FSC CASTLE HEAD AND LUCY'S POND

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During the winter of December 2015, extreme weather hit the northwest of Britain. A field by the FSC's Castle Head Field Centre was flooded, and the remaining water led to the formation of a new pond. These field notes report on the ecological quality of the new pond and provide a baseline for further studies.

POND FORMATION

Storm Desmond hit the UK from 4th-6th December 2015 with strong hydrological impact: extreme levels of rainfall resulted in major flooding events all over the UK. Cumbria was severely affected with new rainfall records for both 24-hour and 48-hour periods at Honister Pass (341.1 mm) and Thirlmere (405.0 mm), respectively (Burt *et al.*, 2016, Marsh *et al.*, 2016). These winter floods also impacted FSC Castle Head, located in southern Cumbria in the Lake District. The field adjacent to the centre was inundated with water in December 2015. Since this flooding event the water has neither evaporated nor infiltrated and has therefore created a new pond (Figure 1). A pond can be defined as "a body of water, of man-made or natural origin, between 1m^2 and 2 ha, which usually holds water for at least four months of the year" (Biggs *et al.*, 1998). The total size of the field is 3.7 ha; however, the water body normally covers an area of approximately 19,000 m^2 or 1.9 ha which falls under the definition of a pond.

FIGURE 1. Lucy's Pond; (left) aerial view of the pond formed after the 2015-2016 floods; (right): Ordnance Survey map of Castle Head grounds (within black circle) and surrounding areas. Source: created on https://www.ordnancesurvey.co.uk).

The field is owned by Castle Head Field Centre and managed by Mr Hamilton, owner of Low Meathop Farm, who uses it to graze livestock. The Pond is surrounded mainly by rural landscape, with Morecambe Bay located 1.2 km southeast of the Pond (Figure 1). The surrounding landscape also contains several other bodies of water including three other ponds, one lake, numerous ditches and one river (River Winster) which is over 4 m wide. This suggests that the study area is presently located within a wetland environment; however, historically this landscape varied greatly from that which is seen today. The fields adjacent to the Centre, including the Pond's location would have been part of Morecambe Bay prior to 1780. Around this time an industrialist named John Wilkinson built the house which is now Castle Head Field Centre and reclaimed the surrounding land, as well as channelling the river which is evident in Figure 1. This reclaimed land was previously farmed for potatoes which required well drained soils; however, in the last few years the fields have become wetter environments (Bond, *pers comm.* 12/3/18).

HYDROLOGY

The pond was assessed following the National Pond Survey methodology (Biggs *et al.*, 1998), which allowed for comparisons to previous national pond surveys to determine the overall ecological quality (Biggs *et al.*, 2005; Williams *et al.*, 2010). The winter floods of 2015/16 have created a pond of moderate ecological value. This partially supports the hypothesis that new ponds (<9 years old) would have high ecological value (Williams *et al.*, 2010). Overall, the physical properties of the pond, the variable large size and depths, allowed for a variety of mesohabitats in which a wider range of freshwater life could exploit. Water quality was deemed as good with the key parameters, pH and DO,

remaining within the range to support aquatic flora and fauna. Despite elevated levels of phosphate and nitrate, which normally decrease water quality, freshwater life was able to thrive. Plant species richness was low (Figure 2) but invertebrate species richness was high (see Tables 2-5) with reference to Biggs *et al*. (2005). The large number of birds recorded on the pond highlights its importance as a site which can support birds from Morecambe Bay and also birds of conservation concern (Table 1). It is anticipated that this study will be the start of a long-term monitoring project on the pond. This would develop our understanding of this environment and determine any needs for future management to maintain or improve this valued pond.

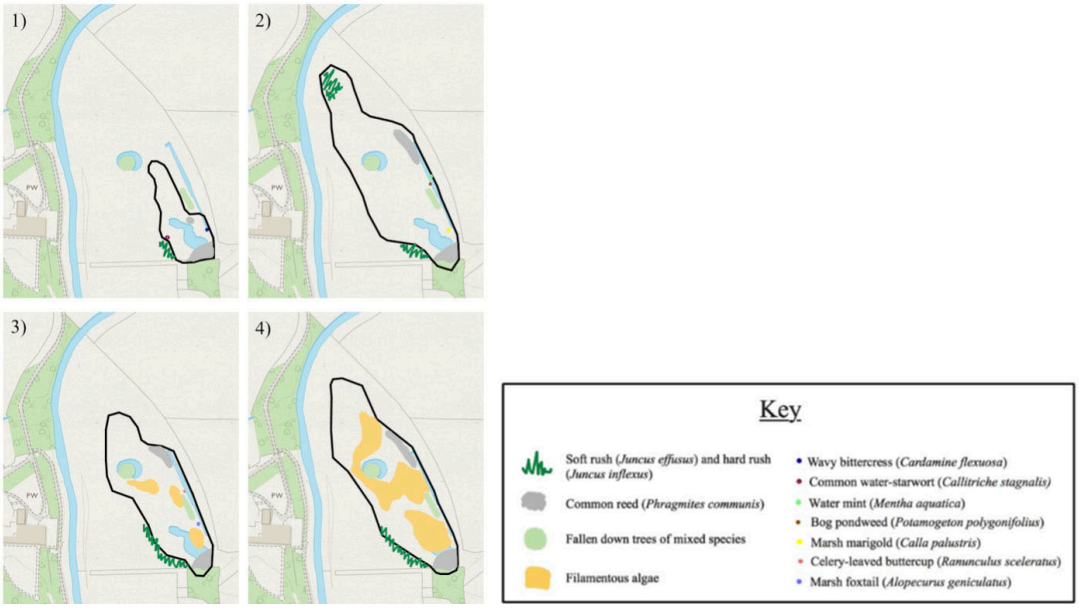

FIGURE 2. Plant species richness at Lucy's Pond, for surveys 1-4.

TABLE 1. Birds recorded on survey days at Lucy's Pond. Level of conservation concern (as Eaton *et al.*,2015), is indicated by: * Green list; * Amber list; * Red list.

	Number of individuals	Total for survey day	Species Richness
Survey 1 (16/2/18)			
Curlew (*Numenius arquata*) *	1	1	1
Survey 2 (5/4/18)			
Moorhen (*Gallinula chloropus*) *	2		
Coot (*Fulica atra*) *	10		
Mallard (*Anas platyrhynchos*) *	10	27	5
Shelduck (*Tadorna tadorna*) *	3		
Shoveler (*Anas clypeata*) *	2		
Survey 3 (31/5/18)			
Coot (*Fulica atra*) *	1		
Curlew (*Numenius arquata*) *	1		
Greylag goose (*Anser anser*) *	1		
Mallard (*Anas platyrhynchos*) *	11		
Mute Swan (*Cygnus olor*) *	5	29	10
Pied Wagtail (*Motacilla alba*) *	1		
Shelduck (*Tadorna tadorna*) *	4		
Swift (*Apus spus*) *	2		
Tufted duck (*Aythya fuligula*) *	1		
Wood pigeon (*Columba palumbus*) *	2		
Survey 4 (30/7/18)			
Black headed gull (*Chroicocephalus ridibundus*) *	1		
Grey heron (*Ardea cinerea*) *	2		
Little egret (*Egretta garzetta*) *	1	7	6
Mallard (*Anas platyrhynchos*) *	1		
Mute Swan (*Cygnus olor*) *	1		
Swallow (*Hirundo rustica*) *	1		

SPECIES LIST

TABLE 2. Survey 1 (16/2/18) of Lucy's Pond, species found and frequency.

Mesohabitat	Freshwater invertebrate	Scientific name	Number of individuals
Open water	Common/lesser water boatman	*Corixa punctata*	1
	Non-biting midge larvae	*Chironomidae* spp.	6
	Water fleas		130
	Swimming mayfly nymph	*Caenis horaria*	1
	Worm		1
Reeds	Water hog-louse	*Asellus aquaticus/meridianus*	5
	Freshwater shrimp	*Gammarus pulex*	3
	Swimming mayfly nymph	*Caenis horaria*	1
	Non-biting midge larvae	*Chironomidae* sp.	1
	Water fleas		25
Fallen trees (east of the Pond)	Non-biting midge larvae	*Chironomidae* spp.	40
	Bladder snail	*Physella acuta*	1
	Snail (very small)		1

TABLE 3. Survey 2 (5/4/18) of Lucy's Pond, species found and frequency.

Mesohabitat	Freshwater invertebrate	Scientific name	Number of individuals
Area of rushes	Small water beetle	*Hydroporus palustris*	1
	Large water beetle	*Acillius sulcatus*	1
	Shrimp	*Gammarus duebeni*	6
	Shrimp	*Gammarus lacustris*	1
	Nematoda worm	*Rhabdolaimus aquaticus*	10
	Horse hair worm	*Nematomorpha*	100
	Non-biting midge larvae	*Chironomidae* sp.	1
	Caseless caddisfly larvae	*Trichoptera*	1
	Biting midge larvae	*Chironomidae* sp.	1
	Stonefly nymph	*Plecoptera*	1
	Mosquito larvae	*Culicidae* sp.	1
	Stonefly nymph	*Nemoura erratica*	1
Fallen trees (east of the Pond)	Horse hair worms	*Nematomorpha*	10
	Nematoda worm	*Rhabdolaimus aquaticus*	9
	Water hog-louse	*Asellus aquaticus/meridianus*	2
	Shrimp	*Gammarus duebeni*	5
	Shrimp	*Gammarus pulex*	1
	Mosquito larvae	*Culicidae* spp.	4
	Mayfly nymph	*Siphlonuridae* spp.	2
	Common/lesser water boatman	*Corixa punctata*	1
	Shrimp	*Gammarus lacustris*	2
Northern reeds	Nematoda worm	*Rhabdolaimus aquaticus*	10
	Water springtail	*Collembola*	3
	Horse hair worms	*Nematomorpha*	1
	Caseless caddisfly larvae	*Trichoptera*	1
Open water	Non-biting midge larvae	*Chironomidae* spp.	10
	Nematoda worm	*Rhabdolaimus aquaticus*	5
	Horse hair worm	*Nematomorpha*	2
	Water fleas		8
	Stonefly nymph	*Plecoptera*	2
Fallen trees (west of the Pond)	Water flea - daphnia	*Daphnia pulex*	1
	Nematoda worm	*Rhabdolaimus aquaticus*	2
	Horse hair worms	*Nematomorpha*	1
	Non-biting midge larvae	*Chironomidae* sp.	1
	Snail	*Radix balthica*	1
	Snail	*Hydrobia jenkinsi*	1
Reeds	Water fleas		3
	Water flea - Daphnia	*Daphnia pulex*	3
	Mayfly nymph	*Siphlonuridae* spp.	4
	Stonefly nymph	*Cloeon dipterium*	1

TABLE 4. Survey 3 (31/5/18) of Lucy's Pond, species found and frequency.

Mesohabitat	Freshwater invertebrate	Scientific name	Number of individuals
Fallen trees (east of the Pond)	Common/lesser water boatman	*Corixa punctata*	13
	Beetle larvae	*Dytiscid hydroporus*	2
	Water flea	*Daphnia pulex*	100
	Saucer bug	*Llyocoris cinicoides*	4
	Water spider	*Hydracarina* sp.	1
	Common water flea	*Sida crystallina*	50
	Nematoda worm	*Rhabdolaimus aquaticus*	1
	Caddisfly fly larvae	*Cyrnus trimaculatus*	2
	Pike fry	*Esox lucius*	1
	Fish fry		1
Open water	Water flea	*Daphnia pulex*	64
	Water flea	*Polyphemus* spp.	3
	Water mite	*Cyclopoid copepod*	1
Filamentous algae	Common/lesser water boatman	*Corixa punctata*	20
	Water mite	*Piona* spp.	120
	Common bladder snail	*Physa fontinalis*	1
	Water flea	*Daphnia pulex*	6
	Fish fry		1
Marshy grassland (south west of the Pond)	Moss bladder snail	*Aplexa hypnorum*	1
	Large black beetle	*Ilybius* spp.	1
	Water flea	*Daphnia pulex*	100
	Beetle larvae	*Dytiscid hydroporus*	1
	Non-biting midge larvae	*Chironomidae* spp.	1
	Cased caddis fly larvae	*Limnephilus lunatus*	1
	Common/lesser water boatman	*Corixa punctata*	3
	Small black beetles	*Agabus bipustulatus*	2
	Stonefly	*Perla bipunctan*	1
	Water spider		1
	Fish fry		1
	Water mites		200
Reeds	Common/lesser water boatman	*Corixa punctata*	7
	Greater water boatman	*Notonecta glauca*	1
	Saucer bug	*Llyocoris cinicoides*	4
	Nematoda worm	*Rhabdolaimus aquaticus*	2
	Water flea	*Daphnia pulex*	20
	Common bladder snail	*Physa fontinalis*	14
	Dwarf pond snail	*Galba truncatula*	1
	Snail	*Physella acuta*	2
Northern grassy area	Water flea	*Daphnia pulex*	150
	Common/lesser water boatman	*Corixa punctata*	80
	Saucer bug	*Llyocoris cinicoides*	10
	Pupae of Chironomid midge	*Chironomidae* spp.	2

TABLE 5. Survey 4 (30/7/18) of Lucy's Pond, species found and frequency.

Mesohabitat	Freshwater invertebrate	Scientific name	Number of individuals
Area of rushes	Water flea	*Daphnia pulex*	1
	Common/lesser water boatman	*Corixa punctata*	60
	Water mite	*Nauplius cyclops*	10
	Non-biting midge larvae	*Chironomidae*	2
	Tanypus larvae	*Tanypus* sp.	1
	Cyclops	*Cyclopoidea* spp.	20
	Forciponyia larvae	*Forciponyia* sp.	1
Fallen trees (east of the Pond)	Common/lesser water boatman	*Corixa punctata*	7
	Whirligig beetle	*Gyrinidae* sp.	1
	Lesser water boatman nymph	*Corixa punctata*	15
	Water mite	*Nauplius cyclops*	12
	Crustacea	*Ostracoda*	5
	Forciponyia larvae	*Forciponyia* spp.	1
Open water	Common/lesser water boatman	*Corixa punctate*	2
	Water mite	*Nauplius cyclops*	2
	Cyclops	*Cyclopoidea* spp.	4
Northern grassy area	Common/lesser water boatman	*Corixa punctata*	2
	Lesser water boatman nymph	*Corixa punctata*	20
	Water mite	*Nauplius cyclops*	3
Reeds	Common/lesser water boatman	*Corixa punctata*	2
	Lesser water boatman nymph	*Corixa punctata*	7
	Water mite	*Nauplius cyclops*	3
	Mayfly nymph	*Canis horaria*	3
	Cyclops	*Cyclopoidea* spp.	5
	Mayfly nymph	*Centroptilum luteolum*	1
	Caddisfly larvae	*Philopotamus momtanus*	2
Marshy grassland (south west of the Pond)	Common/lesser water boatman	*Corixa punctata*	25
	Water mite	*Nauplius cyclops*	40
	Cyclops	*Cyclopoidea* spp.	10
	Fairy shrimp	*Chirocephalus diaphanus*	1
	Beetle	*Platambus maculatus*	1

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