Aquilina Environmental Quality

New Forest Fairy Shrimp (*Chirocephalus diaphanus*) Survey Report

Higher Level Stewardship Agreement
The Verderers of the New Forest
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Fairy shrimp *Chirocephalus diaphanus*

Robert Aquilina MSc MIEEM is an independent consulting ecologist specialising in freshwater ecology. He is a Full member of the Institute of Ecology and Environmental Management and abides by their Code of Professional Conduct. For further details see

www.ieem.net
www.aquilina-environmental.co.uk

Table of contents

Summary

Surveys for Fairy Shrimp (*Chirocephalus diaphanus*) were carried out at known historical locations across the New Forest HLS agreement area using two methodologies. The purpose was to assess the locations for the presence of Fairy shrimp and offer management recommendations to ensure their continued survival.

The two methods used were collection of dry soil samples with *ex situ* hatching in aquaria which identifies the presence of eggs and a follow up visit in November/December 2013 to search for adults using visual observation and netting.

Fairy shrimp were hatched from 9 of the 28 locations sampled. They were observed from 6 of the 34 locations visited in Winter 2013/14 when some additional nearby sites were revealed to hold water.

Tadpole shrimp, *Triops cancriformis,* were successfully hatched from three locations, although none were found during the field visits.

Introduction

Fairy shrimp (*Chirocephalus diaphanus*) are rare freshwater crustaceans that have highly specialised environmental requirements.

The purpose of this project is to identify and survey the known locations within the New Forest HLS agreement area for the presence of Fairy shrimp and offer management recommendations for each site. The project consists of a number of phases which are outlined below.

1. Data gathering
2. Site surveys – dry
3. Ex situ hatching
4. Site surveys – wet
5. Reporting

Data was requested from HBIC who provided a spreadsheet and map of locations with records for Fairy shrimp from 1985 onwards. These sites were then visited by Robert Aquilina at the end of July and beginning of August when the ponds were dry. The weather conditions were sunny and warm and therefore suitable for the surveys. Soil samples were collected and processed according to the agreed method statement. The samples were dried and then wetted in aquaria and observed for a minimum of 6 weeks. Counts of hatched Fairy shrimp recorded.

A further visit to each pond location took place in November or December 2013 when the ponds where surveyed by visual observation and netting.

Methodologies are discussed below with results and management recommendations made.

Natural history

Fairy shrimp are widespread but highly localised across England, with a major population centre in the New Forest. They inhabit temporary ponds which dry over the summer. This requirement means that their distribution is limited to an area where evaporation exceeds precipitation between April and September. They appear insensitive to geology as they occur on acid sands and gravels, neutral loams and calcareous soils where they occur across the country.

They do appear to require a summer dry period which both removes predators from their ponds as well as satisfying a requirement for the eggs to dry before they can hatch (diapause). This hydroperiod allows Fairy shrimp to hatch from eggs, grow to adulthood and reproduce over a period of as short as six weeks. They lay eggs which then survive the dry period in the soil at the bottom of the pond. When wetted again by Autumn or Winter rains they hatch and the cycle begins again. The eggs possess differential wetting requirements to overcome the variability in water levels due to

variations in weather, some will hatch on first wetting, others will require a period of wetting followed by drying and then further rewetting before hatching and yet others will require the cycle to be repeated a third time or possibly more. This ensures that they survive the vagaries of hydroperiod in years with little rain.

Fairy shrimp are particularly vulnerable to predation by a wide range of animals from other crustaceans such as Freshwater shrimp, *Gammarus*, and even Ostracods in their early stages, most predatory insects such as Diving beetle larvae, *Dytiscidae*, dragonfly larvae, fish, amphibians and waterfowl. Few of these occur in seasonal ponds because they have a development life cycle that requires water for longer than is usually present. Thus Fairy shrimp avoid predation by using habitats that are generally unsuitable for predators and completing their life cycle in a shorter period than most of their predators. They are suspension feeders and can complete their life cycle in as little as six weeks.

They also appear to require regular disturbance by livestock, ploughing or vehicles which create bare soil on which eggs are laid preferentially. Having said that, they can occur in quite well vegetated ponds although there is usually a period when this vegetation dies back to expose the substrate. This disturbance and preference for bare soil may also be associated with dispersal of eggs during the dry phase, where they are believed to be transported attached to soil by wind, grazing animals, vehicles and waterfowl (Friday (1996)).

Because of widespread habitat loss and these specific environmental requirements Fairy shrimp are listed as Red Data Book Vulnerable species and protected under Schedule 5, Section 9 of the Wildlife and Countryside Act 1981 (as amended), which makes it illegal to kill, take or sell specimens except under licence. All the work carried out here described below was under Natural England licence 20131076 Fairy shrimp (*Chirocephalus diaphanus*) and 20131348 Tadpole shrimp (*Triops cancriformis*).

Historical records

A data search for Fairy shrimp records within the bounds of the New Forest was performed by HBIC (Hampshire Biodiversity Information Centre). Naomi Ewald of Pond Conservation kindly provided all her records as well. The search yielded 31 ponds with confirmed records since 1985. However some of these are outside the HLS agreement area of the New Forest and were therefore ignored. This left 22 locations within or very close to the Keepers bounds.

Denise Eccles of the Forestry Commission undertook to produce Constraints maps of the supplied locations and with her help the potential locations were identified from aerial photographs. Aerial photographs of each area were inspected for features that stood out as either darker patches against the background or as different apparent vegetation types against the surroundings.

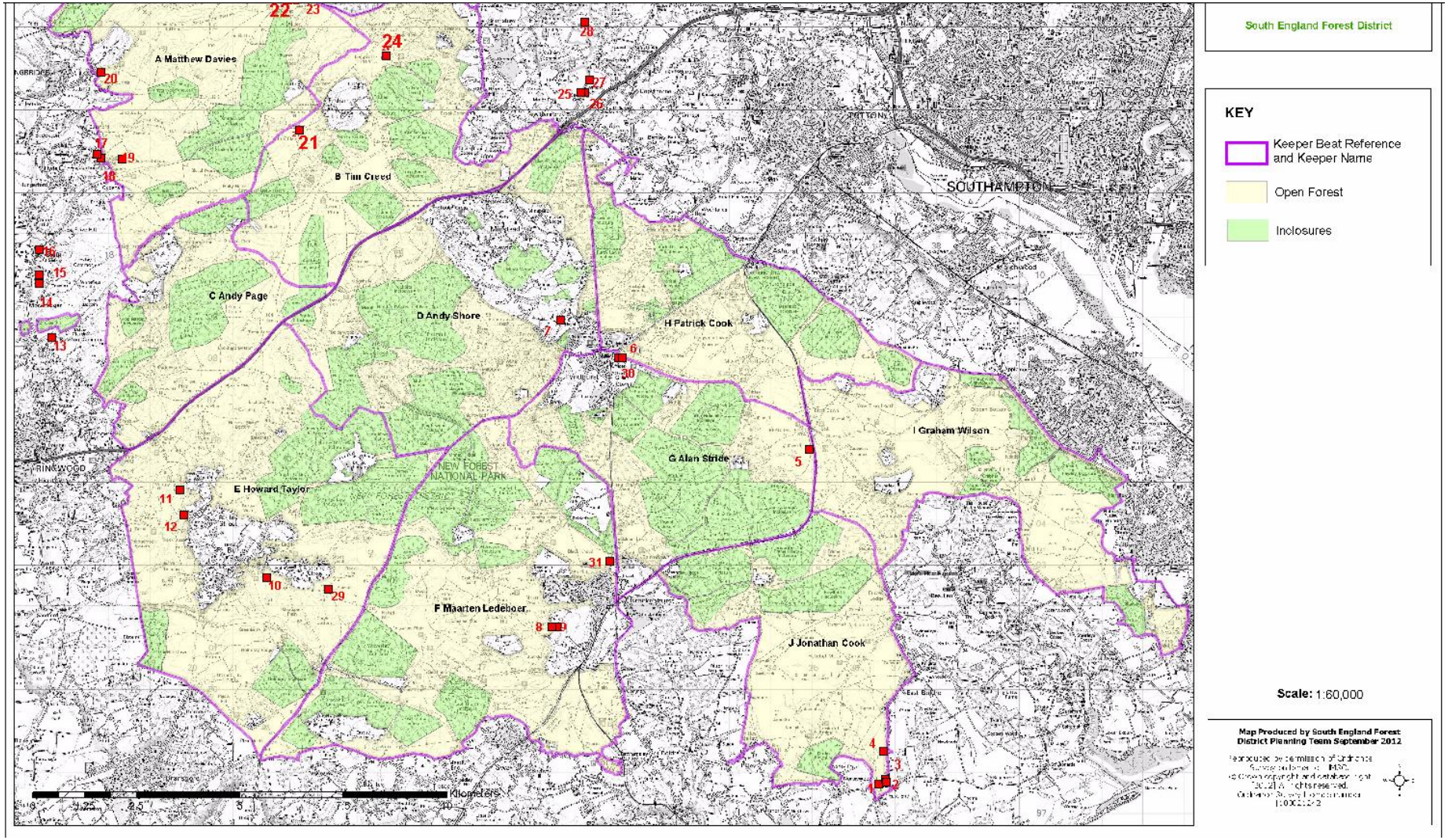
This resulted in a number of additional locations to be identified when the supplied grid reference did not match any feature on the aerial photograph that appeared to be a pond. Both summer and winter photographs were examined in order to attempt to correlate the six figure grid reference with a feature on the ground. In some cases this proved impossible and a number of nearby features were identified as potential candidates for the reference. As a result a total of 28 locations were identified to survey during the dry phase.

Locations

The 22 locations (based on 6 figure grid references) are mapped below. The 28 locations (identified as potential sites from aerial photographs) are listed in the table that follows.

The grid references are taken from a hand held Garmin GPS 60 for the purposes of relocating the features in the field on any subsequent visits and are only accurate to within 5 to 10 metres.

A major problem with working from six-figure grid references in attempting to locate transient features such as these seasonal ponds is that each location represents an area of 100 x 100 metres on the ground which must be searched for potential ponds. As became obvious during the winter (wet phase) surveys, some ponds had been missed as they were only apparent on the ground when filled with water, the aerial photographs having not indicated their presence. Consequently a number of new locations were added during the winter visits which are marked in the results table by an asterisk.



Map 1. Location map of ponds with post 1985 records with Keepers beats highlighted.

Pond #	GPS	Name or Location	Description and comments
1a		3 ponds east of Gravel Pit pond	Shallow pond over gravel with *Crassula* (?)
1b		3 ponds east of Gravel Pit pond	Shallow pond over gravel with Coral necklace (*Illecebrum verticillatum* – a rare RDB Vulnerable plant).
1c		3 ponds east of Gravel Pit pond	Shallow pond over gravel with Coral necklace (*Illecebrum verticillatum* – a rare RDB Vulnerable plant).
2		East End pond in angle of road at junction	Dominated by *Crassula* but also Hampshire purslane (*Ludwigia palustris)*. Poaching.
3a		East End small pond 10 m west of road	Dominated by *Crassula* (but treated with glyphosate by field visit in November and therefore bare of vegetation). Poaching.
3b		East End small pond at field corner	Depression on track. Poaching.
3c		East End top of drainage ditch by field corner	Depression on track. Poaching.
4a		East End small pond west of road opp track to Broomhill Farm	Well vegetated roadside pond reportedly with Yellow Centaury (*Cicendia filiformis* – a very local plant).Poaching.
4b		East End larger roadside pond opp Broomhill Farm	Well vegetated roadside pond reportedly with Yellow Centaury (*Cicendia filiformis* – a very local plant).Poaching.
5		Pond by path S of Beaulieu Road Station. Grassy depression in dry heather to west of track before wet bottom.	Small peaty depression with grass. Similar were found beyond the rail crossing track during field visit in November.
6/30		Appletree Court / Bolton's Bench. Neither pond clearly located. Depression in grassy triangle to north of road.	Open area of closely grazed lawn was sampled but pond locations unclear.
7		Emery Down on road margin just north of field entrance.	Bramble encroaching, reported as toad breeding pond.

8		South Weirs close to track	Scrub on the south side shading pond. Heavily vegetated with Water Pepper (*Persicaria hydropiper*) but reportedly with Small Fleabane (*Pulicaria vulgaris* – a rare RDB plant now confined to the New Forest).
10		Cot Bottom Golf course N of road	Shaded by mature trees and scrub. Waterfowl present.
11		Vereley Hill	Scrub and trees on the west side
12		Little Castle Common	Surrounded by Gorse and scrub.
17		pair of ponds by Abbey Well car park barrier	Rather disturbed by dog walkers exiting car park.
18		Abbots Well very shallow ponds in gravel area	North of *Crassula* blue dye experimental pond.
20a		Godshill	Large pond
20b		Godshill , depression in Gorse by houses	Almost surrounded by Gorse and scrub.
21a		tiny pond adj Green pond	Bare soil but tiny
21b		pond n of gravel track by Green Pond	Peaty depression in heather
22		Bramshaw Telegraph adj B3078, 2 ponds merge at high water levels.	Roadside ponds
23		Hope Cottage pond	Beside entrance track
24		adj Longcross Pond	Largest of a series of shallow depressions to the west of Longcross Pond
29a		Clayhill	Small bare depression
29b		Clayhill	Trackside pond with scrub and trees on the south end.
31		Leechy pond, Brockenhurst	Large permanently wet boggy area which appears unsuitable for Fairy shrimp. Samples were collected from an adjacent temporary pond which appeared more suitable, although small.

Table 1. Historical locations of Fairy shrimp ponds within HLS area.

NB LOCATION DATA IS SENSITIVE AND PROTECTED BY DATA PROTECTION POLICIES

Methods

Ex situ egg hatch

The sites were visited between 23rd July and 6th August 2013 and soil samples from each of the 28 features collected. Each subsample was of approximately 10 cm^3 collected using a cylinder corer and trowel from the dry base of the pond and repeated up to 10 times and the subsamples combined. Each sample was spread out over the base of a white polypropylene tray (30x42x8cms) and allowed to dry thoroughly for 2 weeks (this drying is thought to be a requirement for breaking the diapause and allowing the eggs to hatch).

Each of the samples were then mixed thoroughly and a subsample of approximately one third placed in a plastic aquarium (20x20x34cms) and 10 litres of rain water added. The aquaria were inoculated daily with a dilute fish fry food to encourage the growth of any microorganisms present which would serve as food for any hatching Fairy shrimp. Once signs of life are spotted in the tanks (usually Cladocera or Ostracoda are the first visible signs), food supply is increased. Aquaria were examined twice daily to search for the presence of Fairy shrimp, which were counted when seen.

The aquaria were maintained under natural light and temperature regime for a period of six weeks. The aquaria were inspected daily. At the end of the period, the aquaria were drained down (through a plankton net to capture any larger microorganisms) and the substrate allowed to dry in situ for 2 weeks. They were then rewetted and observed as before. The microorganisms from each tank were inspected under the microscope for hatchling Fairy shrimp and other crustacea.

Field survey

The sites were visited between 6th and 14th November 2013 in order to sample ponds for any Fairy shrimp that had hatched during the onset of Autumn rains. These ponds were visually inspected for Fairy Shrimp and then netted using both a plankton net and a pond net.

Mature adult Fairy shrimp are relatively visible in clear water, however the netting was carried out in case juveniles were present which are less easily observed.

An appropriate date for such a visit is difficult to predict as it depends on local weather (the ponds must have been filled for at least two weeks). A follow-up visit on 12th December 2013 found three out of four ponds near Burley dry just a month after they were apparently full. Ideally a series of visits would be carried out over Winter and Spring which would catch ponds at the appropriate moment within the

wet phase. Therefore the schedule for the project which was due to finish at the end of December 2013 was extended to the end of February which allowed further visits in January and February 2014.

Results

There are no published data or methods for estimating population levels of freshwater Crustacea from egg hatching data or field surveys as far as a literature search showed. Therefore the estimates were derived as follows :-

Fairy shrimp count	Population estimate
1-3	Low
4-8	Medium
>8	High

Table 2. Population estimates based on abundance

In order to account for sample size bias the area of the pond was used as a weighting factor, as in the following table :-

Pond area (m^2)	Weighting factor
< 50	X 1 (no weighting)
50 -300	X 2
>300	X 4

Table 3 Weighting factor for pond size

This is required to take into account the proportion of the pond that has been sampled. Although subsamples were spread out over the whole of the pond area and suitable bare patches selected preferentially, a larger pond should potentially hold a greater population than a smaller pond given the same number of eggs hatch from each. Therefore, the weighting factor is applied to the Fairy shrimp count accordingly.

Ex situ egg hatch

Pond #	pH	Conductivity	Pond area (m^2)	Number of days until hatch	Number of Fairy shrimp	Population estimate
1a	6.0	220	52			
1b	5.7	280	63			
1c	6.5	340	166	13	1	Low
2	5.6	250	532			
3a	6.2	230	92			
3b	5.9	140	38			
3c	6.6	160	45			
4a	6.4	230	41	9	1	Low
4b	5.9	160	112			
5	4.3	60	15			
6/30	6.6	140				
7	6.4	200	16			
8	6.4	210	108	6	9	High
10	6.4	360	768	7	9	High
11	6.1	260	269	7	4	Medium
12	5.7	200	219	16	1	Low
17	6.9	240	82	6	3	Medium
18	6.5	170	16			
20a	6.5	220	640	3	1	Medium
20b	6.2	530	23			
21a	5.5	50	6			
21b	5.4	70	179			
22	5.8	340	27			
23	6.3	140	100	4	2	Medium
24	5.6	110	287			
29a	6.6	220	6			
29b	6.3	170	158			
31	5.6	60	21			

Table4. Results of ex situ egg hatch with population estimates for successful ponds.

Positive hatching results were found across the whole range of conductivities with the exception of the very lowest (150 □S upwards). Similarly successful egg hatch was associated with more neutral pH (6-7) with one exception at 5.5. This suggests that Fairy shrimp will not be expected to be present in peaty bogs and mires but would be likely to turn up in neutral or slightly acid sandy or gravelly ponds or those on a mineral substrate, even if vegetated.

Field survey

The field survey consisted of a slow circumnavigation of the pond searching for adult Fairy shrimp swimming in open water usually near to vegetation. Once an adult had been spotted a timed count was then begun (5 minutes) and this was used as the basis of the population estimate using the same criteria as in Table 2. No account of pond size was made.

If no adults were seen, then the pond was netted, first with a plankton net in open water and then with a pond net in vegetation. The plankton net samples were examined in the laboratory under a microscope for juvenile Fairy shrimp, but none were found. The pond net samples were emptied into a white tray in situ and examined by eye, again no Fairy shrimp were found.

Suitable conditions for the field visits were lack of rain and wind as these disturb the water surface making visual inspection difficult. Therefore all the field visits took place on dry days with little wind.

Pond #	Date of visit	Status	Population estimate
1a	13.11.13		none
1b	13.11.13		none
1c	13.11.13		none
	8.1.14		none
2	13.11.13		none
3a	13.11.13		none
3b	13.11.13		none
3c	13.11.13		none
4a	13.11.13		none
4b	13.11.13		none
5	13.11.13		none
6/30	7.11.13		none
6/30	17.1.14		none
6/30	28.1.14		none
6/30	7.2.14		None
7	7.11.13		none
7	13.11.13		none
7	28.1.14		none
8	7.11.13		none
8	12.12.13		none
8	8.1.14		none
10	6.11.13		none
10	19.12.13		present
10	28.1.14		none
10	7.2.14		none
10*	12.12.13		none
10*	7.2.14		none
11	6.11.13		Medium
11	19.12.13		present
12	6.11.13		none
12	12.12.13		none
12	28.1.14		none
12	7.2.14		none
12a*	6.11.13		Medium
17	4.10.13		present
17	10.11.13		Low
18	10.11.13		none
19	10.11.13		none
20a	10.11.13		High
20a	24.11.13		present
20b	10.11.13		none
21a	14.11.13		none
21b	14.11.13		none
21c*	14.11.13		none

22	14.11.13		none
22	24.11.13		present
22	11.1.14		Medium
22a*	14.11.13		none
22b*	14.11.13		none
22b*	11.1.14		none
23	14.11.13		none
23	11.1.14		none
23	7.2.14		none
23a	14.11.13		none
23a	11.1.14		none
23a	7.2.14		none
24	14.11.13		none
24	11.1.14		none
24a	7.2.14		none
29a	6.11.13		none
29a	12.12.13		none
29b	6.11.13		none
29b	12.12.13		none
	28.1.14		none
31	7.11.13		none

Table 5. Results of field survey with population estimates (ponds not sampled for ex situ egg hatch are marked in red, ponds not identified from aerial photographs are marked with an asterisk).

Conclusions

Fairy shrimp

Nine of the twenty-eight locations successfully hatched Fairy shrimp, one of which had not been recorded since 1987 (pond 8 at South Weirs). Some of the recently recorded locations have failed to produce.

Six of the thirty-four ponds visited held adult Fairy shrimp, of which one was a location not sampled for the ex situ egg hatch in the summer (pond 12a Little Castle Common). The timing of the visits during November was a little early as some ponds held little or no water. Repeat visits in December were less successful as the intervening period was almost completely dry and most of the ponds had reduced water levels or had dried up completely. Therefore further visits after a prolonged period of rain and allowing some weeks for development were carried out (late January through to February).

In total, Fairy shrimp were found in eleven ponds, with 4 ponds successfully hatching from soil samples as well as from field visits. These are tabled below.

Pond #	Location	Egg hatch	Field survey
1c	East End	Low	
4a	East End	Low	
8	South Weirs	High	
10	Cot Bottom	High	(Present)
11	Vereley	Medium	Medium
12	Little Castle Common	Low	
12a	Little Castle Common		Medium
17	Abbey Well	Medium	Low
20a	Godshill	Medium	High
22	Bramshill Telegraph		Medium
23	Hope Cottage	Medium	

Table 6. Successful sites for Fairy shrimp 2013 with population estimates.

Tadpole shrimp

Tadpole shrimp, *Triops cancriformis,* are freshwater crustaceans that have a similar natural history to Fairy shrimp. They are however much rarer with only two sites known from the whole country, New Forest and Solway Firth, Scotland. Within these sites, the New Forest has two known ponds and Solway Firth some 6, recently discovered and within a hundred metres of the original, now lost pond.

Although their life cycles are similar, Tadpole shrimp appear to be more demanding in terms of water chemistry than Fairy shrimp and are thus far more restricted in distribution.

The two historical sites within the New Forest are also known for Fairy shrimp and were therefore sampled as part of this project. They successfully hatched during the ex situ processing as well as a third, previously unrecorded, site.

Tadpole shrimp *Triops cancriformis*

Discussion

It is important to place these results in a context as both Fairy shrimp and Tadpole shrimp are unlike most target species for a survey. They exhibit large natural seasonal and annual variation in population numbers across different locations depending on a number of environmental factors but primarily upon the hydroperiod of the particular pond under investigation.

In any one year, only a subset of the viable populations are likely to hatch and breed successfully, both within an individual pond and across the site as a whole. This means that survey results from a single season are almost certain to be underestimates of the true population. This can be seen within these results here as a greater number of sites successfully yielded Fairy shrimp from the ex situ egg hatch than from the field visits.

The same problem extends to population estimates in that they will vary naturally over orders of magnitude within each pond over a number of seasons depending on how many eggs have successfully broken diapause in that particular pond in that particular season.

A review of recent historical records is useful. The table below gives records of positive Fairy shrimp sightings from field visits only.

Date	**1986-88**	**2007 and 2010**	**2011**	**2012**	**2013**
Positive records within HLS agreement area (figures in brackets for the whole New Forest).	11(16)	8(9)	7(8)	8(9)	7
Positive records within same pond from preceeding period		0	8	7	6

Table 7. Comparison of historical records.

This suggests a fairly constant number of ponds are observed with adult fairy shrimp over the whole Forest each year, although the actual ponds differ between years. Of course, this data is biased by the limited number of interested observers who probably return to the same locations so it is neither systematic nor random. However it illustrates the transient nature of the populations within each pond. An example is of the South Weirs pond which was last recorded to have Fairy shrimp in 1987 before this year's sightings. Undoubtedly they were present but unrecorded in the intervening years.

A similar caveat should be levelled at the population estimates in that there is inherent variability in the size of the population each year. Thus a High population

estimate does not equate to any level of certainty that the population will manage to persist, a better guide being consistency of sightings between years.

Furthermore, each population estimate must be regarded as highly provisional as there is no accepted methodology for such an estimate and there is clearly some discrepancy between egg hatch derived estimates and field derived observations.

Recommendations

The current management regime is the most likely to sustain the Fairy Shrimp if present because regular poaching by grazing animals does expose new bare soil and grazing keeps the vegetation suppressed.

It is important not to interfere with the hydroperiod of seasonal ponds by attempting to deepen them as this may lead to them becoming permanent and therefore unsuitable for Fairy Shrimp. Similarly no attempts to drain them should be allowed. A number of ponds have formed alongside roads and take drainage form the road surface. Although this is not ideal as this water can contain hydrocarbons and heavy metals, it is not recommended that these are altered in any way as this may lead to unsuitable changes to the hydroperiod. (ponds 4a, 4b, 7, 12a, 22b, 22c).

Scrub encroachment is a potential problem for seasonal ponds as it encourages water loss through additional transpiration. Although shade is not necessarily seen as a problem for Fairy shrimp, it does cause the pond to have a lower water temperature and therefore may increase development time for the Fairy shrimp. Additional leaf litter entering the pond can cover bare soil and make the habitat less suitable for egg laying. Scrub should be cut back from pond edges on affected ponds (ponds 8, 12) but this should be phased so as not to cause excessive change in one go. It is recommended that no more than 50 % scrub is removed in any one year. The most significant negative factor affecting seasonal ponds is the presence of *Crassula helmsii,* a non-native invasive species which, once introduced, tends to form a mat of vegetation which masks and excludes native plants. It is problematic to control and experiments are underway within the New Forest by Hampshire Wildlife Trust with dye to exclude it from a pond at Abbey Well. A number of ponds are badly affected (ponds 2, 3a, 17, 18), although control measures are in place for some.

The following table summarises management actions recommended.

Pond #	Location	Action	Comments
1a, 1b,1c	East End	Scrub removal has already taken place, ensure arisings are spread and not left in pond hollows. Check for Crassula	Rare plants present as well as Fairy shrimp. Good plant diversity which will be lost as Crassula spreads.
2	East End	Crassula control	
3a, 3b, 3c	East End	3a Crassula control in 3a (already in hand). 3b and 3c none required.	
4a, 4b	East End	Avoid ditching that alters pond hydroperiod or directs additional road runoff into ponds.	Pond very small and peaty, slightly better looking ponds further south by track over railway . Historic record may refer to wheel ruts on sandy track itself, now no longer extant.
5	Bealieu Road	None required	Very likely for Fairy shrimp but old record for Triops is likely to be a failed translocation.
6	Appletree Court	None required	
7	Emery Down	Overhanging hedge should be trimmed back ensuring that arisings are removed. Install posts to prevent parking to north of field entrance.	NB location is north of field entrance. Lower location is incorrect. May be outside HLS agreement area.
8	South Weirs	Scrub clearance around mature trees, ensuring that arisings are removed	Scrub clearance should be supervised by an ecologist or ranger after discussion.
10, 10a	Cot Bottom	None required	NB location is north of road. Ponds (10a) to south of road were negative. 10 is an unusual pond for Fairy shrimp as it is quite large and turbid with waterfowl and newts.
11	Vereley	Selected scrub removal from northern end of pond only, ensuring arisings are removed. No ditching or road drainage work to be allowed to flow into pond.	

12, 12a	Little Castle Common	12 Selected scrub removal, ensuring arisings are removed. 12a No ditching or road drainage work to be allowed to flow into pond.	
17	Abbey Well	Create new route for footpath to avoid ponds. Check for Crassula	Ponds are extremely shallow possibly as a result of car parking gravel surface being spread here. Some gentle excavation might be appropriate under ecologist supervision, after Crassula has been dealt with (disposal issues).
18	Abbey Well	Crassula control	
19	Windmill Hill	None required	Historic location not found. Presumably not the main pond as this is permanent. Wheel ruts are present on the track to the southeast which are the most likely location.
20	Godshill	None required	
21, 21b, 21c	Green Pool, Fritham Plain	None required	Historic location not found with certainty. Presumably not the main pond as this is permanent.
22,22a,22b	Bramshaw Telegraph	No ditching or road drainage work to be allowed to flow into pond.	
23, 23a	Hope Cottage	No ditching or road drainage work to be allowed to flow into pond.	
24	Longcross	None required	A number of adjacent ponds look suitable.
29a, 29b	Clayhill	None required	
31	Leachy Pond, Brockenhurst	None required	Historic location not found with certainty. Presumably not the large area of bog as this appears unsuitable.

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