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**Floating Water Plantain *Luronium natans* (L) Raf.:
Current distribution and status in Llyn Padarn and Llyn Cwellyn, Wales**

ECRC Research Report Number 161

Goldsmith, B., Shilland, E, Shilland, J and Turner, S

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1. Introduction

1.1. Background

Luronium natans is native to the UK and is protected by UK and European law under Annexes II and IV of the Habitats Directive, Appendix I of the Bern Convention, Schedule 4 of the Conservation (Natural Habitats, etc.) Regulations 1994, and Schedule 8 of the Wildlife and Countryside Act, 1981. It is also listed as UK priority BAP species and the current distribution is restricted to less than 100 hectads in the UK and it should therefore be classed as nationally scarce (Lockon 2014).

The main stronghold for the species is in the oligotrophic lakes of central Wales and Cumbria, as well as some canals in Wales and Shropshire (Preston *et al.* 2002). Due to its deep-water habit, *L. natans* is easily overlooked and although this may have resulted in it being under-recorded in some locations, there is also evidence of it having been lost from some lowland sites in recent years (Preston & Croft 1997).

In Llyn Padarn, *Luronium natans* was first recorded in 1848 (Kay *et al.* 1999), and more recently is known to have been relatively common with records from at least 4 distinct locations reported by Andy Jones in 1997 (CCW Species & Monitoring Report No. 98/02/11 - *Luronium natans* (floating water-plantain) at Llyn Padarn SSSI) (Figure 1). Survey data since 1997 are less complete. The aquatic flora was surveyed using Common Standard Monitoring methodology (JNCC 2005) for WFD assessment (Goldsmith *et al.* 2005, 2010, 2013), but this method does not necessitate whole-site assessment and *L. natans* was only recorded in one survey section at the south east end of the lake (an extensive bed from 0.8 – 2.4 m water depth). The other survey sections did not coincide with earlier *L. natans* records and therefore the extent of the species within the lake since 1997 has not been verified.

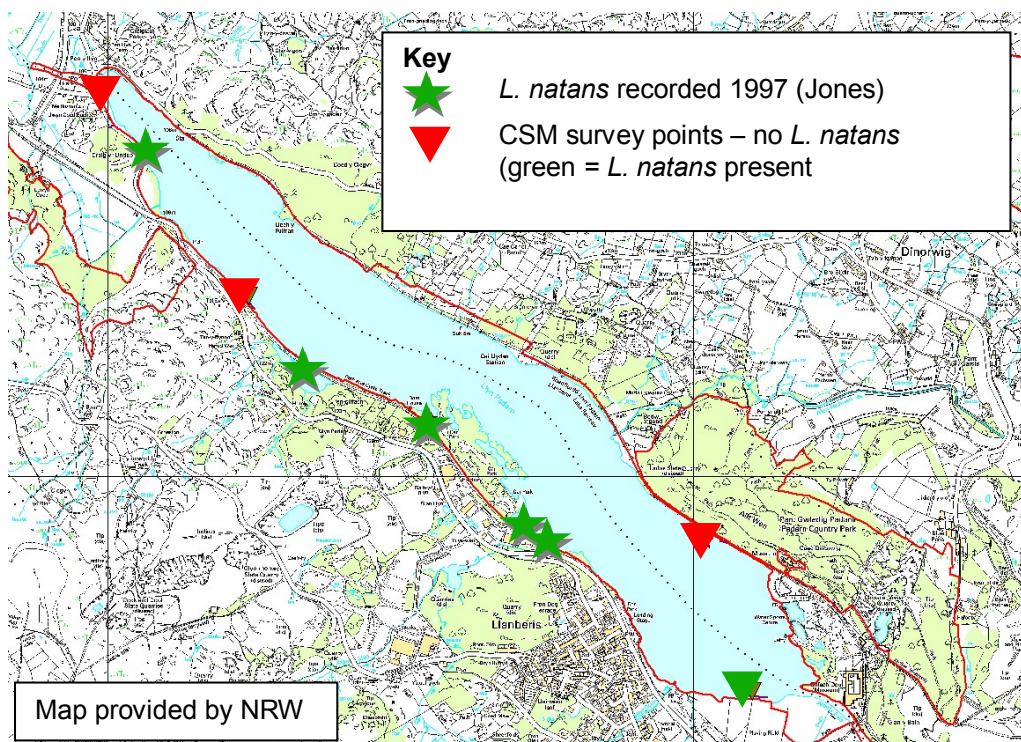


Figure 1 Location of previous survey data in Llyn Padarn

Luronium natans was first recorded in Llyn Cwellyn in 1895 (Kay *et al.* 1999). More recent records from an unpublished survey conducted by D. Monteith in 2002 (pers comm. & Curtis & Simpson, 2004) show the species to be extant around the south east margins. Subsequent records are less complete however and detail only a small deep-water population close to the main inflow found in 2003 and again in 2009 (Goldsmith *et al.* 2004, 2010) during CSM surveys of the site. A CSM survey of Llyn Cwellyn was conducted again in 2012 (Goldsmith *et al.* 2013), but on this occasion, *L. natans* was not recorded, despite an extensive search of the area.

Survey methods used for the CSM surveys are generally restricted to visual (bathyscope) and grapnel methods conducted from a boat. Where *Luronium natans* is present, the use of a grapnel is avoided as much as possible to prevent damage and up-rooting of plants, and therefore detection of the species can prove difficult where it occurs in deep water.

Furthermore, the CSM surveys are (usually) restricted to only four 100 m sections located approximately evenly around the lake shore. Large areas of the site are therefore overlooked unless the specific purpose of the survey is to detect rare species (JNCC 2005). The survey data collected over the past 10 years in both Llyn Padarn and Llyn Cwellyn are not therefore sufficient to confirm the status of *Luronium natans* in terms of the whole-site distribution or population size.

The use of underwater survey techniques such as SCUBA or snorkelling gives a much better chance of detecting *Luronium natans*. In the case of the study sites, we know the depth range of aquatic plants to be less than 5 m deep and therefore snorkelling provides the best means of surveying these shallow water populations without the complexities and time restrictions associated with breathing bottles air. Relatively clear water in the lakes makes effect visual survey to 5 m possible without exceeding 3 m dives for the snorkeler and the entire littoral zone can be assessed within a relatively short timeframe.

1.2. Aim of the Report

- To determine the extent of *Luronium natans* within Llyn Padarn and Llyn Cwellyn using underwater survey methods.
- To map the distribution of *Luronium natans* within Llyn Padarn and Llyn Cwellyn

2. Methods



2.1. Snorkel survey

Snorkel surveys were carried out at both lakes in October 2014. Water temperatures were approximately 15 °C and two PADDI qualified divers (B. Goldsmith and E. Shilland) undertook the snorkelling using 5 mm wetsuit, inclusive of 3 mm hood and gloves as required. Weight belts (2-4 kg) were used to achieve near-neutral buoyancy and minimise effort while in the water. The divers are both expert aquatic botanists with over 10 years experience of surveying *Luronium natans*. Surveys were carried out under NRW Protected Species Licence 59401:OTH:SP:2014.

When in the water, the diver was attached to dive-line at all times, fixed to a surface marker buoy (SMB, Figure 3). The diver was supported in the water by a team in a semi-rigid inflatable boat with 4 hp outboard and a qualified skipper. The second diver acted as watchman. Each diver would spend approximately 45 minutes in the water, followed by 1 hour of surface time in the boat. All dives were less than 5 m deep and sub-surface time was less than 30 seconds for any one dive.

When in the water, the snorkeler had very good vision of the littoral zone to a depth of approximately 2.5 m; a short dive to 2.5-3.0 m was adequate to gain a good view to 5 m. Water depth was measured by the diver at each sample location using a hand-held echo-sounder (Figure 2) and conveyed to the data recorder on the boat. A dive was then conducted and results (presence / absence of *Luronium natans*)

reported to the boat on surfacing. While the diver swam on to the next survey point, the skipper manoeuvred the boat to the dive site and a GPS point was recorded. The entire littoral zone of both sites was searched to a depth of 5.0 m.



Figure 2 Depth measurement



Figure 3 Diver in the water and surface marker buoy (SMB)

3. Results

3.1. Llyn Padarn

The outline of the lake best shows the distribution of the species within the lake (Figure 4). Four discrete populations were recorded. The largest population (1 on the map) was recorded around the south east shore where *L. natans* plants occurred between depths of 50 cm to 2.5 m, dominating in some areas and only very sparse in others. With rarely more than 5-10 m separating beds of the plants in this region of the lake, this is considered to be a single population. Plants consisted only of the submerged “rosette” form and were generally noted as in good condition with abundant stolons present, indicating vegetative growth was occurring. The plants occasionally formed mono-specific stands, but more commonly co-occurred with *Littorella uniflora*, *Isoetes lacustris*, *Nitella flexilis* agg., *Myriophyllum alterniflorum* and *Potamogeton berchtoldii* with occasional *Elatine hexandra* and *Ranunculus peltatus*.

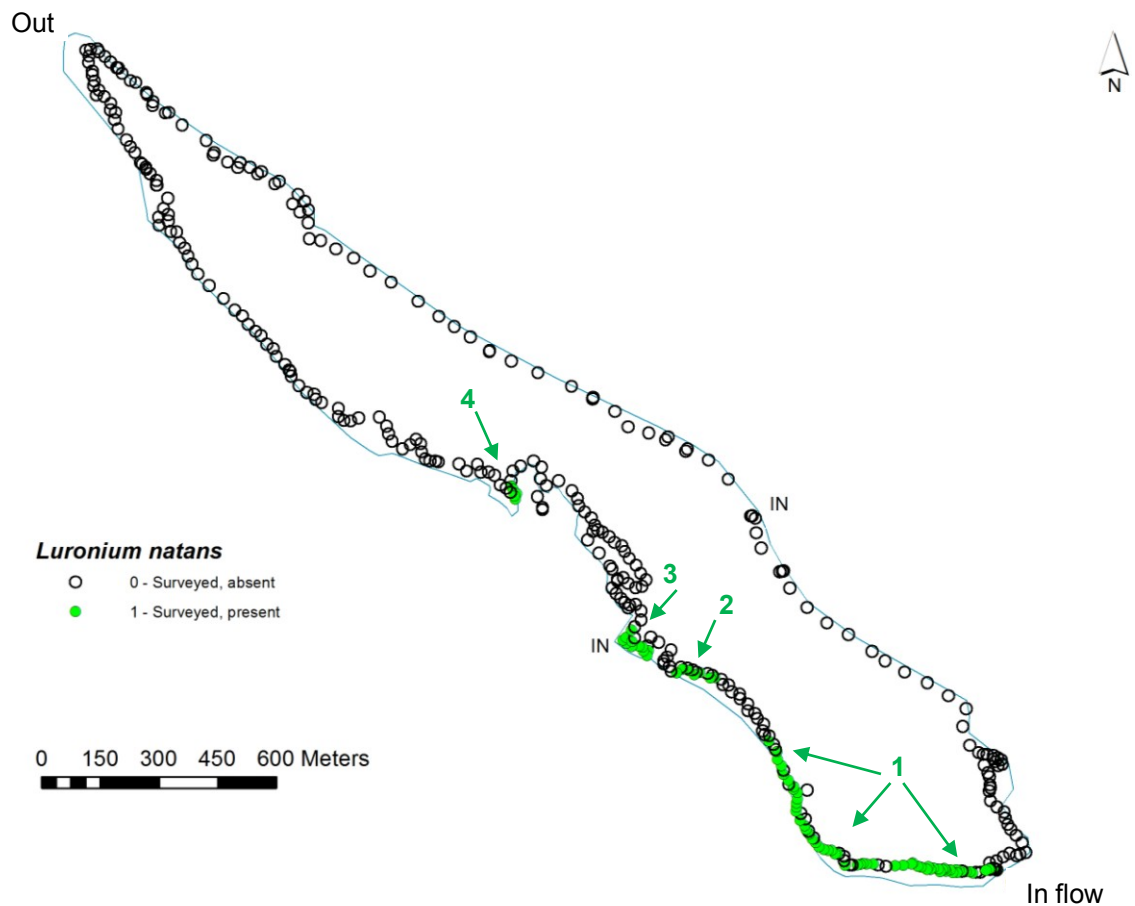


Figure 4 Distribution of *Luronium natans* in Llyn Padarn

Population 2 was small and restricted to depths between 1-1.4 m. Plants were noted as being degraded and the population was very sparse.

Population 3 was separated from 2 by a peninsular. The plants here were generally healthier-looking and formed quite dense beds from approximately 1.0 m to a maximum of 2.3 m. *Luronium natans* plants were common in the vicinity of (and directly below) the floating pontoon used by kayakers.

Population 4 was restricted to a very small area in relatively shallow water between 0.7 – 1.2 m. Here the plants were mostly sparse and many had degraded leaves and looked in poor health. This area was thick with filamentous algae, often covering areas of *L. natans*.

Despite an extensive search, no *L. natans* plants were recorded in the location towards the north western end where it was reported by Andy Jones in 1997. Plants were however present in the isolated “pond” (SH5666961359) that is separated from the lake by the causeway (Cycle track and path). This area was not surveyed, but *L. natans* was observed as present. Vegetation was extremely sparse along the north shore and no *L. natans* was recorded.

Although 83 of the 380 sample points (21.8%) had *Luronium natans* present, these data do not entirely reflect the frequency of the plant within Llyn Padarn. Sample points were not placed evenly, and more points were recorded in areas where the plant was growing, than in areas where it was absent, thus skewing the figures.

3.2. Llyn Cwellyn

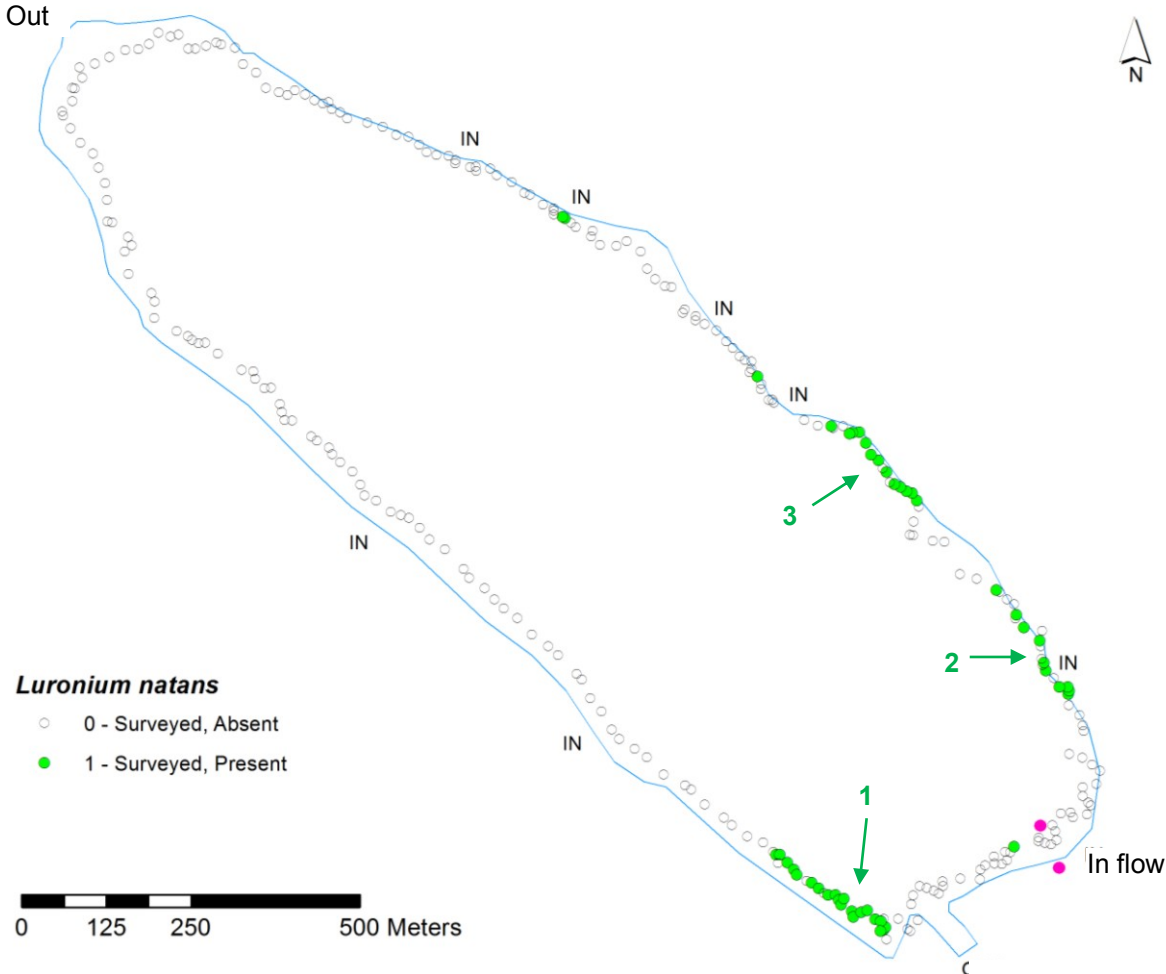


Figure 5 Distribution of *Luronium natans* in Llyn Cwellyn

Contrary to the concerns raised by the CSM surveys of Llyn Cwellyn, *Luronium natans* remains relatively common within the lake with 3 discrete populations present as well as three other small isolated records present (Figure 5).

At location 1 in Figure 5, there was a patchy mosaic of *Luronium natans* plants, in places it was abundant, and in other areas there were few or no plant, but the gaps were generally of less than 10 m between groups of plants. Plants were recorded growing at depths of 0.9 m to 2.9 m, with it being more common at depths of 1.3-2.5 m. Plants consisted only of the submerged, rosette form and were generally in good condition with many stolons present. Other aquatic vegetation in this area was abundant with mixed beds of *Littorella uniflora*, *Isoetes lacustris*, *Myriophyllum alterniflorum*, *Juncus bulbosus*, *Lobelia dortmanna* and occasional *Elatine hexandra*.

Population 2 was also patchy, but had some areas of dense *L. natans*, particularly around the out-wash fan of the small inflow stream. Other patches were spars and some were 10-15 m apart. The plants were at higher density in the easterly end of this area, thinning at the western end to only a few individual plants. The depth range in this area was deeper than 1, with plants recorded between 1.3 to 3.6 m; the latter being well in excess of the 2.0 maximum reported in Preston and Croft (1997).

Between populations 1 and 2 there was a high abundance of filamentous green algae which had a visible impact on the growth of aquatic plants in that region. This area coincides with section 3 of the CSM surveys where *Luronium natans* was recorded in the past (Goldsmith *et al.* 2004 & 2010), but not found in 2012 (Goldsmith 2013). Here a small (< 2 m x 2 m), isolated area of *L. natans* plants was found growing at over 3 m depth. It is not understandable why this small area was overlooked in the 2012 survey.

Between population 2 and 3 (Figure 5) there was abundant filamentous green algae smothering the littoral zone between 1-4 m water depth.

Population 3 was again patchy and also in an area with relatively high filamentous algal growth covering many of the plants. *Luronium natans* was recorded at depths of 1.3 – 2.1 m and the majority of plants looked healthy and vegetative growth was evidenced by numerous stolons.

Two more small areas of *Luronium natans* were recorded along the north shore. Both were in relatively deep water (2.8 m and 1.9-2.5 m) and although small in area, consisted of healthy plants.

In addition to *L. natans*, other common species recorded along the northern shore were: *Littorella uniflora* (A), *Isoetes lacustris* (A), *Myriophyllum alterniflorum* (O), *Juncus bulbosus* (O), *Lobelia dortmanna* (F) and *Potamogeton berchtoldii* (R). *Elatine hexandra* and *Subularia aquatica* were also present, but rare.

The shallower area around the north west end of Llyn Cwellyn had abundant plants – mainly *L. uniflora*, *L. dortmanna*, *I. lacustris* and *M. alterniflorum* – but was without any *Luronium natans*. The long section of shore on the south side of the lake was mainly steeply shelving and typified by boulders. Some plants were present (*L. uniflora*, *L.*

dortmanna, *I. lacustris* and *M. alterniflorum*, *J. bulbosus*), but *L. natans* was not recorded except in the south eastern end (population1).

3.3. Site Comparison

Both Llyn Padarn and Llyn Cwellyn have extensive populations of *Luronium natans* present consisting of many thousands of individual plants. Furthermore, these populations are not restricted to single locations within the site, but in L. Padarn consisted of four distinct and separate locations and in L. Cwellyn, three large populations with three more small patches recorded.

The depth distribution was different between the two sites. In Llyn Padarn the overall depth range was smaller and the maximum recorded depth was 2.5 m. In Llyn Cwellyn, the populations were mainly in deeper water with the maximum recorded depth being 3.6 m (Figure 6). Light availability, and hence water clarity, is a key requirement of *Luronium natans* (Hill *et al.* 1999), and increase algal growth of both planktonic algal and filamentous green algae should be of concern for the long-term survival of this species in both lakes. The data suggest that water clarity is already having a negative impact on the depth of colonisation in Llyn Padarn relative to Llyn Cwellyn.

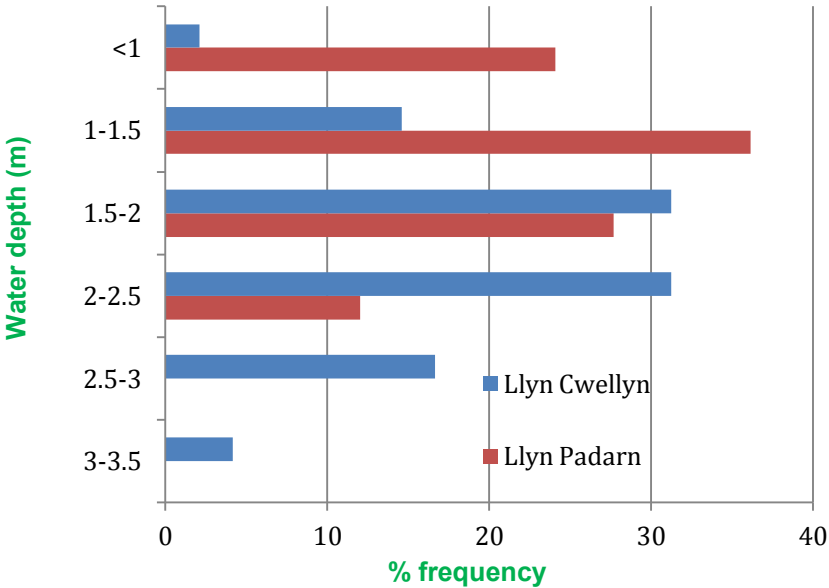


Figure 6 Depth distribution of *Luronium natans* in Llyn Padarn and Llyn Cwellyn

4. Conclusion

4.1. Site condition relative to *Luronium natans*

Both lakes have extensive populations of *Luronium natans*, but there is concern in Llyn Padarn that many plants were in poor condition (particularly population 4 at SH5711461226) and that algal growth may be impacting the overall depth range, and hence habitat availability, of the plants. Filamentous algae was also noted as a problem in Llyn Cwellyn, but here plants appeared to be in better condition.

At neither site was there any evidence of floating leaves or any flowering stems. Generally, both lakes are exposed and do not have any extensive areas of emergent vegetation (e.g. *Carex rostrata*, *Phragmites australis* etc.) that could offer the protection required by flowering plants of this species. Plants in both sites were restricted to vegetative reproduction.

4.2.

The use of snorkelling as a survey method for these clear-water sites is excellent. It has the advantage over boat-based or wading surveys (which utilise bathyscopes and grapnels) by affording much greater visual range and manoeuvrability of the surveyor whilst in the water. The ability to seek out and locate individual plants and investigate uncertainties is also greatly enhanced by being in the water. Where plants are no deeper than 5 m, this method is also considered to be more efficient than SCUBA surveys, which have a much greater reliance on specialist equipment and limit the time the diver can spend in the water during any one period.

When practised safely by trained surveyors and boat operatives, snorkelling is recommended as the most accurate as well as cost and time efficient method for surveying submerged aquatic plants.

5. References

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6. Appendix I

Survey data for Llyn Padarn are presented in Table 1 and for Llyn Cwellyn, . Each point contains a GPS point (approximately 5 m accuracy), a water depth and presence (1) or absence (0) of *Luronium natans*.

Table 1 Survey points and presence of *Luronium natans* in Llyn Padarn

Waypoint	Landranger Grid reference	Water depth (m)	L. <i>natans</i>
323	SH5834260262	1.3	1
324	SH5834160267	1.9	0
325	SH5832660268	2.4	0
326	SH5832260267	1.2	1
327	SH5831160265	1.1	1
328	SH5830060260	1.2	0
329	SH5828860260	1.0	0
330	SH5828060257	0.6	1
331	SH5827360261	1.6	1
332	SH5826360261	1.3	1
333	SH5825460263	1.0	0
334	SH5824560265	1.9	1
335	SH5823760266	2.1	1
336	SH5823960259	2.3	1
337	SH5822960259	1.6	1
338	SH5822260265	1.8	1
339	SH5821260263	2.0	1
340	SH5820960267	2.4	1
341	SH5820760269	1.7	1
342	SH5820360267	2.4	1
343	SH5819760262	0.6	1
344	SH5819260268	1.8	1
345	SH5817960271	2.5	1
346	SH5817260267	2.0	1
347	SH5816760274	2.5	1
348	SH5816360267	1.3	1
349	SH5814760272	1.9	1
350	SH5814060275	0.9	1
351	SH5812760284	1.1	1
352	SH5812360281	2.5	1
353	SH5810360278	1.2	1
354	SH5808160276	1.2	1
355	SH5805860275	1.6	0
356	SH5803860279	1.9	0
357	SH5802660281	1.3	1
358	SH5800860281	1.6	1
359	SH5799960282	2.4	1
360	SH5799260280	0.9	1
361	SH5798560279	0.9	1
362	SH5797260279	1.7	0
363	SH5796660279	1.2	0
364	SH5795460277	0.5	1

Waypoint	Landranger Grid reference	Water depth (m)	L. <i>natans</i>
365	SH5795260290	1.0	0
366	SH5795260301	1.0	0
367	SH5793860308	1.6	0
368	SH5793460307	2.4	1
369	SH5792860306	1.5	1
370	SH5791960315	2.0	1
371	SH5791060316	0.8	1
372	SH5789960318	1.1	1
373	SH5788660325	1.4	1
374	SH5787860335	1.0	1
375	SH5787260349	1.5	0
376	SH5787060345	0.9	1
377	SH5786260358	0.9	1
378	SH5785960365	1.4	0
379	SH5785360369	1.2	1
380	SH5785060378	1.3	1
381	SH5785360396	1.4	0
382	SH5783960393	1.2	1
383	SH5784060411	1.8	0
384	SH5782860415	1.6	1
385	SH5782960427	1.6	1
386	SH5783060436	1.6	1
387	SH5783260447	1.6	1
388	SH5785660470	2.2	0
389	SH5783260463	1.4	1
390	SH5782160471	1.5	1
391	SH5782360478	1.6	1
392	SH5780960484	1.8	0
393	SH5780960495	2.0	1
394	SH5779660510	1.5	1
395	SH5779660521	2.2	0
396	SH5779160532	1.6	1
397	SH5778060548	1.4	1
398	SH5778060568	1.8	1
399	SH5777660574	1.5	0
400	SH5777060587	1.5	0
401	SH5775860595	1.0	1
402	SH5776060609	1.5	0
403	SH5774960612	1.0	0
404	SH5774360621	1.0	0
405	SH5774660639	2.1	0
406	SH5772960653	1.2	0

Waypoint	Landranger Grid reference	Water depth (m)	L. <i>natans</i>
407	SH5772260666	2.3	0
408	SH5770560672	0.9	0
409	SH5770660690	2.6	0
410	SH5768560703	1.4	0
411	SH5768460715	2.3	0
412	SH5766460722	1.0	0
413	SH5765760738	2.6	0
414	SH5764260740	1.2	0
415	SH5763760753	2.9	0
416	SH5762060757	1.2	1
417	SH5761560763	2.2	0
418	SH5760960757	1.2	1
419	SH5760260768	2.8	0
420	SH5758260770	1.0	1
421	SH5757260771	1.6	0
422	SH5756860764	1.4	1
423	SH5756360777	3.1	0
424	SH5755460775	1.4	1
425	SH5755160782	2.9	0
426	SH5753860778	1.0	1
427	SH5753460783	2.5	0
428	SH5752360769	1.0	1
429	SH5750960773	2.0	0
430	SH5750460787	1.6	0
431	SH5749060792	2.3	0
432	SH5749060800	2.2	0
433	SH5749960809	1.9	0
434	SH5750960829	4.0	0
435	SH5747760848	2.4	0
436	SH5745760861	2.0	0
437	SH5744960838	2.3	0
438	SH5745160825	1.6	1
439	SH5744760813	0.8	1
440	SH5743860825	1.2	1
441	SH5743660835	2.3	1
442	SH5742760837	1.5	1
443	SH5740860837	1.2	1
444	SH5739560844	1.0	1
445	SH5738560853	1.6	1
446	SH5739460859	2.0	1
447	SH5740960850	1.5	1
448	SH5741660858	2.1	0
449	SH5740860878	2.0	1
450	SH5741660888	2.0	0
451	SH5743360904	1.5	0
452	SH5743360928	1.9	0
453	SH5741960945	1.3	0
454	SH5740460942	1.7	0
455	SH5739960935	1.4	0
456	SH5739060949	1.4	0

Waypoint	Landranger Grid reference	Water depth (m)	L. <i>natans</i>
457	SH5738060959	1.6	0
458	SH5736960972	1.5	0
459	SH5735860986	2.0	0
460	SH5737261005	1.5	0
461	SH5735861034	1.9	0
462	SH5735261042	2.0	0
463	SH5732461076	1.9	0
464	SH5729561109	1.8	0
465	SH5730961131	1.2	0
466	SH5732161135	3.0	0
467	SH5733461129	1.9	0
468	SH5735061117	2.0	0
469	SH5736361102	1.6	0
470	SH5738261094	1.1	0
471	SH5739061079	1.4	0
472	SH5740261062	2.0	0
473	SH5741961044	1.6	0
474	SH5743161023	2.0	0
475	SH5744561007	1.2	0
476	SH5743460991	2.0	0
477	SH5741860987	1.0	0
478	SH5739960998	1.7	0
479	SH5738761013	3.3	0
480	SH5737261010	1.0	0
481	SH5731461146	1.9	0
482	SH5730461165	1.7	0
483	SH5728961180	2.5	0
484	SH5727361197	2.6	0
485	SH5726961215	1.7	0
486	SH5725561234	1.7	0
487	SH5722161260	2.0	0
488	SH5718961248	1.7	0
489	SH5716861220	1.2	0
490	SH5718061192	1.8	0
491	SH5718061186	1.2	0
492	SH5717561265	1.6	0
493	SH5717861295	1.9	0
494	SH5715761310	2.8	0
495	SH5712461298	2.3	0
496	SH5710561285	2.4	0
497	SH5709961261	1.7	0
498	SH5710061246	1.2	1
499	SH5710461238	0.9	1
500	SH5711461226	0.9	1
501	SH5711161212	0.7	1
502	SH5710961220	1.1	1
503	SH5709861230	0.6	0
504	SH5708761242	0.8	0
505	SH5707261249	0.7	0
506	SH5705761274	2.3	0

Waypoint	Landranger Grid reference	Water depth (m)	L. <i>natans</i>
507	SH5704261282	1.8	0
508	SH5702361282	1.0	0
509	SH5701461302	2.5	0
510	SH5698661284	0.7	0
511	SH5696661304	1.9	0
512	SH5691561308	3.5	0
513	SH5690661311	1.9	0
514	SH5689261311	1.5	0
515	SH5688061316	1.3	0
516	SH5687161333	1.8	0
517	SH5686961355	2.3	0
518	SH5685861366	2.2	0
519	SH5684261352	1.9	0
520	SH5682261342	0.9	0
521	SH5679561362	0.9	0
522	SH5678661381	1.9	0
523	SH5678161399	2.5	0
524	SH5676361423	4.2	0
525	SH5671061420	2.3	0
526	SH5669061413	1.7	0
527	SH5667261414	1.1	0
528	SH5665961424	1.3	0
529	SH5665861444	2.3	0
530	SH5661561460	2.4	0
531	SH5660161468	2.1	0
532	SH5659661482	4.2	0
533	SH5657761485	5.0	0
534	SH5655761503	2.5	0
535	SH5653861527	2.1	0
536	SH5653561539	1.4	0
538	SH5652161556	2.3	0
539	SH5649961577	1.6	0
540	SH5649161597	3.3	0
541	SH5647561608	1.5	0
542	SH5646061631	2.3	0
543	SH5644661641	1.1	0
544	SH5642761659	2.2	0
545	SH5641261680	5.3	0
546	SH5639461696	4.5	0
547	SH5636561725	5.5	0
548	SH5632761758	4.2	0
549	SH5629961788	3.4	0
550	SH5628461813	2.3	0
551	SH5627461834	1.3	0
552	SH5626561854	2.2	0
553	SH5625261868	1.4	0
554	SH5624561896	2.4	0
555	SH5622961897	0.9	0
556	SH5622361924	1.6	0
557	SH5622361940	2.7	0

Waypoint	Landranger Grid reference	Water depth (m)	L. <i>natans</i>
558	SH5620061912	0.7	0
559	SH5619961932	0.9	0
560	SH5621161955	1.1	0
561	SH5622261982	2.4	0
562	SH5619362015	1.0	0
563	SH5619462014	0.9	0
564	SH5619362027	2.3	0
565	SH5617762045	1.7	0
566	SH5616762055	0.5	0
567	SH5616762061	2.2	0
568	SH5615662069	0.8	0
569	SH5615262072	2.6	0
570	SH5613862098	2.5	0
571	SH5612662113	2.0	0
572	SH5611662131	2.6	0
573	SH5609562159	3.0	0
574	SH5608662181	0.6	0
575	SH5608862200	2.9	0
576	SH5607562208	1.0	0
577	SH5607662223	2.5	0
578	SH5606062241	2.4	0
579	SH5603962245	0.7	0
580	SH5604662257	2.7	0
581	SH5603262268	0.7	0
582	SH5603562280	2.1	0
583	SH5602962296	0.9	0
584	SH5602962305	2.3	0
585	SH5601962328	1.5	0
586	SH5602162344	1.0	0
587	SH5601362360	1.0	0
588	SH5602462361	1.9	0
589	SH5604162363	1.0	0
590	SH5604562356	2.7	0
591	SH5606262343	1.7	0
592	SH5607662329	2.6	0
593	SH5609262316	1.9	0
594	SH5609662314	2.1	0
595	SH5609762315	2.7	0
596	SH5610562300	1.7	0
597	SH5612762281	2.3	0
598	SH5614062276	1.1	0
599	SH5616762251	1.1	0
600	SH5617062247	2.7	0
601	SH5618562228	0.7	0
602	SH5618462218	2.8	0
603	SH5621662199	1.6	0
604	SH5622462200	1.8	0
605	SH5625862169	1.9	0
606	SH5632162129	1.3	0
607	SH5634062098	1.0	0

Waypoint	Landranger Grid reference	Water depth (m)	L. <i>natans</i>
608	SH5633862091	2.1	0
609	SH5637562073	2.1	0
610	SH5640762072	0.8	0
611	SH5640162060	2.0	0
612	SH5643262061	1.4	0
613	SH5646162050	1.1	0
614	SH5645262045	1.9	0
615	SH5649662019	1.7	0
616	SH5650762024	1.3	0
617	SH5655561991	1.0	0
618	SH5657261973	0.9	0
619	SH5654161966	1.6	0
620	SH5656061946	1.4	0
621	SH5658261951	1.0	0
622	SH5658161919	1.0	0
623	SH5658461878	1.0	0
624	SH5661361873	1.4	0
625	SH5665261851	4.6	0
626	SH5669761828	1.6	0
627	SH5673961796	2.3	0
628	SH5679461767	3.5	0
629	SH5686161718	2.2	0
630	SH5691561679	1.8	0
631	SH5695461654	3.3	0
632	SH5699561627	2.2	0
633	SH5704661593	1.3	0
634	SH5704561591	2.8	0
635	SH5710161566	1.2	0
636	SH5716861536	2.0	0
637	SH5725461500	2.2	0
638	SH5731061473	1.9	0
639	SH5730861469	3.4	0
640	SH5736561437	1.1	0
641	SH5739861398	1.3	0
642	SH5745261382	1.6	0
643	SH5750061371	0.7	0
644	SH5750161372	1.6	0
645	SH5749561365	2.4	0
646	SH5755161341	1.1	0
647	SH5754661335	2.8	0
648	SH5760561313	1.1	0
649	SH5765561263	2.1	0
650	SH5772461164	0.7	0
651	SH5771661171	1.1	0
652	SH5771261170	2.4	0
653	SH5772661127	1.3	0
654	SH5773961088	1.4	0
655	SH5779661030	0.8	0
656	SH5779361029	1.4	0
657	SH5778761028	2.3	0

Waypoint	Landranger Grid reference	Water depth (m)	L. <i>natans</i>
658	SH5781260986	1.5	0
659	SH5785660936	1.6	0
660	SH5790860896	1.5	0
661	SH5796260867	2.0	0
662	SH5802260825	1.5	0
663	SH5805660801	1.0	0
664	SH5810660771	1.6	0
665	SH5816460745	1.8	0
666	SH5821860711	1.7	0
667	SH5826360679	1.0	0
668	SH5825560633	1.2	0
669	SH5827260585	1.8	0
670	SH5829560566	1.0	0
671	SH5830760561	0.5	0
672	SH5831660561	1.2	0
673	SH5833360558	1.1	0
674	SH5834560552	1.3	0
675	SH5835260547	0.9	0
676	SH5835560537	1.1	0
677	SH5834560533	1.2	0
678	SH5833960542	1.1	0
679	SH5833260550	1.3	0
680	SH5830960534	1.9	0
681	SH5831960514	1.4	0
682	SH5832260504	1.3	0
683	SH5832560483	1.8	0
684	SH5832660476	0.5	0
685	SH5832360468	1.4	0
686	SH5832560442	2.0	0
687	SH5834260427	1.3	0
688	SH5836060415	1.8	0
689	SH5836360399	0.8	0
690	SH5836960382	1.7	0
691	SH5837660371	1.4	0
692	SH5839160355	1.6	0
693	SH5840660336	1.4	0
694	SH5841660311	1.7	0
695	SH5840260307	1.0	0
696	SH5839260303	0.6	0
697	SH5837560309	1.8	0
698	SH5835860299	1.4	0
699	SH5834160289	0.8	0
700	SH5832460284	1.8	0
701	SH5833260271	1.6	0
703	SH5832360268	1.1	1
704	SH5831460265	0.8	1

Table 2 Survey points and presence of *Lurionium natans* in Llyn Cwellyn

Waypoint	Landranger Grid reference	Water depth (m)	<i>L.</i> <i>natans</i>
705	SH5641954259	0.6	0
706	SH5641554273	1.0	1
707	SH5641854277	2.4	1
708	SH5641554289	2.7	0
709	SH5643654289	3.1	0
710	SH5645054274	1.4	0
711	SH5645454271	0.7	0
712	SH5646554287	0.8	0
713	SH5645654311	2.0	0
714	SH5645954324	2.7	0
715	SH5646854338	3.0	0
716	SH5647854335	2.0	0
717	SH5648954331	0.8	0
718	SH5649654327	0.6	0
719	SH5650354338	1.7	0
720	SH5650254344	3.4	0
721	SH5652854348	2.4	0
722	SH5655854347	0.7	0
723	SH5655854362	1.5	0
724	SH5656554368	2.6	0
725	SH5657854381	2.7	0
726	SH5657954371	1.5	0
727	SH5659054370	0.7	0
728	SH5659854376	0.7	0
729	SH5659554388	1.8	0
730	SH5660254388	2.7	0
731	SH5660854396	3.4	1
732	SH5664554409	3.4	0
733	SH5664454404	2.6	0
734	SH5665454401	1.0	0
735	SH5666354399	7.0	0
736	SH5667154406	1.4	0
737	SH5666954418	2.1	0
738	SH5666554428	3.1	0
739	SH5667754445	3.6	0
740	SH5669254446	2.5	0
741	SH5669554439	1.6	0
742	SH5671654443	1.0	0
743	SH5672154457	0.7	0
744	SH5671854461	2.3	0
745	SH5671054470	3.3	0
746	SH5671054484	3.4	0
747	SH5673054489	2.0	0
748	SH5673654508	0.8	0
749	SH5672454517	2.0	0
750	SH5670954527	2.9	0
751	SH5669054533	3.4	0

Waypoint	Landranger Grid reference	Water depth (m)	<i>L.</i> <i>natans</i>
752	SH5671154567	1.9	0
753	SH5670954575	1.0	0
754	SH5670554590	2.4	0
755	SH5668954604	2.0	0
756	SH5668854621	1.9	1
757	SH5669054626	1.6	1
758	SH5668854631	1.3	1
759	SH5667554632	3.6	1
760	SH5666754645	1.9	0
761	SH5665554656	1.9	1
762	SH5665054664	2.3	0
763	SH5665254668	1.6	1
764	SH5664954673	2.0	0
765	SH5664754692	1.3	0
766	SH5664654700	1.3	1
767	SH5665054715	0.8	0
768	SH5662354720	1.9	1
769	SH5661054733	3.7	0
770	SH5661254738	2.0	1
771	SH5660854755	1.3	0
772	SH5659854761	2.0	0
773	SH5658754772	1.3	0
774	SH5658254775	2.0	1
775	SH5655354792	1.7	0
776	SH5652854798	2.6	0
777	SH5650554847	1.9	0
778	SH5648854848	2.1	0
779	SH5645954856	2.6	0
780	SH5645454857	3.4	0
781	SH5645954876	2.3	0
782	SH5646754898	2.2	0
783	SH5646454908	1.9	1
784	SH5645754918	1.8	1
785	SH5644954921	2.0	1
786	SH5643954927	1.9	1
787	SH5643154932	2.1	1
788	SH5642454934	2.3	0
789	SH5641954950	2.1	1
790	SH5641354955	1.9	0
791	SH5640754967	2.0	1
792	SH5639654975	2.0	1
793	SH5638954993	1.6	1
794	SH5637955008	1.7	1
795	SH5636955008	1.8	1
796	SH5636455006	2.0	1
797	SH5635555018	1.1	0
798	SH5634055015	2.2	0

Waypoint	Landranger Grid reference	Water depth (m)	L. natans
799	SH5633855018	1.3	1
800	SH5631755018	1.4	0
801	SH5629755027	1.0	0
802	SH5625255052	2.4	0
803	SH5625055056	1.0	0
804	SH5624555056	1.5	0
805	SH5623355072	3.0	0
806	SH5623355080	1.3	0
807	SH5622855091	2.8	1
808	SH5621655097	3.3	0
809	SH5621955102	2.2	0
810	SH5621955113	0.9	0
811	SH5620955115	2.4	0
812	SH5620155120	3.2	0
813	SH5619155133	2.9	0
814	SH5618155142	1.8	0
815	SH5616755159	0.9	0
816	SH5615055168	1.3	0
817	SH5613755180	1.8	0
818	SH5613655174	3.2	0
819	SH5611755185	3.4	0
820	SH5612055189	1.6	0
821	SH5610155223	0.8	0
822	SH5609155225	2.3	0
823	SH5607655234	3.4	0
824	SH5606555250	2.5	0
825	SH5605555276	1.5	0
826	SH5603455291	1.0	0
827	SH5601955284	1.9	0
828	SH5599555285	3.5	0
829	SH5598255298	3.3	0
830	SH5598455306	1.0	0
831	SH5595955312	1.3	0
832	SH5595255318	3.4	0
833	SH5594355324	2.5	1
834	SH5593955326	1.9	1
835	SH5592655330	3.2	0
836	SH5592655336	1.8	0
837	SH5592655339	2.8	0
838	SH5591055345	2.5	0
839	SH5589155359	3.3	0
840	SH5588255362	1.9	0
841	SH5586455378	0.8	0
842	SH5584255388	2.5	0
843	SH5583255398	1.4	0
844	SH5581155395	3.2	0
845	SH5581155401	0.9	0
846	SH5580255400	2.0	0
847	SH5578055406	3.7	0
848	SH5578155411	1.8	0

Waypoint	Landranger Grid reference	Water depth (m)	L. natans
849	SH5577055417	0.8	0
850	SH5575255418	2.2	0
851	SH5573855422	3.0	0
852	SH5572755433	2.1	0
853	SH5571155445	1.0	0
854	SH5569355448	3.4	0
855	SH5567355460	2.0	0
856	SH5565055466	1.0	0
857	SH5562055472	2.1	0
858	SH5561055481	4.5	0
859	SH5559755486	2.9	0
860	SH5559255496	0.8	0
861	SH5558555494	0.2	0
862	SH5557255499	3.4	0
863	SH5555855507	2.3	0
864	SH5554355514	1.0	0
865	SH5553255507	2.1	0
866	SH5551955511	3.6	0
867	SH5550055517	2.2	0
868	SH5548555540	1.8	0
869	SH5546655552	1.3	0
870	SH5545455577	0.6	0
871	SH5543355581	1.3	0
872	SH5542655584	1.1	0
873	SH5541155579	1.7	0
874	SH5539555575	2.4	0
875	SH5538555575	1.9	0
876	SH5537055596	1.8	0
877	SH5535955593	1.9	0
878	SH5534155599	1.1	0
879	SH5532755582	2.5	0
880	SH5531155575	2.4	0
881	SH5529155573	2.1	0
882	SH5526855562	2.4	0
883	SH5524755553	3.0	0
884	SH5522455548	1.6	0
885	SH5522855533	2.6	0
886	SH5521755517	2.8	0
887	SH5521355517	1.8	0
888	SH5521355498	3.6	0
889	SH5519855482	1.3	0
890	SH5520055476	2.7	0
891	SH5521155458	2.6	0
892	SH5522555436	1.6	0
893	SH5524455420	3.1	0
894	SH5525255400	1.9	0
895	SH5526155377	1.0	0
896	SH5526555352	1.5	0
897	SH5526555320	0.8	0
898	SH5527255318	3.4	0

Waypoint	Landranger Grid reference	Water depth (m)	L. natans
899	SH5529655297	1.5	0
900	SH5530155285	2.5	0
901	SH5529155276	1.8	0
902	SH5529755242	2.2	0
903	SH5533055214	2.0	0
904	SH5533555202	1.0	0
905	SH5533555177	1.5	0
906	SH5536855158	2.7	0
907	SH5538455150	1.9	0
908	SH5539155145	1.9	0
909	SH5540055140	1.4	0
910	SH5541055141	1.5	0
911	SH5542955125	1.3	0
912	SH5546455100	1.4	0
913	SH5548155099	2.8	0
914	SH5548455087	1.6	0
915	SH5549755073	1.9	0
916	SH5550755074	2.8	0
917	SH5552155050	2.2	0
918	SH5552455038	2.0	0
919	SH5552855026	0.9	0
920	SH5553855026	2.8	0
921	SH5556755002	3.5	0
922	SH5557554996	1.4	0
923	SH5559454986	3.6	0
924	SH5559854976	1.5	0
925	SH5561054964	1.0	0
926	SH5562854950	2.2	0
927	SH5564054931	1.7	0
928	SH5564654915	0.9	0
929	SH5566354907	3.6	0
930	SH5568554890	1.9	0
931	SH5570054886	1.0	0
932	SH5571154881	3.3	0
933	SH5572854867	1.6	0
934	SH5574254850	0.9	0
935	SH5576554835	3.5	0
936	SH5579354806	2.1	0
937	SH5580154793	1.0	0
938	SH5582454778	3.3	0
939	SH5583854761	2.1	0
940	SH5585254748	1.0	0
941	SH5587254733	3.4	0
942	SH5589454709	1.0	0
943	SH5591854692	3.4	0
944	SH5593254679	1.7	0
945	SH5596054651	1.0	0
946	SH5596854643	3.3	0
947	SH5598054615	1.6	0
948	SH5599754595	3.3	0

Waypoint	Landranger Grid reference	Water depth (m)	L. natans
949	SH5601254569	1.6	0
950	SH5602354555	0.9	0
951	SH5604654540	3.8	0
952	SH5606454528	2.3	0
953	SH5608954502	1.0	0
954	SH5612154487	3.6	0
955	SH5613054480	1.8	0
956	SH5615054458	1.1	0
957	SH5617854439	2.8	0
958	SH5619054427	1.7	0
959	SH5621354411	0.9	0
960	SH5623654402	3.1	0
961	SH5625254388	2.2	0
962	SH5625654384	2.0	1
963	SH5626154384	2.8	1
964	SH5625954372	1.7	0
965	SH5627254372	2.9	1
966	SH5628254362	2.6	1
967	SH5628654354	1.0	0
968	SH5628654354	2.0	1
969	SH5630154345	2.0	0
970	SH5630854342	2.5	1
971	SH5631854334	2.1	1
972	SH5632654327	1.4	0
973	SH5633254324	1.6	1
974	SH5634454324	2.9	1
975	SH5634854317	2.0	1
976	SH5635254310	1.1	1
977	SH5635654319	2.3	1
978	SH5636854300	1.3	1
979	SH5637054292	1.3	1
980	SH5638254299	1.7	1
981	SH5639054302	2.5	1
982	SH5640254288	1.9	1
983	SH5641154286	2.3	1
984	SH5641054271	0.9	1