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River Dee & Bala lake SAC population attribute condition assessment for brook, river and sea lamprey 2014.

Garrett, HM

NRW Evidence Report No 140

Date: March 2016



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Published by: Natural Resources Wales
Maes y Ffynnon
Penrhosgarnedd
Bangor
LL57 2DW

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River Dee lamprey 2014

Report series: NRW Evidence report
Report number: 140
Publication date: March 2016
Contract number: None
Contractor: None
Contract Manager: None
Title: River Dee & Bala lake SAC population condition attribute condition assessment for brook, river and sea lamprey population 2014.

Author(s): HM Garrett
Technical Editor: Dr TW Hatton-Ellis
Peer Reviewer(s) R Evans & S Gott
Approved By: Dr David Allen
Series editor(s): None
Restrictions: None

Distribution List (core)

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National Library of Wales 1
British Library 1
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Robert Evans, North Operational Team, NRW
Tristan Hatton-Ellis, Freshwater Ecosystems Group, NRW
Richard May, NRM North, NRW

Recommended citation for this volume:

Garrett, HM. 2015. River Dee & Bala lake SAC population condition attribute condition assessment for brook, river and sea lamprey population 2014. NRW Evidence Report No: 40 31pp, NRW, Dolgellau.

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Crynodeb Gweithredol

Cyfoeth Naturiol Cymru sy'n gyfrifol am ddynodi, monitro a rheoli Ardaloedd Cadwraeth Arbennig (ACA) dan y Gyfarwyddeb Cynefinoedd. Mae'r tair rhywogaeth o llysywod pendoll brodorol y DU wedi'u rhestru yn Atodiad II y Gyfarwyddeb Cynefinoedd ac mae'n ofynnol i CNC werthuso'u statws cadwraethol. Hefyd, defnyddir yr wybodaeth gan Cyfoeth Naturiol Cymru i gefnogi gwaith achos a phrosiectau rheoli cadwraeth.

Mae'r canllawiau Monitro Safonau Cyffredin (JNCC, 2005a: 2005b; 2015) yn pennu wyth o briodoleddau asesu bras parthed y boblogaeth a'r amgylchedd ar gyfer cyflwr nodweddion ACA. Defnyddir y targedau ar gyfer y briodoledd poblogaeth i asesu demograffeg, dosbarthiad a dwysedd llysywod pendoll (larfal) ifanc yn yr ACA. Yn ogystal, dylid asesu graddfa'r silio mewn llysywod pendoll y môr llawndwf. Mae'r adroddiad hwn ar ddadansoddi'r boblogaeth yn cyfrannu at asesu cyflwr tair rhywogaeth o llysywod pendoll sy'n frodorol i Ardal Cadwraeth Arbennig (ACA) Afon Dyfrdwy a Llyn Tegid.

Yn 2014, dadansoddwyd y data parthed y boblogaeth ar sail y targedau priodoleddau yng nghanllawiau Monitro Safonau Cyffredin 2005 (JNCC, 2005a).

Mae strategaeth ar gyfer asesu poblogaeth llysywod pendoll yn dibynnu ar samplu is-set o safleoedd o blith detholiad o 30-40 o safleoedd samplu sefydledig trwy ddalgylch yr ACA, a hynny yn ystod yr hydref bob blwyddyn.

Cofnodwyd llysywod pendoll y nant a llysywod pendoll yr afon ar bob un o'r safleoedd samplu a chyrraeddwyd y targedau o safbwynt demograffeg, dosbarthiad a dwysedd yn 2014. Ceid un safle lle y cofnodwyd trawsffurfwr yn unig.

Ni ddaliwyd llysywod pendoll y môr, felly methodd y boblogaeth hon â chyrraedd y targedau dosbarthiad a dwysedd. Ni cheir targed demograffeg ar gyfer llysywod pendoll y môr. Nid oedd data ar gael i asesu graddfa silio llysywod pendoll y môr. Ceir pedwar o rwystrau artiffisial sy'n atal llysywod pendoll rhag ymfudo o fewn ffin ACA Afon Dyfrdwy a Llyn Tegid, felly nid yw'r safle'n bodloni'r meini prawf. **Methu.** Llwyddodd llysywod pendoll y nant ifanc a llysywod pendoll yr afon ifanc i **Basio**'r holl dargedau o safbwynt poblogaeth yng nghanllawiau Monitro Safonau Cyffredin 2005. **Methodd** llysywod pendoll y môr â chyrraedd pob un o dargedau poblogaeth canllawiau Monitro Safonau Cyffredin 2005. Dylid ystyried y canlyniadau hyn yng nghyd-destun canlyniadau arolygon poblogaeth blynyddol eraill rhwng 2015-2018. Bydd dosbarthiad JNCC cyffredinol ar gyfer y nodwedd h.y. Ffafriol / Anffafriol yn cael ei gynnal ar ôl i'r priodoleddau poblogaeth, amgylcheddol a chynefin ffisegol gael eu hasesu hefyd.

Asesiadau blaenorol ar gyfer llysywod pendoll ACA Afon Dyfrdwy a Llyn Tegid:
Cylch adrodd 1 2001-2006: Lampetra & Petromyzon – Anffafriol.
Cylch adrodd 2 2007 – 2012: Lampetra & Petromyzon – Anffafriol.

Executive Summary

Natural Resources Wales is responsible for the designation, monitoring and management of Special Areas of Conservation (SACs) under the Habitats Directive. All three UK native lamprey species are listed in Annex II of the Habitats Directive and NRW is required to evaluate their conservation status. The information is also used by NRW to support case work and conservation management projects. The Common Standards Monitoring guidance (JNCC, 2005a; 2005b; 2015) sets out eight broad population and environmental assessment attributes for the condition of a SAC feature. The population attribute targets are used to assess the demographic, distribution and density of juvenile (larval) lamprey in the SAC. In addition, the extent of spawning in adult sea lamprey should also be assessed.

This population analysis report contributes to the feature condition assessment for three species of lamprey native to the River Dee & Bala lake Special Area of Conservation (SAC).

- In 2014 the population data was analysed against the attribute targets from CSM guidance 2005 (JNCC, 2005a).
- The lamprey population assessment strategy relies on annual autumn sampling of a sub-set of sites from a selection of 30 - 40 established sampling sites throughout the SAC catchment.
- Brook and river lamprey were recorded at all the sample sites and the population met the demographic, distribution and density attribute targets in 2014. There was one site where only transformers were recorded.
- No sea lamprey were caught so this population failed to meet the distribution and density attribute targets. There is no demographic target for sea lamprey. No data were available to assess the extent of sea lamprey spawning.
- There are four artificial barriers to lamprey migration within the River Dee and Bala lake SAC boundary so the site does not meet the criteria. **Fail**.
- Brook and river juvenile lamprey **Pass** all the CSM 2005 population attribute targets. Sea lamprey **Fail** on all the CSM 2005 population attributes targets. These results should be viewed in the context of results of the other annual population surveys planned for 2015 – 2018. An overall JNCC classification of the feature i.e. Favourable / Unfavourable will be undertaken when the population, environmental and physical habitat attributes have also been assessed.
- Previous River Dee & Bala lake SAC lampreys feature condition assessments:
Reporting cycle 1 2001 – 2006: Lampetra & Petromyzon – Unfavourable.
Reporting cycle 2 2007 – 2012: Lampetra & Petromyzon – Unfavourable.

1. Introduction

1.1 Lamprey species & their conservation status

Three species of lamprey inhabit British waters, sea lamprey (*Petromyzon marinus*), river lamprey (*Lampetra fluviatilis*) and brook lamprey (*Lampetra planeri*) (Maitland 2003). All three species spawn in freshwaters, with the larvae (ammocoetes) living in burrows in silty and sandy substrates in rivers and feeding on bacteria, diatoms and organic matter (Maitland 2003). After about 3 years, larvae of river and sea lampreys metamorphose, develop a silvery colouration and migrate to sea where they feed parasitically on marine fish. Brook lampreys remain as larvae for about 6 years before metamorphosing and spawning; they do not feed as adults (Maitland 2003).

All three lamprey species are listed in Annex II of the European Union Directive (92/43/EEC) on the Conservation of Natural Habitats and of Wild Fauna and Flora (known as the Habitats Directive). River lamprey are also listed on Annex V of the Habitats Directive (species whose taking in the wild and exploitation may be subject to management measures). The Directive aims to help conserve the diversity of habitats and species across the European Union and requires measures to be taken to maintain or restore to favourable conservation status in their natural range, habitats and species of wild flora and fauna of Community interest as listed in the annexes of the Directive. These measures include the designation of Special Areas of Conservation (SACs) for the habitats and species listed in Annex I and II of the Directive.

Under the EU Habitats Directive member states are required to monitor Annex II species to make an evaluation of the conservation status of those species. In the UK this is a process known as condition assessment. Condition assessment is carried out for each designated feature at individual sites (rivers) and contributes to an overall assessment of the conservation status of each species across its geographical range in the UK.

To determine condition, the sites selected for survey must be tested against a predetermined set of conservation objectives. JNCC (2005b) have produced guidance on conservation objectives for sites with lamprey species. The River Dee and Bala Lake is designated as a SAC for, amongst other features, the presence of sea lamprey, river lamprey and brook lamprey. Condition assessment targets are published in the NRW Core Management Plan for the SAC (Hatcher, 2008).

The *Common Standards Monitoring (CSM) Guidance for Freshwater Fauna* (JNCC, 2005a) provides guidance on the identification of attributes, targets and methods of assessment for river, brook and sea lamprey in SSSIs and SACs. Conservation objectives for monitoring these species are set out as a number of Favourable Condition targets (JNCC, 2005a). This 2005 guidance includes environmental assessment methods and targets that are now outdated so an updated *Common Standards Monitoring Guidance for Rivers* (JNCC, 2014) provides appropriate guidance on assessing water quality, flow and habitat. The CSM freshwater fauna population guidance has also been revised but it has not yet been adopted by the country agencies (*in prep*), so in the meantime condition assessments will continue to use the 2005 guidance for population attributes.

The combination of targets for direct (population) (JNCC, 2005a) and indirect (habitat quality) attributes (JNCC, 2014) (Tables 1, 2 & 3) enable an assessment of the condition of each feature to be made.

To be in favourable condition the general rule for freshwater faunal species features is that all mandatory attributes must meet their targets. NRW must report on the condition of designated features in a 6-yearly reporting cycle using the 2 available categories – favourable or unfavourable (declining, maintained or recovering). The feature was assessed for the first monitoring cycle in 2006, the second cycle in 2012 and the third (current) cycle runs from 2013 – 2018.

Attribute * discretionary	Target	Method of assessment
Population a. Age structure (<i>Lampetra</i> sp. only)	For samples of 50 or less, at least two distinct size classes should normally be present. If more than 50 larvae are collected, at least three size classes should be present.	Electrofishing of suitable habitat using quadrats.
Population b. Distribution within catchment	Lampreys should be present at not less than 2/3 of sites surveyed. As a minimum, there should be no reduction in the distribution of larvae within the catchment. Where barriers to migration or pollution issues are thought to be a problem, the population should be classed as being in unfavourable condition and targets for an appropriate increase should be set.	Electrofishing of suitable habitat using quadrats.
Population c. Larvae density	<i>Lampetra</i> spp: Optimal habitat: >10 m ⁻² Chalk streams >5 m ⁻² Overall catchment mean: >5 m ⁻²	Electrofishing of suitable habitat using quadrats.
Population c. Larvae density (contd.)	<i>Petromyzon</i> : Larvae should be present in at least four sampling sites, each not less than 5 km apart.	Electrofishing of suitable habitat using quadrats.
Population d. Spawning Activity* (Sea lamprey only)	No reduction in extent of spawning activity year on year	Direct observation or redd counts

Table 1: Favourable Condition Table for brook, river and sea lamprey population attributes (JNCC, 2005a)

Attribute * discretionary	Target	Method of assessment
Flow		
	Natural flow regime should be protected. Daily flows should be close to natural. Flow targets for WFD High ¹ ecological status should be used to avoid deterioration.	Gauging station data & expert judgement.
Water quality		
Organic pollution	10%ile annual mean Dissolved Oxygen (% saturation) = 85%	Water quality field sample: Oxygen dissolved (Instrumental) as % Satn
	Mean Biochemical Oxygen Demand (BOD) = 1.5 mg/l	Water quality sample: Biochemical Oxygen Demand 5d ATU (BOD) mg/l
	90%ile Total ammonia = 0.25mg/l	Water quality sample: Ammoniacal N mg/l
	95%ile un-ionised ammonia = 0.025 mg/l	Lab calculation using Total ammonia, temperature & pH
Nutrients	Reactive phosphorus - site specific targets set by NRW for each WFD water body (Hatton-Ellis, 2015). Annual mean and growing season mean targets.	Water quality sample: Orthophosphate as P with appropriate detection limits
	Total Inorganic Nitrogen (TIN) - site specific target where nitrogen mediated eutrophication is an issue. Target usually 10 x SRP target for WFD water body.	Water quality sample: Lab calculation using Ammoniacal N mg/l & Nitrogen, Total Oxidised as N.
	Trophic Diatom Index (TDI) = 1.0	Diatom samples at routine monitoring sites.
Acidification	Site specific target for sites classified as siliceous or peat.	Lab calculation based on water quality sample for pH, alkalinity & Dissolved Organic Carbon DOC.
Other pollutants	Site specific targets for water bodies for any pollutants listed on Annex VIII of WFD.	Water quality sample & WFD data

Table 2: CSM environmental attribute targets for freshwater fish (JNCC, 2014)

¹ Flow targets in Welsh SAC rivers will more likely to be assessed against the targets agreed under the Review of Consents process.

Attribute * discretionary	Target	Method of assessment
Habitat Structure		
Channel planform	Channel form should be characteristic of river type, with predominantly unmodified planform ≤ 5% of the assessment unit should be artificial, re-aligned or constrained.	Assess planform using map data, aerial imagery, local knowledge & historical data.
Habitat modification score	<p>≥65% or more of condition monitoring sites should fall within the semi-natural HMS class 1, with the remainder predominantly unmodified (class 2).</p> <p>No (or minimal) deterioration from the last monitoring cycle.</p>	HMS scores obtained from RHS survey
Bank vegetation naturalness	Mean SERCON score for the assessment unit of 4 or 5	Simplified Phase I habitat survey, carried out at 10 RHS transect locations or as part of the sweep-up survey (see 'Box 2.1)
Riparian zone naturalness	Mean score for the assessment unit of 4 or 5	RHS transect data using the method described in Box 2.2
Large woody debris	Within each assessment unit: EITHER 75% or more RHS sites have large woody debris "Present" OR 10% or more of RHS sites have large woody debris "Extensive"	River Habitat Survey Data. At least 5 RHS sites should be examined for this target – if fewer than 5 sites are available, assessment units should be amalgamated.
In-channel structures	<p>Throughout the ECS: if present, structures should have no effect (or minor effect) on migration, on sediment transport, and habitat structure.</p> <p>Assessments should include the upstream 'ponding' effects that artificial structures have on flow patterns and habitat structure.</p>	<p>Use expert judgement to assess the ECS. Data sources may include:</p> <ul style="list-style-type: none"> • Local/management personnel/expert assessment • Hydromorphological and walk-over surveys • River Habitat Survey (RHS) • Air photos • Fisheries personnel • Special surveys assessing structures • River Obstructions (EA dataset) • Rapid assessment methodology to assess obstacles to fish migration (SNIFFER project WFD 111)

Table 3: CSM habitat attribute targets for freshwater fish (JNCC, 2014)

Attribute * discretionary	Target	Method of assessment
Fine sediment		
Siltation	No un-naturally high levels of siltation as indicated by: <ul style="list-style-type: none"> a) "silting" highlighted in section P of the RHS form (Overall characteristics – major impacts) OR b) B) one third or more of the total number of RHS spot-checks in the assessment unit have silt (SI) in the predominant channel substrate. 	Field observations & site specific information derived from RHS
Negative Indicators		
Alien / locally absent species	No high impact alien species established (i.e. self-sustaining populations). Standard checklist of species are based on those used for WFD assessments. A site will be assessed as unfavourable when there is good evidence that any non-native species or locally absent species is causing an impact on site integrity.	Where a macrophyte survey has been carried out the presence of alien species in the UKTAG lists should be noted. Where there are no macrophyte survey dates contact external organisations for records.

Table 3 cont: CSM habitat attribute targets for freshwater fish (JNCC, 2014)

2. Objectives

The aim of this project was to assess the population status of the three lamprey species within the SAC using data from an annual monitoring programme.

The specific objectives of the project were to:

- Use the Common Standards Monitoring Guidance (JNCC, 2005a) targets to assess the condition of river, brook and sea lamprey in the River Dee and Bala lake SAC. The following mandatory attributes were to be assessed: Population and river morphology. The water quality and flow attributes will be assessed in separate NRW reports.
- Make recommendations in relation to the conservation objectives and future management.

The Dee Estuary SAC marine site is also designated in recognition of its importance as a migration route for river and sea lamprey. The information obtained during this survey will also feed into the assessment of the river and sea lamprey population attribute for this marine site.

3. Site description

The source of the River Dee lies within the Snowdonia National Park and its catchment contains a wide spectrum of landscapes from high mountains around Bala, steep-sided wooded valleys, near Llangollen, to the rich agricultural plains of Cheshire and north Shropshire and the vast mudflats of the estuary (Hatcher & Garrett, 2008).

The River Dee catchment SAC encompasses the entire stretch of the main River Dee from the mouth of the estuary to Llyn Tegid (Bala lake) and its tributary rivers the Ceiriog, Meloch, Mynach and part of the Tryweryn. A portion of the SAC lies within England: however, this assessment deals only with the Welsh section. In addition to lampreys the River Dee SAC has been designated primarily for the protection of Atlantic salmon (*Salmo salar*), floating water plantain (*Luronium natans*) and watercourses of plain to montane levels with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, bullhead (*Cottus gobio*) and otter (*Lutra lutra*) as qualifying features. The SAC boundary is shown in Figure 1.

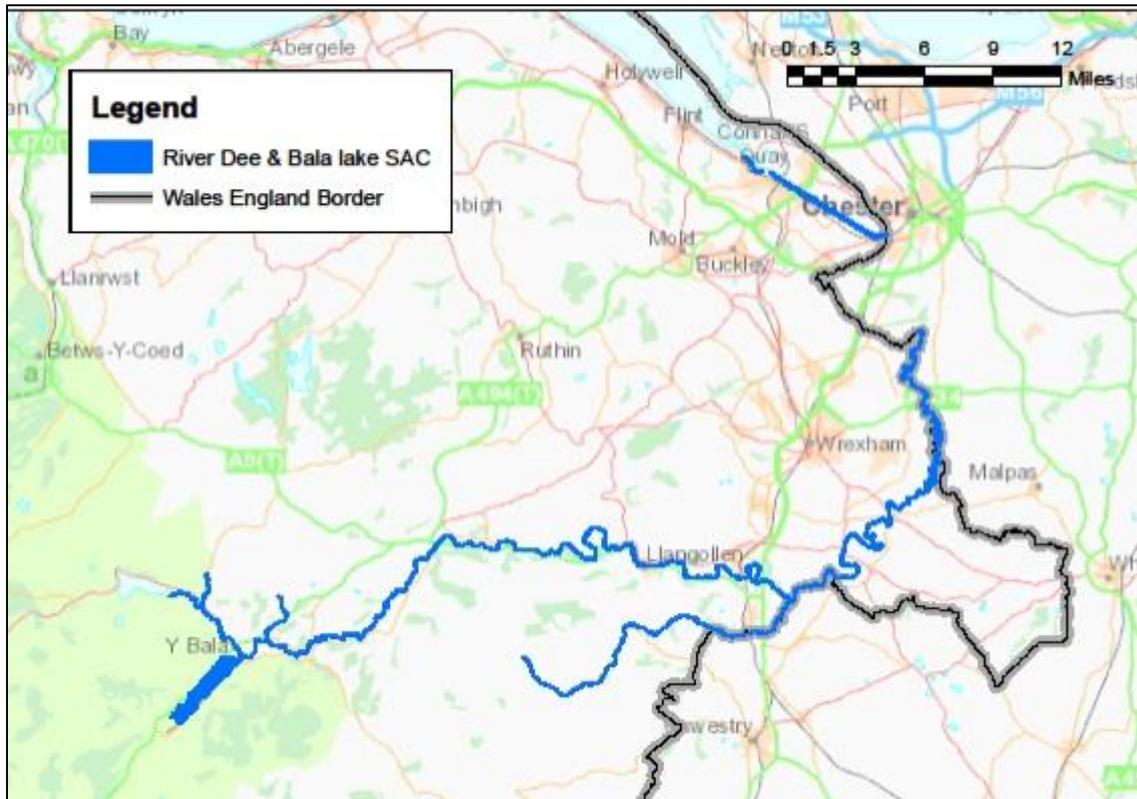


Figure 1: Map showing boundary of River Dee & Bala lake SAC

4. Previous lamprey monitoring projects

Prior to 2002, data on lamprey within the River Dee catchment was limited historically and consisted primarily of anecdotal accounts, incidental presence records and semi-quantitative sampling (West, 2004). Widespread quantitative sampling did not commence until the protection of lamprey species under the Habitats Directive and consequent designation of UK SAC sites, including the River Dee & Bala lake SAC.

The River Dee & Bala lake SAC lamprey population condition was assessed in the first monitoring cycle by West (2004) and Campbell & Williams (2006). In the second monitoring cycle the assessment was undertaken by Teague *et al.* (2012).

Approximately 30 sites were sampled in one season by each survey. For a detailed summary description of each attribute assessment see Thomas & Garrett (2014) (Table 5).

Adult sea lamprey spawning was not assessed in either reporting cycle because no data was available.

Table 4: Summary of condition assessments from reporting cycles 1 & 2.

Habitats Directive monitoring cycle (Report date)	Age structure	<i>Lampetra</i> Larvae density	Distribution in catchment	<i>Petromyzon</i> Larvae density	Population condition assessment
First monitoring cycle 2001 – 2006	Pass	Pass?	Pass?	Fail	<i>Lampetra</i> : Unfavourable <i>Petromyzon</i> : Unfavourable
Second monitoring cycle 2007 – 2012	Pass	Fail	Pass	Fail	<i>Lampetra</i> : Unfavourable – unclassified. <i>Petromyzon</i> : Unfavourable - unclassified

5. Methodology

5.1 Field sampling methodology 2014

Fifteen annual sites were identified from previous survey results (West, 2004; Campbell & Williams, 2006; Teague *et al*, 2012) and were sorted in order of sampling priority as either priority 1 or 2. Priority 1 sites were located in suitable habitat and should be sampled in 2014. Priority 2 sites were selected as additional representative sites that should be sampled if environmental conditions and staff resources allow (Figure 2 & Table 5).

Prior to the formation of Natural Resources Wales (NRW), the sampling frequency was one year in a six year cycle and the 30 sample site survey was conducted by external contractors on behalf of the Countryside Council for Wales (CCW). NRW has the in-house skills to undertake this survey so the monitoring will now be conducted on an annual basis but on a smaller number of sites. Each year the annual data will be analysed against the CSM targets and the final assessment will be drawn up at the end of the Habitats Directive reporting cycle (2013 – 2018).

Additional by-catch records are available from the annual juvenile salmonid electrofishing surveys help inform our understanding of distribution. While the records from the NRW fish trap at Chester weir can confirm the presence of adults which is especially useful for sea lamprey which are not routinely sampled.

In potentially suitable habitat pairs of surveyors' followed a depletion sampling technique within 1m² fine mesh quadrat using electrofishing equipment. The sampling methodology followed the guidance set out by Harvey & Cowx (2003) as amended by NRW (Garrett *et al*, 2015).

Primary sites	NGR	Site name
1	SJ 41294 52754	Dee - Holt
2	SJ 41451 47347	Dee - Worthenbury
6	SJ 27368 41757	Dee - Trevor
7	SJ 18198 44700	Dee - Rhewl
11	SH 96906 35813	Dee - US Caletwr
16	SJ 20751 37968	Ceiriog - Glyn Ceiriog
22	SH 92920 36280	Tryweryn - Bala
30	SH 90574 39221	Mynach
33	SJ 27501 37038	Ceiriog - Chirk Fishery
35	SJ 06802 43200	Dee - Corwen
40	SJ 35816 43815	Dee - DS Overton Bridge
Secondary sites	NGR	Site name
13	SJ 41879 46106	Worthenbury Brook - Worthenbury
14	SJ 39710 56072	Alyn - Ithels Farm
15	SJ 14469 47522	Morwynion - Bryneglwys
21	SH 87201 30696	Lliw - Llanuwchllyn

Table 5: List of prioritised sites proposed for sampling in 2014 on the River Dee

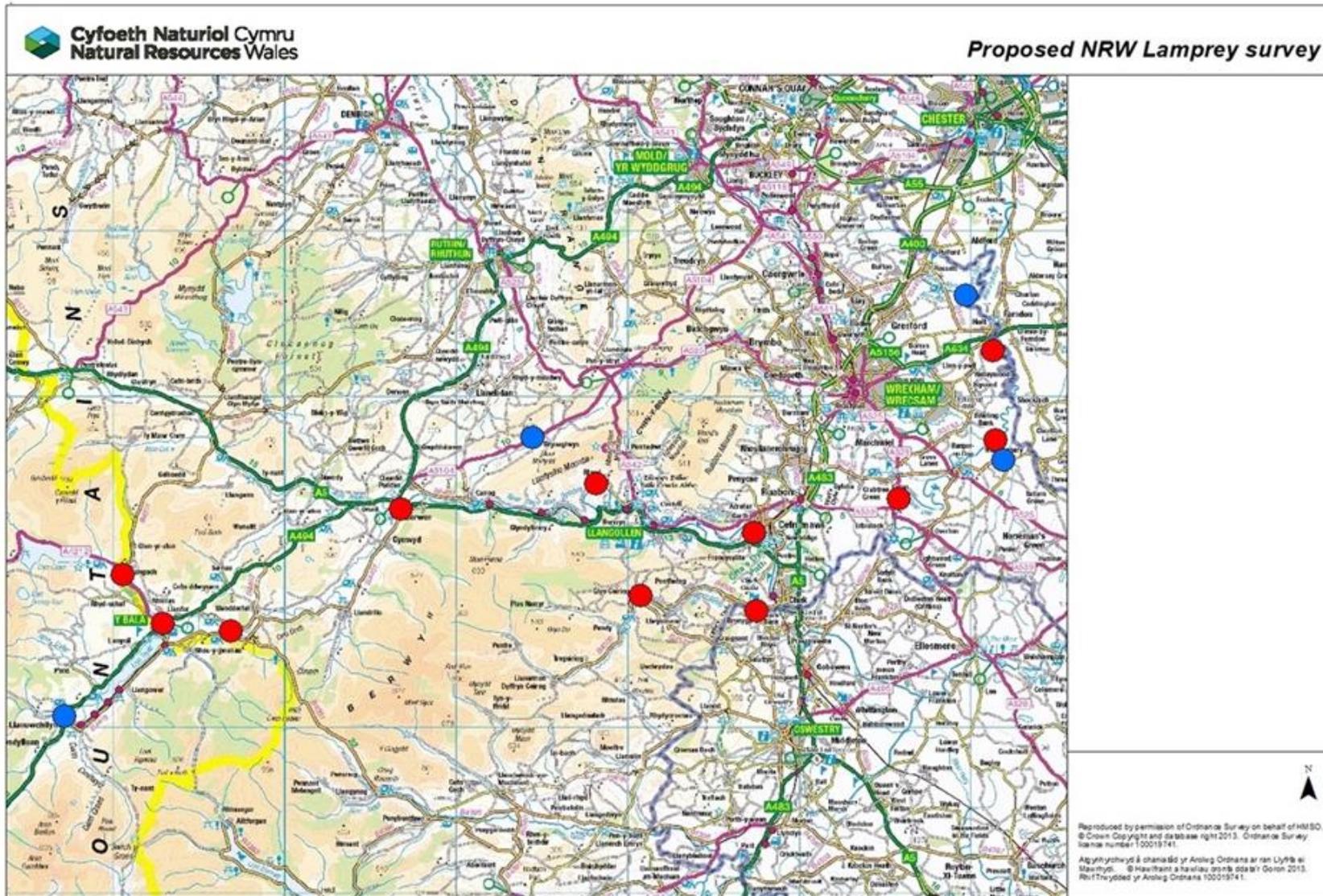


Figure 2: Map showing location of priority 1 sites (red) and priority 2 (blue) for 2014.

5.2 Data analysis

The data for each attribute was analysed as follows:

5.1.1 Age structure modelled using length-frequency histograms

Lamprey larvae live in sediment for up to six years and an area of sediment normally contains larval lamprey of differing ages. Since the larvae grow each year, age classes can be identified using length-frequency analysis (Hardisty & Potter, 1971).

Age structure was assessed through the production of length-frequency histograms for *Lampetra* larvae. It is assumed that the number of individuals within each age class has a normal distribution (Pitcher, 2002) and as such, the length-frequency plots should show several peaks corresponding to the typical length of an individual from a specific age class. A bin range of 2mm was adopted, as recommended in the revised draft CSM (*in prep*).

5.1.2 Distribution within catchment

Sample sites were distributed throughout the catchment (see Figure 2), so the dataset is considered sufficient to assess this attribute. Some sample sites were upstream of known barriers and therefore provided evidence relevant to assessing whether these were passable by lamprey.

5.1.3 Larval density

Population estimates for samples from optimal habitats were made using the Carle and Strub (1978) depletion methodology. The quadrat is sampled three times (runs) and the number of larvae caught in each run reduces as the population in the quadrat becomes depleted. For example, in the first run 15 larvae may have been caught, followed by 7 in the second run and 3 in the final run. The Carle and Strub (1978) statistical test calculates an absolute estimate for the population present within the 1 m² habitat site based upon the depletion over the three or more runs.

Within sub-optimal habitats, population estimates were given as minimum estimates which represent the number of individuals m⁻².

5.1.4 Spawning activity of sea lamprey

The core SAC management plan (Hatcher & Garrett, 2008) does not set any spawning targets but the CSM states that there should be no reduction in spawning activity year on year and that this could be assessed by counting redds or by direct observation at traditional spawning sites between June and August (JNCC, 2005a). This is a discretionary attribute target and sea lamprey spawning sites are not routinely monitored by NRW but some data may be available from the fish trap operated at Chester weir by NRW.

5.1.5 Barriers to migration

There are a number of datasets detailing river obstructions and they were assessed during the previous reporting cycle:

- previous lamprey surveys (Teague *et al*, 2012)
- hydropower opportunities dataset (EA, 2010)
- river obstructions dataset (EA, 2010)

NRW staff were asked to comment on whether any of the obstructions had changed since the previous assessment in the second reporting cycle.

6. Results

6.1 Results 2014

The survey was conducted by NRW sampling and collection team fisheries staff from NRW North Area Operational team, between 24 September and 2 December 2014. A total equivalent of 10 person survey days were required to conduct this survey and eight of the 15 potential survey sites were sampled (53%). The main river corridor and very few of the Dee tributaries have been designated as SAC and so there is limited suitable habitat that can be accessed for sampling. It was decided to sample at three locations outside of the boundary of the River Dee & Bala lake SAC.

Survey date 2014	Survey Site No.	Survey NGR	CCW Unit	WB Id No.	Watercourse name	Habitats present 2014 ²
29/09	1	SJ4129452754	19	GB111067057080	Dee - Chester Weir to Ceiriog	SO
19/11	6	SJ4187946106	4	GB111067052060	Dee - Ceiriog to Alwen	O
19/11	7	SJ3971056072	4	GB111067052060	Dee - Ceiriog to Alwen	O
29/09	13	SH8720130696	Not SAC	GB111067052220	Worthenbury Brook - middle	O & SO
29/09	14	SJ2809837120	Not SAC	GB111067052173	Alyn - Hope to conlf. Dee	SO
02/10	21	SJ3581643815	Not SAC	GB111067051850	Lliw	SO
02/10	33	SJ2728941897	18	GB111067051910	Ceiriog - conlf. Dee to Teirw	O & SO
29/09	40	SJ1819844700	12	GB111067057080	Dee - Chester Weir to Ceiriog	O & SO

Table 6: List of sites surveyed in 2014 & their habitat type.

Lampetra larvae were recorded at seven sites and at the 8th site only lamprey transformers were recorded.

421 *Lampetra* larvae were caught, ranging in length from 8 - 162 mm (mean = 77.43 mm). *Lampetra* were recorded at all eight sites but there was wide variability in the numbers caught; only one larva was caught at site 1 and whereas 158 were recorded at site 40, (mean = 53.25 mm).

Five river lamprey transformers were recorded; two at Worthenbury brook (Site code 13), two at the confluence of Alyn and Hope (site code 14) and one on the Ceiriog (site code 33). The transformer lengths ranged from 128 - 142mm (mean = 136.4 mm).

² O = optimal habitat & SO = sub-optimal habitat as defined by Harvey & Cowx, 2003.

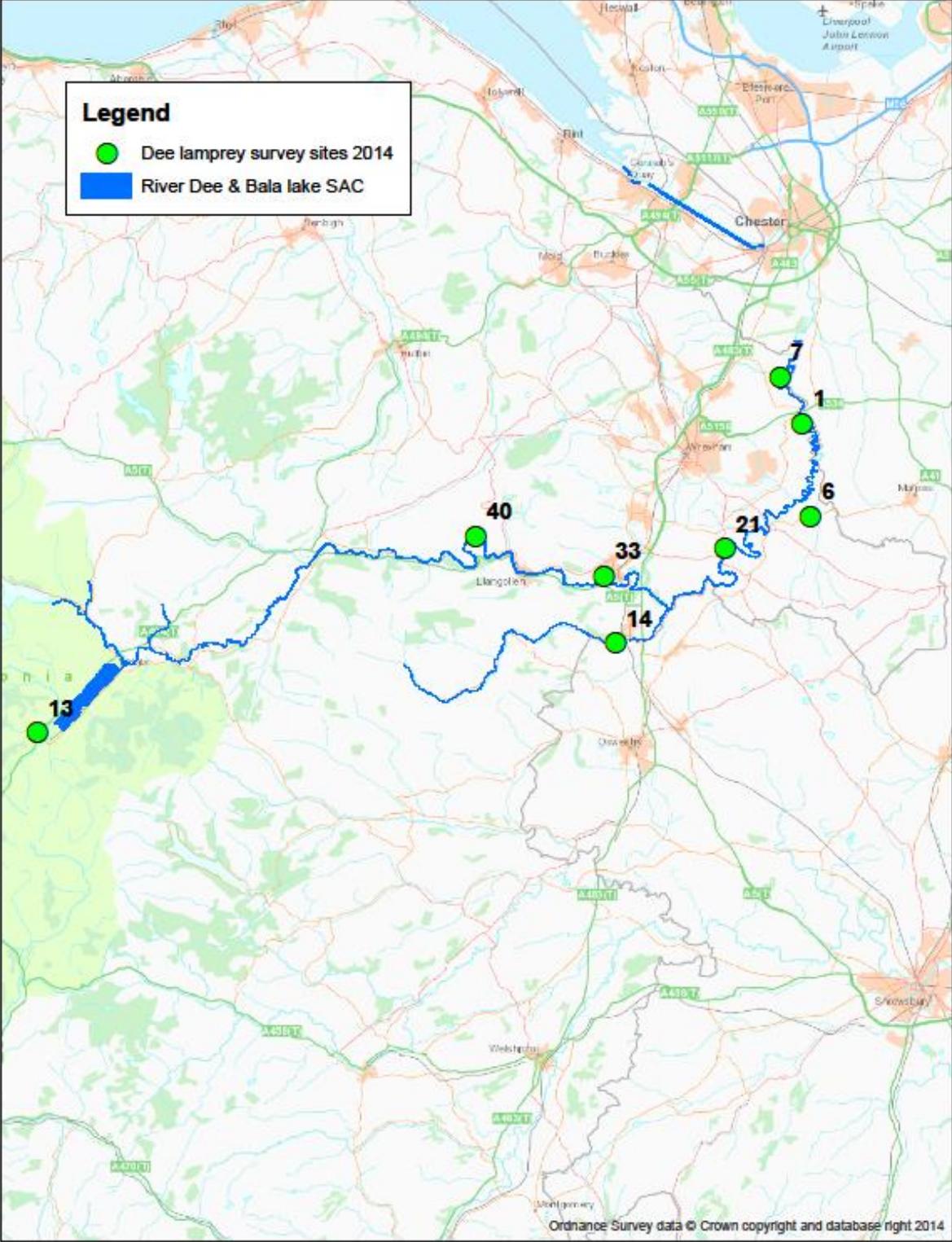


Figure 3: Map showing distribution of sites sampled in 2014.

6.2 *Lampetra* condition assessment for population structure and distribution attributes

There are three CSM population attributes for *Lampetra* species that assess the larvae population structure, distribution within the catchment and the density of larvae in optimal habitat and at a catchment scale. The demographic structure attribute only applies to brook and river lamprey and is not applied to sea lamprey (JNCC, 2005a).

Attribute 1: *Lampetra* spp. only larvae population age structure.

Target: For samples of 50 or less, at least two distinct size classes should normally be present. If more than 50 larval lamprey are collected, at least three size classes should be present.

The bin range of 2mm was selected because that is the recommended range in the revised CSM freshwater fauna (JNC, *in prep*).

Figure 4 shows the results of age-frequency analysis by pooling data from all sample sites. The 0+ and 1+ cohorts were well resolved, with 0+ finishing at about 24 mm and 1+ at c. 50 mm. Age classes above this were poorly resolved, with relatively low lamprey numbers in the 45-100 mm length range and no obvious peaks in length-frequency. Between 100 and 125 mm there was a clear peak in length-frequency, followed by very small numbers in larger length-classes. These categories were used to count the number of age cohorts for each individual sample site (Table 7 & 8; Figure 4).

Sites 13 and 40 are above the Horseshoe falls at Llangollen, which is considered a natural barrier for river lamprey (figure 5). The catch samples from these two sites are assumed to all be brook lamprey larvae which are a smaller species than river lamprey and transform at lengths between 130 – 150mm (Gardiner *et al*, 1995). Samples below the falls will have a combination of brook and river lamprey larvae and Figure 6 shows that there was lower recruitment in recent years (2014 onwards) in these sites.

All age classes were found in the in the total larvae catch and more than two age classes were found in all the samples with less than 50 larvae and three age classes were recorded in all the sites with more than 50 larvae. The 0+ cohort was only recorded at two sample sites but there is a general consensus among fish researchers that small fish are more difficult to catch (Snyder, 1995) and it can be assumed that there is a sampling bias in lamprey less than 25 mm in length. EAW staff have reported that lamprey larvae are also more difficult to catch than other fish species (Beaumont *et al*, 2002). This means that the younger larvae are under-represented in the sample.

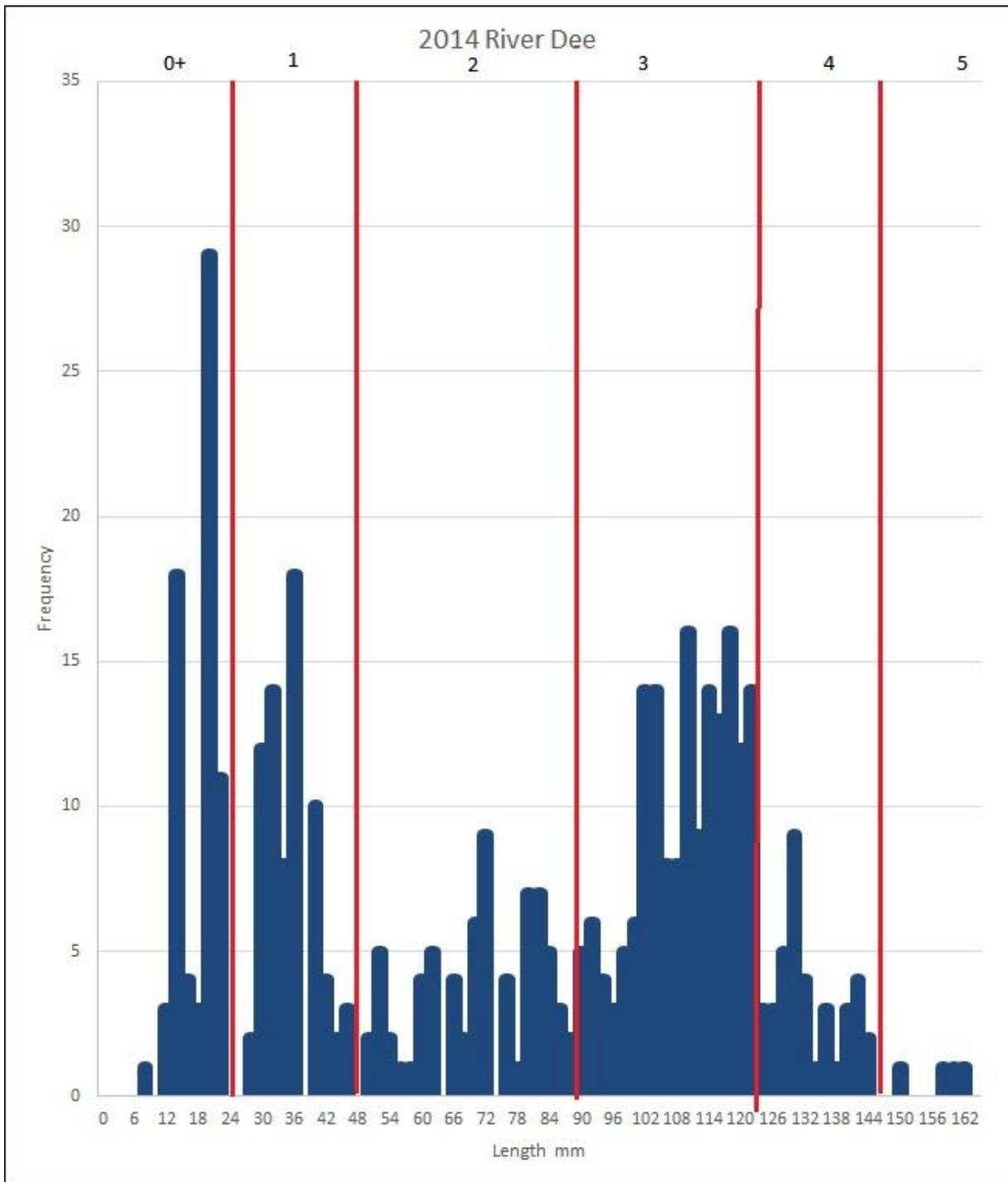


Figure 4: Length frequency histogram (bin range 2mm) 2014 for whole catch.

Age class	Size range cut off (mm) – <i>Lampetra</i> larvae
0+	1 – 25
1	26 - 50
2	51 - 90
3	91 - 125
4	126 - 145
5	>146

Table 7: Assumed size ranges corresponding to each age cohort

SAC	CCW Unit	WFD WB Id No.	Survey Site No.	No. larvae 2014	Age classes present	No. age classes	Age class target (2005a)	Meet target (2005a)?
Yes	19	GB111067057080	1	1	N/A	N/A	N/A	N/A
Yes	4	GB111067052060	6	12	2,3	2	2	Pass
Yes	4	GB111067052060	7	134	1,2,3,4	4	3	Pass
No	None	GB111067052220	13	72	1,2,3,4	4	3	Pass
No	None	GB111067052173	14	2 transformers recorded at this site, no larvae.				
No	None	GB111067051850	21	22	0+,1,2,3,4,5	6	2	Pass
Yes	18	GB111067051910	33	22	2,3,4,5	4	2	Pass
Yes	12	GB111067057080	40	158	0+,1,2,3	4	3	Pass

Table 8: Total larvae catch and age cohorts at each sample site

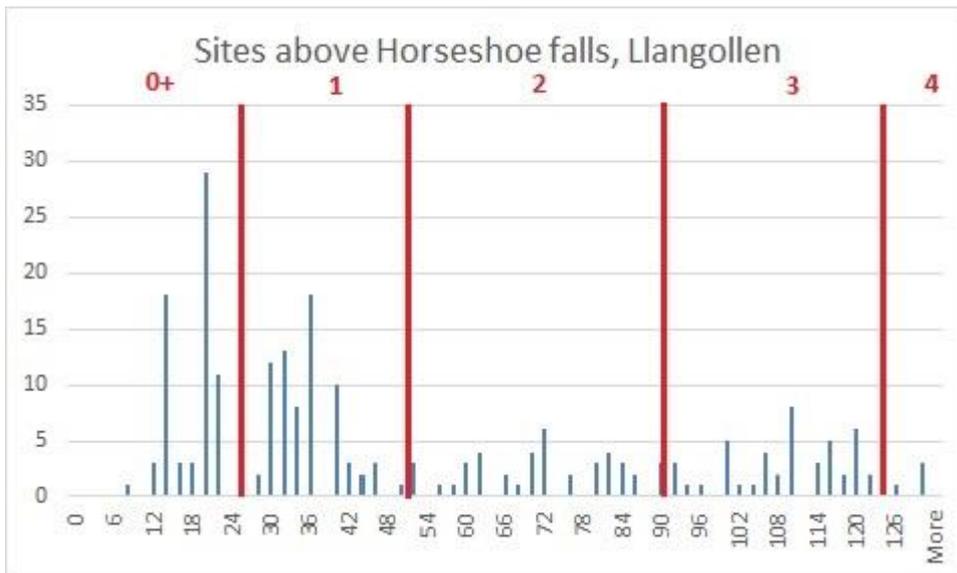


Figure 5: Length-frequency histogram for sites 13 & 40.

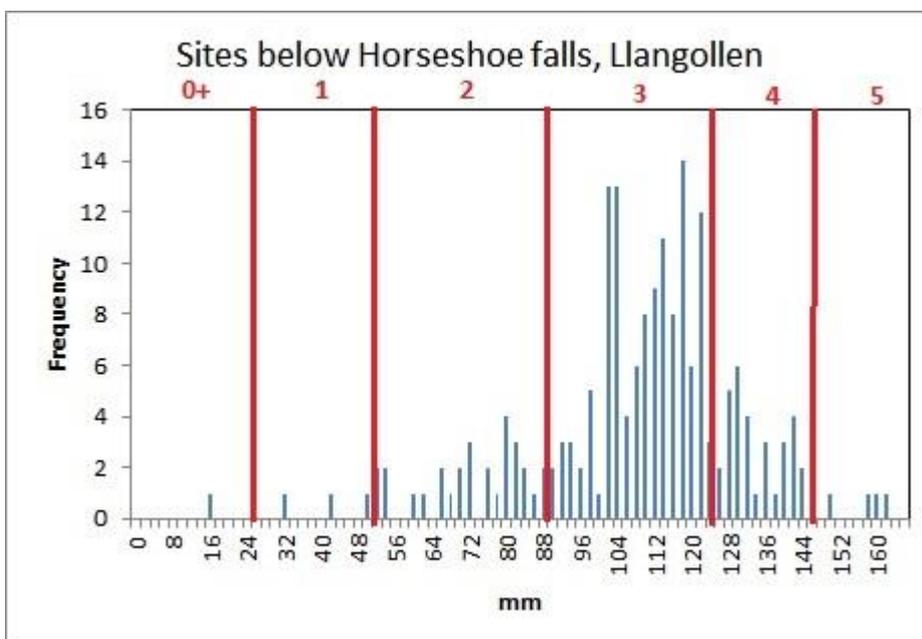


Figure 6: Length- frequency histogram for all sites below Horseshoe falls, Llangollen, 2014.

In 2014 the *Lampetra* species larvae population structure met the criteria set by the CSM & core management plan target (JNCC, 2005a; Hatcher & Garrett, 2008).

6.3 NRW Lamprey distribution survey 2014

Attribute 2: *Lampetra* sp. distribution within catchment.

Target: Brook & river lamprey larvae should be present at not less than 2/3 of sites surveyed.

Lampetra larvae were recorded at seven sites and so the attribute target was exceeded; one larvae was caught at site 1 and 158 were recorded at site 40 (mean = 53.25). The distribution was spread throughout the SAC boundary including the main tributary (Afon Ceiriog) (Fig 5).

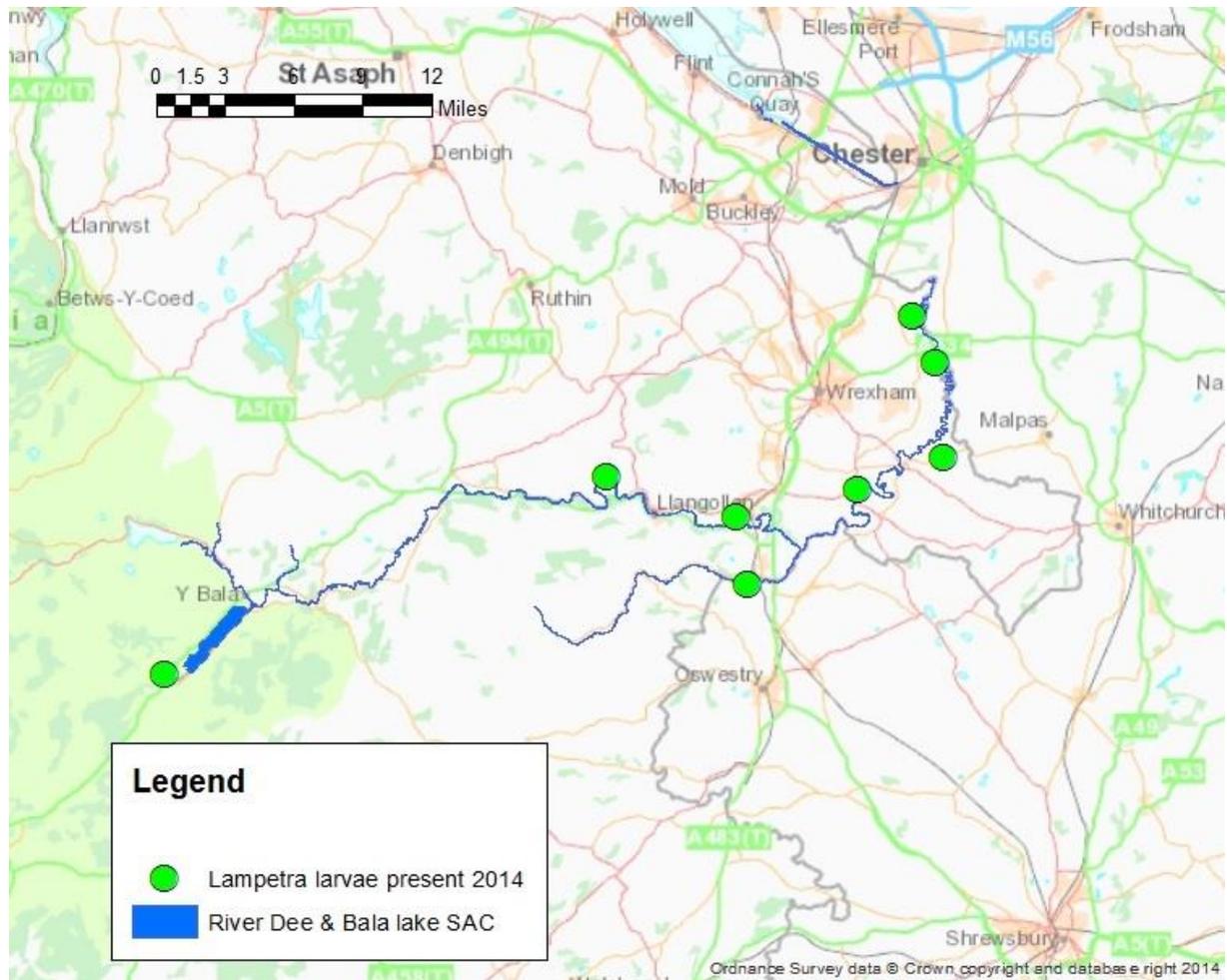


Figure 7: Map showing presence of *Lampetra* larvae in 2014

No *Petromyzon* (sea lamprey) species were recorded during the 2014 survey on the Dee. There are historical records of sea lamprey larvae at four sample sites below of the confluence of the Dee and the Ceiriog near Chirk, (Fig 6) so it was feasible to expect to record sea lamprey at sites numbered 1,6, 7, & 21. However, sea lamprey tend to be under-recorded by electrofishing (REF APEM?).

A fish trap is operated at Chester Weir (River Dee, England) and it is a partial trap that is operated 50% of the time so its records can only be used to assess relative species abundance. The trap records can confirm the presence of species and the following numbers of sea lamprey adults were recorded; 32 in 2013 (May & July); 0 in 2014 and 8 in 2015 (July) (R. Cove, *pers comm*, 2015).

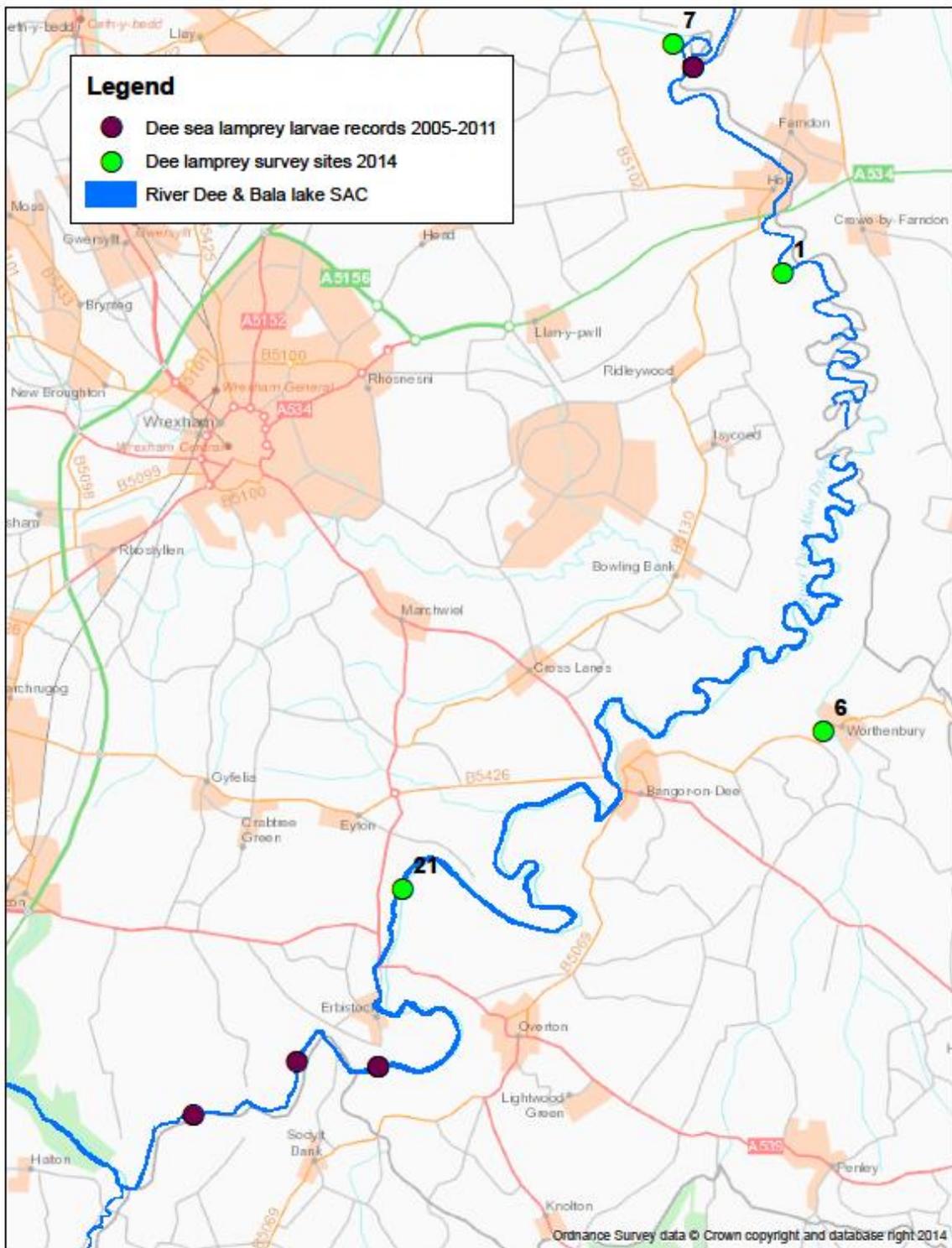


Figure 6: Map showing location of sea lamprey larvae records 2005 – 2011

6.4 NRW National Fisheries Monitoring Programme (NFMP) results 2013/14

Lampetra are often recorded as a by-catch of juvenile salmonid surveys and these records provide valuable additional data. Juvenile salmonid sites are surveyed annually in the Dee catchment. NFMP 2013 and 2014 data included 85 lamprey records in sampling sites spread across nine tributaries, of which two were in the

lower catchment and seven in the upper. Most of these records were in smaller tributaries outside the SAC boundary, reflecting the distribution of salmonid electrofishing sites. The Ceiriog is the only tributary included in the River Dee and Bala lake SAC boundary and three lamprey were recorded at two sample sites in 2013 (Fig 7).

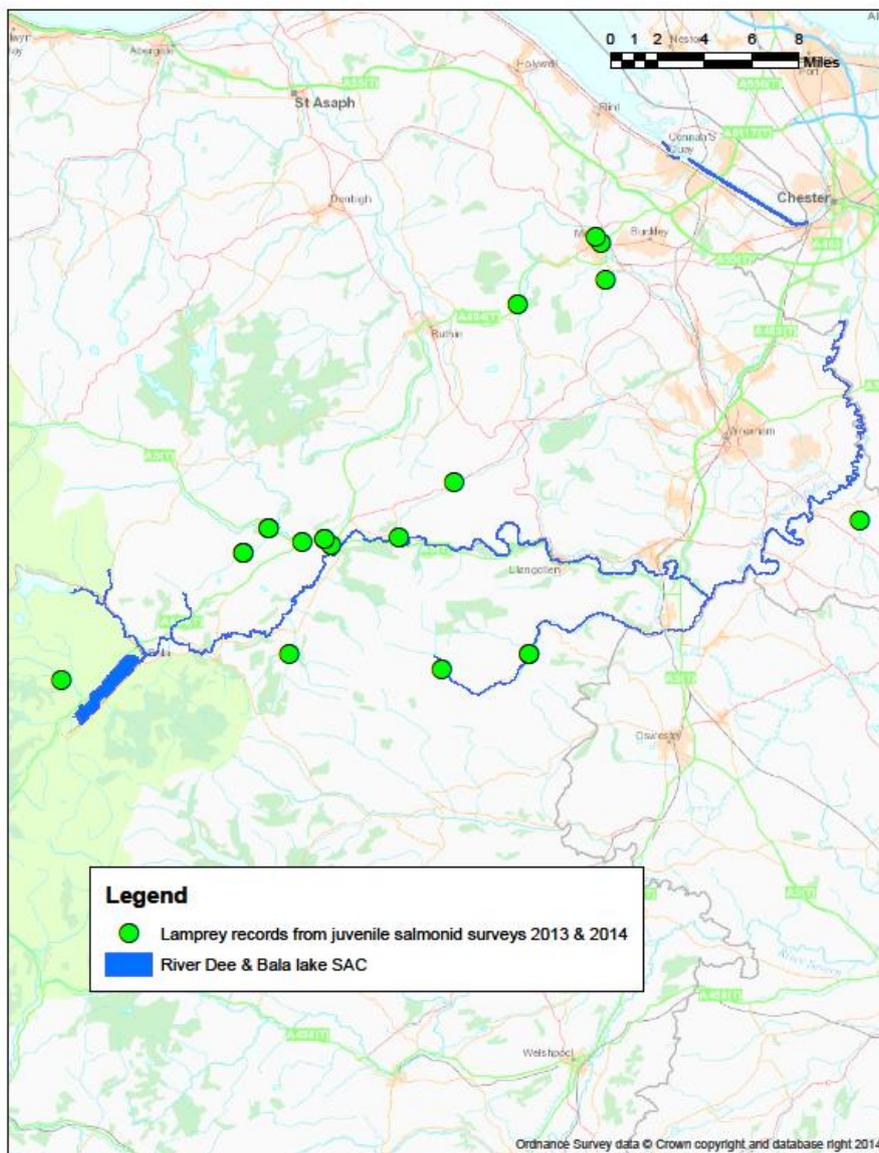


Figure 7: Map showing lamprey records in the Dee catchment from 2013 & 2014 juvenile salmonid surveys.

In 2014, *Lampetra* species were recorded at more than 2/3rds of sample sites and so the population met the distribution criteria.

6.4 Lampetra density

Attribute 3: *Lampetra* spp. density.

Target: Optimal habitat: more than 10 m⁻²
Overall catchment mean more than 5 m⁻²

Attribute 3a: *Petromyzon marinus* / sea lamprey distribution target.

Target 3a: Sea lamprey larvae should be present in at least four sampling sites, each not less than 5km apart.

In order to establish the relative condition of lamprey populations in the river the abundance classification relies on the demographic assessment (attribute target 1 above) and the density of larvae. The density assessment is based on two measures:

- A density estimate based on samples from optimal habitat
- A density estimate based on samples from across the catchment that include the diversity of habitats (Harvey & Cowx, 2003).

The production of this report was delayed by the difficulty in obtaining the density calculations because the software and its density calculation tool are now managed by the Environment Agency and there is only one member of staff within NRW who has the skills to use the BOXI tool.

For optimal habitat the estimated mean densities (Carle & Strub, 1971), ranged from 18 to 228 individuals m⁻² (Table 9 & Figure 6). The highest density was recorded at site 40 which is south of Wrexham on the River Dee and is in the lower catchment. The lowest density (18 larvae) was recorded at site 6 which is west of Llangollen, near Trevor.

The mean density of *Lampetra larvae* within the River Dee & Bala lake SAC boundary was 96.6 ± 95.1 (s.d) m⁻² in optimal habitat ($n = 5$).

Sample site no. (Optimal habitat)	Watercourse	NGR	No. Lampetra caught	Estimated mean population density (m ⁻²) (Carle & Strub, 1978)
13	Worthenbury brook	SJ4187946106	48	50
33	Ceiriog - confluence Dee to Teirw	SJ2809837120	18	21
40	Dee - Chester Weir to Ceiriog	SJ3581643815	155	228
6	Dee - Ceiriog to Alwen	SJ2728941897	12	18
7	Dee - Ceiriog to Alwen	SJ1819844700	135	166

Table 9: Estimated mean density of larvae from 1 m⁻² quadrats in optimal habitat

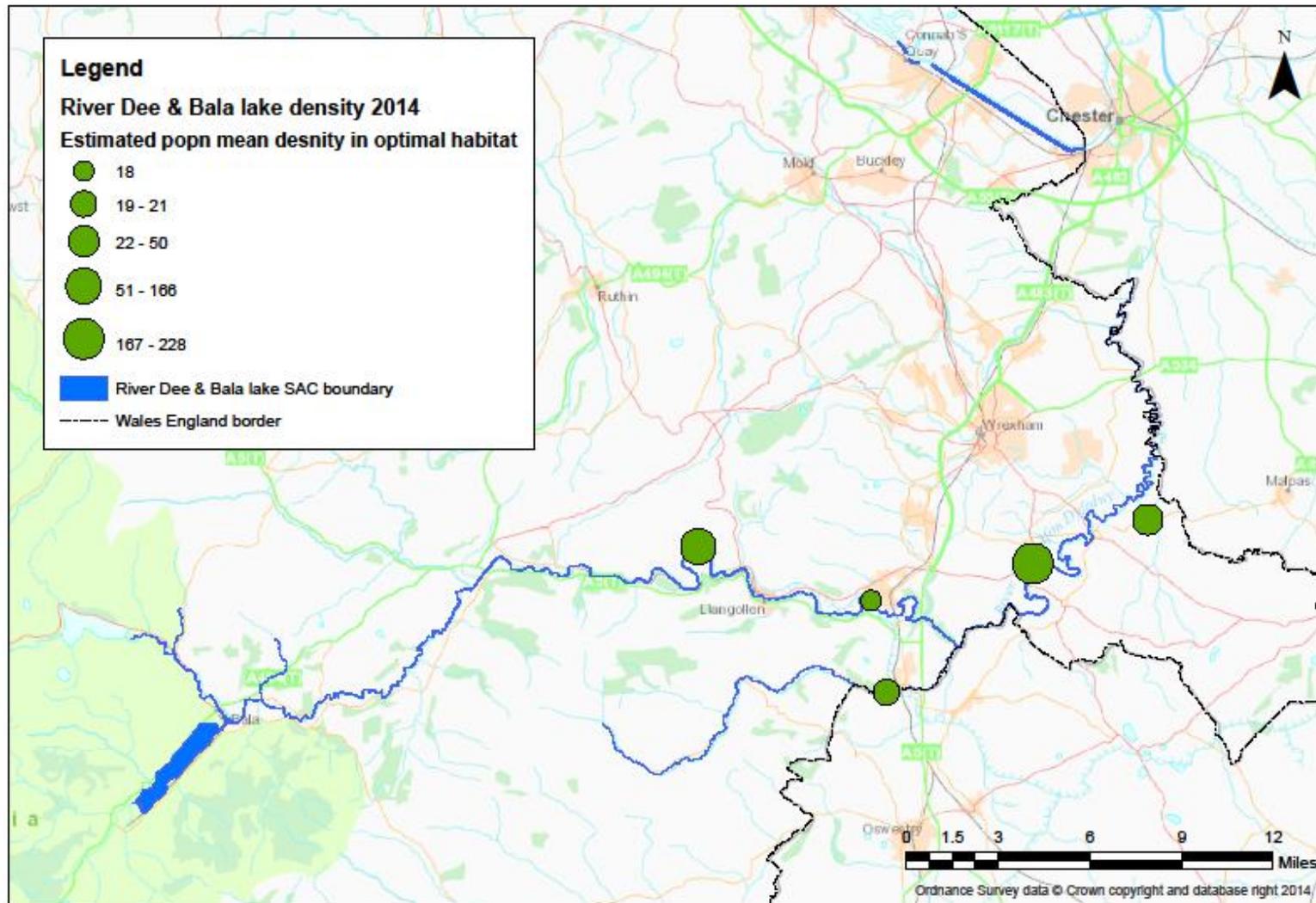


Figure 8: Proportional representation of larvae density at sites with optimal habitat 2014

Sample site no. (Sub-optimal habitat)	Watercourse	NGR	Actual population density (larvae m ⁻²)
1	Dee - Chester Weir to Ceiriog	SJ4129452754	1
13	Worthenbury Brook - middle	SJ4187946106	24
21	Lliw	SH8720130696	22
33	Ceiriog - confluence Dee to Teirw	SJ2809837120	4
40	Dee - Chester Weir to Ceiriog	SJ3581643815	3

Table 10: Actual density of larvae m⁻² sub-optimal habitat

One sample run is conducted in sub-optimal habitat so the density values are the actual densities rather than the estimated values used for optimal habitat where there are multiple depletion sampling runs.

In sub-optimal habitat the actual densities ranged from 1-24 m⁻². The highest density was recorded at site 13 in the lower catchment and the lowest density was at site 1 on the Dee. The overall range in larvae density was very broad, ranging from 1 to 228 larvae m⁻² (Tables 9 and 10).

The mean density for the catchment overall was calculated using estimated optimal habitat densities and actual sub-optimal habitat counts. When data for both optimal and sub-optimal habitats were considered together the overall catchment mean was 53.7 ± 78.21 m⁻² (s.d). This descriptive statistic shows that there is a wide spread of values in this small sample, however by comparison, the median value was 21.5 m⁻² for the entire catchment and 50 for optimal habitat.

The CSM methodology based on the mean calculations was used in this assessment to ensure continuity across SAC sites. The mean density for optimal habitat was 96.6 m⁻² and exceeds threshold target of >10 m⁻². The overall catchment mean was 53.7 m⁻² and exceeds the threshold target of > 5m⁻². Even allowing for variability in the dataset, these values are considerably higher than the target values.

In 2014, the Dee *Lampetra* population density meets the density criteria.

6.5 *Petromyzon* condition assessment for distribution and spawning activity attributes

Attribute 4: *Petromyzon marinus* / sea lamprey spawning activity.

Target 4: No reduction in extent of spawning activity year on year

Adult sea lamprey usually spawn in July but NRW does not have a structured monitoring programme for recording spawning. Occasionally *ad hoc* records are received from the public or NRW Operational staff.

No records were received in 2014 so the *Petromyzon* spawning attribute could not be assessed.

6.6 Artificial barriers to migration

Attribute 5: No artificial barriers significantly impairing adults from reaching existing and historical spawning grounds.

Structural barriers to migration were assessed by checking:

- the barriers previously mentioned in River Dee lamprey surveys
- the NRW Arc GIS “River obstructions” dataset

The NRW North Operational Team members were consulted for their views on the resulting list of artificial barriers. It was concluded that depending on flow conditions, both the artificial weirs at Erbistock and Manley Hall form partial barriers to migration; Manley Hall is passable when the higher flow channels are slightly wetted. On the Afon Ceiriog, the NRW Brynkinallt hydrometry weir (near Chirk) is the main barrier and is thought to be impassable to sea lamprey. A river lamprey transformer was recorded up-stream of the hydrometry weir in 2014. The sluice gates at the outfall of Bala lake are impassable and form a barrier to sea lamprey.

The natural waterfall at Horseshoe Falls, Llangollen are also a barrier to migration but it is not artificial so it is not included in the condition assessment.

There are **four artificial barriers to lamprey migration** within the River Dee and Bala lake SAC boundary so the site does not meet the criteria. **Fail.**

6.7 Summary of results

The presence of lamprey larvae by SAC and WFD water body units is summarised in table 11. Three of the sample sites were outside of the SAC boundary and do not have a SAC unit number. A summary of the condition assessment for all the population attributes is shown in table 12.

Survey Site No.	Survey NGR	SAC Unit	WB Id No.	Watercourse name	<i>Lampetra</i> present 2014
1	SJ4129452754	19	GB111067057080	Dee - Chester Weir to Ceiriog	Present
40	SJ1819844700	12	GB111067057080	Dee - Chester Weir to Ceiriog	Present
6	SJ4187946106	4	GB111067052060	Dee - Ceiriog to Alwen	Present
7	SJ3971056072	4	GB111067052060	Dee - Ceiriog to Alwen	Present
13	SH8720130696	Outside SAC	GB111067052220	Worthenbury Brook - middle	Present
14	SJ2809837120	Outside SAC	GB111067052173	Alyn - Hope to confl. Dee	Transformers only
21	SJ3581643815	Outside SAC	GB111067051850	Lliw	Present
33	SJ2728941897	18	GB111067051910	Ceiriog - confl. Dee to Teirw	Present

Table 11: *Lampetra* larvae presence / absence by SAC & WB unit

Target	Assessment	Condition	Level of Confidence
<p>a. Age structure (<i>Lampetra</i> sp. only) 50 or less larval target = 2 size classes. If more than 50 larvae, target = 3 size classes.</p>	<p>2014 results: met threshold criteria at 6 / 6 sites; 1 age cohort at 1 sites³ 2 age cohorts at 0 sites 3 age cohorts at 1 sites 4 age cohorts at 0 sites 5 age cohorts at 5 sites</p>	<p>Pass</p>	<p>High</p>
<p>b. Distribution within catchment (i) Present at not less than 2/3 of sites surveyed. (ii) No reduction in distribution of larvae in catchment. (iii) If barriers to migration or pollution thought to be a problem population should be classed as unfavourable.</p>	<p>(i) <i>Lampetra</i> met the distribution criteria but <i>Petromyzon</i> larvae did not. (ii) No reduction evident. (iii) 4 artificial barriers to migration in place.</p>	<p>(i) <i>Lampetra</i>: Pass <i>Petromyzon</i>: Fail (ii) <i>Lampetra</i>: Pass <i>Petromyzon</i>: N/A. (iii) Fail</p>	<p>Moderate⁴</p>
<p>c. Larval lamprey density <i>Lampetra</i> spp: Optimal habitat >10m⁻² Overall catchment mean >5m⁻²</p>	<p>Optimal habitat mean: 96.6 m⁻² Catchment mean: 53.7 m⁻²</p>	<p>Optimal habitat: Pass Catchment: Pass</p>	<p>High</p>
<p><u><i>Petromyzon</i></u>: Larval sea lamprey should be present in at least 4 sampling sites each not less than 5km apart</p>	<p>Present at no sites</p>	<p>Fail</p>	<p>Low (due to potentially unsuitable sampling method)</p>
<p>d. Spawning activity (sea lamprey only)* No reduction in extent of spawning activity year on year</p>	<p>Insufficient data to determine</p>	<p>Not assessed</p>	<p>n/a</p>

Table 12: Summary of population attributes condition assessment in 2014.

7 Discussion

This assessment of the 2014 results is a contribution to the overall assessment of the population that will be completed when the programme of annual surveys is completed in 2017 /18. It is based on a sample from a small number of survey sites although the net total of larvae caught is relatively high; 421 recorded at 8 sites in 2014 compared to 236 recorded at 40 sites in 2011 (Teague *et al.*, 2012). It is anticipated that annual surveys will identify a pattern of natural fluctuations in the population and any variation between seasons in the availability of suitable habitat at survey sites throughout the catchment.

The absence of sea lamprey from the survey is not unusual because there have been concerns about the suitability of the survey technique for sea lamprey larvae. They are thought to show a preference for deeper pools in larger rivers (Hardisty, 1986) and there is evidence from studies on the Afon Tywi with an acoustic sonar camera (DIDSON) which suggests that sea lamprey show a three year recruitment cycle (Clabburn, 2012). This work also demonstrates an alternative sampling method that could be considered by NRW.

There is no sea lamprey spawning observation strategy and NRW's condition assessment relies on anecdotal evidence. There is evidence that a DIDSON could also be used to collect relevant data if the camera was deployed during spawning season.

8 Conclusions

The juvenile population of brook and river lamprey met all the attribute criteria in 2014.

The juvenile population of sea lamprey failed to meet the attribute targets.

9 Recommendations

Based on this interim report it is recommended that:

Sampling:

- Potential alternative survey / record collection methods are explored for recording spawning sea lamprey activity.
- Potential alternative methods for catching sea lamprey larvae are investigated.
- The programme of annual autumn surveys are continued using in-house resources and skills.

Data management

There are insufficient in-house skills to run the density calculations query on the EA BOXI, so additional staff should be trained until the database until the NRW replacement system (WISKI) is available.

³ based on a sample of 1 larva recorded at site 1, so not assessed as part of the target.

⁴ Considered moderate due to only marginal pass of the target (71% vs. target of 67%)

Operational / management advice

A comprehensive list of conservation actions is published in the Prioritised Improvement Plan for the River Dee & Bala lake SAC (NRW, 2015). The plan lists the following operations / land management activities that impact on the condition of the three lamprey species populations in one or more of the SAC management units: modified water courses, non-native invasive species, diffuse and point source water pollution, in-channel structures and weirs, water abstraction, inland flood defence and over grazing.

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Data Archive Appendix

The data archive contains:

- [A] The final report in Microsoft Word and Adobe PDF formats.
- [B] A full set of maps produced in JPEG format.
- [C] A series of GIS layers on which the maps in the report are based with a series of word documents detailing the data processing and structure of the GIS layers

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue <http://libcat.naturalresources.wales/webview/> (English Version) and <http://libcat.naturalresources.wales/cnc/> (Welsh Version) by searching 'Dataset Titles'. The metadata is held as record no. 116498

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