Cyfoeth Naturiol Cymru
Natural Resources Wales

The importance of exposed riverine sediments at Llanelltyd on the Afon Mawddach for invertebrates in 2016

Adrian Fowles

NRW Evidence Report No. 182

Arctosa cinerea, Llanelltyd Aug 2016 © Deion Lewis-Smith

About Natural Resources Wales

Natural Resources Wales is the organisation responsible for the work carried out by the three former organisations, the Countryside Council for Wales, Environment Agency Wales and Forestry Commission Wales. It is also responsible for some functions previously undertaken by Welsh Government.

Our purpose is to ensure that the natural resources of Wales are sustainably maintained, used and enhanced, now and in the future.

We work for the communities of Wales to protect people and their homes as much as possible from environmental incidents like flooding and pollution. We provide opportunities for people to learn, use and benefit from Wales' natural resources.

We work to support Wales' economy by enabling the sustainable use of natural resources to support jobs and enterprise. We help businesses and developers to understand and consider environmental limits when they make important decisions.

We work to maintain and improve the quality of the environment for everyone and we work towards making the environment and our natural resources more resilient to climate change and other pressures.

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 Evidence Report
Report number: 182
Publication date: November 2016
Contract number: 2024456
Contractor: A.P. Fowles
Contract Manager: Dr M.A. Howe
Title: The importance of exposed riverine sediments at Llanelltyd on the Afon Mawddach for invertebrates in 2016
Author(s): **A.P. Fowles**
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)

Mike Howe, NRW Invertebrate Ecologist
David Smith, NRW Senior Conservation Officer Meirionnydd

Recommended citation for this volume:

Fowles, A.P. 2016. The importance of exposed riverine sediments at Llanelltyd on the Afon Mawddach for invertebrates in 2016. NRW Evidence Report No: 182, 22pp, Natural Resources Wales, Bangor.

Contents

List of Figures

List of Tables

1. Crynodeb Gweithredol

Cafodd banciau gwaddodion i fyny ac i lawr yr afon o hen bont Llanelltud eu harchwilio ar dri dyddiad yn ystod Gorffennaf a Medi 2016. Cofnodwyd cyfanswm o ddeuddeg math o greadur di-asgwrn-cefn Gwaddodion Afonol Agored, gan gynnwys saith tacson cenedlaethol brin, gyda dwy rywogaeth (y chwilod crwydr Hydrosmecta fragilis a Thinobius crinifer) yn newydd i Afon Mawddach. Efallai fod llifogydd annhymhoraidd yn ystod Awst a Medi wedi cyfyngu ar gynefin y rhywogaethau, ond ymddengys hefyd y gallai newidiadau i dopograffi banc Tan-lan (i fyny'r afon) fod yn gyfrifol am gyfyngu ar faint y cynefin.

Cymharwyd yr arolwg hwn gydag arolwg tebyg a gynhaliwyd ar fanc Tan-lan yn 2003 a chyflwynir Mynegeion Ansawdd Gwaddodion Afonol Agored. Nid esgorodd yr arolwg presennol ar ddigon o rywogaethau i greu mynegai dibynadwy, ond nid oes unrhyw reswm i dybio nad yw banciau graean Llanelltud yn bwysig bellach i gasgliad Gwaddodion Afonol Agored yr afon. Efallai y bydd ailbroffilio banc Tan-lan, neu gael gwared â'r glasbrennau bedw o leiaf, yn rhwystro gwaddodion agored rhag diflannu yn sgil llystyfiant sydd wedi ennill ei blwyf, ac ni thybir y bydd cael gwared â rhywfaint o waddodion oddi ar y banc i lawr yr afon yn arwain at niwed parhaol i'r anifeiliaid.

2. Executive Summary

The sediment bars upstream and downstream of Llanelltyd old bridge were investigated on three dates in July & September 2016. A total of twelve specialist invertebrate species of Exposed Riverine Sediments (ERS) was recorded, including seven Nationally Scarce taxa, with two species (the rove beetles *Hydrosmecta fragilis* and *Thinobius crinifer*) new to the Afon Mawddach. Unseasonal floods during August and September may have limited the range of species, but it would also appear that changes to the topography of the Tan-lan (upstream) bar may also be responsible for limiting the area of habitat.

Comparisons are made with a similar survey carried out on the Tan-lan bar in 2003 and Exposed Riverine Sediment Quality Indices are presented. The current survey did not yield sufficient species to allow a reliable index to be calculated but there is no reason to suppose that the Llanelltyd shingle bars are no longer important to the ERS assemblage on the river. Reprofiling of the Tan-lan bar or at least the removal of encroaching birch saplings may prevent the loss of open sediment to established vegetation and removal of some sediment from the downstream bar is not thought to present lasting damage to the fauna.

3. Introduction

In order to alleviate flooding problems on the Afon Mawddach at Llanelltyd (SH719194), Natural Resources Wales is considering the removal of gravel from shingle bars immediately upstream and downstream of the bridge. These bars have been identified in the past (Entomological Monitoring Services, 1995, Bell & Sadler 2003) as supporting important invertebrate faunas associated with Exposed Riverine Sediments (ERS) and constitute the principal locations on the Mawddach for the Qualifying ERS Feature on the Aber Mawddach/Mawddach Estuary SSSI. This contract was instigated to evaluate the current significance of these bars for ERS invertebrates and to indicate the possible impact of gravel removal on the ERS fauna.

3.1. Background

The contract specification provides an overview of existing knowledge on the invertebrates and shingle deposits of the Llanelltyd bars:

> The Afon Mawddach is a 23km unregulated river which rises in the southern part of the Arenig mountains and heads in a mostly westerly direction to Cardigan Bay at Barmouth. In the 1948, the river supported 36 shingle bars and an ERS area of 57,440m^2 which by 1992 had reduced to 25 bars and 35,818m^2, a reduction of 38% of its area (Brewer et al., 2006), principally attributed to the increase in the amount of vegetation on active and formerly active bar surfaces. The key shingle bar in 1948 was at Llanelltyd (Tan Lan: Sediment 68 in Figure 1) which measured 17,339m^2 and represented 30% of the total ERS resource; by 1992, this had reduced to 5,679m^2 and 16% of the resource but it remains an important resource.

Figure 1. Location of shingle bars at Llanelltyd

In 1994 the Countryside Council for Wales funded a survey of ERS within the Afon Mawddach, Gain and Wnion catchments to estimate its value for invertebrates (Entomological Monitoring Services, 1995). The shingle bars at Llanelltyd were identified as having High to Very High conservation potential. All supported a range of substrate sizes from fine sand to large cobbles, enhancing their importance for invertebrates. The upstream bar (Sediment 68) was identified as having important areas of vegetated shingle, including stands of very parched grassland. Invertebrates recorded included the spider *Arctosa cinerea*, the beetles *Bembidion atrocoeruleum, Oreodytes septentrionalis* and *Zorochros minimus*, and the bug *Cryptostemma alienum*. A more intensive survey of the invertebrates of Tan Lan was undertaken in 2003, using pitfalls and standardised hand-searching and excavation techniques (Bell & Sadler, 2003). A total of 76 species was recorded of which 21 exhibited total or high fidelity to ERS including the beetles *Bidessus minutissimus* and *Perileptus areolatus*. On the basis of these records and data provided by CCW, the Afon Mawddach was ranked as the 6th most important in Wales for its ERS invertebrate fauna and the 14th in the UK at that time. As a result, the River Shingle Invertebrate Assemblage is a Notified and Qualifying feature of Aber Mawddach/Mawddach Estuary SSSI, the upstream boundary of which is at Gelligemlyn where it adjoins Afon Eden – Cors Goch Trawsfynydd SSSI.

The surveys in 1994 and 2003 noted small-scale damage to the Llanelltyd sediments both in terms of livestock and human trampling and the removal of gravels for local use. Bell & Sadler (2003) suggested that continual smale-scale gravel removal or large-scale extraction would have a deleterious impact upon the ERS invertebrate fauna. In winter 2015-16, high water levels within the Mawddach caused the river to overtop its banks at Llanelltyd and flood the nearby Vanner Farm. As a consequence, NRW is looking at ways to prevent future flooding, including the removal of gravel from Sediments 68-70. A site meeting on 24th June 2016 concluded that Sediment 68 would remain intact, with management works focused on Sediments 69-70, skimming off the surface gravels and placing them immediately downstream of the bar. Gravels would also be cleared from the arches of the old bridge. It was agreed that assessment of the current invertebrate interest of these bars would be undertaken prior to any flood defence works.

3.2. 2016 survey

Two visits will be made to the Afon Mawddach at Llanelltyd, one in July and the other in late August, to determine the current invertebrate interest of Sediments 68 and 69-70 (see Figure 1). Whilst it is recognised that pitfall trapping provides the best assessment, timing and funds constrain the current evaluation to visual and hand-searching, and excavations. The protocols outlined in Bell & Sadler (2003) should be followed. A list of all species found should be made, highlighting those species which belong to Fidelity Grade 1 (total or virtual fidelity to ERS) and Fidelity Grade 2 (high fidelity) and providing an Exposed Riverine Sediment Quality Index (ERSQI) (see Bell & Sadler, 2003). An assessment of the likely impacts of gravel removal on the ERS invertebrate fauna should be made.

4. Methods

In order to inform the proposed management works on the Llanelltyd gravels, this contract needed to be undertaken by September 2016. The contract was let on 13 July and did not include provision to undertake pitfall trapping. Excluding pitfalling, the methods utilised by Bell & Sadler (2003) were employed, with the addition of systematic ‘splash-samples’ as part of the visual search technique. Fieldwork was

carried out on 29 July, 7 and 14 September 2016. The location of visual search transects and excavations is shown in Figure 2, along with the approximate distribution of different sediment types.

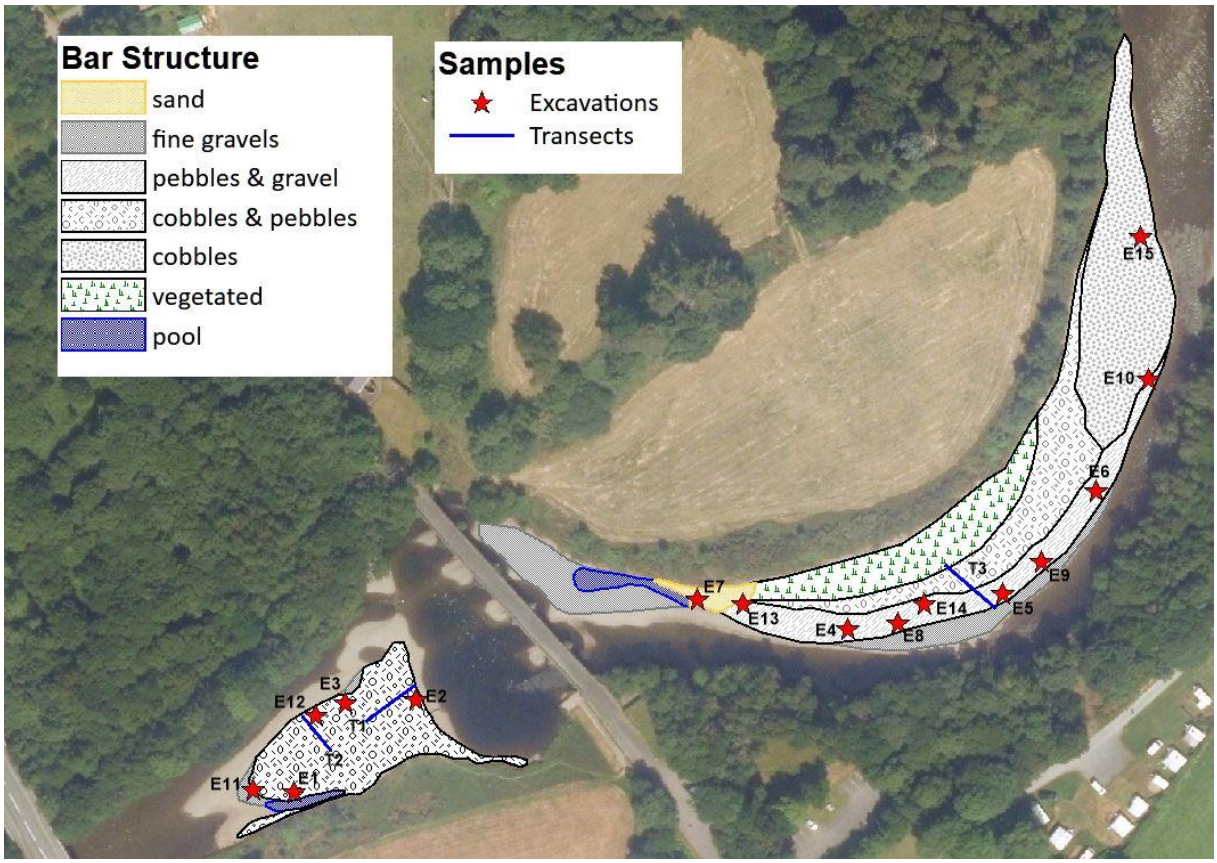

Figure 2. Sample locations and bar structure

4.1. Splash Sampling

Surface active ERS invertebrates are known to include stranded aquatic invertebrates as a significant part of their diet (Hering & Plachter, 1997) and as such several species can be concentrated along the river's edge. By splashing water onto the gravels along the margin of the bar, invertebrates are forced out of hiding as they react to what they perceive as rising water levels. This can be a very effective technique, especially in early summer and particularly for carabid beetles. At every five paces around the margin of each bar (Figure 3), water was kicked onto the gravels three times and the area was then examined to check for species moving higher up the bar. On 29 July 2016, 24 splash-samples were taken on the downstream bar (Sediment 69-70), whilst on the upstream bar (Sediment 68) 41 samples were taken. During the visit on 7 September 2016 five splash samples were taken on the upstream bar and on 14 September 2016 five splash samples were made on both the downstream and upstream bar.

Figure 3. Example of kick samples on Sediment 69-70

4.2. Excavation

Bell & Sadler (2003) recommend excavating an area of one metre square at a distance of 1-2 metres from the water's edge and they carried out four such excavations in 2003. This was modified slightly in the present survey in that smaller excavations were used as the ability to detect tiny invertebrates over a square metre of muddy water and froth is debatable. Sites for excavation were selected on the basis of sediment composition (a mix of fine gravels beneath a matrix of larger pebbles) at a point where the water table was estimated to be about 20 cms beneath the surface – usually about one metre in from the water's edge. Shingle was removed with a trowel until the resultant hole began to fill with water. The surface of the water was then examined for invertebrates and then part of the excavation sides were collapsed into the hole and the process repeated. Shingle was again removed from the hole to reveal open water and more of the sides collapsed in. At each excavation this procedure was carried on for thirty minutes. On 29 July, three excavations were dug on each bar. Only the upstream bar was visited on 7 September 2016 and here four excavations were carried out. On 14 September 2016 there were two excavations on the downstream bar and four on the upstream bar.

Figure 4. Example of excavation on Sediment 68

4.3. Hand-searching

The previous study (Bell & Sadler 2003) included several periods of hand-searching (of 20 minute duration), amounting to a total of 140 minutes over the two survey dates. This technique relies on the observer's expertise in recognising potentially significant micro-habitats and can be very effective in generating inventory lists. However, without comprehensive documentation of locations searched it is difficult to interpret the results with regard to the significance of different sections of the bar. For the current survey transects across the bars were searched for twenty minutes, with all surface stones removed over a width of approximately 50 cms (Figure 5). Any invertebrates disturbed during the transect were collected or recorded. On 29 July 2016 two transects were investigated on Sediment 69-70. On Sediment 68 only a single transect was investigated (the other having been abandoned in view of poor results from the previous three – see section 4 Results). To supplement hand-searching on Sediment 68 twenty minutes were spent investigating the shallow backwater at the toe of the bar.

Figure 5. Hand-searching transect on Sediment 69-70

More time was spent hand searching on the upstream bar during the visit of 7 September 2016. Thirty minutes were spent investigating the shallow backwater (which was much reduced in size from the previous visit), twenty minutes were spent searching amongst the strandline in mid-bar (Figure 6), and a further thirty minutes were spent turning stones to look for invertebrates on the upper (dry zone) part of the bar.

Figure 6. Strandline left by flood on 3 September 2016 (four days before sampling).

On 14 September 2016 the backwater pool on the downstream bar was examined for ten minutes and hand searching was carried out on the central dome of the bar for twenty minutes. Upstream, the small shallow pool remaining of the backwater was examined for ten minutes and one hour was spent hand searching, focused mainly on the new strandline of a couple of days previous and on the upper sandy zone at the top of the bar.

5. Results

5.1. Downstream bar (Sediment 69-70)

Three hours in total were spent investigating the bar downstream of Llanelltyd Bridge (sediment 69-70). This was split across visual searches (including two transects) and excavations. In that time just 23 individual invertebrates were recorded, representing ten species. More than half of the individuals (and all but two of the species) were recorded from two of the excavations (E1 & E3) on the visit of 29 July 2016. By contrast, no invertebrates were found in the two excavations conducted here on 14 September 2016. Hand-searching and splash sampling were also unproductive, with just eight individuals of four species recorded.

Despite these disappointing results, two of the species encountered were newly-recorded for the Mawddach shingle assemblage (the staphylinid beetles *Hydrosmecta fragilis* and *Thinobius crinifer*), both of which are currently classified as Nationally Scarce (Hyman & Parsons 1994). The carabid beetle *Perileptus areolatus*, already known from the Llanelltyd shingles, is also considered Nationally Scarce (Telfer 2016), as is the staphylinid *Hydrosmecta subtilissima*. Five specimens of the Red Data Book (Insufficiently Known) rove beetle *Hydrosmecta delicatula* were collected from the excavations here.

Bar			Downstream				Downstream		
Date	29/07	29/07	29/07	29/07	29/07	29/07	14/09	14/09	14/09
Sample	**Splash**	**E1**	**E2**	**E3**	**T1**	**T2**	**Splash**	**E11-12**	**Hand Search**
HEMIPTERA									
Cryptostemma alienum	3	1	1				1		
Saldula sp. (imm.)	1								
COLEOPTERA									
Hydrosmecta delicatula		3		2					
Hydrosmecta fragilis				1					
Hydrosmecta subtilissima		1							
Hydrosmecta eximia				1					
Thinobius crinifer		1							
Aloconota cambrica		1							
Perileptus areolatus	1	3							
Bembidion atrocoeruleum					1				1
total individuals	**5**	**10**	**1**	**4**	**1**	**0**	**1**	**0**	**1**
ERS species	**3**	**6**	**1**	**3**	**1**	**0**	**1**	**0**	**1**

Table 1: Invertebrates recorded from the downstream bar (sediment 69-70)
[E1, E2 etc. are excavations; T1 & T2 are visual search transects]

5.2. Upstream bar (sediment 68)

More time was spent surveying the upstream bar in recognition of its much larger area and greater range of habitat types. Six and a half hours in total were spent here over three survey dates, with a similar amount of time spent on both excavations and visual searches. Excluding the 19 water beetles (all either *Oreodytes sanmarkii & O. septentrionalis*) recorded in the backwater, 59 individual invertebrates from fourteen species were recorded. Six of these are Nationally Scarce (the spider *Arctosa cinerea*, the rove beetles *Deleaster dichrous, Hydrosmecta longula* & *Hydrosmecta fragilis*, and the ground beetles *Perileptus areolatus* and *Elaphropus parvulus*), whilst the rove beetle *Hydrosmecta delicatula* is classed as RDBK (Insufficiently Known).

Bar		Upstream				Upstream				Upstream				
Date	29/07	29/07	29/07	29/07	07/09	07/09	07/09	07/09	07/09	14/09	14/09	14/09	14/09	14/09
Sample	**Kick**	**E4-6**	**T3**	**Hand Search**	**Kick**	**E7-8**	**E9**	**E10**	**Hand Search**	**Splash**	**E13**	**E14**	**E15**	**Hand Search**
HEMIPTERA														
Cryptostemma alienum								5					5	1
ARANEAE														
Arctosa cinerea			1	1					5			1		5
Pardosa agricola				1										
COLEOPTERA														
Oreodytes septentrionalis				1					15					
Oreodytes sanmarkii				1					2					
Dryops ernesti											1			
Dryops luridus									1					
Deleaster dichrous									1					1
Hydrosmecta delicatula								3						
Hydrosmecta fragilis							1	1					1	
Hydrosmecta longula													3	
Aloconota sulcifrons									1					
Ochthephilum omalinus									1					
Perileptus areolatus								2					2	
Bembidion atrocoeruleum					1				5	1				6
Elaphropus parvulus														2
total individuals	**0**	**0**	**1**	**4**	**1**	**0**	**1**	**11**	**31**	**1**	**1**	**1**	**11**	**15**
ERS species	**0**	**0**	**1**	**4**	**1**	**0**	**1**	**4**	**8**	**1**	**1**	**1**	**4**	**5**

Table 2: Invertebrates recorded from the upstream bar (sediment 68)
[E4-6 etc. are excavations; T3 is a visual search transects]

6. Discussion

The shingle invertebrate assemblage of the Afon Mawddach is regarded as an Individually Qualifying Feature of the SSSI on the presence of a diverse specialist fauna which includes nationally rare species such as the water beetle *Bidessus minutissimus* and the rove beetle *Scopaeus gracilis*. With the addition of the two species newly-recorded for the Mawddach from this survey, a total of 29 Exposed Riverine Sediment (ERS) invertebrate species is now known from the Mawddach. The Dyfi with 19 ERS species, the Conwy with 17 and the Wnion with 16 are the only other North Wales rivers where more than 10 ERS species have been recorded. The Mawddach is also of note in that it supports Nationally Scarce species on the

estuarine sediments (the ground beetles *Bembidion laterale* and *B. maritimum*) as well as those on the river gravels.

A provisional system for assessing the quality of ERS assemblages has been developed (Fowles 2004). This utilises the original Invertebrate Site Register national conservation statuses as used in the Recorder 3.3 software, with some revisions to take account of increases knowledge in the status and distribution of these species (see: http://yrefail.net/Coleoptera/ersqi_status_changes.htm). The statuses of ground beetles (Coleoptera: Carabidae) in Britain have recently been revised (Telfer 2016) but the only effect this has is to reinstate *Elaphropus parvulus* as Notable from the Very Local status used by Bell & Sadler (2003) to calculate ERSQI for the Mawddach.

The ERS Quality Index (ERSQI) is based on geometric scores depending on the known status of each species. The scores are summed, divided by the total number of scoring species, and then multiplied by 100 to give the ERSQI value. Species designated as common score 1; local species score 2, very local species score 4; Notable/Notable B (N and Nb) species score 8; Notable A (Na) and Red Data Book K (RDBK) score 16, Red Data Book 3 and Red Data Book I (RDBI) species score 24, and Red Data Book 1−2 species score 32.

Species	Order	Family	Conservation Status	Revised Status	ERSQI Score	2003 survey	2016 survey
Caviphantes saxetorum	Araneae	Linyphiidae	Na	**Notable/Nb**	8		
Arctosa cinerea	Araneae	Lycosidae	Notable/Nb	Notable/Nb	8	√	√
Pardosa agricola	Araneae	Lycosidae	Local	Local	2	√	√
Bembidion atrocoeruleum	Coleoptera	Carabidae	Local	***Common***	1	√	√
Bembidion decorum	Coleoptera	Carabidae	Common	Common	1		
Bembidion punctulatum	Coleoptera	Carabidae	Local	Local	2	√	
Bembidion tibiale	Coleoptera	Carabidae	Common	Common	1		
Clivina collaris	Coleoptera	Carabidae	Local	Local	2	√	
Perileptus areolatus	Coleoptera	Carabidae	Na	Na	16	√	√
Elaphropus parvulus	Coleoptera	Carabidae	Notable/Nb	Notable/Nb	8	√	√
Bidessus minutissimus	Coleoptera	Dytiscidae	RDB3	RDB3	24	√	
Fleutiauxellus maritimus	Coleoptera	Elateridae	Na	***Notable/Nb***	8	√	
Zorochros minimus	Coleoptera	Elateridae	Local	***Common***	1	√	
Helophorus arvernicus	Coleoptera	Hydrophilidae	Notable/Nb	***Very Local***	4		
Aloconota cambrica	Coleoptera	Staphylinidae		Local	2	√	√
Aloconota insecta	Coleoptera	Staphylinidae	Common	Common	1	√	
Aloconota sulcifrons	Coleoptera	Staphylinidae		Local	2	√	√
Deleaster dichrous	Coleoptera	Staphylinidae	Notable/Nb	***Local***	2	√	√
Erichsonius signaticornis	Coleoptera	Staphylinidae	Notable/Nb	Notable/Nb	8		
Hydrosmecta delicatula	Coleoptera	Staphylinidae	pRDBK	***Na***	16	√	√
Hydrosmecta eximia	Coleoptera	Staphylinidae	Local	***Very Local***	4	√	√
Hydrosmecta thinobioides	Coleoptera	Staphylinidae	Notable/Nb	***Very Local***	4	√	√
Hydrosmectina septentrionum	Coleoptera	Staphylinidae	Notable/Nb	***Very Local***	4	√	√
Hydrosmecta fragilis	Coleoptera	Staphylinidae	Notable/Nb	***Very Local***	4		√
Ochthephilus omalinus	Coleoptera	Staphylinidae		Local	2		√
Scopaeus gracilis	Coleoptera	Staphylinidae	pRDBK	***RDB3***	24	√	
Stenus guttula	Coleoptera	Staphylinidae	Local	Local	2	√	
Thinobius crinifer	Coleoptera	Staphylinidae	Notable/Nb	Notable/Nb	8		√
Cryptostemma alienum	Hemiptera	Dipsocoridae	Local	Local	2	√	√

Table 3: Afon Mawddach ERS assemblage with national conservation statuses

Assemblage	n spp.	ERSQS	ERSQI
Mawddach as @ 2003	27	159	588.9
Mawddach as @ 2016	29	171	589.7
2003 survey	21	135	642.9
2016 survey	16	85	531.3

Table 4: ERSQI scores for the Afon Mawddach and for the 2003 & 2016 surveys

The addition of two new ERS species for the Mawddach in 2016 has had little impact on ERSQI, implying that the Index is now representative of the quality of the fauna regardless of additional survey effort. The Mawddach has the highest ERSQI score of surveyed rivers in north Wales, although several rivers in mid and south Wales

have higher ERSQI scores. It should be noted that 20 qualifying species is the recommended threshold for calculating ERSQI and only sixteen species were recorded in 2016 so the lower ERSQI score of the current survey is not meaningful. The high ERSQI score for the 2003 survey reflects the fact that it was conducted entirely on Sediment 68.

The different species totals between the two surveys requires comment. In 2003 two full survey days, 25 June and 15 July, were devoted to the Tan-lan bar. Bell & Sadler (2003) were able to utilise pitfall traps and the earlier start date would have allowed them to record early summer species that were less likely to be present in late July. Many ERS invertebrates are spring-breeders, with larval development taking place in the summer months before autumn floods disturb the bar sediments, and few adults are evident in July and August. Pitfall traps catch surface active invertebrates and although many ERS species are subterranean by nature they do emerge at night to move to different parts of the bar in search of food and mating opportunities. Seven of the 2003 survey species were recorded only from pitfall traps and four of their species were recorded in June but not July, totalling eight species that were recorded exclusively either in pitfall traps or in June. Bell & Sadler (2003), therefore, found thirteen ERS species by hand-searching or excavation on 15 July 2003.

The current survey began later in the season (29 July) and relied solely on visual searches and excavation but, nonetheless, managed to record sixteen ERS species from the two bars. Surveys were also conducted in September (7 & 14) when it was hoped that emerging adults from the new generation would have been encountered, but only eleven ERS species were found in five and a half hours of survey effort. This was disappointing, and not entirely understood, but it seems plausible that atypical floods on 22 August and 3 September (eg. http://www.walesonline.co.uk/whats-on/whats-on-news/cars-stuck-six-hours-water-11840776) may have affected emergence or encouraged mobile adults to move to higher ground.

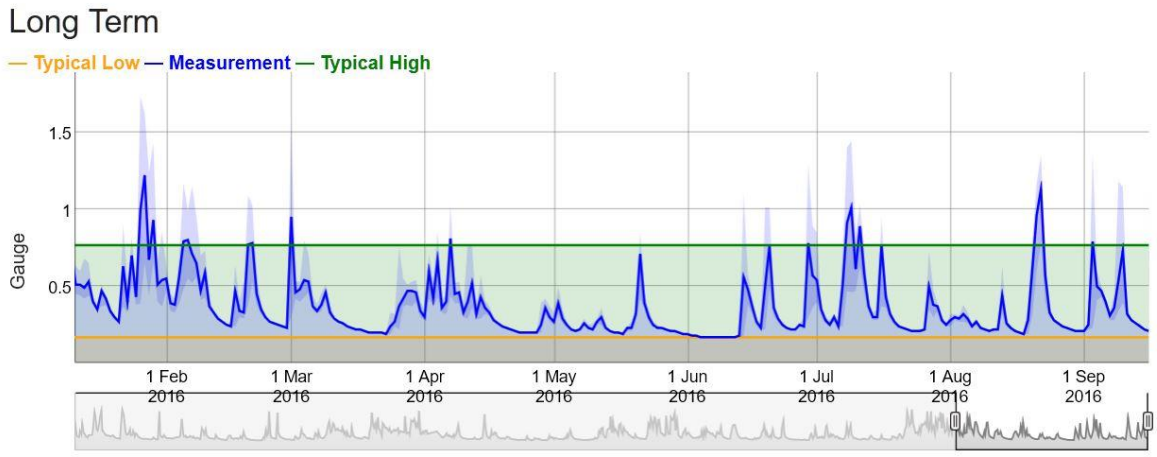

Figure 7. Water level at Tyddyn Gwladys, Mawddach, monitoring station [data from https://www.riverlevels.uk/mawddach-ganllwyd-community-tyddyn-gwladys]

The presence of a marked strandline high up the Tan-lan bar (Figure 6) on 7 September demonstrates how much of the sediment area would have been underwater a few days earlier.

The most striking discovery of the 2003 survey was a single dead adult of the BAP Priority water beetle *Bidessus minutissimus* in an excavation on 15 July. This was the first record of this rare species from the Mawddach catchment. *Bidessus* is known to inhabit gravel-bed rivers, where it can occur in mid-channel but is most readily found in shallow temporary pools on shingle bars (Lott 2004, Foster 2010). The origin of the dead individual is unknown but it was suspected (Bell & Sadler 2003) that *Bidessus* may be breeding in the pools and backwaters on sediment 68. A total of 70 minutes was spent examining the pools at Llanelltyd over the three survey dates in 2016 but no evidence of *Bidessus* could be found. The backwater on Sediment 68 had abundant adults of the water beetle *Oreodytes septentrionale* and a few individuals of the related species, *O. sanmarkii*. Both species are characteristic of gravel-bed rivers in northern and western Britain. Further surveys of these pools would be worthwhile earlier in the season, but for now the mystery of where *Bidessus* is breeding on the Mawddach remains unresolved.

Figure 8. Backwater pool on Sediment 68 in July 2016

7. Management recommendations

This survey was arranged to provide information on the significance of the Llanelltyd shingle bars in order to inform decisions about gravel removal to alleviate flooding. Both bars have presumably been present in their current locations since the old bridge was constructed in the mid-eighteenth century, and quite probably much longer. The shape and form of these bars will have changed in response to flood events, mining activities in the upper catchment, and erosion of sediment deposits in the riverbank. These processes, or their legacy, continue today and contribute to the dynamic nature of exposed riverine sediment that sustains their specialist fauna.

Bars will grow and shrink over time but there will also be subtle changes in sediment composition and topography.

7.1. Upstream (Sediment 68)

The approximate distribution of sediment types on Tan-lan is shown in Figure 2, characteristically with larger cobbles and a few boulders at the head of the bar and fine gravels and sands at the toe. In many respects this is a perfect example of a point bar on Welsh gravel-bed rivers, but there does seem to have been a noticeable change in recent years. Back in 2003, at the time of Sadler & Bell's survey, the bar looked superficially similar to today (Figure 9) but there are slight differences which may limit the significance of the bar for ERS invertebrates.

Figure 9. Sediment 68 on 15 July 2003

It is not easy to discern in this image, but there is a belt composed predominantly of sand that extends from the embedded trunk in the foreground around the water's edge to where Jon Sadler is sampling as the river curves north. The profile of the bar from water's edge to the line of gorse scrub on the field margin is shallow and there is little evidence of vegetation on the dome of the bar. In 2016 the belt of sand is much more restricted, the profile is steep, and birch saplings are widely established on the upper zone of the bar (Figure 10). The river is now much wider here than it was in 2003 and hence the area of exposed sediment, at least at the toe end where finer sediments support a rich fauna, is much reduced.

Figure 10. Sediment 68 on 29 July 2016

Figure 11. Steep profile to upper dome of Sediment 68, 7 Sept 2016

Figure 11 shows how steep the bank profile now is, rising quickly some two-three metres above the river level at low flow. The effect of this is to considerably limit the

zone near the water's edge where ERS invertebrates can burrow, find prey, and develop through their larval stages in permanently damp fine gravel. Above this zone the sediments will dry out to an increasing depth and, whilst surface active species will not be affected, subterranean species will not be able to thrive.

Figure 12. Established birch saplings on Sediment 68, 7 Sept 2016

Raising the dome of the bar also has the effect of reducing disturbance from flash floods, which would normally rejuvenate and redistribute sediments. As a result the higher zones become stabilised and vegetation becomes established. The denser the vegetation the less open sediment there is for specialist invertebrates and the more opportunity there is for non-specialist species to infiltrate from the adjacent field margins. These latter species can be competitively advantaged and further reduce specialist ERS populations. On Sediment 68 birch saplings up to two metres tall are now established (Figure 12) and their roots will bind the sediment making it less likely to be reworked during flood events.

The Mawddach has experienced several large floods over the past decade and it would appear that they have scoured out more of the river channel whilst pushing the shingle bar higher and higher. **It would be advantageous to reprofile the dome of Sediment 68 (effectively the area currently occupied by birch saplings) so that there is once again a shallow profile down to the water's edge. In the short term, the birch saplings should be removed.**

7.2. Downstream (Sediment 69-70)

As with Tan-lan, superficially the bar downstream of the old bridge looks much the same as it did in 2003 (Figure 13). The dome is slightly taller and the river has cut an earth clifflet in the left bank, where previously the grassland of the adjacent pasture spread out onto the shingle in a gentle slope. The bar is still poorly-sorted, with large cobbles forming the armour layer over much of its surface and few patches where fine gravels predominate in the matrix.

Figure 13. Sediment 69-70, 15 July 2003

Figure 14. Sediment 69-70, 29 July 2016

This bar is very popular with holidaymakers during the summer months and the upstream margin, nearest the old bridge, shows signs of considerable trampling. This will have an effect on the ERS fauna but the trampling intensity is localised and the remainder of the bar will support typical ERS species, as shown by this survey. I would expect that this bar is very dynamic and the sediments are probably redistributed each year during flood events. **Proposals to remove some of the sediment from the bar are unlikely to have a lasting impact on the ERS species present. It is recommended that the zone along the left bank is left untouched to preserve the existing backwater.**

8. Conclusion

All of the ERS species known from the Mawddach apart from *Thinobius crinifer* (found on Sediment 69-70 in this survey) have been recorded from the Tan-lan shingle bar (Sediment 68). The interest is not confined to these two sediment areas, however, as other significant bars occur 2-300 metres downstream of the A470 road bridge, but they have not received the same survey effort as Tan-lan. Nonetheless, Sediment 68 is almost certainly the most important individual bar on the Mawddach because of its size, topography and diversity of sediment types. The occurrence of the wolf spider *Arctosa cinerea*, which is frequently encountered on this bar, reflects the presence of substantial deposits of fine sediment in which the spider creates burrows (Jones 2005).This survey failed to record either of the specialities of the Mawddach ERS assemblage (*Bidessus minutissimus* and *Scopaeus gracilis*) but did find one Red Data Book and eight Nationally Scarce species, indicating that the high quality of these shingle bars is maintained.

There are obvious differences between Sediments 68 and 69-70, the latter effectively being a mound of poorly-sorted cobbles and gravels that is impacted by recreational access. However, one Red Data Book and four Nationally Scarce species (all of them subterranean in habit) were recorded here and Sediment 69-70 does have a small backwater. It would seem likely that removal of some of the sediment from the downstream bar would have no lasting effect on the Mawddach ERS assemblage, especially as this bar will almost certainly develop again. The Tan-lan bar, Sediment 68, would be damaged by extensive removal of gravels as there is no guarantee that a similar mix of well-sorted sediments would be reinstated over time. However, floods have modified the topography of this bar over the past decade or so and it would benefit from re-profiling to reduce the height of its dome and to prevent scrub vegetation becoming established on the higher zones. In the meantime, the control of invading birch scrub is recommended.

9. Acknowledgements

I am grateful to Mike Howe for arranging this contract, to Rachel Morris for GIS layers and aerial photography, and to Dave Smith for facilitating access to Tan-lan. Dave Boyce is thanked for his assistance with the identification of the Staphylinidae. Thanks also to Deion Lewis-Smith for his excellent photograph of *Arctosa cinerea*.

10. References

Bell, D. & Sadler, J.P. 2003. *Assessment of the river shingle invertebrate fauna at Llanelltyd on the Afon Mawddach, Meirionnydd*. CCW Contract Science Report No. 599. Countryside Council for Wales, Bangor.

Brewer, P.A., Gittins, S.D.R. & Macklin, M.G. 2006. *Long-term river channel and planform dynamics in Wales: Phases 1 & 2.* CCW Contract Science Report No. 741. Countryside Council for Wales, Bangor.

Entomological Monitoring Services. 1995. *Distribution of exposed riverine sediments in the catchments of the Afonydd Mawddach, Gain and Wnion.* CCW Contract Science Report No. 117. Countryside Council for Wales, Bangor.

Foster, G.N. 2010. *A review of the scarce and threatened Coleoptera of Great Britain. Part 3: aquatic Coleoptera. Species Status. 1*. Joint Nature Conservation Committee.

Fowles, A.P. 2004. Specialist Coleoptera of Exposed Riverine Sediments (ERS). http://yrefail.net/Coleoptera/ersqi.htm

Hering, D. & Plachter, H. 1997. *Riparian ground beetles (Coleoptera, Carabidae) preying on aquatic invertebrates: a feeding strategy in alpine floodplains*. Oecologia, **111**: 261-270.

Hyman, P.S. & Parsons, M.S. 1994. *A review of the scarce and threatened Coleoptera of Great Britain. Part 2*. UK Nature Conservation. 12. Joint Nature Conservation Committee.

Jones, E. 2005. *Arctosa cinerea in mid-Wales*. British Arachnological Society Newsletter. **103**: 2

Lott, D.A. 2004. *Shingle invertebrate survey and condition assessment at Rheidol Shingles and Backwaters & Afon Rheidol ger Capel Bangor SSSI*. Unpublished report. Countryside Council for Wales.

Telfer, M.G. 2016. *A review of the beetles of Great Britain: Ground Beetles (Carabidae).* Species Status No.25. Natural England Commissioned Report. NECR189. Natural England.

11. Appendix 1: Invertebrate Records

Taxon	Site	Grid ref	Recorder	Determiner	Date	Quantity	Comment
Aloconota cambrica	Sediment 69-70: Llanelltyd, Afon Mawddach	SH717192	Fowles, A.P.	Boyce, D.C.	29/07/2016	1	excavation: shingle bar d/stream of bridge
Bembidion atrocaeruleum	Sediment 69-70: Llanelltyd, Afon Mawddach	SH717192	Fowles, A.P.	Fowles, A.P.	29/07/2016	1	shingle bar d/stream of bridge
Cryptostemma alienum	Sediment 69-70: Llanelltyd, Afon Mawddach	SH717192	Fowles, A.P.	Fowles, A.P.	29/07/2016	5	shingle bar d/stream of bridge
Hydrosmecta delicatula	Sediment 69-70: Llanelltyd, Afon Mawddach	SH717192	Fowles, A.P.	Boyce, D.C.	29/07/2016	5	excavation: shingle bar d/stream of bridge
Hydrosmecta eximia	Sediment 69-70: Llanelltyd, Afon Mawddach	SH717192	Fowles, A.P.	Fowles, A.P.	29/07/2016	1	excavation: shingle bar d/stream of bridge
Hydrosmecta fragilis	Sediment 69-70: Llanelltyd, Afon Mawddach	SH717192	Fowles, A.P.	Fowles, A.P.	29/07/2016	1	excavation: shingle bar d/stream of bridge
Hydrosmecta subtilissima	Sediment 69-70: Llanelltyd, Afon Mawddach	SH717192	Fowles, A.P.	Fowles, A.P.	29/07/2016	1	excavation: shingle bar d/stream of bridge
Perileptus areolatus	Sediment 69-70: Llanelltyd, Afon Mawddach	SH717192	Fowles, A.P.	Fowles, A.P.	29/07/2016	4	excavation: shingle bar d/stream of bridge
Thinobius crinifer	Sediment 69-70: Llanelltyd, Afon Mawddach	SH717192	Fowles, A.P.	Fowles, A.P.	29/07/2016	1	excavation: shingle bar d/stream of bridge
Bembidion atrocoeruleum	Sediment 69-70: Llanelltyd, Afon Mawddach	SH717192	Fowles, A.P.	Fowles, A.P.	07/09/2016	1	shingle bar d/stream of bridge
Cryptostemma alienum	Sediment 69-70: Llanelltyd, Afon Mawddach	SH717192	Fowles, A.P.	Fowles, A.P.	07/09/2016	1	shingle bar d/stream of bridge
Oreodytes sanmarkii	Sediment 68: Llanelltyd, Afon Mawddach	SH718193	Fowles, A.P.	Fowles, A.P.	29/07/2016	1	shallow, clean gravel backwater pool u/stream of bridge
Oreodytes septentrionalis	Sediment 68: Llanelltyd, Afon Mawddach	SH718193	Fowles, A.P.	Fowles, A.P.	29/07/2016	1	shallow, clean gravel backwater pool u/stream of bridge
Arctosa cinerea	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Fowles, A.P.	29/07/2016	2	shingle bar u/stream of bridge
Pardosa agricola	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Fowles, A.P.	29/07/2016	1	shingle bar u/stream of bridge
Aloconota sulcifrons	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Boyce, D.C.	07/09/2016	1	strandline: shingle bar u/stream of bridge
Arctosa cinerea	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Fowles, A.P.	07/09/2016	5	shingle bar u/stream of bridge
Bembidion atrocoeruleum	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Fowles, A.P.	07/09/2016	6	shingle bar u/stream of bridge
Cryptostemma alienum	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Fowles, A.P.	07/09/2016	5	shingle bar u/stream of bridge
Deleaster dichrous	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Fowles, A.P.	07/09/2016	1	strandline: shingle bar u/stream of bridge
Dryops luridus	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Fowles, A.P.	07/09/2016	1	shingle bar u/stream of bridge

Hydrosmecta delicatula	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Boyce, D.C.	07/09/2016	3	excavation: shingle bar u/stream of bridge
Hydrosmecta fragilis	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Fowles, A.P.	07/09/2016	2	excavation: shingle bar u/stream of bridge
Ochthephilum omalinus	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Boyce, D.C.	07/09/2016	1	strandline: shingle bar u/stream of bridge
Oreodytes sanmarkii	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Fowles, A.P.	07/09/2016	2	shallow, clean gravel backwater pool u/stream of bridge
Oreodytes septentrionalis	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Fowles, A.P.	07/09/2016	15	shallow, clean gravel backwater pool u/stream of bridge
Perileptus areolatus	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Fowles, A.P.	07/09/2016	2	excavation: shingle bar u/stream of bridge
Arctosa cinerea	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Fowles, A.P.	14/09/2016	6	shingle bar u/stream of bridge
Bembidion atrocoeruleum	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Fowles, A.P.	14/09/2016	7	shingle bar u/stream of bridge
Cryptostemma alienum	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Fowles, A.P.	14/09/2016	6	shingle bar u/stream of bridge
Deleaster dichrous	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Fowles, A.P.	14/09/2016	1	strandline: shingle bar u/stream of bridge
Dryops ernesti	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Fowles, A.P.	14/09/2016	1	shingle bar u/stream of bridge
Elaphropus parvulus	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Fowles, A.P.	14/09/2016	2	upper dry zone: shingle bar u/stream of bridge
Hydrosmecta fragilis	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Fowles, A.P.	14/09/2016	3	excavation: shingle bar u/stream of bridge
Hydrosmecta longula	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Boyce, D.C.	14/09/2016	3	excavation: shingle bar u/stream of bridge
Perileptus areolatus	Sediment 68: Llanelltyd, Afon Mawddach	SH719193	Fowles, A.P.	Fowles, A.P.	14/09/2016	2	excavation: shingle bar u/stream of bridge

12. Appendix 2: Data Archive Appendix

The data archive contains:

[A] The final report in Microsoft Word and Adobe PDF formats.

[B] Species records, which are held on the NRW Recorder 6 database.

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue http://libcat.naturalresources.wales or http://catllyfr.cyfoethnaturiol.cymru by searching 'Dataset Titles'. The metadata is held as record no 116796.

Published by:
Natural Resources Wales
Maes-y-ffynnon
Penrhosgarnedd
Bangor
Gwynedd
LL57 2DW

0300 065 3000 (Mon-Fri, 8am - 6pm)

Further copies of this report are available from:

Email: library@cyfoethnaturiolcymru.gov.uk