Within modelled range area and typical size range.

3.2 Range

French *et al*. (2014) adopted a more conservative approach to determining the range metric generally applied by JNCC (JNCC 2013a) because an “Extent of Occupancy” approach where the range is assigned to be the area that is defined by the shortest line encompassing all observations of the species can result in an overestimate (Wilkinson *et al*. 2011). This is likely to occur when animals with relatively low mobility, such as great crested newt, are absent from large areas within this outer perimeter. In such cases a method that deducts areas of absence from the total area within the boundary is more appropriate. French *et al*. (2014) therefore used a convex hull algorithm (Pateiro-Lopez & Rodriguez-Casal, 2013), and trialled several values of alpha to select the one that best represented observed species distribution in Wales. The resulting range of the great crested newt in Wales is shown by the red hashed area in Figure 1 and was estimated to represent approximately 7312 km^2, equivalent to 35.2% the total area of Wales (Table 1).

The modelled data shows that the great crested newt occupies a broad eastern strip of Wales running continuously from north to South, excepting the Brecon Beacons, and also occurs throughout the island of Anglesey. The main hotspots of occurrence were defined as north Denbighshire, Flintshire, parts of central eastern Powys, northern Rhondda, Merthyr Tydfil and neighbouring authorities, southern Bridgend, the whole of the Vale of Glamorgan, parts of Cardiff, Newport and Monmouthshire (French *et al*. 2014). Smaller suitable areas of habitat were described in Anglesey (“especially Holy Island”), Gower and the eastern half of Powys. Altitude was cited as the most likely historic and current barrier to dispersal in explanation for the absence of the species from south-western Denbighshire and most of western Powys. Physical barriers to dispersal (altitude and large rivers) were believed to account for the absence of the species in Pembrokeshire, even though its habitat appears otherwise suitable. French *et al*. (2014) recommended increased survey effort at the boundaries of the present known range i.e. the western edge and Brecon Beacons to enable the enhancement of future models and status assessments. In the period since their assessment, however, it appears that most of the new species records have arisen from, or close to, locations where the species was already known (see Figure 2), so this remains a recommendation.

Figure 1
Range of great crested newt in Wales (red hashed area, 7312km^2), estimated using species distribution records and the concave bounding polygon method (alphahull = 8000) after French *et al*. (2014). Blue diamonds represent ponds predicted to be suitable for great crested newts which lie outside the present known range but within counties where the species is native (cream area) after French *et al*. 2014.

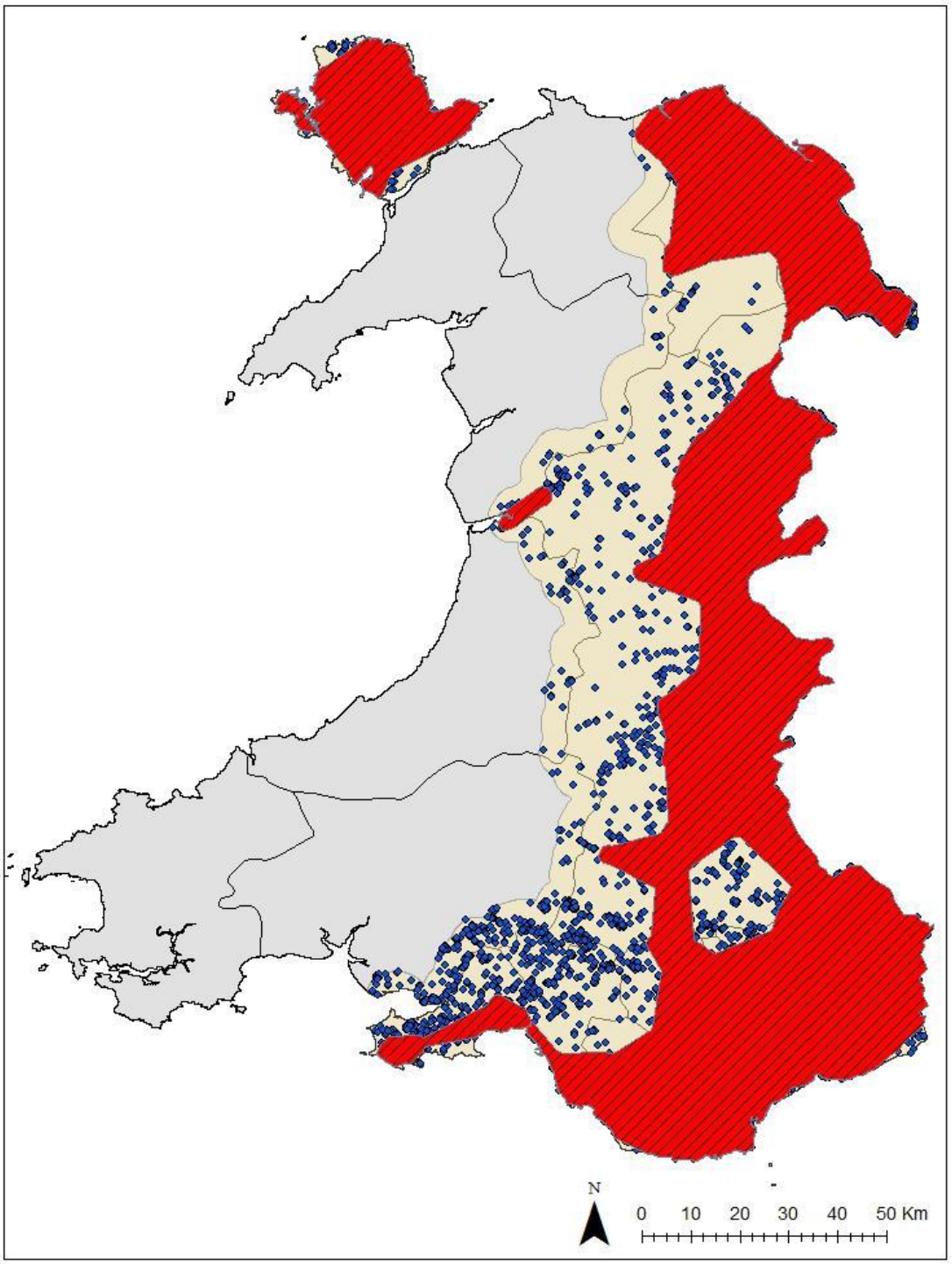


Figure 2
Map showing the location of great crested newts recorded in Wales. Pink dots represent records that were available at the time of French *et al*. (2014). Green dots show the location of records accrued since this report.

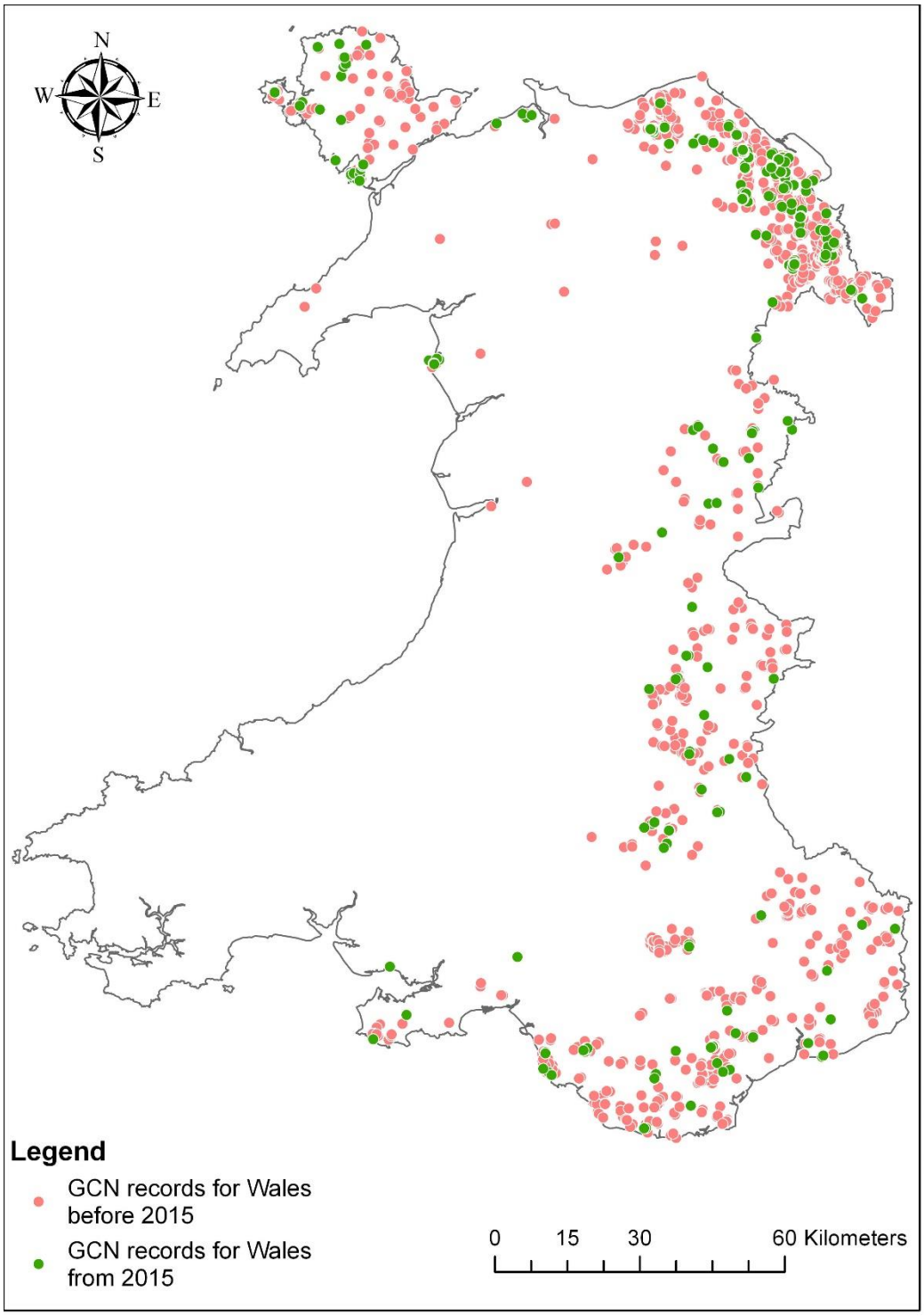


Table 2. The number of records of great crested newt in Wales up to 2017. Data are organised by Watsonian vice-county. Source: ARC Living Archive database.

County	Total GCN records found up to 2017	Total 1km locations recorded up to 2017
Anglesey	880	79
Breconshire	358	43
Caernarvonshire	60	9
Cardiganshire	2	1
Carmarthenshire	2	1
Denbighshire	5642	169
Flintshire	9769	165
Glamorganshire	1468	162
Merionethshire	56	9
Monmouthshire	301	90
Montgomeryshire	323	51
Radnorshire	304	80

3.3 Population

Since the reporting metric used to report status and change in populations of great crested newt in the most recent UK Article 17 report was the number of ponds occupied by great crested newt (JNCC 2013b) French *et al*. (2014) used GIS modelling approaches, species records data and habitat and pond GIS layers to generate estimates of the number of ponds of suitable size, number of likely occupied ponds and number of ponds with high (0.7 or above) score on the Habitat Suitability Index. This index is widely used to infer the suitability of a pond for maintaining a robust local population of great crested newt (Oldham *et al*. 2000).

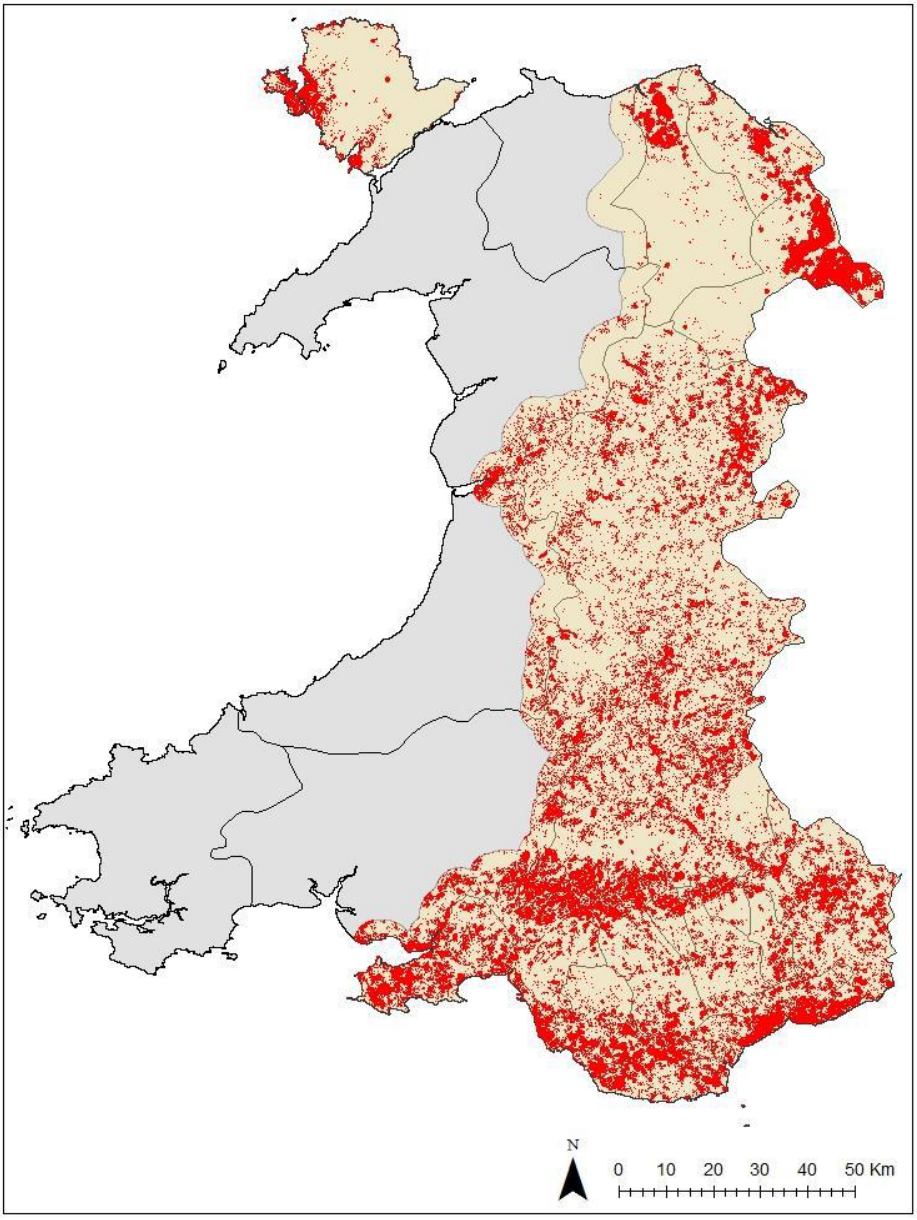
French *et al*. (2014) estimated that approximately 3271 ponds in Wales (around 11% of all ponds in Wales, or 16% of ponds of the size typically used by great crested newt) were likely to be occupied by the species. French *et al*. (2014) commented that there was a strong association between occurrence of great crested newt and areas of high pond density. The strong association between hotspots of great crested newt and the density of ponds may be used to support the argument that great crested newt populations are likely to be much lower in Wales compared to

their status historically because, as in other areas of the UK, there have been substantial losses of ponds over the past hundred years. In an area of northeast Wales around Wrexham, Gleed-Owen (2007) estimated net pond loss rates of around 37% over a period of 160 years since the 1840s (Gleed-Owen 2007). This would also have coincided with other factors likely to have impacted on great crested newt populations such as agricultural intensification and changes in water quality. There has been no new evidence since the French *et al*. (2014) report on which to build a significant revision of these estimates.

3.4 Habitat

French *et al.* (2014b) identified suitable habitat for great crested newt in Wales using species record data, various GIS habitat data layers and MaxEnt models which were mapped spatially (Figure 3) and quantified in km^2. This process determined that suitable habitat extends beyond the range that the species occupies presently (see Figure 1). The area of suitable habitat that occurred within the range of great crested newt was estimated to be 2170 km^2, representing approximately 10.5% of the total area of Wales and 29.7% of the defined species range (Table 1). An earlier assessment exercise using a coarser modelling approach and phase 1 habitat data (Wilkinson *et al.* 2011) had estimated the amount of suitable habitat to be around 1989 km^2. Fletcher *et al*. (2014 a) found that the best indicators of habitat suitable for great crested newt were, in descending order of importance pond density, seasonality of precipitation, land cover type and slope followed by bioclimatic variables that influence newt breeding success. This modelling approach was later improved by incorporating information on flood plains, as areas prone to regular flooding are at higher risk of introductions of fish that predate great crested newt. Not incorporating data on floodplains may lead to the area of habitat and number of ponds suitable for the species being overestimated (Russell *et al*. 2017a,b,c).

Figure 3
Extent of modelled suitable habitat (red) for great crested newts in Wales (based on 25 x 25 m cells) within the total area of model output (pale orange). Total extent = 4,199 km^2, clipped to known GCN range = 2,664 km^2 reproduced from French *et al.* (2014). The area encloses all counties where the species extending beyond, but including, the present known range (see Figure 1).



3.5 Future prospects

No earlier report has defined this conclusively at Wales level, and this remains the most challenging of the component measures of conservation status to define with certainty. Rather than being a judgement derived from the three measures of status discussed above, it is desirable that this evaluation also takes account of other pressures acting on the species, the anticipated trend in these pressures and the

likelihood of change in exposure to risks such as disease. For example, the predicted impact of future land-use change, urbanisation, agricultural policy, climate change etc. Modelling approaches similar to those deployed by French *et al*. (2014) and other studies could be adapted to define possible outcomes over different climate and development scenarios or in response to other potential pressures such as the spread of disease (e.g. Spitzen-van der Sluijs *et al*. 2013).

4. Current conservation status of the Great Crested Newt in the counties of Wales

Objective: To provide an assessment of the current conservation status of the species at county levels and relate this to its predicted historic conservation status, with particular emphasis on north east Wales

4.1 Overview

A number of recent studies have examined the status of great crested newts at regional or county scales. In 2007, a review to collate and map records of great crested newts in the four counties of northeast Wales found 693 records (Conwy 8, Denbighshire, 105, Flintshire 282, Wrexham 298) (Gleed-Owen 2007). While the majority of records were associated with newt ponds, it was noted that it was difficult to use the data to count the total number of newt ponds, nor to use the data for temporal analyses owing to inconsistencies in data collection and storage formats (Gleed-Owen 2007). Gleed-Owen (2007) recommended the development of an inventory of all great crested newt ponds in combination with a systematic monitoring scheme such as NARRS and database in order to develop a more robust structure for monitoring change in the status of great crested newt in Wales. In response to these recommendations the Online Wales GCN Monitoring database was established, and a comprehensive data collation exercise was undertaken to gather and store records centrally. The database has subsequently been promoted as the primary resource for holding the results of site monitoring, across Wales.

More recent attempts to examine the current and favourable conservation status of great crested newts in selected Welsh counties (e.g. Arnell *et al*. 2013, Fletcher *et al*. 2014a, Russell *et al*. 2017a,b,c) have deployed searches of species records in combination with high resolution GIS modelling approaches. This section collates relevant results of studies that have focused on individual Welsh counties or the northeast Wales region. Additionally, for northeast Wales, the Online database has been explored with regard to its potential use for generating trends and informing other elements of conservation assessment at different scales. Some preliminary analyses were undertaken for purposes of illustration.

Coordinated site and species monitoring, indeed widespread species recording, is a relatively recent phenomenon. While there is compelling anecdotal evidence to suggest severe declines of great crested newt across many counties of Wales, because of general landscape changes and issues that have occurred across the UK such as agricultural intensification, urbanisation and fish introductions, much of the change is believed to have occurred before species recording systems were in place. To develop a quantitative context for presumed historical declines in great crested newt it has been necessary to infer likely changes by reference to documented changes in the habitat features with which the species is most closely associated. Gleed-Owen (2007) examined changes in pond density in northeast Wales over a period of approximately 160 years. Ponds were identified and counted on Ordnance Survey maps in a sample of 25 1km squares that contained modern great crested newt records which were selected at random across the great crested newt's range in Flintshire, Denbighshire, Wrexham and Conwy. The sample was stratified so that 12 of the squares fell in a 10 x 10km grid around Wrexham and the remaining 13 throughout other areas of the four counties. The exercise was repeated for the same sample of 1km squares for a modern map and four historical periods. The time period considered was somewhat arbitrary, reflecting the availability of adequate maps; the earliest suitable maps dated from the1840s. Over this period approximately there was a 37% net loss of ponds, with the most rapid loss occurring between the final historical period studied (1919-1939) and the present day as at time of study (2007). Spatial variations in the rate of loss were very large, with the largest change recording a net loss of 88% of the ponds that had been present in the earliest historic period.

While these data are indicative of the scale and direction of trend, the quantitative accuracy, and degree to which change may vary geographically among the Welsh counties is uncertain, due to the relatively small sample that could be examined in the time available. Gleed-Owen (2007) postulated that the loss rate may not correspond directly to rate of decline in newt populations. The proportion of ponds occupied by great crested newts may thus have varied over time, although only present day estimates are available. In the sample of squares studied, 35% of ponds were known to be occupied. Rates of newt population loss may have been higher than net pond loss due to the additional impacts of factors known to degrade the suitability of ponds to sustain great crested newt populations. These include pond isolation, fish stocks,

non-native plants, agricultural practices and it is therefore plausible that declines in newts may have been higher than net loss of ponds alone suggests. Never-the-less, Gleed-Owen (2007) remains the most geographically relevant estimate of change in pond density available, and has been used to predict the likely historic pond resource in all the studies summarised below.

4.2 County-level summaries

Northeast Wales:

Conwy

No study analogous to the series of reports described below for other counties has been undertaken for the county of Conwy.

Flintshire

Flintshire is, with other areas of northeast Wales, regarded as one of the strongholds of the great crested newt in the UK (Jehle *et al*. 2011). Soil type, geology and farming history have resulted in a high density of ponds that are suitable for the species especially in southeast Flintshire (Russell *et al*. 2017c). There are two SACs that are internationally significant sites for the species, namely Deeside and Buckley Newt Site SAC, encompassing Buckley Clay Pits & Commons, Connahs Quay Ponds & Woodlands and Maes y Grug Sites of Special Scientific Interest and Halkyn Mountain SAC which comprises Halkyn Common & Holywell Grasslands and Herward Smithy SSSIs. As in other areas of the UK, great crested newts are known to have declined in Flintshire (Russell *et al*. 2017).

Russell *et al*. (2017c) used high resolution spatial modelling approaches, previously developed in other project work in north Wales, to review aspects of the current and favourable conservation status of the great crested newt in Flintshire. The modelling process identified a total of 1116 extant ponds in the county, of which 174 were estimated to be currently occupied by great crested newts. Based on the 37% rate of pond loss estimated by Gleed-Owen (2007) it was predicted that the number of ponds occupied by great crested newts in the county in 1843 may have been around 258 out of a predicted total resource of 1659 ponds.

Denbighshire

No study analogous to the series of reports described for other Welsh counties has been undertaken for the county of Denbighshire.

Wrexham

Wrexham forms part of the northeast Wales stronghold for great crested newts in the UK (Jehle *et al*. 2011). As in the neighbouring county, Flintshire, it appears that soil type, geology and farming history have led to a high density of suitable ponds in lowland areas, and the species is widespread. One protected area, the Johnstown Newt sites SAC, has been designated as internationally important for great crested newts; the SAC comprises the Stryt Las a'r Hafod SSSI. The species is known to have declined in the county historically and there are on-going issues at certain sites. For example, surveillance undertaken to inform the Wrexham Industrial Estate Road Improvement Scheme concluded that hydroseral succession had impacted negatively on great crested newt and may have been associated with its decline; the survey found a decline in the proportion of ponds containing great crested newt between 2000 and 2009 in the southern route survey area (Anon. 2010). Surveillance for the road scheme also analysed aerial photographs that were available for four years between 1974 and 2006 and concluded that these showed evidence of succession. Ground surveys in 2008 found many ponds had been encroached by *Salix* and *Typha*. A high resolution spatial modelling exercise to examine aspects of the current and favourable conservation status of the great crested newt in the county identified 2593 extant ponds and predicted 403 ponds would be occupied by the species. Based on the 37% rate of pond loss estimated by Gleed- Owen (2007) it was predicted that the number of ponds occupied by great crested newts in the county in 1843 may have been around 640 out of a predicted total resource of 4116 ponds.

Northwest Wales

Anglesey

Anglesey is at the western edge of the great crested newt's range and the county is considered important for the species within Wales, hosting some important populations. For example, at Glan-traeth, an SAC and SSSI have been designated in

part because the site is of international importance for the species. Great crested newts are reported to have declined on Anglesey (Russell *et al*. 2017a).
Russell *et al*. (2017a) used high resolution spatial modelling approaches, previously developed for north Wales, to review aspects of the current and favourable conservation status of the great crested newt in Anglesey. The modelling process identified a total of 2,146 extant ponds in Anglesey, of which 334 were estimated to be currently occupied by great crested newts. Based on the 37% net loss of ponds estimated by Gleed-Owen (2007) for northeast Wales, it was predicted that the number of ponds occupied by great crested newts in the county in 1843 may have been around 464 out of a predicted total resource of 2983 ponds.

Central Wales:

Powys

Arnell *et al*. (2013a) used spatial modelling approaches, previously developed for north Wales, to review aspects of the current and favourable conservation status of the great crested newt in the unitary authority of Powys and the Brecon Beacons National Park. High resolution (25m) GIS modelling (MaxEnt software) was used to assess likelihood of great crested newt presence (distribution) and population connectivity, predicting areas of suitable and core habitat as well as identifying locations meriting future field surveys.

The project collated 1108 recent (from 1990 onwards) records of great crested newt which were aggregated into 196 population clusters. Further spatial filtering gave 149 records that were at least 500m from the nearest other record and of appropriate quality to become a training set for model development.

Suitable habitat was identified mainly in lowland areas in the east of Powys. Areas predicted to be fragmented “core” habitat were found in the north of Powys (above Newtown), and it was recommended that further surveys be targeted here to inform the picture. It appeared that newt populations were in general, poorly connected, owing in part to their sparse distribution. As in some other regions of Wales, outside the north east, survey effort in this area was recognised to have been historically patchy, and this was believed to have influenced to some extent both the analyses of

suitable habitat areas and of connectivity. Similarly record quality was an issue in this study, with a high proportion of the original records found being removed before analyses because they did not meet the criteria required. The authors recommended evaluating connectivity of ponds, as a possibly more robust alternative to modelling connections between actual newt populations. Large areas of potentially suitable habitat were identified as areas to prioritise new survey work, to improve future knowledge of actual species distribution.

As in other areas of Wales, large numbers of ponds were suspected to have been lost since documentation of this feature began in the mid-nineteenth century. The number of extant ponds in Powys excluding the Brecon Beacons National Park in 2007 was estimated to be 4769. The number occupied by great crested newts was 739, assuming a 15.5% occupation rate. Based on the 37% rate of pond loss estimated by Gleed-Owen (2007) for northeast Wales, it was predicted that the number of ponds occupied by great crested newts in Powys in 1843 may have been around 1173 out of a total resource of 7570 ponds.

South Wales:

Fletcher *et al.* (2014a) used spatial modelling approaches to review aspects of the current and favourable conservation status of the great crested newt in south Wales, between Gower and Monmouthshire. This work followed methodologies that were previously developed for similar exercises in north Wales and Powys. High resolution (25m) GIS modelling via MaxEnt was used to develop maps and metrics for great crested newts in 12 south Wales Unitary Authorities. The aims of the project included assessing the known distribution of the species and areas where habitat was predicted to be suitable. It also considered the connectivity of newt metapopulations, suggested appropriate local population targets at the level of the unitary authority, identified areas to prioritise pond or habitat creation and proposed where new surveillance effort should be focused.

The project collated 1382 recent (from 1990 onwards) records of great crested newt which were filtered into 206 records that were of adequate precision, associated with a pond and at least 500m from the nearest other record. Fletcher *et al*. (2014a)

concluded that fairly extensive areas of habitat suitable for great crested newts remain in south Wales, particularly in the east. Species records and model outputs placed the most suitable habitat patches in Bridgend, Vale of Glamorgan, Cardiff and Newport and Monmouthshire, with isolated patches of very suitable habitat identified on the Gower. Suitable habitat in these areas was patchy rather than well-connected.

The relatively small number of distinct great crested newt locations identified in the region (206) was thought to be symptomatic of under-recording, as well as patchy distribution. It is predicted that many ponds have been lost from the region since the middle of the nineteenth century when the first suitable Ordnance Survey maps are available. Modelling predicted current great crested newt might currently occupy 927 ponds out of a regional total of 5980 ponds. Based on the 37% rate of pond loss estimated by Gleed-Owen (2007) for northeast Wales, it was predicted that the number of ponds occupied by great crested newts in south Wales in 1843 may have been around 1471 out of a total resource of 9492 ponds.

With regards to future prospects, Fletcher *et al.* (2014a) anticipated further conflict between great crested newt conservation and other land-uses, due to the most suitable habitat being concentrated at low altitudes in southern unitary authorities within the region that are already fairly urbanised. This conclusion was given further weight by a GIS analysis (Fletcher *et al.* 2014a) to propose areas suitable for habitat creation which found that some Local Authorities had little habitat appropriate or available for this purpose. Any habitat creation effort to restore populations to predicted historical levels would therefore only be achieved by working in cooperation with other unitary authorities where potentially suitable habitat remains.

4.3 Current conservation status of great crested newts in northeast Wales: insights from the Online Wales GCN Monitoring Database

4.3.1 Introduction

A preliminary examination of data in the Online database was undertaken with a view to understanding what additional insights, beyond information available in previous reports and published sources summarised may be achievable. The development of

the database is relatively recent and its use has not been fully explored to date. Due to the limited time available, only preliminary examinations of what analyses the data might allow were undertaken, so the work reported here should be considered primarily as a scoping exercise. We suggest options for more detailed exploration, consider whether the data that can be readily accessed are suitable for such analyses and identify barriers to analyses or interpretation. We recommend ways in which the data and metadata currently available through the database could be improved to extend its future use in conservation assessments, including analyses of trends over time.

4.3.2 Methods

Great crested newt data held in the Online database were examined using the standard options available to members with a COFNOD login (detailed further below, Figures 4 and 5). To undertake preliminary regional-level analyses, annual maximum counts of great newts were downloaded for all individual ponds listed for sites. Site-level data on number of ponds were also downloaded in order to be able to make general comments on the types of sites for which monitoring data are available and features that may affect conservation status at a site level, where possible. The database also stores data on Habitat Suitability Index (HSI) assessment values (see Oldham *et al*. 2000), which may be downloaded for ponds on the sub-site view tab (Figure 5). These were initially downloaded with the intention of commenting on typical values and the range of values for the pond dataset as a whole at regional level (relevant to habitat and future prospects metrics). However, a technical issue relating to the precision at which data were downloaded (*i.e*. insufficient number of decimal places), curtailed further examination as part of this project. COFNOD has now resolved the technical problem, and these data could be explored further at a later date.

Summary statistics providing overview of the whole dataset e.g. number of sites monitored in each year, number of ponds per site, range of great crested newt maximum counts at site level and for individual ponds (sub-sites), length of time series available for individual ponds/sites were compiled in excel. Excel spreadsheet data were then converted to long format csv file to permit further analyses in R, using rtrim (Bogaart *et al*. 2016), in order to investigate trends in maximum counts of great crested newts over time at a regional scale. The rtrim package is a reimplementation of the

software programme TRIM that was originally developed by Jeroen Pannekoek and Arco van Strien at Statistics Netherlands (Pannekoek & van Strien 2005). TRIM was developed to estimate trends in animal populations using repeat counts at multiple sites and has particular value where time series include years of missing data, because values are imputed. TRIM analyses have been used to examine national population trends of various taxa including birds, butterflies, bats, amphibians and reptiles in the Netherlands (e.g. van Strien *et al.* 2016) and also to support multi-collaborator international indicator initiatives for birds, butterflies and bats (e.g. Gregory *et al*. 2005, van Swaay *et al*. 2008, Haysom *et al*. 2014).

Figure 4 Screenshot showing user view of the Online Wales GCN Monitoring Database site level information. Annual maximum counts (across all ponds counted in a year) are shown for each site. Gaps in the time series are assumed to represent years in which no monitoring data is available for (any pond on) the site.

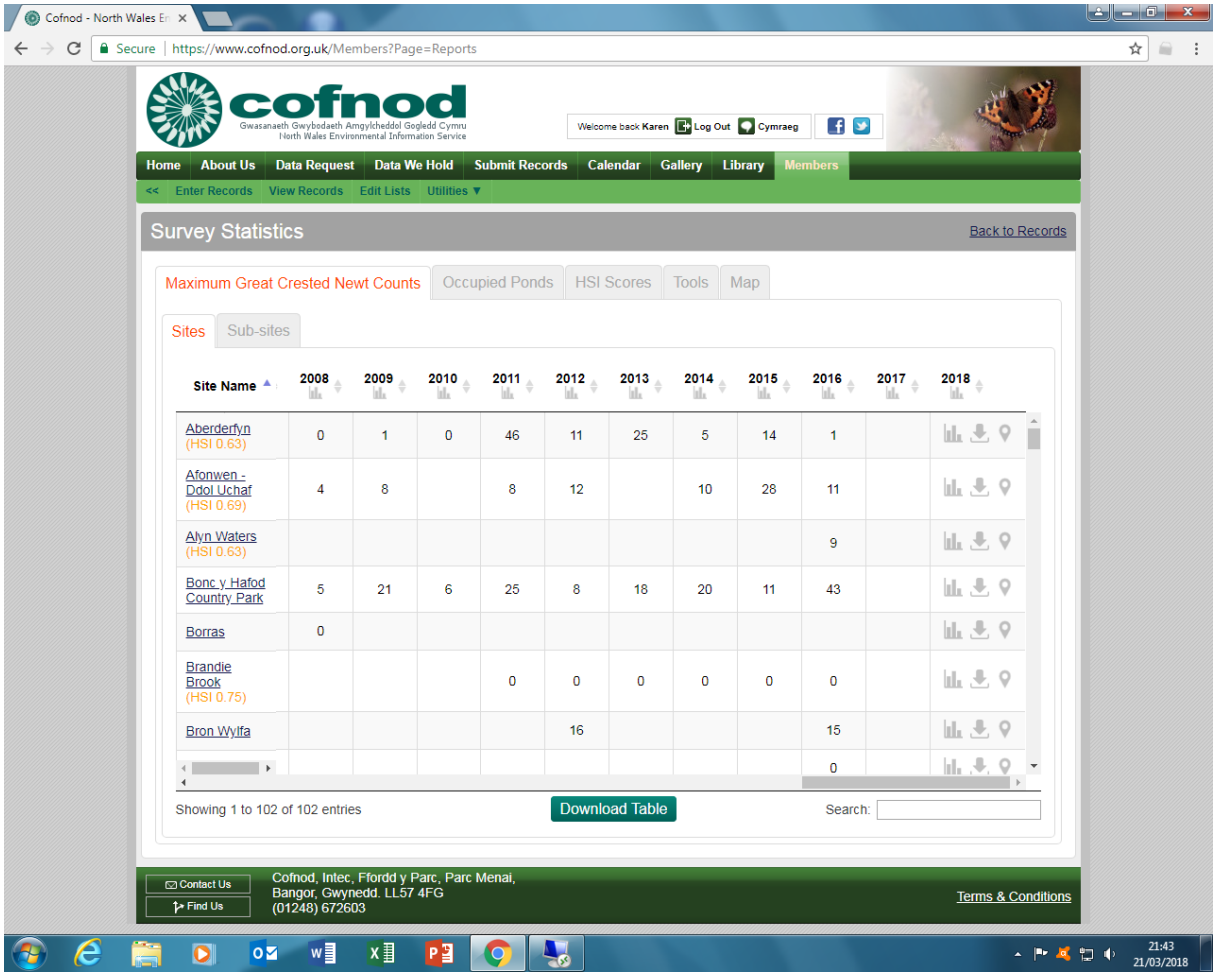
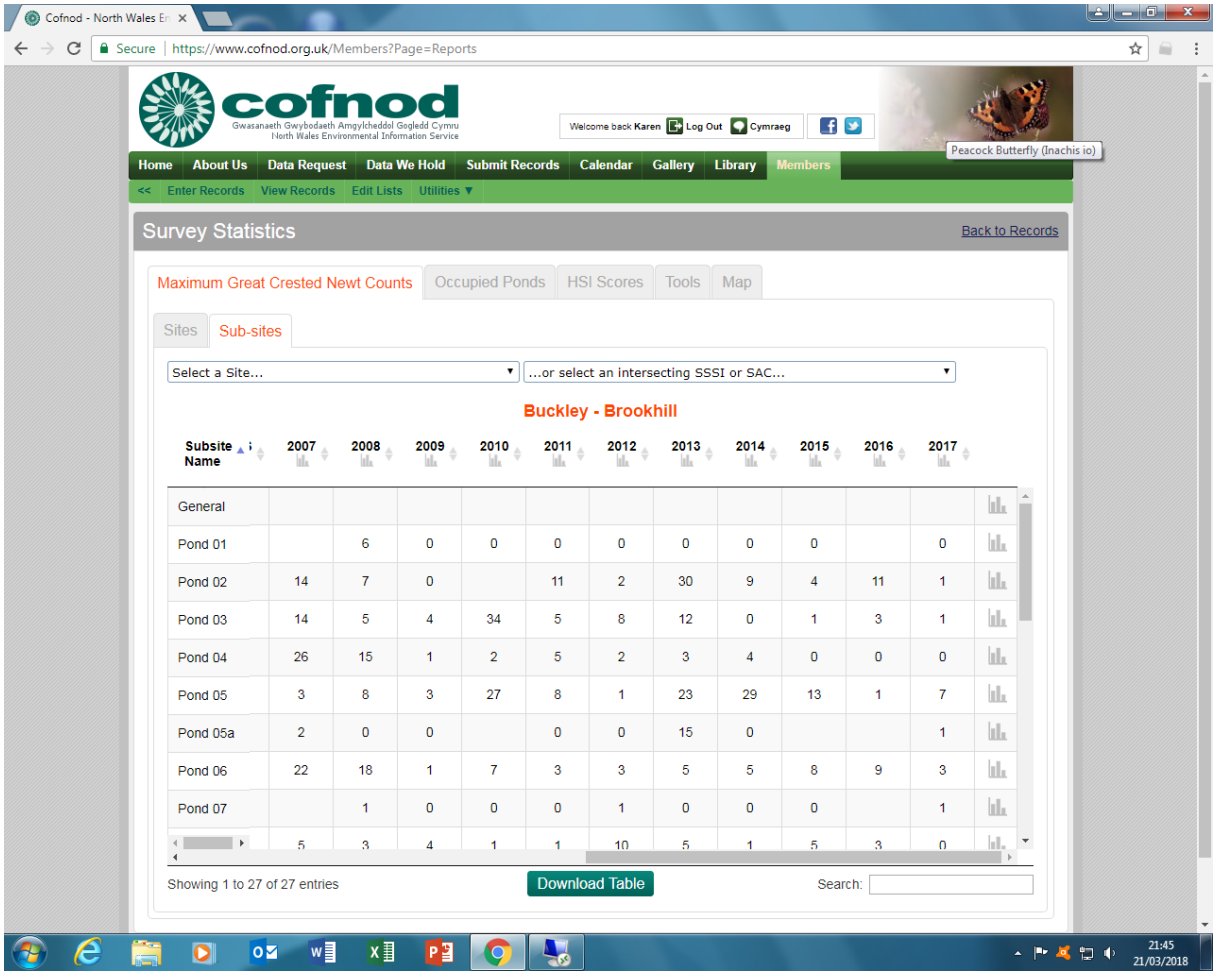


Figure 5 Screenshot showing user view of the Online Wales GCN Monitoring Database sub-site level information. The view presents counts of great crested newts at Buckley-Brookhill and shows the annual maximum counts recorded at each pond monitored on the site. Gaps in the time series are assumed to represent years in which individual ponds were not surveyed.



Subsite Name	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
General											
Pond 01		6	0	0	0	0	0	0	0		0
Pond 02	14	7	0		11	2	30	9	4	11	1
Pond 03	14	5	4	34	5	8	12	0	1	3	1
Pond 04	26	15	1	2	5	2	3	4	0	0	0
Pond 05	3	8	3	27	8	1	23	29	13	1	7
Pond 05a	2	0	0		0	0	15	0			1
Pond 06	22	18	1	7	3	3	5	5	8	9	3
Pond 07		1	0	0	0	1	0	0	0		1
	5	3	4	1	1	10	5	1	5	3	0

Showing 1 to 27 of 27 entries

4.3.3 Results

Data availability

A search of the Online Wales GCN Monitoring Database found approximately 6000 records, comprising *ad hoc* records and records that were related to repeat counts at long-term monitoring sites. The oldest records dated from 1970.

At present data are viewed by selecting tabs to see maximum counts of ponds at sites, maximum counts collated across the whole site, the total number of ponds per site, or HSI scores. Some aspects of the database, such as the ability to view relevant maps or access tools, are in development. The database appears to be designed primarily for users who wish to access data on individual sites; it is possible to download data

site by site, but not to download groups of sites for comparison. These (tab) views are primarily useful for people who have an interest in the history and current status of individual sites or ponds.

Analyses and interpretation of quantitative data from counts at sites or sub-sites (ponds) is impeded, to some degree, by the absence of metadata for the various data-sets. The user experience and ability to interpret data would both be improved through the addition of metadata to clarify terms such as site, sub-site, maximum count and description of the survey methods used, and context of surveys.

An issue of particular importance with regards to analysis of trends is the need for clear distinction between zero counts and missing counts in time series. In the examples shown, (Figures 4 and 5), spaces are presumed to represent missing values, but this should be explicitly stated, ideally in the form of guidance to those uploading data, and to users of the data.

One feature of the Online database is the facility to download bar chart summaries of fluctuations in annual maximum count at a site (for example charts see case studies in section 6). This is an appealing feature, however, further contextual information, is needed to avoid misinterpretation of the data. Where the annual maximum counts at site level are derived from the same surveying regime, (i.e. consistent survey effort, same ponds), conducted each year, such a chart may be a reliable representation of changes over time. Examination of pond level data on the sub-site tab for a sample of sites, however, found that in many cases different combinations of ponds were counted in different years. In such cases, variations in maximum count between years may relate to temporal fluctuations in population or be influenced by differences in relative abundance among the ponds counted. For this reason, a preliminary analysis of regional changes in counts over time (see below) was undertaken through examination of pond, rather than site, data. Unless variations in the spatial pattern of sampling at a site (which ponds were surveyed and how many), surveillance method (combination of torch count, bottle trapping etc. was used) and surveillance effort (how many surveillance visits, length of time searching etc.) are properly understood, and consistent from year to year at a site, temporal patterns of change should be interpreted cautiously. Although site-level graphical summaries of year to year variation

in maximum count have been included for each site case study (section 6), all are shown with the caveat that the site- level summary may not represent a proper overview of changes across the ponds that constitute the site.

Some sites have many different ponds, and it is only feasible to survey a proportion of the ponds on one day, or in a season. As emphasised in section 8, the sampling strategy for assessing usage by or counts of great crested newts is an important feature of the surveillance protocol, and for subsequently interpreting the data. For example, at some sites there may be a target to assess species presence or a count at all ponds over a three-year period. An understanding of the monitoring cycle would be essential in interpreting long-term fluctuations in count. The information presently available on the Online database web pages does not make clear whether the summed maximum counts relate to counts made on the same day; seasonal maximum counts taken on different days/parts of the season might be influenced by dispersal of newts around the site.

The ponds used by great crested newt are prone to hydro-seral succession and a justifiable rationale for making changes in which ponds are surveyed over long time series, is that some ponds dry, become terrestrial habitat and are no longer available to newts. At the same time conservation management may create new ponds that are colonised by newts, and that did not exist at the beginning of the time series. It could be argued that a surveillance approach that accounted for all ponds suitable for the species in each surveillance period might reasonably represent the status of the species at the site, even though the combination of ponds itself varies from year to year. A means of tracking spatial changes (i.e. recording pond availability) or the proportion of available ponds that were surveyed might be a useful future improvement. It is noted that the map feature on the website is not yet developed, and this could show both the ponds at the site and those that are part of the surveillance regime; regardless of whether these data are available to users of the data, provision of guidance to recorders, a means of archiving pond features and the surveillance protocol to record the location and status of ponds would be of value. Such an approach recording transient pond features used by natterjack toads is currently being developed as a strategic feature of ARC's national natterjack toad surveillance

programme; conservation of this rare species is aided by a fine-scale understanding the spatial availability of resources and how they are used by toads.

Characteristics of the data

Most records of great crested newt in the Online database were from locations in Wrexham, Flintshire and the Flintshire/Denbighshire border (Figure 6). There were also small clusters of records in Anglesey and Montgomeryshire.

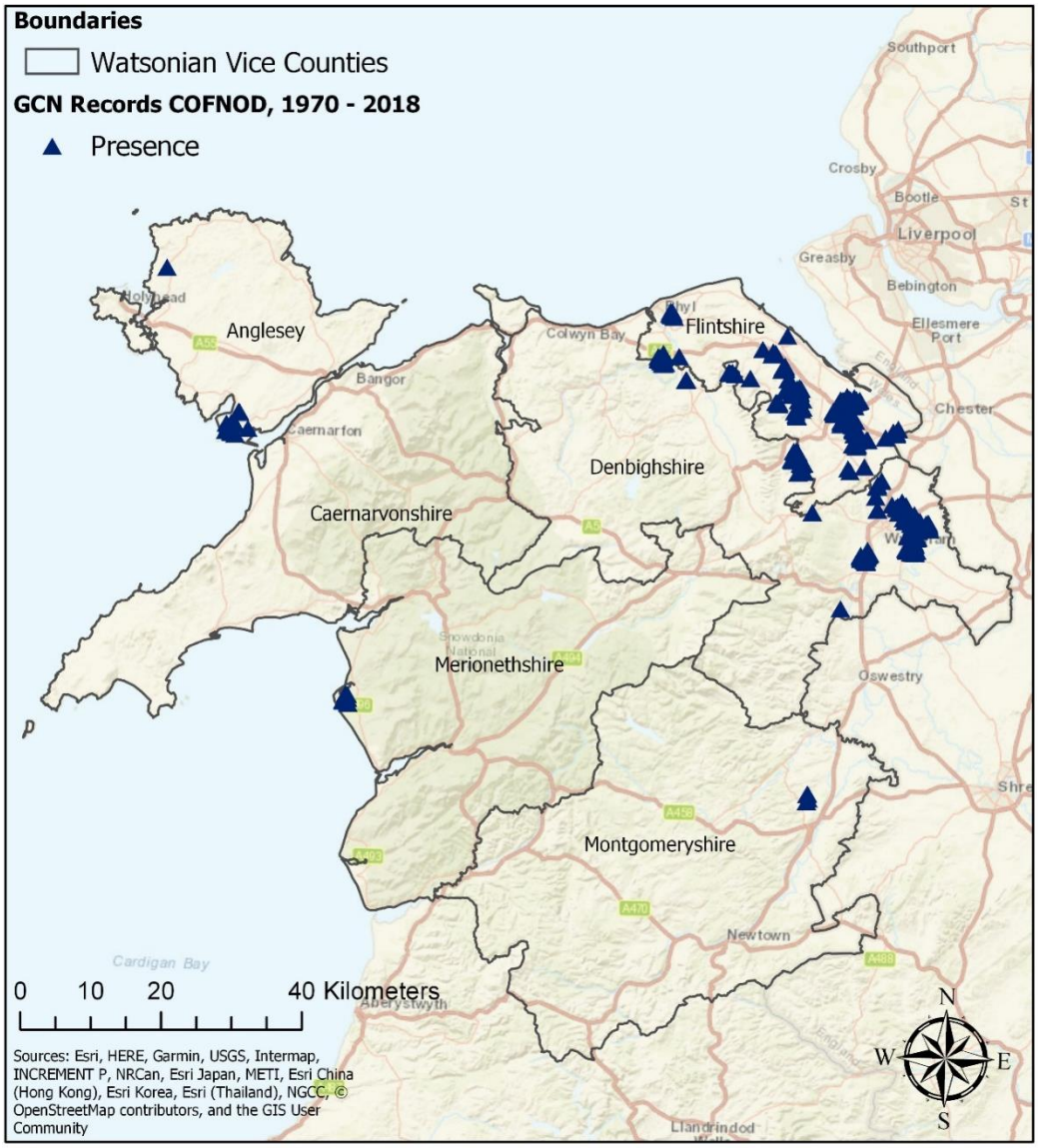


Figure 6 Map to show locations of great crested newt records held in the Online wales GCN Monitoring Database to 2018. Source: COFNOD.

The site-level tab of the database listed a total of 987 sites. Each site had one or more ponds (minimum 1 to 73, median 6 ponds). A total of 219 (22%) of the ponds listed in the database had no great crested newt presence or count data entered for any year. None of the ponds that were monitored for great crested newts annually

(i.e. those that had at least one count of 0 or more newts during the whole of the time series) was monitored in every year. The maximum number of annual counts collected from any pond was 26 years of data, but the average number of years' survey data from a pond was 4.5 years; 364 (37%) ponds in the dataset had been surveyed in fewer than four years (Figure 7). Ponds enter or leave the database at different points in time (i.e. count data begins and ends), but it is not possible to deduce why the pond is no longer counted e.g. whether the absence of data represents lack of surveillance effort (for example the end of an obligation to monitor as part of licence requirements at mitigation sites), or that the pond is no longer there, or otherwise unavailable to monitoring.

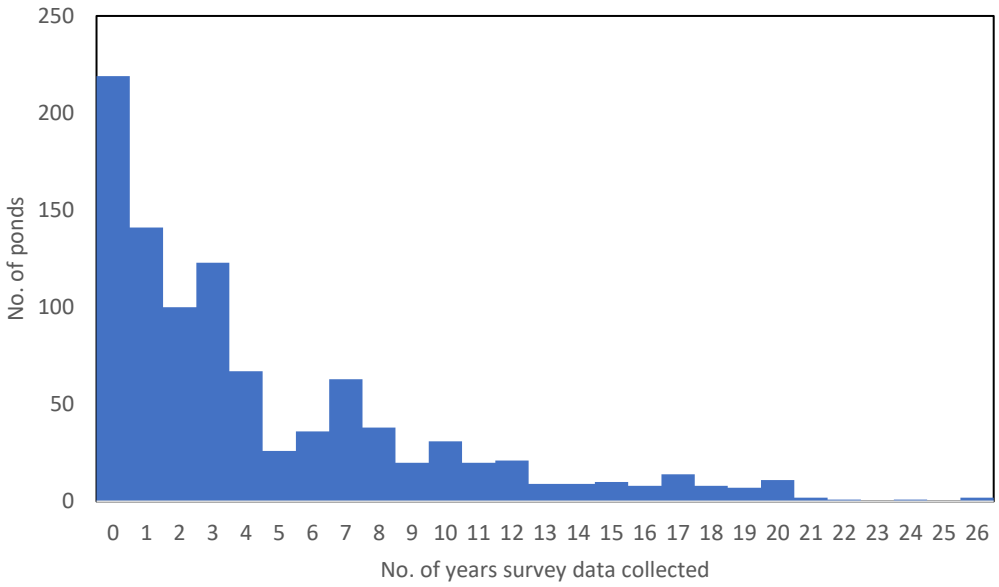


Figure 7 Histogram to show availability of great crested newt count data in the Online Wales GCN Monitoring Database. Number of years is the total number of years for which data are available for a pond (i.e. it may not represent consecutive years)

Although monitoring of one site began as early as 1970, between 1971 and 1983 inclusive, no count data was available for any pond. Fewer than five ponds were surveyed per year before 1990 and in four years (1970, 1984, 1985, 1989), count data was available for only a single pond. There was a sharp increase in the number of ponds monitored from the mid-nineties onwards; from 1995 onwards there has been a constant increase in the number of ponds surveyed each year with 382 ponds counted in 2017 (Figure 8). This is likely to reflect, to some extent, success in securing long-

term monitoring as an obligatory part of mitigation and licence condition and in passing of sites to sympathetic ownership, as well as the promotion of the principle of species monitoring to support conservation.

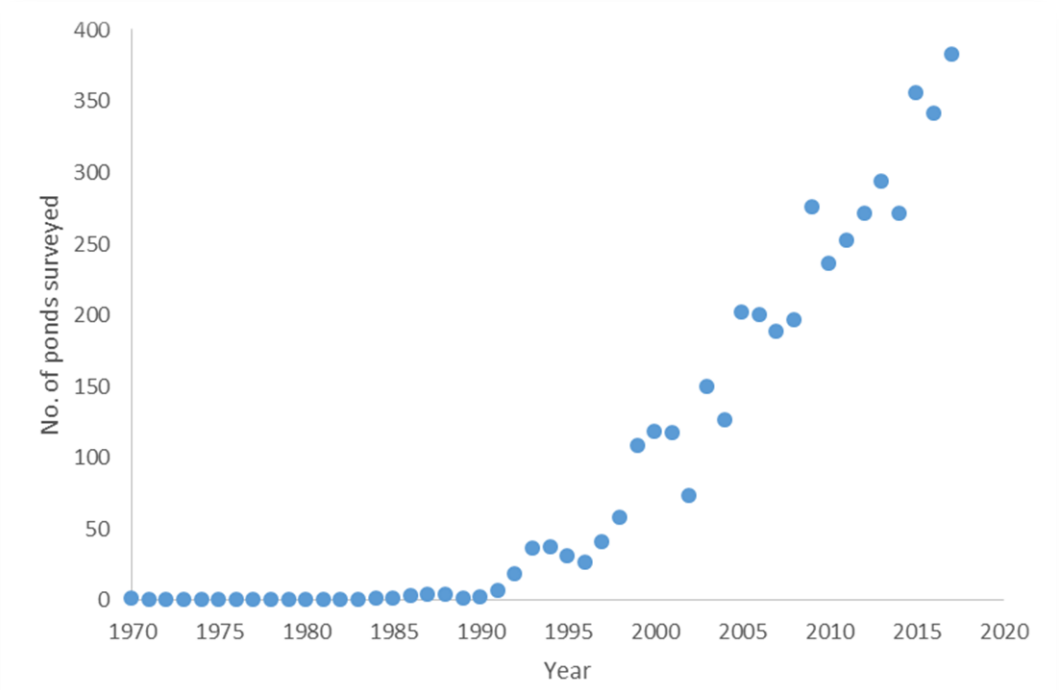


Figure 8 The annual number of ponds in north east Wales where great crested newts were counted. Source: Online Wales GCN Monitoring Database 1970 to 2017.

Long-term trends in great crested newt counts

The challenge of obtaining robust quantitative estimates of great crested newts in ponds is well-known and may be affected by, among other factors, the techniques used, prevailing weather conditions and survey effort (see English Nature 2001, JNCC 2004b). There is thus considerable uncertainty about how counts of great crested newts in ponds or groups of ponds, translate into population estimates for a site. Attempts to determine how populations vary across larger scales (region, national etc.) are further complicated when there are variations in surveillance effort, timing of surveys and approaches within and among sites across the site network.

Accepting these major caveats, the Online database has succeeded in bringing together a dataset that is large enough to allow exploration with different analytical approaches. There is presently much interest in how data of different types (*ad hoc* records, structured quantitative surveys etc. may be used alone or in combination to determine long-term trends in population size, distribution and spatial organisation.

Occupancy models, generalized linear modelling, N-mixture models are some of the tools currently being used and further developed for this purpose (e.g. van Strien *et al*. 2013, Isaac *et al.* 2014).

To investigate the existence of any overarching trend in newt counts in the Online Wales GCN Monitoring pond dataset described above, a TRIM analysis was undertaken. TRIM is a poisson loglinear regression technique designed to assess population trends across multiple sites and is the main statistical approach, alongside occupancy modelling, used to analyse national trends in amphibians and reptiles in the Netherlands (e.g. van Strien *et al*. 2016). It calculates trends for repeat counts at multiple sites and is able to cope with time series that include years of missing data by imputation. During the analysis, there are preliminary checks to confirm whether data are sufficient to estimate a trend (Pannekoek *et al*. 2016). A general rule of thumb followed by Statistics Netherlands, the developers of the programme is that analysis of regional or national trends usually requires a sample of at least 50 sites for robust statistical trends over five years. Due to the paucity of data prior to 1995, our analysis was restricted to surveillance data collected from 1995 onwards.

Figure 9 plots the results of the preliminary TRIM analysis. The y-axis represents the imputed total of maximum counts across all the sites for the sample of 565 sites for which counts were undertaken in more than one year. The preliminary plot of the imputed estimates looks biologically plausible showing large oscillations that are typical of amphibian populations. There is a distinct upward trend in the total estimate over time although the modelled trend line is a poor fit of the data.

If time were available to examine this dataset in adequate depth, and if there were access to better descriptive information about the different sites in the dataset and how the data were collected, it would be desirable to refine and test this analysis further. The crude analysis plotted treated all “sites” (in this instance the ponds) as though they were independent of each other. As many of the ponds were actually clustered geographically (median average six ponds per site) it would be prudent to re-run the analysis taking account of site as a possible “blocking” factor. It would also be of interest to consider the possible influence of covariates such as HSI value, if sufficient annual data are available. Similarly, where the metadata allow, it could

be of interest to examine whether different categories of site e.g. nature reserves, mitigation sites etc. exhibited similar trends.

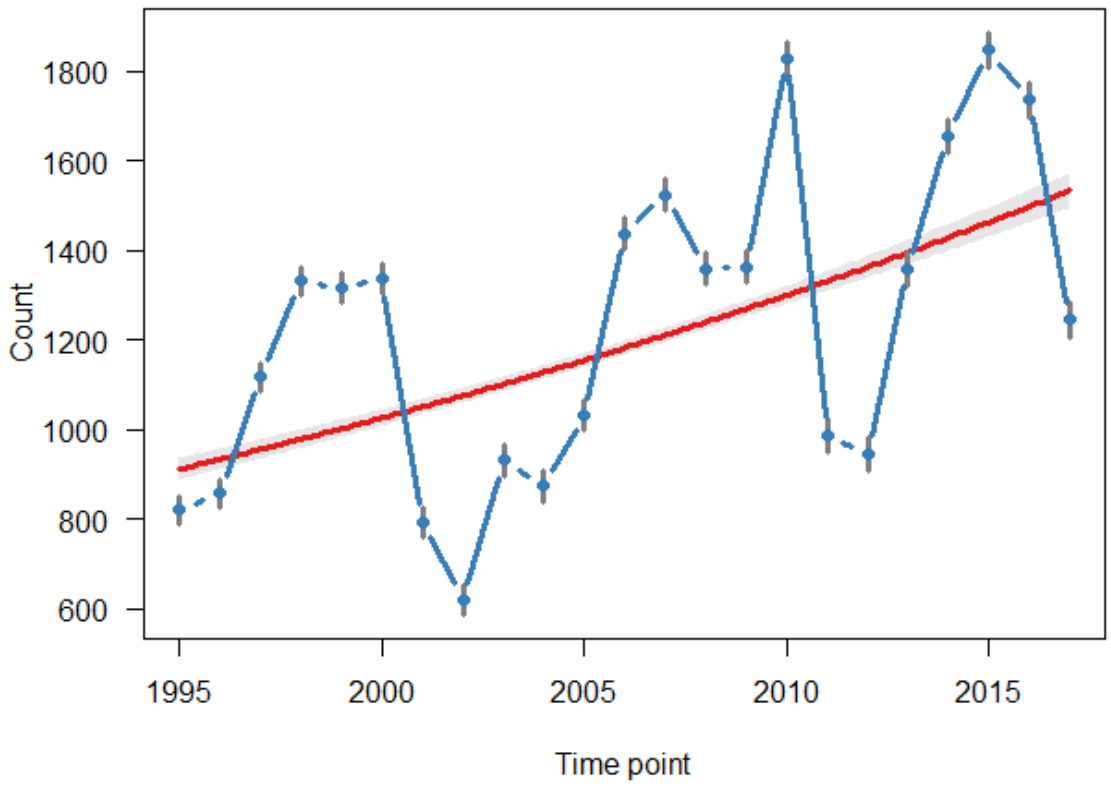


Figure 9 Preliminary analysis of variation in great crested newt count over time using TRIM based on a sample of 565 ponds. Blue hashed line is the modelled total "population" estimate based on maximum great crested newt counts across all sites. Red line is the modelled trend.

As already stated, the summary trends in maximum great crested newt count at site level that are available as download charts from the Online website are often potentially misleading, where apparent long time series and strong trends at "site" level are the result of totalling maximum counts across the site and comparing counts at different ponds at the beginning and end of time series. For those sites where length of the series and the number of ponds is sufficient, it would therefore be potentially interesting to use TRIM to examine the site level trends

4.3.4 Discussion

The results of the analysis presented should be treated with considerable caution at present, given the inherent need to repeat the approach using covariates to

understand likely influences and improve the overall fit of the model. Probably the most important learning point achieved is that the Online Wales GCN Monitoring Database had sufficient data (number of ponds, length of time series) to permit the analysis to run. The lack of information about how the data were collected, i.e. year to year variations in sampling effort such as the use of different sampling approaches, different time periods, interchange of experienced with inexperienced surveyors etc. makes interpretation more uncertain. The suggested trend observed may be real, but possible systematic biases in data collection cannot be ruled out at this stage.

The work done in northeast Wales in mobilising and capturing data and establishing a framework by which it is widely available is a very significant achievement; for maximum benefit, such a system would work in parallel with a structured and centrally coordinated surveillance programme deploying standardised protocols, to reduce controllable variation in data collection. Ideally this would be a national monitoring scheme coordinating the collection of data across the UK because of the added value this would bring in enabling reporting at different scales national, regional to local, and in maintaining common approaches across all countries.

For the purpose of regional or national trend analysis, TRIM is reasonably tolerant of site to site variations in actual surveillance approach. For robust trends, the most important assumptions are that the distribution of the sites is representative of the area for which the trend is being calculated and that for individual sites, survey effort is constant from year to year. In the case of these data, the sites are probably not yet representative of the region as a whole; it is known that the long-term monitoring sites have a high proportion of nature reserves and mitigation sites. Further site recruitment would be advised to examine the character of sites in the database and work towards improving the representation of less represented site types and in the meantime, a clear description of what types of sites the database represents should be made available. An over-arching monitoring scheme would largely address issues of survey effort variation, or at least document variation.

Furthermore, it would be of value to explore the Online dataset using several methods in parallel, for example TRIM, occupancy modelling and N mixture models

to maximise understanding of the northeast Wales dataset and of the use of these developing techniques with regard to great crested newt data. Testing several different analytical procedures was recently of great value for interpreting surveillance data for snakes in Jersey (Ward *et al*. 2017).

In conclusion, this examination of the Online Wales GCN Monitoring Database dataset has resulted in some additional information relevant to conservation status, not available via previous reports. Griffiths & Williams (2000) concluded that to achieve a 5% extinction risk after 50 years, at least five subpopulations (i.e. ponds) are required (assuming at least some dispersal between ponds). Sixty-five of the 107 sites (61%) in the database had at least five ponds, although it is not certain whether in every case the ponds were clustered closely enough to facilitate the required dispersal, nor whether all the ponds counted were in adequate condition to support great crested newts. Other assessments based on population size are harder to apply because of the uncertain translation between maximum count and real population size. Using population viability analysis approaches, Halley *et al* (1996) found that populations of great crested newt populations with less than 40 individuals were unlikely to persist for more than 20 generations if they were more than 0.5km from a source pond and Griffiths & Williams (2000) concluded that a population size of at least 100 was required to reduce extinction risk below 5% in an isolated population. In the Online dataset, 16 ponds spread among 11 sites had counts >= 40 and only 2 ponds, one at Glan-traeth and one at Hafod Lagoons, had maximum counts that were greater than 100 in the most recent survey year (2017). However, it is difficult to interpret the true implication of this, given that real population size is likely to be larger than any maximum count due to detectability issues and that isolation cannot quickly be determined from a simple examination of the data downloads. Russell *et al*. (2017c) noted the use of counts of more than 30 individuals for assigning County Wildlife Site status in England, and on this basis around 17 sites in the database could qualify (if they were in England) because they have one or more ponds meeting this criterion.

5. Status and population trajectory at selected sites

Objective: For selected sites, including those associated with mitigation, to review local population changes and suggest likely reasons why change has occurred.

5.1 Introduction

To complement the overviews presented of conservation status at country scale (section 4) and county and regional scale (section 5), this section collates site histories and species status information for a portfolio of case study sites in northeast Wales. Examining information at the site level presents additional insights into variation in the quality of data available and different site-specific influences and challenges for great crested newt conservation. The sites were selected to showcase a range of situations; though the exact combinations of histories, influences and trends described are all specific to each case study, many elements of individual case studies are typical of experiences known in other sites. To be selected as a case study it was essential that some basic information on site history, management and at least intermittent monitoring data were available. In this respect, the case study sites differ from many other great crested newt sites where such data is not available.

The eight selected case study sites (Table 3) include sites given the highest level of protection (SAC) and those on land that has no special designation. Several of the sites are ex-industrial sites, where ponds formed in dis-used quarries or clay-pits for example, others were specially created in compensation for developments on land where the species was present. The portfolio includes sites with small numbers of ponds through to others with large complexes of water bodies. Management approaches, influences on the newts and the number of individuals counted over time varied.

Likely reasons for changes in great crested newt populations at these sites are offered with the caveat that these explanations are often anecdotal; site population

trends are inferred from data not calculated from robust statistical models. The summary bar charts of site-level annual variations in maximum count have been downloaded from the Online Wales GCN Monitoring Database and may be misleading where the counts have been made at different ponds in different years (see section 5). The explanations for trends are interpretations, not scientifically robust analysis. Despite these possible limitations they illustrate some of the more common issues affecting conservation status of great crested newt at the site level in Wales.

5.2 Buckley-Brookhill, Flintshire

Owners/managers: Flintshire County Council. ARC has managed the land since 2014 and will continue to do so under a lease.
Designations: SSSI and SAC.
No. of ponds: 20

Known history: This site was created in compensation for the infilling of the adjacent landfill. The industrial heritage of Buckley is dominated by brickworks, potteries and collieries. These industries were determined by a corridor of clay and coal that runs across the district from Ewloe in the north to Padeswood in the south. The gradual demise of the brickworks left various clay holes which eventually filled with water and were colonised by amphibians. Some of these were used as landfill sites for domestic rubbish (e.g. Belmont, Etna, Standard, and, latterly, Brookhill). The disused railway line infrastructure has become wildlife corridors.

Management information: In the early 1990s, many amphibians were collected from areas to be developed and released in other ponds with no proper guidance, mitigation, compensation or data collection. Brookhill was the first site of its kind in Buckley where mitigation/compensation was successfully delivered.

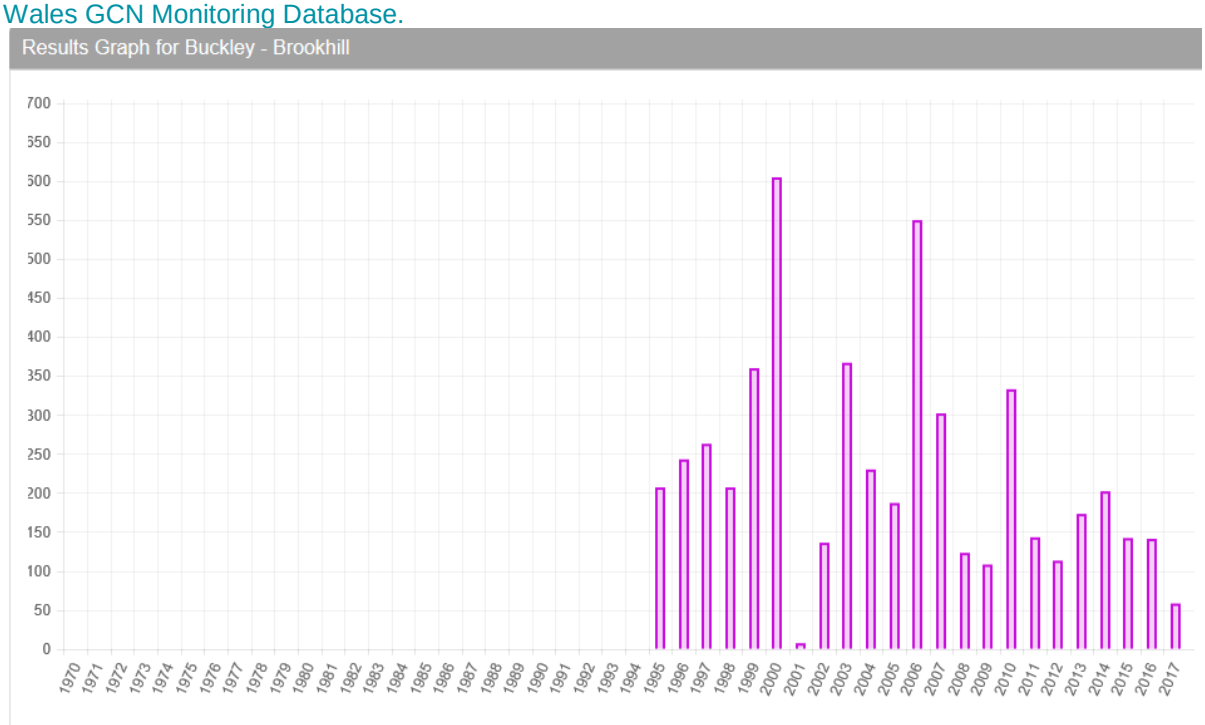
Site management responsibility has transferred periodically between a number of bodies, leading to variations in the management regimes applied over time North East Wales Wildlife (NEWW) (now Wild Ground) managed the site from the beginning but, due to funding issues, handed the responsibility back to Flintshire Council in 2011. Early management has not been recorded but, since 2014, pond

and habitat management is on-going. In 2014 ARC/Flintshire Council developed a partnership and since then ARC has managed the site. ARC currently holds a 5-year lease and expects to renew it.

Pond number 1 was unsuccessful in holding water and has developed into rough grassland. Pond number 2 has previously had *Crassula* issues but it has always been detected and controlled from an early stage. It occupied no more than a metre strip of the pond. Fish were detected in pond 20 (close to the access point) on site in 2016. NRW fisheries officers netted out most of the fish and plan to return in 2018 to review the issue. This pond is located close to a public right of way so easily accessed for individuals to introduce carp to the pond. Grass snakes are present on site in very good numbers and predate great crested newts.

GCN population trend: The GCN counts have been broadly stable with peaks and troughs. The ponds had developed with vegetation, with *Typha* being dominant around the edges; this could potentially contribute to visual obstruction during survey and/or more rapid succession. The site was not surveyed in 2001 due to foot and mouth disease.

Figure 10. Great crested newt counts at Brookhill, Flintshire, 1995 to 2017. Downloaded from Online Wales GCN Monitoring Database.



5.3 Fields Farm, Flintshire

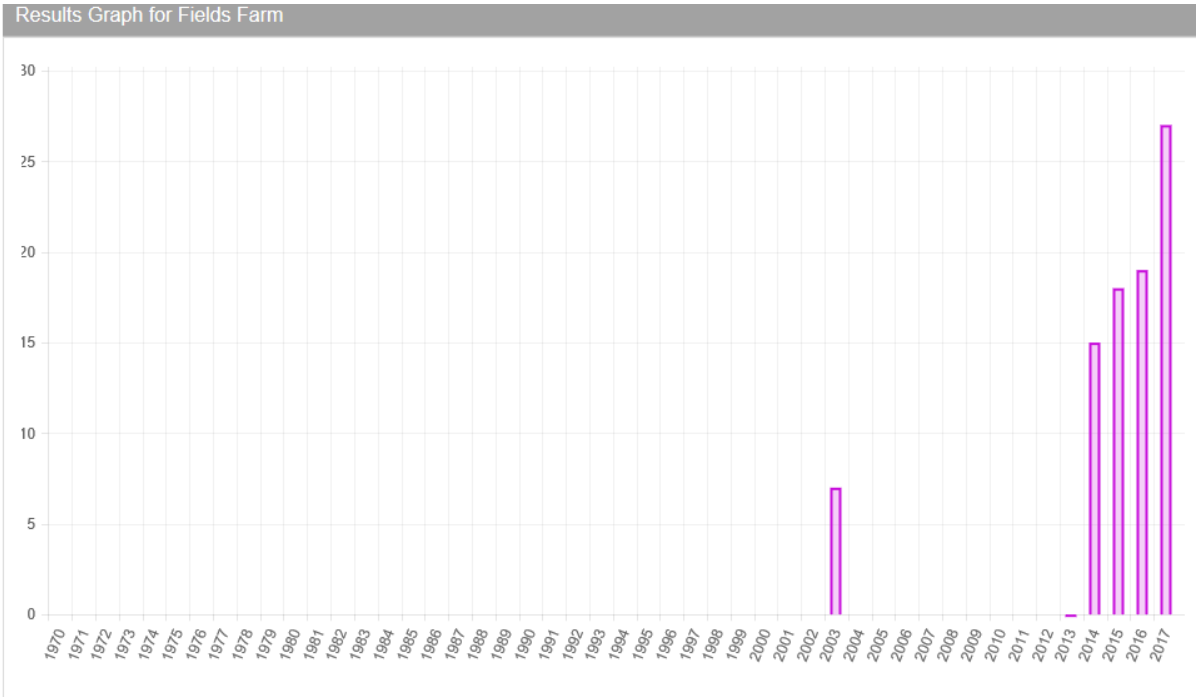
Owners/managers: ARC.
Designations: None, but 50m away from Deeside and Buckley SSSI and SAC.
No. of ponds: Previously five, now six with a new addition in January 2018.

Known history: This site was a compensation area from a housing development. The compensation area was transferred over to ARC in 2015 with a dowry for 21 years (100k). As part of the handover a five-year management plan which was written by TEP was provided.

Management information: The site houses six ponds surrounded by wildflower meadow and woodland compartments. New hedgerows were planted as part of the mitigation. There was also a wildlife corridor secured within the development which is managed by an external company but to a management plan.

GCN population trend: The GCN count has increased in a short space of time, in contrast to counts at the adjacent Lower Common, which are down as compared to previous years. The site also has good numbers of common frog and toad, and all three newt species. To accommodate the amphibian assemblage on site an additional pond was created in January 2018 which will bring the total number of ponds to six.

Figure 11. Great crested newt counts at Fields Farm, Flintshire, 2003 to 2017. Downloaded from Online Wales GCN Monitoring Database.



5.4 St. Asaph Business Park, Glascoed, Denbighshire

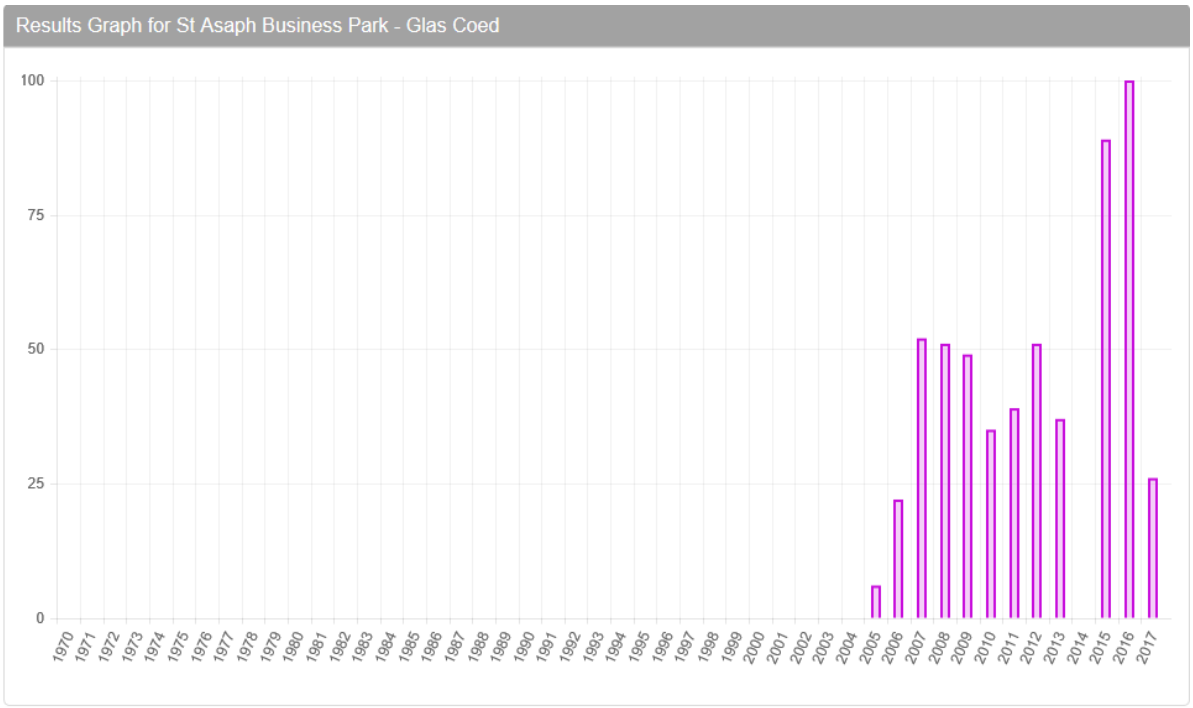
Owners/managers: Wild Ground (formerly NEWW).
Designations: None.
No. of ponds: 16.

Known history: As early as c.1907 there is reference to St Asaph supporting notable GCN populations (Forrest 1907). The site was created as a compensation site for the development of St Asaph Business park and was transferred over to NEWW with a 21-year dowry. Since then a variety of ponds and hedgerows have developed alongside the expansion of the business park.

Management information: Three agricultural fields were handed over to create a nature reserve for the priority of GCN. The site comprises of native hedgerows, planted woodland compartments with 16 ponds located in through the site where wet areas were present. The site has had issue with *Azolla* since 2007, since when it has been managed using weevils.

GCN population trend: The site has been monitored by NEWW (now Wild Ground) since 2005 with a steady increase in counts until 2015 when the population has increased substantially. It is uncertain why no surveys were conducted in 2014. This demonstrates how sustainable development can increase GCN populations through the right guidance and management. Previously the area was of low wildlife value due to the land being managed for agriculture but now, having ponds, wildlife corridors, monitoring and management, it has developed a robust population of GCN.

Figure 12. Great crested newt counts at St. Asaph Business Park, Denbighshire, 2005 to 2017. Downloaded from Online Wales GCN Monitoring Database.



Site and location	Type of site /designation	Targeted Management	No. of ponds	GCN trend
Brookhill, Flintshire	Compensation site. Claypits on former industrial site. SSSI & SAC.	✓	20	Stable.
Fields Farm, Flintshire	Compensation site for housing development. Close to SAC.	✓	5-6	Rapid increase.
St Asaph Business Park, Glascoed	Ex agricultural land used as nature reserve in compensation site for business park development	✓	16	Increased to robust population.
Globe Pools, Flintshire	Purchased for GCN conservation during industrial expansion but until recently under-resourced.	(✓)	10-12	Low newt numbers at a long neglected site where conservation management recently instigated.
Mold Road, Wrexham	Mitigation and compensation for housing scheme incorporating an original and created pond	x	2	Uncertain, currently low numbers.
Halkyn, Pen-yr-Henblas, Flintshire	SSSI and SAC. Natural ponds at former quarry	x	2+	Stable. Periodic issues with *Crassula*.
Stryt Las Park, Wrexham	Country Park on former colliery /landfill site	✓	5	Increase. Historic fish issues.
Maes Mynan, Flintshire	Redundant sand and gravel quarry	x	6	Decrease, no recent monitoring.

Table 3. Summary of case study portfolio giving overview information on site characteristics and trends in great crested newt population at selected sites

5.5 Globe Pools, Flintshire

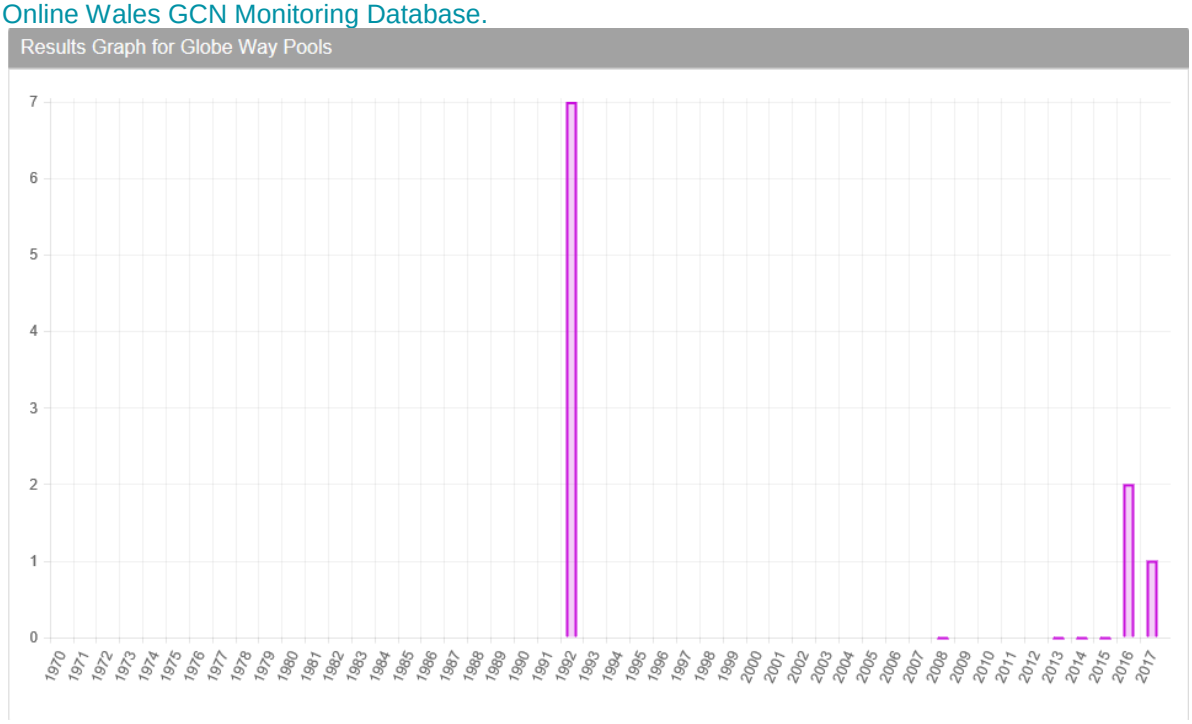
Owners/managers: FCC own the land, but ARC have a licence to work until 2022 with the view to renew.
Designations: None, but 50m away from Deeside and Buckley SSSI and SAC.
No. of ponds: Historically 12, currently 10.

Known history: As part of the expansion of the adjacent industrial estate the land was secured for GCN conservation. Ponds were created but no funding was available for the long term up keep. The site was neglected until ARC took the parcel of land on via a lease and as part of a suit of reserves in a form of partnership with the council.

Management information: Historically there were 12 ponds on site. Pond BCC311 was removed due to the neighbouring boundary needing to be adjusted. To compensate for this, pond BCC302 was re-designed in 2017 due to it never holding water. Also, in 2017, ponds BCC303, 304, 307 and 308 were re-designed due to unreliable hydroperiods. Pond BCC300 is mainly used by common toads in very high numbers. They do suffer mortality due to the road that runs adjacent to the pond, so a road patrol group was set up in 2016. In 2016, habitat management commenced on site which prior to then had been neglected. The site has a PROW running through the site which connects to other networks of paths that make up the Buckley Heritage Trail. ARC have secured HLF and Building Wildlife funding to undertake meadow cuts, path enhancements and habitat enhancement works on site.

GCN population trend: Low newt numbers at a long-neglected site where conservation management has recently been instigated. BCC309 is the most productive pond on site for newts and where GCN have been recorded since 2016.

Figure 13. Great crested newt counts at Globe Pools, Flintshire, 1992 to 2017. Downloaded from Online Wales GCN Monitoring Database.



5.6 Mold Road, Wrexham

Owners/managers: Redrow/ARC.

Designations: None.

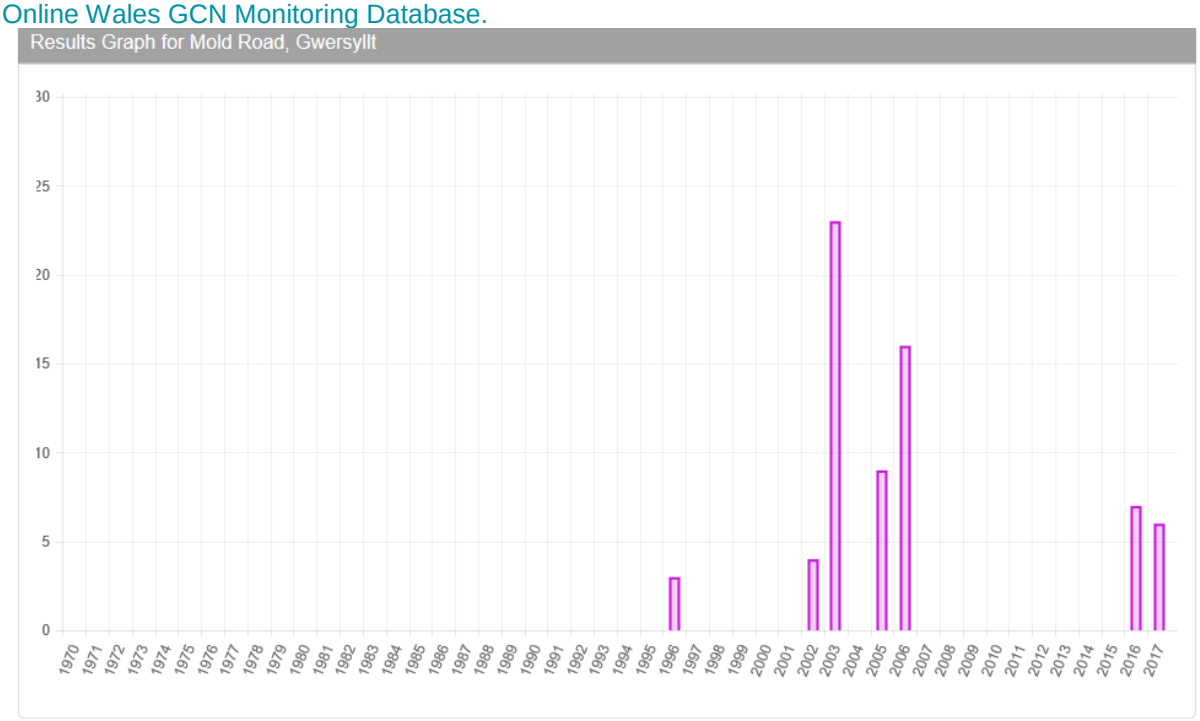
No. of ponds: Two.

Known history: The site has been created via a housing scheme where mitigation and compensation has taken place. As part of the section 106 agreement 20k was passed over to the council to fund GCN relevant projects that are located near the site. Redrow and ARC are under consultation regarding the transfer of the land. A meeting was held in early January 2018 where Redrow committed that the land will be transferred to ARC by the end of March, 2018. It was agreed that the land will be transferred to ARC with the attenuation pond remaining in Redrow ownership. Redrow will then draw up a lease so that ARC can actively manage the pond but not be liable for it.

Management information: Management has been undertaken on site annually by Ecological Land Management Ltd. This consists of wildflower meadow cuts, scrub clearance and work to overhanging trees at pond 1. Pond 1 is an original pond on site containing GCN. The surveys up to 2006 represent this. Pond 2 has been installed as part of the mitigation but is small in size and does dry up before metamorphosis would take place. There are monies secured to add an additional pond in 2018.

GCN population trend: Uncertain, numbers currently only low.

Figure 14. Great crested newt counts at Mold Road, Wrexham, 1996 to 2017. Downloaded from Online Wales GCN Monitoring Database.



5.7 Halkyn, Pen-yr-Henblas, Flintshire

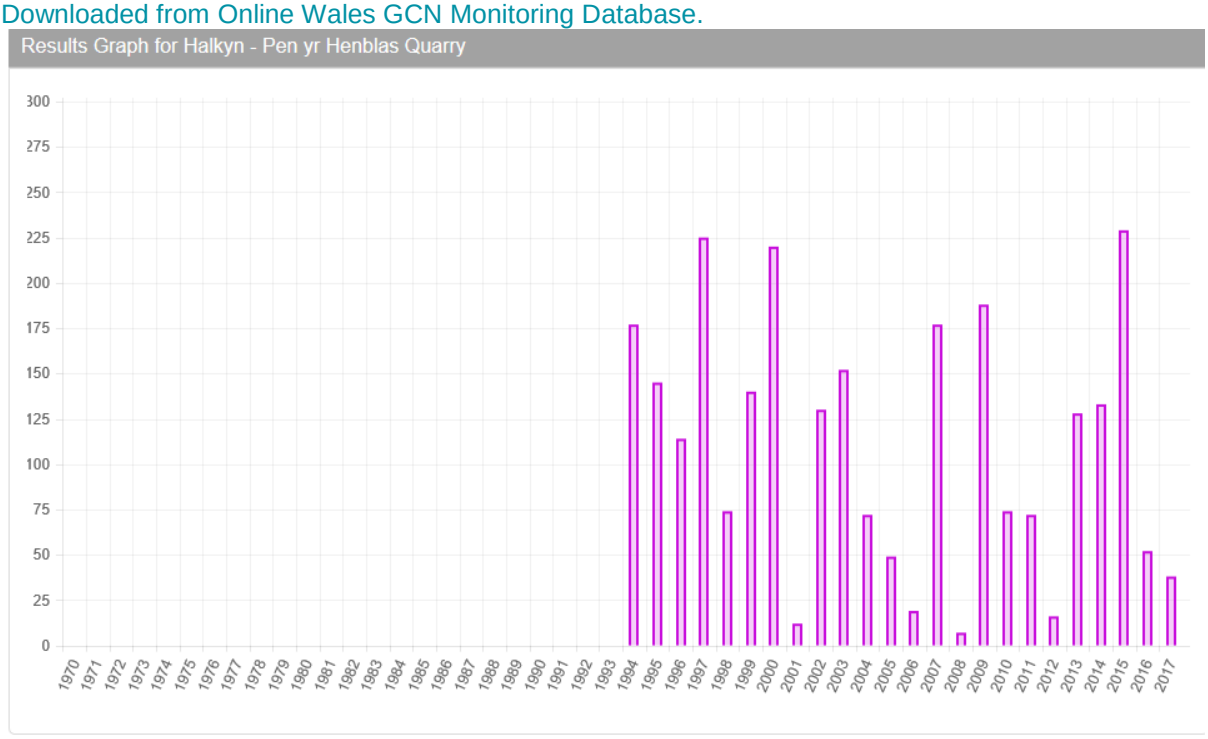
Owners/managers: Grosvenor Estate.
Designations: Halkyn SSSI and SAC.
No. of ponds: Two permanent, others seasonal.

Known history: The site is a former chert quarry. The site has issues with *Crassula* for the past 8 years and attempts at control are on-going. The site is used by motorcycles, dog walkers etc. so is hard to police.

Management information: There is a dedicated ranger who is employed via the Grosvenor estate to manage the Halkyn SSSI/SAC and its features. The ponds are not man-made so their water levels are very unpredictable. The main two ponds are surveyed annually. There is also a grazing programme for the whole of the SSSI and SAC. The number of graziers has dropped over the years due to it not being profitable and they now undertake this as a hobby rather than a way of living. This has left some areas over-grazed and others under-grazed due to the hefting nature of sheep.

GCN population trend: The site shows a consistent number over the years and with 24 years of data. The site also has very good palmate numbers due to its higher altitude.

Figure 15. Great crested newt counts at Halkyn, Pen-yr-Henblas, Flintshire, 1994 to 2017. Downloaded from Online Wales GCN Monitoring Database.



5.8 Stryt Las Park, Wrexham

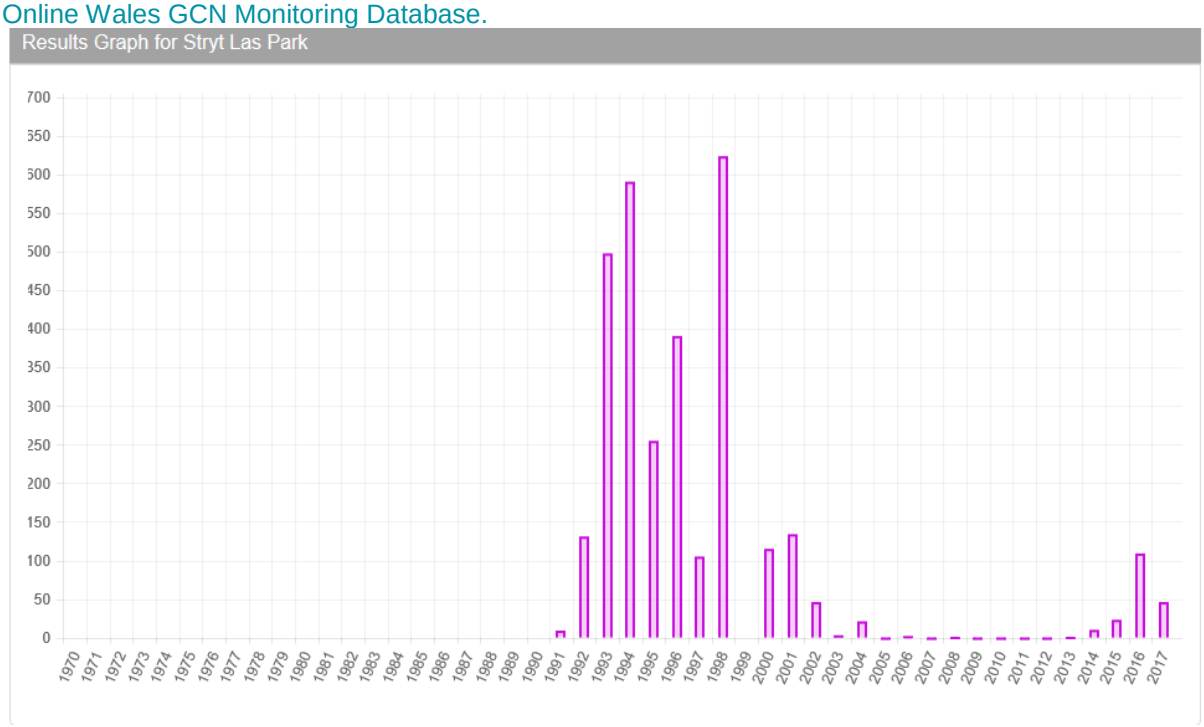
Owners/managers: Wrexham County Council.
Designations: SSSI and SAC.
No. of ponds: Five.

Known history: Former colliery / landfill site.

Management information: Great demonstration of a GCN recovery site. The site is a Country Park so has a lot of public pressure from anti-social behaviour to dogs jumping in ponds. The large pond (408) also has wildfowl using it and the local community do feed the ducks. Fish have also been recorded in this pond. The site has had and still does have issues with *Crassula*, management of which is on-going, though fish have now been eradicated.

GCN population trend: The GCN population has now started to rise slowly in correlation with the management works. Wrexham Council also carry out an annual gully pot survey in the area surrounding the site which evaluates incidental capture and killing in the gully pots and also serves to indirectly corroborate the understanding of amphibian population fluctuations achieved through the on-site monitoring effort. In 2016, 454 amphibians including 160 great crested newts were rescued alive during the gully pot surveys and a further 626 amphibians (including 54 great crested newts) were found dead in the gully pots (Wrexham County Borough Council 2016). These numbers represented a significant increase on numbers observed in previous years, and together with increased sightings during torchlight surveys in the big pond were considered to reflect a successful breeding season following the removal of fish.

Figure 16. Great crested newt counts at Stryt Las Park, Wrexham, 1991 to 2017. Downloaded from Online Wales GCN Monitoring Database.



5.9 Maes Mynan, Flintshire

Owners/managers: Privately owned.
Designations: None.
No. of ponds: Six.

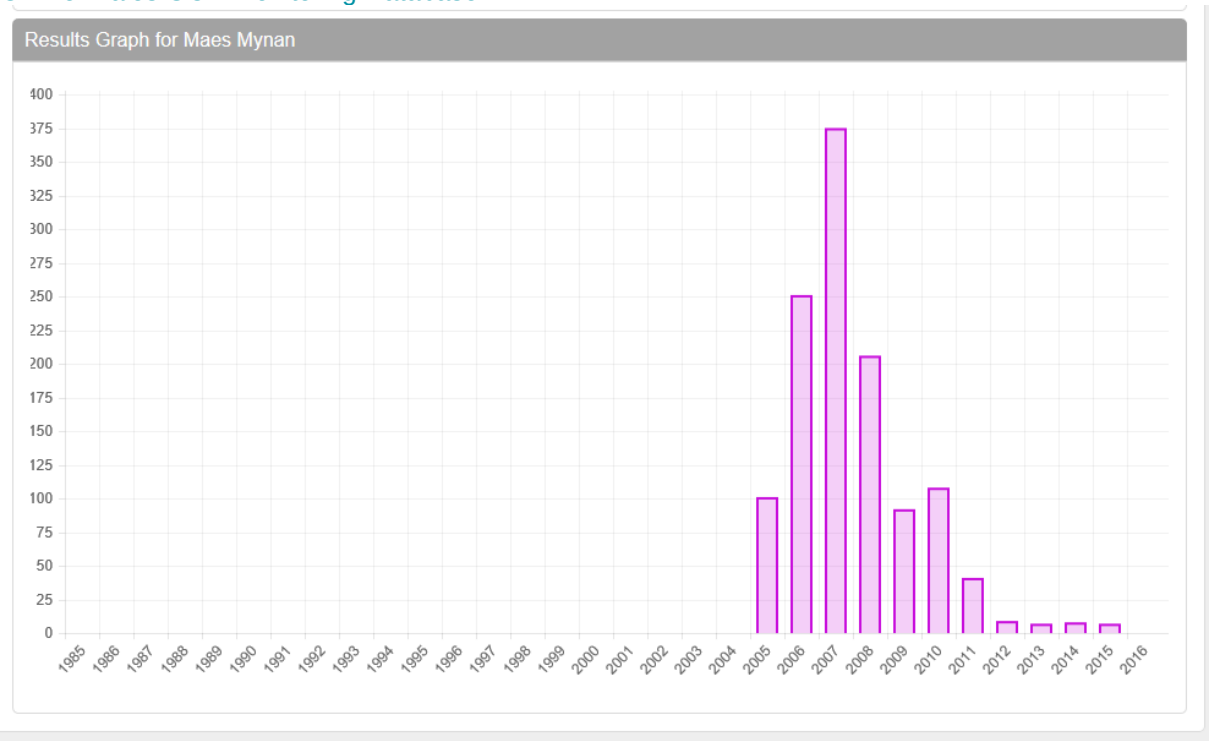
Known history: The site is a redundant sand and gravel quarry that has been disused for over 15 years. The quarry was first opened in the 1930's. The land came into the ownership of the current landowner in November 2015. The site is currently seeking planning permission to develop the site into three different holiday lodges. Tourers, Caravans and up market lodges. This would be created in a phased approach. As part of the planning application there will be a view to manage parts of the site with the aim of a GCN recovery emphasis.

Management information: This site has never been managed as a nature reserve. The adjacent quarry has developed 4 ponds and there are long-term plans to

manage the land post quarrying. This will be handed over to ARC for long term management and monitoring.

GCN population trend: NRW began surveys in 2005 which demonstrated a strong population of GCN present on site. The population peaked in 2007 with 375 GCN and then started to decline with a huge drop from 2011 onwards. Surveying ceased in 2016 due to permission from landowner not being granted. Current counts are therefore unknown.

Figure 17. Great crested newt counts at Maes Mynan, Flintshire, 2005 to 2015. Downloaded from Online Wales GCN Monitoring Database.



5.10 Discussion

Contrary to a common perception that great crested newt is well dispersed, and perhaps less in need of protection and conservation management than its legal status infers, this short selection of case studies provides a snapshot of common challenges to maintaining and enhancing its status.

An over-arching point is that in the main it is relatively hard to ascribe with confidence the reasons for great crested newt population change at a pond or at a

site, because good information on site management and on counts of the species over a prolonged period is often lacking. Even in this short and highly selective group of examples, the information available varied in quality and quantity. Without the full mobilisation of habitat and species data to a central place such as the Online Database or a national monitoring scheme, it is unlikely that the pressures impacting on the species can be ranked without resorting mainly to expert opinion.
A second lesson from the site portfolio is that site protection alone is not enough, as ponds and their surrounding habitats are prone to deterioration in habitat quality so that over time their newt populations may reduce. The species may decline or be lost altogether from land that is set aside for its conservation, if the right programme of rotational management is not set in place and monitored to maintain the condition of the features it requires (e.g. Maes Mynan). Sometimes an appropriate management plan may be difficult to realise in practice, as in the case of Halkyn where the lack of local graziers has resulted in vegetation structure that does not meet the targeted sward condition across all areas of the site. Even when sympathetic habitat management is in place, new challenges to the maintenance of a population can emerge such as the natural or human-mediated introduction of fish predators or non-native invasive plant species (e.g. Brookhill, Halkyn). Habitat creation measures may not always be successful (e.g. the pond at Brookhill that failed to hold water).

Sites provided in compensation for development can, with the right management regime, be rapidly colonised by great crested newt (e.g. Fields Farm). This leads to the possibility that when appropriately situated and managed, mitigation for development may result in net gain for great crested newts and other wildlife, sometimes increasing the biodiversity interest of an area (e.g. St Asaph business park). However, as is shown by Globe Pools, a positive management regime is required if a mitigation site is to succeed. In particular, hydrological issues can be particularly difficult to manage; these may originate within or outside the site and may impact on the length of time ponds hold water, so that they dry prematurely or fail to hold water at all (Mold Road, Brookhill, Globe Pools). Elsewhere, surveillance conducted to assess the likely impact of the Wrexham Industrial Estate road improvement scheme exposed issues of hydroseral succession in the area and linked this to a decline in the proportion of ponds known to be occupied by great

crested newt (Anon. 2010). Other issues outside land managed for great crested newt include gully pots, which can result in large numbers of amphibians being incidentally captured or killed such as at Stryt Las.

Finally, it should be stated that many of the issues described occurred even on protected sites, however, only a tiny proportion of the Welsh great crested newt population occurs on land where through some form of nature conservation designation SSSI, SAC there is motivation to manage the land for the benefit of the species. Great crested newts in the wider countryside are likely exposed to similar, if not greater pressures, but such populations are less likely to be monitored.

6. Long term prospects for the Great Crested Newt

Objective: To advise on the long term prospects for the species within both rural and urban areas, particularly within known strongholds for the species.

6.1 What is meant by “long term”?

The phrase “long term” is used in various contexts within great crested newt conservation, yet it has no precise and universally accepted definition. From a purely ecological perspective, one might consider the life history of the great crested newt. The species has a typical generation time of 2-4 years and is relatively long-lived for its size (Jehle *et al.* 2011). After a high mortality phase during the first few months of life, once great crested newts have emerged from the breeding pond onto land their survival increases markedly. Individuals reaching this stage can commonly live to 5 years, and the maximum recorded age for a wild newt is 17 years. Using this information, it would seem appropriate to consider around 20 years as a minimum for “long term” in an ecologically meaningful sense.

The phrase “long term” is perhaps most often used in a mitigation context, when describing the period over which an area set aside for newts will be managed, monitored and/or safeguarded. Even in this context, “long term” has been variously set at 10, 20, 25, 50, 100 years, or “in perpetuity”. The length of time such activity would continue would depend on the type of agreements (typically between developers and Local Planning Authorities or a licensing authority) and the funding mechanism (for example, a Section 15 or Section 106 agreement). EC guidance on reporting under the Habitats Directive (Evans & Arvela 2011) gives some interpretation of short- and long-term trends. It states while short term trends should cover the period encompassing two reporting cycles, i.e. 12 years, that “…The recommended period for assessing longer term trends is four reporting cycles (24 years)…” This is generic guidance, applying across scheduled taxa, rather than specifically for the great crested newt.

6.2 Long term prospects of great crested newt populations in Wales

The great crested newt is often regarded as a conservation-dependent species. That is, in most habitats where the species is currently found, the species long term persistence relies on some form of human-mediated intervention. Historically, ponds would have been more volatile with succession and creation occurring such that the metapopulation could function in a way that is now often constrained. The precise habitat conditions that great crested newts require to be created and maintained typically need some form of external activity. Most fundamentally this relates to the suitability of breeding sites. Great crested newts typically breed in medium-sized waterbodies – typically ponds - which are largely unshaded, have a good range of aquatic plants, hold water until midsummer, provide a source of prey, and are free of fish. Those conditions tend not to be stable in the long term in modern landscapes. For example, ponds become shaded in the absence of activity to reduce shrub and tree growth on the south side. Likewise, ponds in most habitats go through hydro-seral succession i.e. they gradually acquire a higher density of vegetation within the pond basin and become more prone to drying out. Fish may colonise or be introduced. All of these processes can lead to the loss of the great crested newt sub-population from a given pond, and if the processes affect ponds over a wider area then a local extinction can result.

The activity that creates or maintains habitat may not be specifically conservation-related. For example, pools forming in mineral extraction sites can provide ideal breeding conditions for great crested newts, at least in the short term. The felling of trees in forestry plantations can maintain light levels at great crested newt ponds.

Whilst historically great crested newts would clearly persist without human intervention, modern landscapes are so radically altered, as are the processes that affect them, meaning that intervention is normally required. Habitats that have remained more intact, and where therefore much less intervention is normally needed to conserve newts, include dune slacks and uplands.

It may be instructive to consider the best strategy for conserving great crested newts over the long term in north Wales. Currently, many of the largest known populations

occur at post-industrial sites, often mineral extraction sites. Quarrying activity has sometimes created breeding pools which have been colonised by newts from the surrounding agricultural landscape; such post-industrial sites have often subsequently been used for landfill and then mitigated for. The best known sites in north Wales are now protected, including some as SACs. In some cases, construction relating to residential or industrial activity has resulted in mitigation projects designed to conserve great crested newt populations. In turn, some such sites have also been designated. Over time, these populations can become surrounded by further development, which often leads to higher levels of risk and reduced long term prospects. For instance, the risk of fish introduction increases greatly when there is new residential development nearby. Whilst there are some notable exceptions, mitigation practice has typically been characterised by a lack of ongoing habitat management. This results in declining habitat condition, often through unchecked succession e.g. Globe Pools case study (section 5.5), Fron Haul (Matt Ellis, pers. comm.), Wrexham Industrial Estate Road Improvement scheme ponds (Anon. 2010). Whilst these new risks can be mitigated to some extent – for example by putting in place wardening, outreach activity, habitat management, and capacity for remedial action – there will remain a residual level of risk to the population. In addition, such mitigation activities can be costly to set up and maintain and may not operate perfectly.

Great crested newt populations in the wider countryside – in agricultural areas, forestry, woodland and coastal habitats, for example – tend to be exposed to lower levels of acute risk when compared to ponds within or close to urban areas. These wider countryside populations are rarely subject to statutory protection, chiefly because newts are more dispersed and not amenable to designation because of the way that SSSI and SAC site selection operates. In order to protect the same size population as might be found in a post-industrial site, a much larger area would need to be designated and that is unlikely to pass through the site selection process unchallenged. To illustrate how little the protected sites series impacts directly on land occupied by great crested newts, it is useful to consider an analysis undertaken in c.2008. Using coarse GIS data it was predicted that 97% of the range of the great crested newt in Wrexham county was outside designated sites; the only site

designated for great crested newts (Stryt Las a'r Hafod SSSI) accounted for c.0.05% of its predicted range within the county (M Ellis, pers comm).

One conclusion from this situation could be that great crested newts might benefit from adopting what might be termed an "Area of Outstanding Natural Beauty approach." In other words, rather than designating small areas of land that support large populations which then require costly ongoing measures, perhaps it would be better to adopt a less strict but wider area of active conservation activity, or to use this as a complementary approach. Agri-environment measures could be used to target and fund habitat creation. This landscape management approach would lead to a different pattern of investment and might be closer to some approaches used on the continent. However, it would represent a significant shift from current conventions, and would not be without risks. An alternative could be to review the SSSI selection criteria so that it encourages designation of wider countryside newt populations covering a wider area, or perhaps archipelago sites (i.e. those that incorporate multiple discrete areas across a landscape). An archipelago approach to site boundaries might be beneficial for species like the great crested newt that form metapopulations, ranging across large areas of the landscape, yet fundamentally depending on particular small-scale features for their persistence. Metapopulations are typically not well served by the existing approach to designation. The designation system would need to ensure that inter-patch connectivity is maintained. The challenges of conserving small yet ecologically important features in agricultural landscapes is gaining more attention from continental European researchers (Poschlod & Braun-Reichert, 2017).

7. Key performance indicators for long term prospects

Objective: To propose and articulate the rationale for long term prospects Key Performance Indicators (KPI's)

7.1 Introduction

Conservation objectives for SACs are a requirement under the Habitats Directive (92/43/EEC). Fundamentally, the Habitats Directive requires Member States to have a number of provisions for maintaining (and restoring, where applicable) European protected habitats and species at a favourable conservation status. This includes the provision of a network of protected sites, including SACs, for those species listed under Annex II (including great crested newts), and to have conservation measures in place to manage these sites accordingly, which is where conservation objectives, and key performance indicators apply. The Directive also obliges Member States to undertake surveillance (Article 11) and to report on the status of the species and habitats every 6 years (Article 17), and this is where conservation objectives also play a vital role.

Key Performance Indicators (KPIs), also known as Performance Indicators, are used by NRW to articulate the current condition and conservation status of an SAC and SSSI. With respect to SAC monitoring, KPIs are informed by the conservation objectives set for the site.

The conservation objective describes Favourable Conservation Status (FCS) for each interest feature on site. In Wales, the conservation objective comprises two parts, *the vision* for the feature and the *performance indicators.* The former includes a descriptive summary of the elements required to sustain the interest feature in favourable condition, and the latter includes all the factors which affect the condition of the feature; these are the measurable elements of the objective. It is important to note that performance indicators are only part of the conservation objective; *"A conservation objective, because it includes the vision for the feature, has meaning and substance independently of the performance indicators, and is more than the sum of the performance indicators"* (CCW, 2008a,b,c). For the purposes of this report, the term 'performance indicator' will be used in preference to 'key

performance indicator' as the majority of the management plans and monitoring reports examined for this report use performance indicator terminology.

Performance indicators are essential for SACs, and protected sites in general, to be managed and monitored effectively. They provide a means to measure the condition of an interest feature in a standardised way; important for temporal assessments at the site, but also for comparisons throughout the SAC network if consistent performance indicators are used. Similarly, performance indicators clarify the key elements that need to be evaluated and enable targets to be set, allowing management to be prioritised, and the effectiveness of management on site to be reviewed objectively. This also enables the ambition for the site to be communicated effectively to all stakeholders, facilitating the development of a shared vision for the SAC.

The targets, (or upper and lower thresholds as used by many SACs) of the performance indicators need to be flexible to allow for important site specific characteristics to be maintained; for instance, if a number of ponds are set within a woodland, the target for the shading attribute would need to have a higher threshold value than for a grassland site, but this level of specificity can be accommodated well within this system.

7.2 Common Standards Monitoring

Common Standards Monitoring for protected sites was developed by JNCC in 2004, as one of their purposes defined by the Environment Protection Act 1990. Common Standards Monitoring was specifically devised to monitor SSSIs, ASSIs, SACs, SPAs and RAMSAR sites, although this approach can be used for other areas of land with a conservation importance (JNCC 2004a).

As highlighted by JNCC (2004a), having common standards for monitoring is valuable in two key ways. Firstly, providing a reliable methodology to be used by statutory nature conservation organisations to be able to evaluate the main interest features on site with confidence and allows changes to be detected. Secondly, the system enables summary reports to be compiled from a range of site assessments, facilitating the identification of priorities at a local and national level. The benefits

detailed for the common standards mirror those previously described for the performance indicators. It appears that a different approach has been developed in Wales for SAC condition assessment for great crested newts. The variation of the approach is briefly referred to in the Core Management Plan for a number of newt SACs, where it states *"As a result of the general practice developed and agreed within the UK Conservation Agencies, conservation objectives include performance indicators, the selection of which should be informed by JNCC guidance on Common Standards Monitoring*" (CCW 2008 a,b,c).

The Common Standards Monitoring protocol for species interest features evaluates a range of attributes developed to assess the status of the species on site. It includes species performance indicators/attributes (e.g. counts of great crested newts), and also evaluates habitat features on which the species depends, such as number of ponds, and the extent and the condition of terrestrial habitat etc. As we understand it, the approach taken in Wales has been similar to the generic Common Standards methodology to the extent that both species and habitat attributes/indicators have been developed; however, the development of the performance indicators deviates from those described in the Common Standards methodology, as well as being inconsistently applied across the three SACs examined in this report (Appendix 1). This limited examination suggests there may be several weaknesses in the methodology chosen for assessing condition of the great crested newt interest feature on SACs in Wales, including inconsistency between sites, poor choice of attributes and an example of inappropriate methodology being used (*i.e*. egg counting) for at least one survey report. The text below compares and critiques the Wales performance indicator method with that of the Common Standards Monitoring as far as the information available allows. To further elaborate, we compared the UK Common Standards Monitoring guidance document (JNCC, 2004b) and site specific core management plan documents (CCW 2008), rather than a high-level framework template outlining the performance indicators, as like for like documents were not available.

Notwithstanding, it would be useful for surveyors and those involved in SAC management etc. to have a generic template that is used across the sites in Wales to: achieve performance indicator and target setting consistency; outline where

deviation from this framework is permitted; and for all sites to elaborate within the relevant site documents the rationale for a change to the basic targets. This is assuming that the agreed divergence from the UK Common Standards Monitoring methodology is considered to remain the best course of action.

The performance indicators approach also has additional attributes to the Common Standards Methodology at some SACs; these include evidence of breeding success (larvae), as well as some factors such as presence of pollution and presence of non-native aquatic plant species, where the target is for their continued absence. This appears to be a poor choice of attribute because it examines the factor influencing condition and not the condition of the feature *per se*, as outlined in the introductory guidance to the Common Standards Monitoring (JNCC, 2004a).

7.3 Species attributes/performance indicators

A population count is the main species attribute provided to evaluate great crested newts on sites. The Common Standards Monitoring stipulates a target of at least 20% of the peak count for four consecutive years (fail if the peak count falls below 20% for 4 successive years), while for the performance indicator, a lower numerical threshold value for the number of newts is given (for the SAC documents examined). The threshold value is sometimes provided per management unit, depending on the size and spatial arrangement on the SAC. There is a key difference however; the Common Standards Monitoring refers to a count in all, or a sample of ponds (depending on the number of ponds, and size of the site), but the population target under the performance indicator approach is seemingly restricted to breeding ponds only; '*Extent and distribution of adult great crested newts Triturus cristatus in breeding ponds'*, where a breeding pond is defined as '*..a pond in which T. cristatus is/or is likely to conduct egg laying, and successful metamorphosis once in every 4 years.*'

In the Common Standards Monitoring methodology, all ponds that might be used by the species could be sampled, unless there are a large number of ponds, whereas the performance indicator system restricts surveillance to breeding ponds. The definition of a breeding pond seems subjective as it is based on an assessment of

the likelihood for successful metamorphosis once in 4 years. This is an important difference, as it is well known that great crested newts can move between ponds throughout the breeding season. Some ponds are not used for breeding each year, whilst others are. Limiting the count to breeding ponds may lead to important ponds not being surveyed. As, in reality, many sites have a large number of ponds and surveying all the ponds is unrealistic, it is important to note the differences in approaches and to be aware of the limitations. Where there are large numbers of ponds on SACs, it is important to provide detail and the rationale for the sampling approach used to determine the ponds to survey, allowing for it to be understood at a later date. The Common Standards Monitoring system provides some detail on the core elements to be taken into account for sampling, but perhaps insufficient for sampling to be undertaken in a standardised way. From the work undertaken to date, no generic guidance to guide the methodology and the selection of ponds for survey appears to be readily available specifically for Wales.

A critical aspect to be investigated is how the data is collected for this population attribute; for the Common Standards Monitoring methodology, a peak count is referred to, where this is derived by '*summing counts across site on "best" night for each season'*. It is not clear how the population count is considered in Wales; the concern is that the peak count for each pond could be summed (and could therefore involve double counting of newts, if the 'peaks' at each pond are on different nights). This is more likely to be a factor on large sites where there are a large number of ponds, or where the ponds are quite widely dispersed, making it difficult to survey all the ponds in one evening. In such cases a sampling methodology is particularly important. A practical solution to sampling large sites and achieving the peak count on a single "best" night, is to work within a pond cluster/ meta-population unit and undertake the sampling for that unit in one night. The sampling regime would need to specify the number of ponds to be sampled for each of these units for a given survey night. Although this approach may not exclude the possibility of double counting, it should help to reduce it. This approach may have already been taken at some sites, such as Johnstown Newt Site SAC, where a lower threshold (number of newts), has been provided per management unit. As referred to earlier, JNCC (2004b) provides some guidance on procedural aspects.

One other difference between the approaches is the number of years within the six-year monitoring/reporting cycle in which surveys are expected; for the Common Standards Monitoring this is four consecutive years in six, while the Welsh approach requires surveys every year. Achieving yearly surveys across the great crested newt SAC network is ideal, but this level of effort may be unsustainable in the long-term. If this is the aim, the recommendation would be to revisit the performance indicators, clarify and standardise methodologies (e.g. state the number of survey visits expected each survey year, sampling strategies etc.), to make the surveys more efficient and easier to undertake.

The assessment of breeding is handled differently by the two methodologies. The target for this attribute under the Common Standards Monitoring approach is for eggs to be detected in all/or a sample of breeding ponds at least once in every four years to infer breeding, whereas the Welsh performance indicator approach accepts the detection of eggs, larvae or juveniles as an indicator of breeding.

The protocol for this performance indicator has been left open in the site documents explored, which explains the divergence in methodologies applied across the SACs; '*Evidence of breeding success; Based on the number of breeding ponds showing recruitment which are required to maintain a viable population*', with a breeding pond defined as '*a pond in which T. cristatus is/or is likely to conduct egg laying, and successful metamorphosis once in every four years*'.

The targets for Johnstown Newt Site SAC vary among management units. For example, in certain units the lower limit given is "one or more breeding ponds with evidence of recruitment per specified management unit", while in other management units the lower threshold set is higher. As the threshold refers to "recruitment", this would intimate that juveniles, rather than the presence of eggs or larvae, is the life stage intended to be surveyed at this site. It is likely that observing any of these life stages would merit a 'pass' for this performance indicator but clarifying the protocol may lead to more consistent future condition assessments. For Halkyn Mountain SAC, the breeding performance indicator specifies larvae; *'Extent and distribution of Triturus cristatus larvae*', but the rationale of the indicator is similar to that of

Johnstown Newt Site SAC, with two ponds with newt larvae present articulated as the lower threshold for specified pond clusters.

There are disparities between monitoring approaches taken at different sites, but also in the way this is translated into monitoring on site. For example, one SAC monitoring report refers to an “egg count” to be undertaken in specific ponds, in contrast to the site Core Management Plan that highlighted eggs and or juveniles present in the main water bodies. This observation reinforces the need to have generic guidance/template for the survey methodology to prevent inappropriate survey work from occurring.

Surveying for eggs is a valuable survey technique for detecting presence of the species, and confirms breeding is taking place, but should not be used as an abundance measure. This is due to a number of factors; female newts lay a large number of eggs across the breeding season, newt eggs and larvae are predated, and the intriguing biological fact that 50% of all eggs laid do not hatch, due to a chromosome abnormality (Horner & MacGregor 1985). An egg count is therefore pointless, but more importantly, potentially damaging; to identify the species of newt (great crested newt or smaller newt species), the folded leaf (folded to bestow some degree of protection for the egg), often needs to be unfurled to determine egg characteristics (colour, shape and size). Once opened the leaf will not close, making the egg more vulnerable to predation etc.

Recruitment can be a time-consuming and difficult measure to determine for the species, requiring the detection of metamorphosed or juvenile newts, as once metamorphosis is complete survival is more assured for great crested newts. However, finding late-stage larvae close to metamorphosis in ponds could also be used to achieve this part of the assessment. Surveying for newly metamorphosed or juvenile newts would involve, in the main, terrestrial refuge searching i.e. looking under logs, rocks and debris etc. where moisture is retained and where some protection is afforded to the animals. Terrestrial refuge searching should only be used as an additional survey technique (Langton *et al*. 2001). Although detecting juvenile and metamorphosed newts terrestrially when surveying at night is not an unusual observation *per se*, such sightings are not as frequent as they would need to

be to make this a mandatory performance indicator for SACs. It is likely that the criteria chosen by Common Standards Monitoring consider the practicalities involved, and the need to have a fairly quick survey method capable of detecting breeding in ponds (although one could not confer recruitment from this survey technique).

We recommend adherence to the commons standards approach (looking for eggs), as a mandatory attribute/performance indicator. Some reference to best practice for great crested newt survey work should be briefly outlined in the guidance to avoid inappropriate survey practices from being undertaken. The survey effort required to detect eggs should be outlined. At some sites detection may not be easy and in some instances a well-timed survey looking for larvae would be much more productive. Observations of other life stages should always be encouraged, and an optional/discretionary performance indicator to detect the presence of larvae on SACs could be used at some sites, amending the text from the existing performance indicator. We advise outlining a clear methodology for sampling etc., that can then be adopted by the individual sites, where site specific detail (and deviation from the generic guidance) can be noted in the relevant site documents.

Ponds are the obvious starting point when assessing habitat condition for great crested newts. The Common Standards Monitoring methodology's metric examines the number of ponds on site, allocating a minimum figure at the site level. A site fails if there is a net loss of ponds after the site was designated. For the Welsh sites inspected in this report, differ significantly in their approach to this performance indicator. At Johnstown Newt Sites SAC (CCW, 2008b) and Halkyn Mountain SAC (CCW, 2008c), the pond performance indicator is described as '*Extent of breeding/display ponds'* with the rationale that it is "*Based on a number of breeding and display ponds required to maintain a viable population…*". In contrast the Core Management Plan for Granllyn SAC (Mitchell, 2008), states that the rationale for this same performance indicator is '*based on the area required to maintain a viable population'* and makes no reference to the number of ponds on site, although ponds are referred to in the operational limits/targets section. Such differences may lead to confusion, particularly with regard to monitoring; consistency of wording and rationale is required across all sites.

A key difference between Common Standards Monitoring and the Welsh methodology appears to be the type (or status) of ponds to include in the assessment. The CSM advises counting *all* ponds, (i.e. permanent and temporary, breeding and non-breeding ponds), reasoning that non-breeding ponds are likely to be significant resource for foraging. Ponds are dynamic, and the suitability of ponds for breeding by the species may change from one year to another, making it difficult to define all the breeding ponds on site. Only surveying known breeding/display ponds could lead to important ponds being missed from all surveys.

For sites with a large number of ponds, where surveying all ponds is difficult, developing a sampling methodology for the site would be a sensible way forward. This should be based on clear principles outlined in a national/template document (as proposed in this report), rather than arbitrarily limiting the ponds to be surveyed for the pond performance indicator. We recommend following Common Standards Monitoring guidance on the use of attributes to assess the ponds on SACs, as this examines the pond resource holistically, taking into account the species' likely habitat use on site.

7.3.1 Aquatic macrophyte cover

Both methodologies assess macrophyte cover, but in slightly different ways. The approach taken by Common Standards Monitoring is to allow for a large degree of variation in macrophyte cover, within defined set limits, with two classes of macrophyte (marginal and emergent, and pond bottom, midwater and surface), as newts prefer well-vegetated ponds. The target is 50% of breeding ponds to have a "good" cover of vegetation, as defined in the method of assessment. This requires a site specific target to be made, and the main breeding ponds to be known, which as outlined earlier, can be problematic. The Common Standards Monitoring document is good at providing some guidance on assessing this attribute, but for this attribute to work well, knowledge of the site is required to make site specific targets.

In Wales, assessment of aquatic macrophyte cover is also restricted to breeding/display ponds, but the target is "*based on the amount of plant material required for egg laying and the area of open water required for displaying- knowledge provided by staff with experience of the site*." The flexibility to have site specific targets is sensible but having guidance on the upper and lower thresholds would

make this performance indicator less subjective, particularly as the habitat preferences for the species is well known for this factor. Where there is a clear reason to set different thresholds for a site, the rationale and target should be well-reasoned and highlighted in the appropriate site documents. The targets for the sites examined for this report provide both upper and lower thresholds. There appears to be inconsistency in how the targets are applied in practice. A monitoring report for Granllyn SAC (Wilkinson, 2010), groups a number of performance indicators together for 'quality of aquatic habitat' and uses criteria very similar to the CSM methodology.

7.3.2 Pond persistence/water depth

Pond persistence is examined by both assessments. The CSM attribute has a generic target for most sites, where 50% of all, or a sample of ponds, have a minimum summer water depth of 10cm. The Welsh methodology follows the CSM approach, referencing it directly, and the minimum water depth target is used across the sites examined.

7.3.3 Shading

Shaded ponds, particularly those that are heavily shaded on the southern perimeter, tend to be less suitable for great crested newts (Cooke et al, 1994), therefore it is an important attribute to include when undertaking condition assessment. Common Standards Monitoring has two targets for pond shading by trees or scrub, one to cater for sites with fewer than 20 breeding ponds, and one for sites with more than 20 breeding ponds (nothing is specified for sites with exactly 20 breeding ponds). For sites with fewer than 20 breeding ponds, the target is for *<25% of breeding ponds to have >20% of southern margin solidly shaded*. For sites with more than 20 breeding ponds, the target should be the same in the majority of cases, but the guidance highlights that for some sites, based on habitat type and newt monitoring data, the target could be <50% of breeding ponds to have >20% of southern margin solidly shaded.

In the Welsh approach, the key performance indicator for shading is confusing. At two of the sites investigated, two upper limits are provided: *20% shading on the southern margin or 60% of the total pond margin shaded on 50% of breeding/display ponds*, but with no site criteria to direct the surveyor to the appropriate target to use at the site. A further site examined also used this approach but with different target

values. With the shading target as it stands, the attribute could be considered to be in favourable condition but have the entire southern perimeter shaded; which in many situations would be unsuitable, but the threshold for shading is set too high for a standard attribute.

The monitoring reports examined, varied in their treatment of shading, sometimes grouping it with other performance indicators including water depth and the presence of fish, instead of assessing it separately. Evaluating and scoring individual performance indicators separately, facilitates easier examination of the results and clearer specification of any management required.

We recommend developing a clearer attribute that allows for site differences and particular characteristics and provides logical criteria to identify when different targets should be used.

7.3.4 Terrestrial habitat

Terrestrial habitat assessment may sometimes be overlooked during monitoring, as the focus is often concentrated primarily on the site's ponds. The extent and structure of terrestrial habitat, particularly around waterbodies, is also essential for the species and needs to be appropriately monitored.

Under Common Standards Monitoring, terrestrial habitat is divided into two attributes, the first relating to the extent of the habitat, and the second examining its structure and quality. For extent, the target is for there to be no loss or fragmentation (i.e. barriers to newt dispersal) of the terrestrial habitat since designation. The assessment is made by traversing the site and comparing what is seen on the ground to a site map or aerial photograph. The guidance document outlines the area to be evaluated, terrestrial habitats within 500m, and the frequency of evaluation. The structure and quality attribute examines the availability of suitable refuge areas, with the assessment needing to be undertaken once every 3 years.

Of the sites studied for this report, Johnstown Newt Sites, Halkyn & Granllyn SACs, terrestrial habitat extent and quality of habitat is grouped together as one performance indicator, with all sites highlighting a lower threshold (target) for terrestrial newt habitat within a 250m radius of a breeding/display pond. The distance highlighted here is significantly lower than the distance for assessment

under the CSM and may be insufficient, as terrestrial habitat providing refuge, foraging areas, good connectivity etc. is an important species' requirement.

The terrestrial habitat performance indicator appropriately details the need for refuge areas and potential hibernation areas etc. which is useful as it offers some detail to facilitate assessment. Monitoring reports for the sites we examined suggest, however, that the terrestrial habitat performance indicator is applied inconsistently, perhaps due to the lack of an overall template/guidance for monitoring. The specified limits/targets are decided by staff with knowledge of individual sites. Without generic template/guidance, this may encourage inconsistencies. For example, Johnstown Newt Sites SAC has a separate performance indicator for dispersal routes', whereas Halkyn Mountain SAC, includes this within the '*extent and quality of terrestrial habitat*' indicator.

The level of detail specified as a requirement of monitoring this performance indicator varies. The Core Management Plan for Granllyn (Mitchell, 2008) specifies the area in hectares of habitat types that should be found in different units. This level of detail is appropriate in the core management plan but is beyond the scope of a performance indicator to assess condition. This issue is illustrated by the Glan-treath SAC monitoring report, where it states against the performance indicator for terrestrial habitat extent *"This target has not been incorporated in the PIs because it was not deemed possible or practical to set measurable and objective targets for GCN terrestrial habitat at Glan-traeth should consist of."*

7.3.5 Fish

It is important to monitor if fish are present in ponds, and this is covered by both methodologies. The Common Standards Monitoring considers this attribute by grouping fish and wildfowl together, with two targets. The first is for sites with fewer than five breeding ponds, where the target is for fish and wildfowl problems to be absent from all ponds. and the second target is for sites with more than five breeding ponds and requires more than 75% of ponds to be free of fish and wildfowl. In Wales, the performance indicator for fish is not addressed consistently across the sites studied for this report. At Johnstown Newt Sites SAC and Halkyn Mountain SAC, fish are dealt with as a separate performance indicator, with an upper limit/target "*no fish species (including sticklebacks) present in display/breeding ponds*." as outlined in the

core management plans for the sites (CCW, 2008b and c). Granllyn SAC has no performance indicator for fish, although the absence of fish in breeding/display ponds is mentioned in the vision for the site. Important factors that can directly affect the status of the species, should be monitored via a performance indicator. In the case of fish, it is important to detect any fish introductions as early as possible, so that they may be addressed.

7.3.6 Other indicators

A few of the sites studied for this work use other performance indicators, namely dispersal routes (Johnstown Newt Sites SAC, Granllyn SAC), the presence of pollution (Halkyn Mountain SAC, Johnstown Newt Sites SAC) and non-native aquatic plant species (Halkyn Mountain SAC, Johnstown Newt Sites SAC). As for the other indicators evaluated in this section, it is important that the relevant criteria are defined clearly in each case to ensure consistent evaluation between years and sites.

In conclusion, the fundamental purpose of setting and monitoring key performance indicators at designated sites should be to provide sufficient evidence to judge whether the integrity of the site is being maintained and inform site management. Ideally monitoring should reveal how great crested newts are responding to the management implemented. Furthermore, because the number of SACs is a small fraction of all the sites where the species is recorded, the monitoring approach would ideally integrate well with initiatives to monitor the status of the species/species' habitats across the wider countryside i.e. integrate with, and contribute to, a centrally co-ordinated UK-wide monitoring scheme. Specific recommendations for setting and monitoring key performance indicators are given in section 9.

8. Monitoring the Great Crested Newt

Objective: To advise on methodologies and approaches required to sustain long term surveillance.

8.1 Monitoring great crested newt sites over the long term

As a European Protected Species, there is a statutory duty (shared by Welsh Government and Natural Resources Wales) to undertake surveillance of the conservation status of great crested newt. This arises from Article 12 of the Habitats Directive, transposed into UK law by the Conservation of Habitats and Species Regulations 2017. Article 12 also confers a duty to monitor the incidental capture and killing of great crested newts; although not formally agreed, this could relate to capture in roadside drains and killing during land management, amongst other activities.

Important great crested newt sites, for example protected areas or large mitigation sites, should be a target for monitoring. Clearly there is a challenge here, not least in terms of funding and the logistics of ensuring that monitoring activity is implemented for the long term. Designated sites procedures for SACs should mean that a condition assessment is undertaken for each 6-year period, and there are agreed methods for both setting site-specific targets for species and habitat components, and monitoring performance against those targets (JNCC, 2004). For SACs, a similar assessment period applies, with additional reporting to the EC under Article 17. See also section 8 for more detail on protected site monitoring.

At mitigation sites, the specification for monitoring and the mechanism to ensure it will happen normally depend on agreements made at the development control and/or licensing stage. The rationale for monitoring mitigation sites essentially has two elements: reporting on the derogation and informing management activity to maintain the population. There is guidance on what monitoring protocols should be used in England (English Nature, 2001), and this is often referred to in Wales. This guidance focuses on assessments of species presence or relative abundance. Unfortunately,

research demonstrates that in practice, such monitoring data are often difficult to access, if indeed they were ever collected (Lewis, 2012.)

New guidance on post-development monitoring protocols is currently being considered by Scottish Natural Heritage and may apply in Wales when published (ARC understands that NRW staff have provided comments). It is the authors' understanding that this is likely to emphasise the value of monitoring of both habitat condition and species status. Case studies of long-term monitoring reveal the value of assessing habitat condition, rather than solely a measure of species status (e.g. Lewis et al, 2016; Cooke, 1997). By tracking key characters of the habitat, it is possible to infer likely or actual threats to the newt population before they have a serious impact. For instance, it is useful to detect increasing frequency of early pond drying, since then remedial action can be taken to improve the pond before there are serious consequences for the newt population. Monitoring only the newts themselves would effectively delay the detection of problems until there were a noticeable demographic response, by which time management problems are more difficult to resolve. The great crested newt Habitat Suitability Index (HSI) (Oldham et al, 2000) offers an extremely useful tool for assessing habitat quality. "Habitat" is one of the four Habitats Directive conservation status parameters, and so an explicit aim to monitor habitat condition seems appropriate. The EC has produced guidance on assessing Future Prospects, including a list of potential threats, pressures and conservation measures. Whilst it is not a simple match, this list could be used to design more compliant post-development monitoring regimes that explicitly include Future Prospects.

It might be argued that monitoring habitat quality alone is a more cost-effective approach. However, it is important to recognise that habitat condition is not a perfect surrogate for population. It would be possible, for example, for a newt population to collapse while habitat parameters appeared to show the site to be in good condition e.g. Glan-traeth. Clearly, the more detailed and frequent the habitat assessment is, the less likely this situation is to arise, yet we suggest that habitat only monitoring is insufficient.

Large scale mitigation projects potentially generate opportunities for sustained long term surveillance. This subject was discussed at a recent conference aimed at mitigation practitioners (CIEEM Autumn Conference, “Mitigation, Monitoring and Effectiveness,” 21 & 22 November 2017), including one particular example (Whitehorne *et al*. 2017) that proposed habitat assessment with proportionate species assessment. Funds generated by mitigation projects can be used to sustain long-term surveillance, although typically only for the specific area affected by the development and any restored or created areas used as mitigation. It is possible that diversification of funding mechanisms, including development-related projects, could help to sustain long-term surveillance. In England, the strategic licensing pilot project in the South Midlands aims to use developer contributions to fund monitoring of both compensation sites and newt status in the wider countryside.

With datasets on great crested newt arising from different sources, it is important to aim for integration. In North Wales, NRW has supported COFNOD to set up a “SMART” (Single-entry Multiple Applications for Reporting Trends) reporting system. This should allow more streamlined reporting and sharing of great crested newt data, for example meaning that licence reports are effectively automated.

A more straightforward approach, combining simple repeated habitat and species assessments, would likely apply in most cases using the Online Wales GCN Monitoring Database. For the great crested newt, we have a fairly established method for assessing habitat quality at the pond level (the great crested newt Habitat Suitability Index [Oldham *et al*. 2000]). A development from this is to use HSI assessments at a spatial scale above the pond, to allow site or landscape-level assessment. ARC has proposed ways to do this for SSSI condition assessment, and it could potentially be used for other applications. In particular, HSI scores can be especially beneficial for informing land managers about improvements at sites that are declining in condition. New technologies such as remote sensing offer opportunities for assessing newt habitat (e.g. Cranfield, 2017), and ARC is currently working with Natural England to explore these methods for designated site assessment.

NRW has described three tiers of monitoring (see Figure 18).

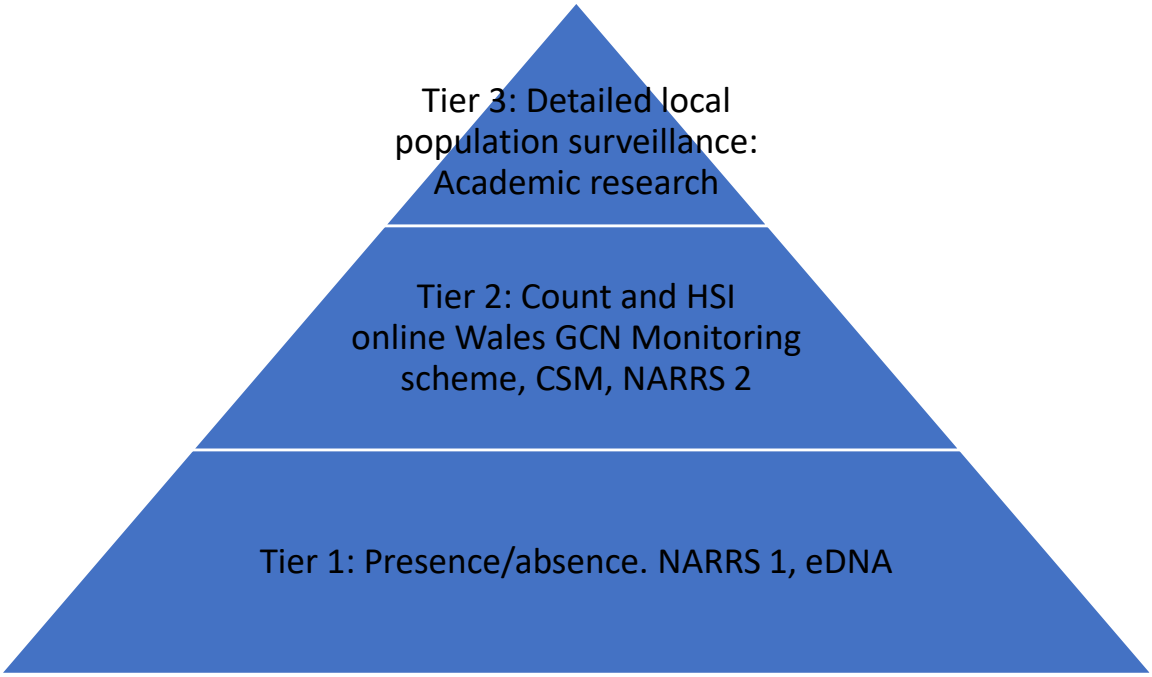


Figure 18. Diagram summarising a framework of surveillance approaches. The breadth of the horizontal layer indicates the relative number of sites. Higher tier activities require the collection of more complex data.

8.2 Monitoring great crested newt sites at mitigation sites

There are a number of challenges for monitoring the effectiveness of mitigation projects:

- Agreeing a protocol that sets out a level of effort that is proportionate to the development impact.
- Agreeing methods for monitoring, to include both species and habitat assessments, which result in meaningful assessments that (a) assess conservation status, and (b) provide information useful to the site manager.
- Ensuring that monitoring is implemented, especially in the long term.
- Ensuring that monitoring data are collected in a consistent manner.
- Ensuring that monitoring data are collated centrally and shared with appropriate audiences.

Many of these issues are discussed in reviews published over the last decade or so (primarily: Edgar *et al.* 2005; Lewis *et al.* 2005; Lewis *et al*. 2016). The issue of setting standards for guidance could be addressed by publishing national guidance, and we understand that Scottish Natural Heritage is considering this at present. Once

published, that could be tied in to planning and licensing conditions, and associated agreements, with resourcing from the developer.

In terms of mitigation we have good and bad 'evidenced' examples (see case studies in section 6 for examples of varied responses by great crested newts to mitigation). One example where the response of newts to mitigation seems particularly positive, was St Asaph where the WG (previously WDA) held a single (strategic) licence for the majority of the business park. This enabled strategic mitigation and enabled prior clearance of working areas. The population has increased and is now of national importance.

It may be instructive to review progress with the monitoring of the reporting processes and outcomes of mitigation projects for bats (which are also European Protected Species and are subject to the same licensing regime). Cross-taxa reviews of mitigation tend to show at least some common themes (e.g. Germano *et al*. 2015), which could be transferable to great crested newts.

Natural England recently announced that it was to begin a trial of District Level Licensing (DLL) for great crested newts (Natural England 2017). Essentially this is an alternative approach to conventional site-by-site licensing, which instead assesses newt status at a landscape scale in advance of development *a priori*. It shifts mitigation towards a greater contribution of off-site compensation areas, with reduced focus on protection of individual newts and more emphasis on creating large areas of habitat. Natural England is currently developing proposals for monitoring under DLL. ARC has been involved in a pilot of great crested newt DLL in the South Midlands, and here we have developed a detailed approach to monitoring. This entails assessment of species and habitat condition at sites subject to habitat creation, as well as assessment of great crested newts in the wider countryside in order to provide a context for data gathered at mitigation areas. At the time of writing these methods are being reviewed by Natural England and so may alter, but essentially, they entail species presence (eDNA and traditional methods), abundance (via individual counts and by Capture Mark Recapture methods), and habitat assessment (via HSI plus a small number of additional measures). The level to which each site is assessed by these methods will vary, so that a proportionate level of resource is

used for monitoring. For example, it is envisaged that a sample (rather than all) of wider countryside ponds in the scheme would be subject to newt abundance assessment.

8.3 Monitoring great crested newts at SACs

Building on the evaluation of monitoring method protocols and surveillance reports for some example SACs (see section 8), some recommendations for activities to enhance the effectiveness of monitoring SACs, including explicit amendments to approaches to KPIs and surveillance regimes are detailed below.

8.3.1 Protected site monitoring workshop

The key recommendation is for SAC monitoring to follow the Common Standards Monitoring (CSM) approach, as the CSM approach was designed as a common approach for protected site monitoring in the UK. The CSM methodology for amphibians and reptiles is, however, currently under review, with work undertaken by ARC (NE-ARC MoA 2012-2013) contributing to progress this. It is recommended the SNCOs meet to discuss the best monitoring approach for protected sites sharing experience/lessons learnt. Topics to be explored could include: the current CSM, the amendments put forward to date, comparison with the Online Wales GCN Monitoring Database, debate further changes and what else is needed to strengthen the system. ARC would welcome participation in the workshop and/or subsequent consultations.

Vision for SAC monitoring and protected site monitoring as a whole
Based on the SAC monitoring documents explored to date, the vision for SAC monitoring in Wales seems unclear. In reality there is a need for a survey methodology and a sampling strategy, as well as an understanding of the overall vision. It would be useful if there was a plan outlining a schedule of surveys detailing the sites to be surveyed each year and the level of detail expected from the survey work (how many visits, the survey techniques to be used etc). This should form part of the framework/template document, but an over-arching plan should be articulated.

8.3.2 Survey methodology

Specific recommendations for surveillance are:

- Survey methodology should include HSI, as this is an accepted methodology and provides useful habitat information about ponds, as well as some assessment of the terrestrial habitat. It is a well understood technique and allows comparisons between sites and between years as well as enabling a broader understanding of the condition of habitats across the SAC network.
- The survey methodology and sampling regime needs to be achievable. The recommendation would be to consider reducing the number of sites surveyed each year but increase the number of visits per site in a survey season, as the count information is likely to be more robust. The suggestion would be a 2-year survey cycle, where each SAC is surveyed once in a 2-year period.
- Develop a sampling strategy for sites where there are a large number of ponds, or where the ponds are some distance from each other and all ponds cannot be surveyed in one evening. A practical solution to sampling large sites and achieving the peak count on a single “best” night, is to work within a pond cluster/ meta-population unit and undertake the sampling for that unit in one night. The sampling regime would need to specify the number of ponds to be sampled for each of these units for a given survey night. Although this approach may not exclude the possibility of double counting, it should help to reduce it.
- Consider photographic monitoring of each pond and key terrestrial habitat (frequency of monitoring to be determined).
- Produce clear and succinct survey forms and brief survey methodology ‘reminder’ forms to ensure survey information is collected in a standardised way. Ideally have an option where the data can be collected in the field in an electronic format and can be easily submitted on-line.

8.3.3 Requirement for an overall template document

If CSM is followed, some amendments will need to be made to this document; if the decision is taken not to follow the CSM, a separate document outlining similar topics

to those examined in the CSM guidance, (JNCC 2004) is vital for consistency. A framework document outlining the attributes/performance indicators, the necessary targets, method of assessment and any comments to help with the assessment- including providing information to facilitate making decisions about site-specific targets (where a site may need to deviate from the generic guidance etc.) would be useful and help with consistency issues. Details should include:

- An outline of the criteria for each performance indicator/attribute with target information, including upper and lower thresholds/targets (as appropriate).
- Consistent wording of the attributes, units/metrics used, information provided
- Two tiers of performance indicators; the suggestion is to have basic/mandatory performance indicators (such as population counts), and other discretionary indicators, to possibly include surveying for larvae. These should use generic wording (and rationale) for consistency.
- Explanation of terminology, to ensure that surveying is undertaken in a standardised way, including elements such as breeding ponds, peak count etc.
- Sampling regime/methodology outline; it would be useful if guidance is provided on the key elements/generic points to be included and 'rules' to help with site specific sampling methodology development to standardise monitoring between sites and in all subsequent years.

In many of the site documents explored for the report, some of the performance indicators are reliant on the input of experienced site staff for target setting. It is important that all relevant information pertaining to target setting is clearly captured and outlined in the relevant site documentation together with a rationale, so the reasons for decisions are clear.

It would be useful if protected site information is accessible on the internet, with the facility to download citations, site maps results of previous condition assessment, similar to the information available for England: https://designatedsites.naturalengland.org.uk/ .

9. Conclusions and recommendations

Findings, conclusions and recommendations are included within each of the previous sections of this report. Here we collate some summary findings and recommendations that emerged during the project.

9.1 Conservation status assessments at the scale of Wales, region and county

Recent estimates of range, population and habitat for great crested newt are available for Wales and the counties with the most important populations of great crested newt through a series of reports commissioned by NRW between 2014 and 2017. These were based on MaxEnt modelling approaches using the species records available at the time. While there has been a highly successful effort to mobilise species records to the Online Wales GCN Monitoring Database, most recording effort appears to have been directed to places where the species is already well-known including sites that have been monitored over a number of years. Modelling suggests that other areas of habitat could be suitable for the species, and ground-truthing of models / new searches for great crested newt has been recommended previously. However so far it appears that little new survey effort has focused on finding the species outside the typically surveyed area. Some, but not all, recent models have been refined to incorporate information on flood plains; some earlier models that did not incorporate this data may have overestimated the area of habitat suitable for great crested newts.

Historical declines based on the net rate of pond loss are based on data from a small number of sites in the Wrexham area of north east Wales and then extrapolated to other sites. While significant pond loss is likely to have occurred in many other areas, the actual rate may have varied so extrapolation of historic populations should be regarded as indicative, with caution where predictions are applied far from the original source data. Similar caveats are applied to habitat prediction models where these have been built on small numbers of species records due to under-recording. Previous attempts to set favourable reference values and conservation targets have been based on likely historic status at the earliest point for which suitable mapping data are available. There is scope to review and update this approach based on recent (unpublished) ideas being developed by Natural England. While precise,

evidence-based, targets may be somewhat uncertain, it is however reasonable to conclude that the present population of great crested newts across Wales, while representing a European stronghold, is significantly below historic levels. when considering a range of factors and attributes of conservation status, the current conservation status of the species in considered to be unfavourable at national and county spatial scales. At a site based level, current conservation status is variable and is critically dependant on targeted management and control of adverse factors. The species is vulnerable to ongoing and likely future threats and pressures such as land-use change, climate change and hydroseral succession; in some localities there is already limited scope to create new habitat to extend and connect populations due to the extent of land-use change.

- Maintain existing surveillance effort at long-term monitoring sites and direct new recording effort to ground-truth the predictions of models and addressing under-recording in certain areas.
- Explore the use of recent unpublished Natural England methodology for setting favourable reference values and conservation targets.
- Investigate historic pond loss rates outside of the Wrexham area e.g. what loss rates are likely to have occurred in south Wales.
- Mobilise data and enhance recording efforts, outside northeast Wales, with the aim of achieving greater equity in the quantity and quality of data available throughout Wales.
- Seek to ensure any remaining extant long term surveillance data sets, particularly for sites in south Wales (e.g. Coed Darcy) are mobilised into the Online Wales GCN Monitoring Database.
- Extend the analysis of the Online great crested newt monitoring data using complementary statistical approaches (e.g. TRIM, occupancy modelling, GLM, N mixture models) to improve understanding of possible temporal trends in great crested newt distribution and population in northeast Wales.

9.2 Status and population change at selected sites

The small portfolio of case studies examined highlighted some recurring challenges to maintaining and enhancing the status of great crested newts. There is a general need for better long-term data that combines information on both the species and habitat at sites. Site protection alone is not enough to conserve great crested newts; ponds and their surrounding habitats are prone to deterioration in habitat quality so that over time their newt populations may reduce. To counteract hydroseral succession it is usually necessary that some programme of rotational management is followed to maintain the availability and condition of required habitat features. Some habitat creation attempts (e.g. pond creation) may not always succeed, grazing to obtain target vegetation structure may not be possible, and the introduction of fish, non-native invasive plant species or other localized hazards such as gully pots may impact great crested newt populations severely. Where appropriate management is instigated and maintained in long-term nature reserves or compensation areas that have been established to mitigate development, populations may increase significantly.

- Enhance the quality of site-level data so that it becomes more feasible to determine what has driven changes in species status.

9.3 Long-term prospects for great crested newts

The phrase “long term” has no precise and universally accepted definition within great crested newt conservation; considering their ecology and EC reporting guidance, 20-24 years might be a minimum interpretation of “long term” with respect to great crested newts. In radically altered modern landscapes, intervention is normally required for populations to persist long-term, hence the view that they are a “conservation dependent species”. In habitats that have remained more intact, such as dune slacks and uplands less intervention is normally needed. The best known sites in North Wales are now protected, including some as SACs. Great crested newt populations in the wider countryside tend to be exposed to lower levels of acute risk when compared to ponds within or close to urban areas. They are also rarely subject to statutory protection, however, because current approaches to SSSI and SAC site selection are difficult to apply in the context of more dispersed populations.

- Review possible modifications to existing mechanisms of protection and conservation targeting that would benefit great crested newt populations in

the wider countryside e.g. use of an “Area of Outstanding Natural Beauty approach”, modification of SSSI designation criteria, use of agri-environment schemes.

- Ensure inclusion of great crested newt-friendly options in any new future agri-environment schemes.

9.4 Use of key performance indicators

(Key) Performance Indicators (KPIs) are used by NRW to articulate the current condition and conservation status of an SAC and SSSI. With respect to SAC monitoring, KPIs are informed by the conservation objectives set for the site. Evaluation of site designation, management objectives and monitoring protocols for a selection of SACs found differences between Welsh methodology and the JNCC Common Standards Monitoring guidance, as well as some inconsistency between different SACs. The suitability, and application, of various performance indicators was considered.

- Consider review of SAC key performance indicators with the aim of making approaches more consistent among different SACs; ideally aligning more closely with Common Standards Monitoring Guidance
    - Notwithstanding the above, revise the performance indicators so that there are mandatory attributes/indicators, and discretionary attributes, to allow for accurate assessment of site specific characteristics
    - Outline survey effort (minimum number of surveys) as part of the monitoring protocol.
- Ensure survey implementation at SACs follows the procedures outlined in the core management plan (or other relevant document), to avoid inconsistent approaches
- As a matter of urgency review protocols for surveys particularly those involving egg searching. The practice of egg counting (documented in at least one SAC monitoring report) should be discontinued, because it is not a useful metric and most importantly because it may lead to increased predation of newt eggs.

9.5 Monitoring framework

As a European Protected Species, there is a statutory duty (shared by Welsh Government and Natural Resources Wales) to undertake surveillance of the conservation status of great crested newt. This includes a duty to monitor the incidental capture and killing of great crested newts. Important great crested newt sites such as protected areas or large mitigation sites should remain a target for monitoring.

- Review the overarching strategy for great crested newt surveillance in Wales and as part of UK-wide surveillance e.g. NARRS
    - This may include harmonising tier 2 surveillance approaches.
    - This should also consider surveillance of incidental capture and killing.
    - Specifically, the strategy should include provision for monitoring at designated sites, mitigation sites and wider countryside populations.
- Ideally move towards a co-ordinated, directed system of data collection on species and sites (e.g. a managed, standardised, national level monitoring scheme) rather than passive collation of available data on species counts etc.
- Develop funding strategy to sustain long-term surveillance. This may require diversification of funding mechanisms such as utilising funds generated by mitigation projects.
- Monitoring data for mitigation sites should be available in the public domain. Make deposition of data in COFNOD, other publicly accessible system a mandatory condition of licences

9.6 Online Wales GCN Monitoring Database

The work done in northeast Wales in mobilising and capturing data and establishing a framework by which it is widely available is a very significant achievement. For maximum benefit, such a system would work in parallel with a structured and centrally coordinated surveillance programme deploying standardised protocols, to reduce controllable variation in data collection. Ideally this would be a national monitoring scheme coordinating the collection of data across the UK because of the added value this would bring in enabling reporting at different scales national, regional to local, and in maintaining common approaches across all countries.

- Review the characteristics of sites in the Online Database and work towards improving the representation of less represented site types.
- Provide summary information on site type.
- Provide metadata and clarification of terms to improve the user experience and ability to interpret data. e.g. clarify terms such as site, sub-site, maximum count, describe the survey methods used, context of surveys and how missing values/zeros should be interpreted.
- Improve spatial understanding of data (e.g. ponds that are counted/not counted/no longer present, HSI).
- Add monitoring KPIs to improve contextual understanding.
- Add ‘development licence number’ where applicable.

10. Acknowledgements

We thank: Matt Ellis, Liz Howe and Jane Garner for access to NRW reports and useful discussions; Roy Tapping for access to, and advice on, the Online Wales GCN Monitoring Database; Jasja Dekker, Tom van der Meij, Rob Ward for advice on R and TRIM analyses; Arne Loth for other record searches and production of maps.

11. References

Amphibian and Reptile Conservation & Cofnod. 2010. *Determination and application of the concept of favourable conservation status to address conservation of great crested newts in north Wales*. CCW Contract Science Report No. 939. CCW, Bangor.

Anon. 2010. Wrexham Industrial Estate, Wrexham: Historical Review of Great Crested Newt Survey Data and Aerial Photography. AMEC. Unpublished. Paper provided in support of an application to the Welsh Government for EPS derogation licence (Nos.1975 and 1976).

Arnell AP & Wilkinson JW. 2013a. *Spatial Conservation Status Modelling of the Great Crested Newt in Powys and Brecon Beacons National Park*. CCW Contract Science Report No. 1026. CCW, Bangor.

Arnell AP & Wilkinson JW. 2013b. *Spatial Conservation Status Modelling of the Great Crested Newt in Anglesey and North-East Wales*. CCW Contract Science Report No. 1044. CCW, Bangor.

Beebee TJC. 1975. Changes in the status of the Great Crested Newt *Triturus cristatus* in the British Isles. *British Journal of Herpetology*, 5, 481-486.

Biggs J, Ewald N, Valentini A, Gaboriaud C, Dejean T, Griffiths RA, Foster J, Wilkinson JW, Arnell A, Brotherton P, Williams P & Dunn F. 2015. Using eDNA to develop a national citizen science-based monitoring programme for the great crested newt (*Triturus cristatus*). *Biological Conservation*, 183, 19-28.

Bogaart P, van der Loo M & Pannekoek J. 2016. rtrim for TRIM users. http://cran.wustl.edu/web/packages/rtrim/vignettes/rtrim_for_TRIM_users.html .

CCW. 2008a. Core management plan including conservation objectives for Granllyn Special Area of Conservation and Site of Special Scientific Interest. Version 2.

CCW. 2008b. Core management plan including conservation objectives for Johnstown Newt Sites Special Area of Conservation EU SAC code UK 0030173. Final Version.

CCW. 2008c. Core management plan including conservation objectives for Mynydd Helygain / Halkyn Mountain Special Area of Conservation. SAC EU code: UK0030163 Final Version.

Cooke AS. 1997. Monitoring a breeding population of crested newts (*Triturus cristatus*) in a housing development. *Herpetological Journal*, 7, 37-41.

Cooke SD, Cooke AS & Sparks TH. 1994. Effects of scrub cover on great crested newts breeding performance. *In: Gent, T. & Bray. R (eds): Conservation and Management of Great Crested Newts: Proceedings of a symposium held on 11 January 1994 at Kew Gardens, Richmond, Surrey: pp.71-74. English Nature, Peterborough.*

Cranfield J. 2017. Monitoring the effectiveness of species and habitat translocation through 7 years of post-development monitoring using modern and traditional survey methods at a case study in Basildon, Essex. Presentation to CIEEM Autumn Conference, 21-22 November 2017. Presentation available at: https://www.cieem.net/2017-autumn-conference-

Edgar PW, Griffiths RA. & Foster JP. 2005. Evaluation of translocation as a tool for mitigating development threats to great crested newts (*Triturus cristatus*) in England, 1990-2001. *Biological Conservation,* 122, 45-52.

English Nature. 2001. *Great crested newt mitigation guidelines*. English Nature, Peterborough.

Evans D & Arvela M. 2011. *Assessment and reporting under Article 17 of the Habitats Directive Explanatory Notes & Guidelines for the period 2007-2012 Final version*. July 2011 European Topic Centre on Biological Diversity.

Ewald NC, Biggs J, Williams P, Quinlan L, Worker H, Heathcote A, Case P, Dunn F & Shaw H. 2018. *PondNet: A national citizen science-based monitoring programme for Great Crested Newt 2015 - 2017*. Freshwater Habitats Trust, Oxford.

Fletcher DH, Arnell AP, French GCA & Wilkinson JW. 2014a. *Spatial Conservation Status Modelling of the Great Crested Newt in South Wales*. NRW Science Report Series. Report 30 pp36, NRW, Bangor.

French GCA, Wilkinson JW, Fletcher DH & Arnell AP. 2014b. *Quantifying the Status of Great Crested Newts in Wales*. Report No. 31. 24 pp. Cyfoeth Naturiol Cymru Natural Resources Wales, Bangor.

Forrest HE. 1907. *A Handbook on the Vertebrate Fauna of North Wales*. Witherby & Co., London.

Germano JM, Field K J, Griffiths RA, Clulow S, Foster J, Harding G, & Swaisgood R R. 2015. Mitigation- driven translocations: are we moving wildlife in the right direction? *Frontiers in Ecology and the Environment*, 13, 100-105.

Gleed-Owen C. 2007. *Development of a National Amphibian and Reptile Recording Scheme (NARRS), Phase 2 – Historic, current and future conservation status of the great crested newt (Triturus cristatus) in northeast Wales*. Final report for CCW: contract UC29-006 and RQ03-022. Countryside Council for Wales.

Griffiths RA & Williams C. 2000. Modelling population dynamics of great crested newts (*Triturus cristatus*): a Population Viability Analysis. *Herpetological Journal*, 10, 157-163.

Gregory RD, van Strien A, Vorisek P, Gmelig Meyling AW, Noble DG, Foppen RB & Gibbons DW. 2005. Developing indicators for European birds. *Philosophical Transactions of the Royal Society B*, 360, 269-288.

Halley JM Oldham RS & Arntzen JW. 1996. Predicting the persistence of amphibian populations with the help of a spatial model. *Journal of Applied Ecology,* **33**, 455-470.

Haysom KA, Dekker J, Russ J, van der Meij T, & van Strien AJ. 2014. *European bat population trends. A prototype biodiversity indicator.* EEA Technical Report No 19/2013. DOI 10.2800/10311. European Environment Agency, Copenhagen.

Horner HA & Macgregor HC. 1985. Normal development in newts (*Triturus*) and its arrest as a consequence of an unusual chromosome situation. *Journal of Herpetology*,19, 261-270.

Isaac NJ, Strien AJ, August TA, et al. 2014. Statistics for citizen science: extracting signals of change from noisy ecological data. *Methods in Ecology and Evolution,* 5, 1052-1060.

Jehle R, Thiesmeier B & Foster J. 2011. *The Crested Newt - A Dwindling Pond Dweller*. Laurenti Verlag, Bielefeld.

JNCC. 2004a. *Common Standards Monitoring Introduction to the Guidance Manual*. JNCC, Peterborough, UK.

JNCC. 2004b. *Common Standards Monitoring Guidance for Reptiles and Amphibians. Version February 2004*. JNCC. Peterborough, UK.

JNCC. 2013a. *The UK Approach to Assessing Conservation Status for the 2013 EU Habitats Directive Article 17 Reporting. JNCC, Peterborough*. Available to download from http://jncc.defra.gov.uk/page-6563 or http://jncc.defra.gov.uk/page-6564 .

JNCC. 2013b. *European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC). Third Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2007 to December 2012. Conservation status assessment for Species: S1166 - Great crested newt (Triturus cristatus).* Available: http://jncc.defra.gov.uk/pdf/Article17Consult_20131010/S1166_UK.pdf

Langton TES, Beckett CL, & Foster JP. 2001. *Great Crested Newt Conservation Handbook*, Froglife, Halesworth.

Lewis, B. (2012*). An evaluation of mitigation actions for great crested newts at development sites*. PhD Thesis, Durrell Institute of Conservation and Ecology, University of Kent, UK.

Lewis, B., Griffiths R.A., Barrios, Y. (2005). Field assessment of great crested newt *Triturus cristatus* mitigation projects in England. Natural England Research Report No. 001, Natural England, Peterborough.

Lewis, B., Griffiths, R. A., & Wilkinson, J. W. (2016). Population status of great crested newts (*Triturus cristatus*) at sites subjected to development mitigation. *Herpetological Journal*, 27(2), 133-142.

Natural England (2017). National roll-out of new approach to great crested newt licensing. Press release, 7 February 2017. Available at: https://www.gov.uk/government/news/national-roll-out-of-new-approach-to-great-crested-newt-licensing

Nicholson, M. & Oldham, R.S. 1986. Status of the warty newt *Triturus cristatus*. CSD Report No. 703. Nature Conservancy Council, Peterborough.

Oldham, R.S., Keeble, J., Swan, M.J.S. & Jeffcote, M. 2000. Evaluating the suitability of habitat for the great crested newt (*Triturus cristatus*). *Herpetological Journal*, 10, 143-156.

Pannekoek, J. & van Strien, A. (2005). *TRIM 3 manual. Trends and indices for monitoring data*. Research Paper 0102. Statistics Netherlands (CBS), The Hague, the Netherland.

Pannekoek, J., van Strien, A. & Bogaart, P. (2016). TRIM by example. http://cran.wustl.edu/web/packages/rtrim/vignettes/Skylark_example.html

Pateiro-López, B., & Rodríguez-Casal, A. (2013). Recovering the shape of a point cloud in the plane. *Test*, 22, 19-45.

Plowman J. 1995. *Biodiversity: The UK Steering Group Report Volume 1: Meeting the Rio Challenge. Joint Nature Conservation Committee*. UK Biodiversity Steering Group.

Poschlod P, & Braun-Reichert R. 2017. Small natural features with large ecological roles in ancient agricultural landscapes of Central Europe-history, value, status, and conservation. *Biological Conservation,* 211, 60-68.

Russell L, Starnes T & Wilkinson J. 2017a. *Spatial Action Plan for Great Crested Newts in Anglesey, A Manual for Achieving Favourable Conservation Status*. NRW Science Report Series. Report 76, pp 69, NRW, Bangor.

Russell L, Starnes T & Wilkinson J. 2017b. *Spatial Action Plan for Great Crested Newts in Wrexham, A Manual for Achieving Favourable Conservation Status*. NRW Science Report Series. Report 77, pp 69, NRW, Bangor.

Russell L, Starnes T & Wilkinson J. 2017c. *Spatial Action Plan for Great Crested Newts in Flintshire, A Manual for Achieving Favourable Conservation Status.* NRW Science Report Series. Report 78, pp 69, NRW, Bangor.

Spitzen-van der Sluijs A, Spikmans F, Bosman W, de Zeeuw M, van der Meij T, Goverse E, Kik M, Pasmans F & Martel A. 2013. Rapid enigmatic decline drives the fire salamander (*Salamandra salamandra*) to the edge of extinction in the Netherlands. *Amphibia-Reptilia*, 34, 233-239.

van Strien AJ, van Swaay CAM & Termaat T. 2013. Opportunistic citizen science data of animal species produce reliable estimates of distribution trends if analysed with occupancy models. *Journal of Applied Ecology*, 50, 1450-1458.

van Strien AJ, Gmelig Meyling AW, Herder JE, Hollander H, Kalkman VJ, Martin Poot JM, Turnhout S, van der Hoorn B, van Strien-van Liempt WTFH, van Swaay CAM, van Turnhout CAM, Verweij RJT, & Oerlemans NJ. 2016. Modest recovery of

biodiversity in a western European country: The Living Planet Index for the Netherlands. *Biological Conservation*, 200, 44–50.

van Swaay CAM, Nowicki P, Settele J & Van Strien AJ. 2008. Butterfly monitoring in Europe: methods, applications and perspectives. *Biodiversity Conservation*, 17, 3 455–3 469.

Ward RJ, Griffiths RA, Wilkinson JW & Cornish N. 2017. Optimising monitoring efforts for secretive snakes: a comparison of occupancy and N-mixture models for assessment of population status. *Scientific Reports*, 7,18074. | DOI:10.1038/s41598-017-18343-5.

Whitehorne D & Lee R. 2017. Great Crested Newt: Post -impact monitoring at HS2 focussing on focussing on habitats. Presentation to CIEEM Autumn Conference, 21-22 November 2017. Presentation available at: https://www.cieem.net/2017-autumn-conference-

Wilkinson K. 2010. Granllyn SAC Monitoring Report Great Crested Newt *Triturus cristatus*, May 2010 Monitoring Round 2 (2017-2012) Final.

Wilkinson JW, Arnell A, Driver D & Driver B. 2011. *Assessing population status of the great crested newt in Great Britain*. Natural England Commissioned Reports, Number 080.

Wilkinson JW, Starnes T & Ellis MAR. 2015*. Integrated Great Crested Newt Status Surveillance for Wales. Part 1 Report (March 2015)*. ARC Research Report 15/02.

Wilkinson, J.W., Starnes, T. & Ellis, M.A.R. (2015) *Integrated Great Crested Newt Status Surveillance for Wales. Part 2 Report (November 2015).* ARC Research Report 15/03.

Wrexham County Borough Council. 2016. *Stryt Las Park Gully Pot Results 2016. 14pp*. Unpublished Report, Wrexham Parks, Countryside and Rights of Way Service, Wrexham County Borough Council, Wrexham, UK .

12. Appendices

Appendix 1. Review of performance indicators currently used in site assessments at selected SACs in Wales.
Data compiled using CCW 2008a, b, c and Wilkinson (2010).

Performance indicators	**Attribute rationale (some, but not all, detail)**	**Johnstown Newt Site**	**Halkyn Mountain**	**Granllyn (Monitoring Report)**	**Granllyn (Core Management Plan, incl. Conservation Objectives)**	**Comments**
A1: Extent and distribution of adult Tc in breeding ponds	Night counts of adults during the breeding season. Monitoring to take place each year. Knowledge provided by staff with experience of the site.	Lower limit (no. of newts) provided per management units.	Lower limit provided of number of individuals in ponds across units (specified).	Lower limit: GCN present in both Granllyn Pool and The Moat every year and a combined total of 100 GCN or more, 1 year in 3. (No upper limit)	A1. Population size (adult newts). Upper limit: none. Lower limit: Present in the main water bodies in Units 1 & 2 during the breeding season. And 100 individuals in Granllyn Pool (unit 1) and The Moat (unit 2) combined. For at least 1 year in every 4.	Performance Indicator described differently at Granllyn - called Population Size. Reference in Granllyn to “main water bodies” needs to be specify which water bodies explicitly.

A2: Evidence of breeding success	Based on the number of breeding ponds showing recruitment which are required to maintain a viable population. Knowledge provided by staff with experience of the site. *NB: A breeding pond is defined as a pond in which Tc is/or is likely to conduct egg laying, and successful metamorphosis once in every 4 years.*	Upper limit: Not required. Lower limit: 1 or more breeding ponds with evidence of recruitment per each of the following Management Units 7, 9, 10, 11, 12. Lower limit: 5 breeding ponds with evidence of recruitment per each of the following Management Units MU 2, 3, 4, 13			Lower limit: Eggs and/or juveniles present in the main water bodies in units 1 & 2 during the breeding season. For at least 1 year in every 4.	These are the same KPI just worded differently. Ideally looking for larvae, especially having a target within a cluster of ponds is a good idea. If this survey commitment can be resourced, the KPI is useful but this aspect of surveillance may not be sustainable. The definition of a breeding pond should be tangible, with some clear guidance; at the moment it's too subjective.

A2: Extent and distribution of Tc larvae	Based on the number of breeding ponds showing recruitment which are required to maintain a viable population. *NB: A breeding pond is defined as a pond in which Tc is/or is likely to conduct egg laying, and successful metamorphosis once in every 4 years.*		Lower Limit: Tc larvae are present in at least 2 ponds within each of the following pond clusters (pond clusters specified).			These are the same KPI just worded differently. Ideally looking for larvae, especially having a target within a cluster of ponds is a good idea. If this survey commitment can be resourced, the KPI is useful but this aspect of surveillance may not be sustainable. The definition of a breeding pond should be tangible, with some clear guidance; at the moment it's too subjective.

(No number provided) Evidence of breeding	Egg searching			At least 5 GCN eggs are recorded in one hour of searching at Granllyn Pool every one year in three. At least one egg should be found in section 1 and section 2 of the pool … At least 2 GCN eggs found in 30 minutes of searching at The Moat one year in three. Survey methods should follow the procedure provided. (Upper limit none set)		Egg searching is valuable to determine presence/absence, and to confirm breeding, but counting of the eggs is pointless due to a number of factors. Having a set time to look for eggs could be a practical proposal, and if agreed, this should be outlined in the methodology. The survey account does give reasons for method, and highlights unfolding a large number of eggs is damaging.

Quality of aquatic habitat:				The following criteria are met annually for both Granllyn Pool and The Moat. Assessment should be made between May and September. There is a minimum cover of submerged or floating macrophytes of 25% and a maximum cover of 75% · Marginal vegetation covers at least 25% of the periphery · There is <20% shading on the south side as indicated on Map		This is a large grouping of factors for one KPI. It would be best to have the factors separate.

				2 and 3. · The water depth is at least 10cm when at least one location in each pond. · Fish are absent from Granllyn Pool and The Moat · There is a maximum of 2 pairs of wildfowl on Granllyn Pool and wildfowl are absent from The Moat.		

F1. Extent of breeding/display ponds	Based on the number of breeding ponds showing recruitment which are required to maintain a viable population, and to clarify for legal purposes- knowledge provided by staff with experience of the site.	Lower limit (4 breeding/display ponds across 5 specified units) & for other units - 11 breeding ponds across 4 specified units.	Rationale worded slightly differently to JNS. Lower limit provided as 46 ponds in total across specified units.	Upper limit- none set. Lower limit: The minimum extent of aquatic habitat is 0.25 ha at Granllyn Pool and 250m X1m at The Moat during mid-May to mid-September.	Upper limit: Additional ponds could be created, especially in units 2, 4, 6, 7 & 8). Lower limits: Granllyn Pool (unit 1) = 1.15 ha The Moat (unit 2) = 0.5 ha	There are some differences in the rationale for this KPI across the sites. The commitment to survey work 46 ponds at JNS is substantial and may lead to inconsistent surveillance effort. Sites methodologies should outline the rationale for the approach taken. Insufficient information available to determine whether approach taken is suitable - certainly there are differences between the sites.
F2. Macrophyte cover	Based on the amount of plant material for egg laying and the area of open water required for displaying- knowledge	Upper limit: 60% of display/breeding ponds will have 75% native macrophyte cover. Lower limit: 60% of display/breeding	Upper limit: 60% of display/breeding ponds will have 75% native macrophyte cover. Lower limit: 60% of display/breeding	This attribute is grouped with 'Quality of aquatic habitat'.	For each water main body (units 1 & 3): Upper limit: 70% water plant cover Lower limit: 50% water plant cover.	

	provided by staff with experience of the site.	ponds will have 50% native macrophyte.	ponds will have 50% native macrophyte.			
F3. Water depth	Based on standard CSM parameters	Upper limit: 10m (TYPO??) between July and Sept in 50% of display/breeding ponds and lower limit: >10cm between July and Sept in 50% of display/breeding ponds; relevant management units listed.	Lower limit provided:>10cm between July and Sept in 50% of display /breeding ponds.	This attribute is grouped with 'Quality of aquatic habitat'.	Upper limit: None Lower limit: Water depth > 10 cm between July and September in both main water bodies (units 1 & 2).	

F4. Presence of pollution	Based on the water conditions that are appropriate for suitable breeding	Upper limit (no surface sheens or algal blooms in display/breeding ponds and management units. *(Comment: Think this should be the lower limit - upper limit should be something similar to Halkyn?)*	Upper limit: No surface sheens and algal blooms on any ponds within any of the units.			The methodology needs to define clearly; what is being evaluated. Without this evaluation is unlikely to be consistent between years, for sites.
F5. Extent of shading	Based on the water conditions that are appropriate for successful breeding-knowledge provided by staff with	Upper limit: 20% shading on the southern margin or 60% of the total pond margin shaded on 50% of breeding/display ponds. Lower	Upper limit: 20% shading on the southern margin or 60% of the total pond margin shaded on 50% of breeding/display ponds. Lower	This attribute is grouped with 'Quality of aquatic habitat'	For each water main body: Upper limits: 20% shading on the southern margins or 30 % of the total pond/water body margins shaded	The attribute wording is confusing. With the current target, the attribute could be in favourable condition and have all of the southern perimeter shaded. Need a clearer attribute here but allow for site differences, for example where the southern edge is small,

	experience of the site.	Limit: not required.	Limit: not required.		Lower limit: Some shading, on northern margins at least.	or if pond is set within a woodland etc...

F6. Extent and quality of terrestrial habitat	Based on habitat required to provide foraging areas, hibernacula and connectivity for dispersal- knowledge provided by staff with experience of the site.	Lower limit Terrestrial "newt" habitat with a 250m radius from a breeding/display ponds in specified units. Characteristics outlined regarding refuge, foraging and potential hibernation areas.	Lower limit Terrestrial habitat with a 250m radius from a breeding/display ponds should have all of the following characteristics: refuge areas, foraging areas and potential hibernacula & migration and dispersal corridors.	Upper limit: None set. Lower Limit: No loss of mapped area of semi-natural habitat.	Upper limits: No cultivated land or temporary grass leys within the site. Lower limits: 18% 'Semi-natural habitat'*[1] within the site as a whole. Unit 1: Wetland – see F1. Woodland/scrub – 0.8 ha Unit 2 Wetland – see F1. Rushy pasture –0.4ha Orchard (rough grass) – 0.4 ha. Unit 4 Trees/scrub – 0.1 ha. Unit 5 Amenity grassland/graves – 0.4 ha Unit 6. Scrub – 0.05 ha Unit 9 Amenity/garden – 0.1 ha	More challenging to define and will be site specific, but potentially list the key features habitats types to be included to help with site specific targets. Essential that experienced staff document their site knowledge. Key areas and features should be mapped, with any barriers to dispersal highlighted.

					And Habitat within a 250m radius from Granllyn Pool (unit 1) and the Moat (unit 2) should have all of the following characteristics: Refuge areas, e.g. shady areas, tall vegetation, scrub, fallen deadwood, underground crevices, tree root systems and mammal burrows. Foraging areas, e.g. grasslands and woodlands. Potential hibernacula, e.g. log piles rubble piles and/or old walls.	
Quality of terrestrial habitat				Referred to in Granllyn monitoring report (2010), but no	Grouped in with extent.	Inconsistencies across the sites. The quality of the terrestrial habitat is included, but at some sites this is a separate performance

				targets appear to have been set.		indicator, for others this is grouped with extent of terrestrial habitat.
F7. Dispersal routes	Existing dispersal corridors should be maintained, and no new obstructions created. Assessment visual.	*Upper limit*: no increase (or change in position) of barriers, such as roads and hedges. *Lower limit:* No significant loss or fragmentation of hedgerows and other dispersal corridors.			Upper limits: No increase (or change in position) of barriers, such as roads and hedges. Lower limit: There should be no significant loss, or fragmentation, of hedgerows and other dispersal corridors.	This performance indicator is not included across the SAC sites. Suggest this performance indicator is important to include and should be assessed as it is a key element to establishing whether a site is in favourable condition.
F8. Presence of water and wildfowl	Based on CSM parameters.	Upper limit: 3 pairs of water or wildfowl per ha of open water between April & Sept in (specified	F7. Upper limit 3 pairs of water and wildfowl per ha of open water between April and September.	This attribute is grouped with 'Quality of aquatic habitat'.	Upper limit: 4 pairs of breeding 'wildfowl' per hectare of open water between April and September.	The number of wildfowl per ha is different between 2 sites, and the approach taken during the survey (Granllyn) is different again. This KPI should be consistent across the sites.

		management units).			Lower limit: Not required.	
F9. Presence of fish	Based on knowledge from staff with experience of the site that the presence of fish will be detrimental to the GCN population	Upper limit: No fish species (Including sticklebacks)	Upper limit: No fish species (including sticklebacks) present in display/breeding ponds.	This attribute is grouped with 'Quality of aquatic habitat'.		The performance indicator is not treated consistently. At Granllyn the monitoring report groups this with quality of aquatic habitat and the core management plan doesn't include it as a factor.
F10. Presence of non-native aquatic plant species especially Crassula helmsii	Based on knowledge from staff with experience of the site.	Upper limit: No non-native aquatic plant species present in any ponds.	Upper limit: No non-native aquatic species present in any ponds on the site. Lower limit: If non-native aquatic plant species are present within a pond they are			This performance indicator is not included across the SAC sites. This issue is becoming increasingly important so suggest that it is included.

			subject to a programme of strict, active controlled management and biosecurity measures.			

13. Data Archive Appendix

No data outputs were produced as part of this project, all data sourced from Cofnod or ARC.

The data archive contains: The final report in Microsoft Word and Adobe PDF formats.

Published by:
Natural Resources Wales
Maes y Ffynnon
Penrhos Road
Bangor
LL57 2DW
0000 000 000

Further copies of this report are available from:

Email: library@cyfoethnaturiolcymru.gov.uk