Fen Raft Spider Recovery Project:
2010 Summary Report for Redgrave & Lopham Fen

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Summary

1 This report describes the results from the twentieth year of systematic monitoring of the nationally endangered fen raft spider (*Dolomedes plantarius*) at Redgrave & Lopham Fen National Nature Reserve, Norfolk. This work was undertaken as part of Natural England's Species Recovery and Biological Action Plan (BAP) programmes in 2010. Habitat management work and measurements of surface water levels are also documented and discussed in relation to spider population trends.
2 The BAP target for *D. plantarius* at this site is for 65ha of habitat occupied in 3 years out of 5 by 2020.
3 Throughout the 20-year census, the population on the reserve was small and its range restricted to two small and spatially separated areas, on Little Fen and Middle Fen.
4 Desiccation of the fen by artesian abstraction, thought to be responsible for the decline in this semi-aquatic species, ended in 1999 with relocation of a borehole that had drained the fen. Hydrological recovery was rapid.
5 An annual index of the size of the *D. plantarius* population, that allowed statistical comparison between years, showed that the census data were best described by a model in which population size varied substantially and sometimes significantly between years with no evidence of a sustained upward or downward trend.
6 Modelling of the census data for both the Little and Middle Fen sub-populations showed that there was a significant difference between them in the pattern of annual variation. In 2010 the index for Little Fen was the highest recorded although it was not significantly higher than in recent years. The index for Middle Fen was slightly lower than in 2009 but was well within the range of values for the previous 19 years.
7 On Middle Fen, a westward expansion in the spider's range that began in 2006 was sustained although not increased in 2010. They now occupy a linear series of ponds, over 120m beyond the area in which they had previously been recorded since 1993. The spiders in this new spur of the population have bred only in alternate years, suggesting an origin in a single saltatory colonisation event rather than a spread on a broad front.
8 Numbers of both breeding females and nursery webs on Little Fen in 2010 were the highest recorded. No nursery webs were found on Middle Fen and only one adult female was encountered. Slightly later census dates, in combination with rapid drying-out of the ponds on Middle Fen, may have contributed to this.
9 On Little Fen a large stand of *Cladium mariscus* within the core area for *D. plantarius* was cut in late July. No *C. mariscus* was cut on Middle Fen for the second successive year. Grazing stock had access to both areas.
10 After a wet winter, a spring drought resulted in low levels and rapid rate of loss of water in the ponds by the time of the July census. The drought ended by the late July.
11 An excavator was used to deepen some of the ponds in the core *D. plantarius* areas by removing sediment from their centres in October. The pond margins were left undisturbed.
12 Twenty three new turf ponds were excavated immediately west of the core *D. plantarius* area on Middle Fen. This area retained scattered clumps of *C. mariscus* but lacked turf ponds deep enough to hold water through most summers. It is hoped that targeted habitat management of this kind will allow a natural expansion in the spider's range.
13 The monitoring data in 2010 and previous years, together with recent research findings, led the conclusion that translocation would be needed to meet the BAP target for recolonisation of suitable habitat at this site. Funding from the BBC Wildlife Fund enabled the first translocation to be carried out in early October 2010 when *ca* 400 captive-reared spiderlings of local provenance were introduced to Great Fen. If post translocation monitoring suggests that this was successful, a second generation will be moved to the same area in 2011 to ensure that the new sub-population has a natural age-structure

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1 Introduction

This report summarises monitoring and management work undertaken in 2010 as part of the Fen Raft Spider (*Dolomedes plantarius*) Recovery Project at Redgrave & Lopham Fen National Nature Reserve (NNR), one of only three UK sites for this Schedule 5 species.

Systematic monitoring and targeted management for *D. plantarius* began at this site in 1991 (under English Nature's Species Recovery Programme) to prevent extinction of the population. Desiccation of the fen, resulting from artesian abstraction since 1960 and compounded by droughts in the 1980s and 1990s, reduced the spider population to very low levels (Smith 2000). By the late 1980s, the remnant population had become restricted to turf ponds on two separate parts of the NNR. Throughout the 1990s, despite targeted habitat management, monitoring showed that there was no significant increase in the size of the population and that its range was continuing to contract. Between 1991 and 1999, irrigation of the ponds inhabited by the spiders appeared to be the key factor in their persistence (Smith 2000).

Abstraction of water from the aquifer underlying the fen ended in 1999 and resulted in rapid hydrological recovery (Harding 2000). This was expected to result in a rapid increase in *D. plantarius*, which has very high potential fecundity. This expectation was encapsulated in the original *D. plantarius* Species Action Plan targets for this site (U.K. Biodiversity Steering Group 1999), of a sustained increase in density per pond to the maximum recorded during the 1990s, and a ten-fold increase in range.

By the time of the 2005 BAP Review, the *D. plantarius* population still showed no sign of sustained or significant recovery (Smith 2006). It was clear that any recovery would be slow and that the wetness of the fen was not the only factor required to trigger it. The revised BAP targets (BARS 2008) included both an increase in range on Redgrave & Lopham Fen (to 13 Ha in three years out of every five by 2010, and to 65 Ha by 2020) and reduction in the risk of stochastic extinction by the establishment of six more new, sustainable populations in the UK by 2010. By 2020 the total number of sites with sustainable populations should be increased to 12.

A small increase in range of the Middle Fen population began in 2006 - the first since systematic monitoring began in 1991 and eight years after restoration of the fen's hydrology. Although this range expansion involved small numbers of spiders it was the first indication that habitat conditions beyond the core range of this sub-population were becoming suitable for the spiders. By 2009 the spiders had recolonised one extremity of a series of turf ponds last occupied in the mid-1980s.

This very slow rate of recolonisation is consistent with recent research that shows that *D. plantarius* at this site has very limited tendency to disperse (Pearson 2008). To meet the BAP targets for this species both within this site and nationally, a translocation programme was initiated in 2010. With the help of the BBC Wildlife Fund, the first introduction within the Redgrave & Lopham Fen complex was made in early October, founding a new, third sub-population.

This report presents the results from the standardised annual census of *D. plantarius* at Redgrave & Lopham Fen and examines the progress of the range expansion. These results are discussed in the context of the previous nineteen years' monitoring data. The initial phase of translocation is described and the next steps required to progress the BAP targets, in terms both of further translocations and habitat management, are discussed. This report also summarises ground water and rainfall data collected by the Suffolk Wildlife Trust (SWT), the NNR managers.

Further background to the project, and details of previous years' work, are given by Duffey (1991) and Smith (1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000a, 2001, 2005, 2006, 2007, 2008, 2009, 2010).

2 Methods

2.1 Annual census

The annual census of *D. plantarius* followed the methodology adopted in 1993 and described by Smith (1993, 2000, 2009a, 2010). The three replicate counts were made at 29 turf ponds on Little Fen (Fig. 1) and 30 on Middle Fen (Fig. 2) in late July. Whenever consistent and favourable weather conditions allowed, the counts for each fen were made on three consecutive days (Table 1).

Table 1 Census dates for 1994-2009

Year	July (& /Aug.) Census dates	
	Little Fen	Middle Fen
1994	26-29	9-18/08
1995	20-25	27-1/08
1996	18-21	22-26
1997	24-21	22-26
1998	18-21	21-24
1999	17-19	21-26
2000	-	17-20
2001	-	17-20
2002	14-18	19-21
2003	18-22	23-27
2004	21-27	12-24
2005	21-05/08	18-21
2006	13-17	17-20
2007	31-11/08	19-31
2008	24-28	21-23
2009	13-20	23-28
2010	19-26	26-30

In 2000 and 2001 very high water levels made it impossible to census Little Fen during the summer. From 2002 onwards, two Little Fen ponds included in the original scheme had to be excluded from the census because they had been substantially infilled with spoil during the fen restoration operations (Harding 2000). Counts at two other Little Fen ponds were made from the bank because the depth of sediment made work in the water unsafe (L31 and L33: Fig. 1). By 2004 two of the three replicate counts at a further pond (L36) also had to be made from the bank and in subsequent years all counts at this pond were made from the bank.

In 1991 and 1992 pools were censused in a much more restricted area, on both Little and Middle Fens. The methodology was changed in 1993 to include a wider area and allow detection of changes in range (Smith 1993) although the two methods were run in parallel until 2005 (Smith 1995). There was sufficient overlap in the sets of pools sampled to allow formal analysis of population trends for the entire period, since 1991 (Section 2.2).

2.2 Analyses of annual census data

The annual census data are expressed as an index derived from analyses of population trends carried out using generalised linear models, with the maximum count for each pond in July as the response variable (Smith 1995, 2000). Log-linear Poisson regression models were fitted to the systematic data collected since 1991 (excluding Little Fen in 2000 and 2001,when it was deeply inundated), as implemented in program TRIM (Pannekoek & van Strien, 1998). TRIM allows the data to be split into different strata: in this context Little and Middle Fens form separate co-variate strata. The model also allows sites to be censused in some years and not others and so both the data from the set of ponds

censused at the outset of the project (1991-1995), and those from the set of ponds censused from 1993 onwards, could be utilised (see Smith 1995).

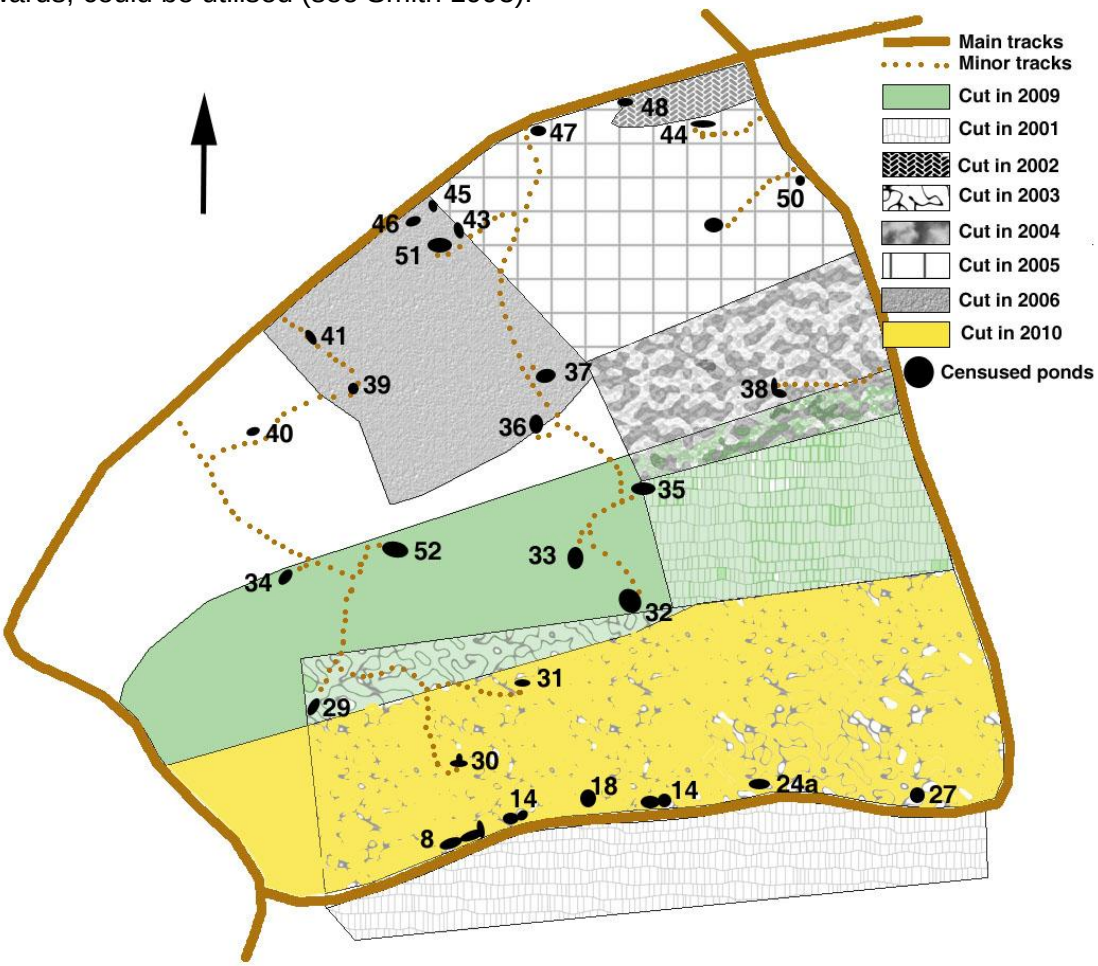


Fig. 1 The Little Fen census area showing ponds included in the census. Shading shows areas where vegetation was cut and removed in July/August each year.

The program fits five standard models: (i) no time (year) effects; (ii) linear trend (in log numbers); (iii) linear trends within covariate strata (linear trends differ between Little and Middle Fen); (iv) time effects (separate effects for each year); (v) time-effects within covariate strata (year effects differ between Little and Middle Fen.

2.3 Breeding indicators

Very limited but comparable quantitative information on breeding success each year is derived from the counts of adult females and of nursery webs during the annual census (above). Additional information comes from casual records and from observations during sedge-cutting management, but this cannot be used for quantitative comparison between years.

2.4 Water levels

In most years routine water level measurements are made at approximately monthly intervals against posts in the census ponds on Little and Middle Fens and in the ponds dug on Great Fen in 1998 (Smith 2000, 1998). This regular monitoring was not possible in 2010: after March the only measurements taken on Little and Middle Fens were during the July population census. No further measurements were

made on Great Fen. The levels in the Little and Middle Fen ponds are expressed relative to an arbitrary datum established in April 1992. The levels in the Great Fen ponds are expressed relative to Ordnance Datum.

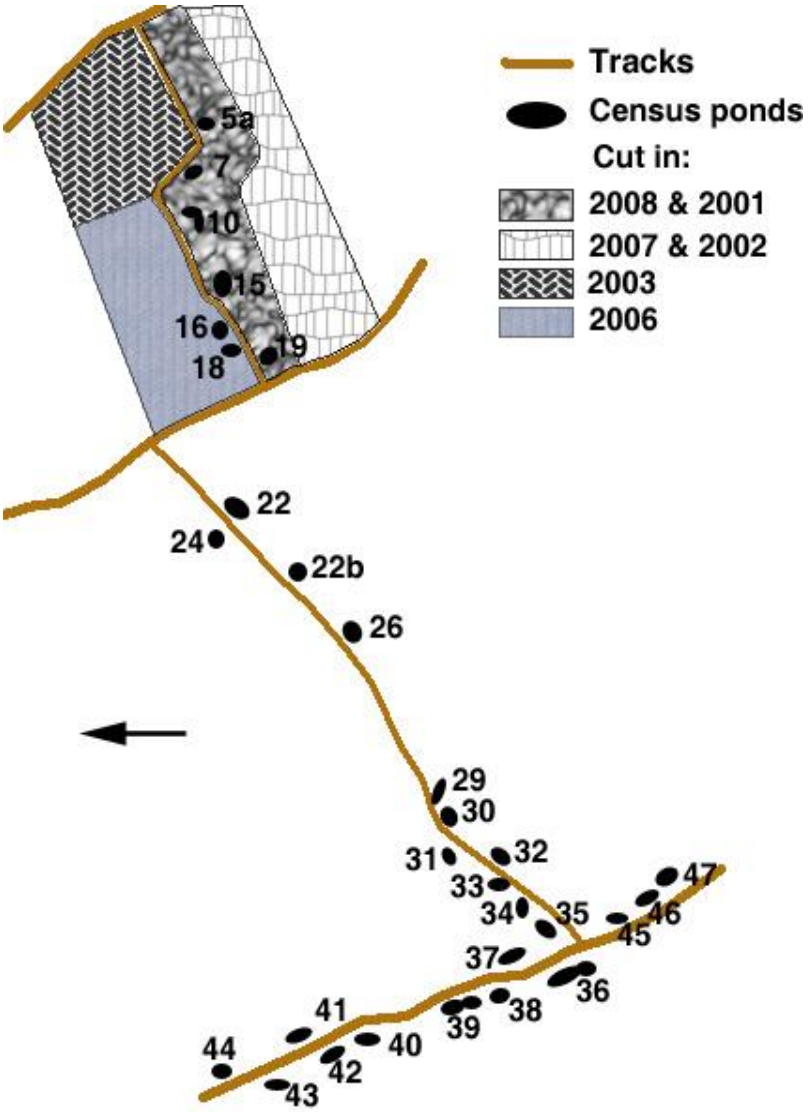


Fig. 2 The Middle Fen census area showing ponds included in the census. Shading shows areas where vegetation was cut and removed in July/August each year.

Ground water levels on the Fen have been monitored by the SWT since 1976 using a network of 54 piezometer tubes (Smith 2000). Most of these monitor near-surface hydrology: eight are sunk into the underlying chalk. The data presented in this report are the highest monthly mean recorded from all of these tubes between November and April (winter maximum) and the lowest monthly mean recorded between May and September (summer minimum) each year. Although this is a coarse measure, it gives a good picture of differences between years over the 34-year recording period. Monthly rainfall data measured by the SWT at a gauge on the fen since 2001 are also presented.

2.5 Introduction of *D. plantarius* to Great Fen

The spiders introduced to Great Fen in 2010 were all the progeny of animals caught as adults on Little Fen and Middle Fen in May. The parents were mated in captivity and the resulting spiderlings, from four broods, were reared in individual test tubes over the summer using established protocols (NE, unpublished reports). This technique results in far higher survival (varying between these broods from 65 to 85%) over the first three months of life than is thought to occur in the field. A total of 414 spiderlings

was released in October. Most of these animals varied in body length from 3.5 to 4.5 mm and were in their 3rd or 4th instar since emerging from the egg sac.

To ensure that the source populations on Little and Middle Fen were not depleted by removal of the parents of these broods, the mothers were retained in captivity to produce second broods. They were then released at their site of capture with together with their new brood. Releases were made when the spiderlings were *ca* one week old, at around the time when they would normally disperse from the nursery. Successful second broods are rare in the wild (Pearson (2008) estimated 11%) but 60% of the females kept in captivity in 2010 successfully hatched spiderlings from second egg sacs (Smith 2011). All of the females that produced the broods released on Great Fen produced second broods that were released on Middle Fen (2 broods) and Little Fen (2 broods).

The spiderlings were released on Great Fen on 11 and 12 October 2010. The release was made around five of the ponds excavated in an extensive bed of *C. mariscus* in 1998 (Smith 1998), including ponds deepened the previous month (Section 4.3, Fig. 12). The tubes were positioned at *ca* 4cm intervals along lines of tape prior to release. This helped to reduce the risk both of cannibalism and of creating concentrations of spiderlings that might attract predators. The lines of tubes were positioned in dense *Cladium mariscus* around the pond margins. They were slanted downwards to avoid rain and the lids were removed. Two days later they were collected and checked to ensure that the spiderlings had left.

3 Results

3.1 Distribution

On **Little Fen** the number of census ponds on which *D. plantarius* was recorded in 2010 was the highest since the current systematic census began in1993 (Table 2). Since closure of the artesian borehole in 1999, *D. plantarius* has been found predominantly in the southern part of the census area (Fig. 3). This area also held the core of the population during the 1990s when it was irrigated with a piped water supply to maintain summer water levels in the ponds. In most years spiders have also occupied a band of ponds stretching north from this core area but records outside this zone have been sporadic. In 2010 spiders were recorded much more consistently in a wide band behind this zone, and particularly to the north and east.

On **Middle Fen** *D. plantarius* was also recorded in more ponds than at any time since the present census was established in 1993 (Table 2). One more occupied pond was recorded than in the previous two years. This reflects the very slow but consistent westward expansion of range that began in 2006 (Fig. 4). All of the *D. plantarius* recorded from this recent spur of the population were immature.

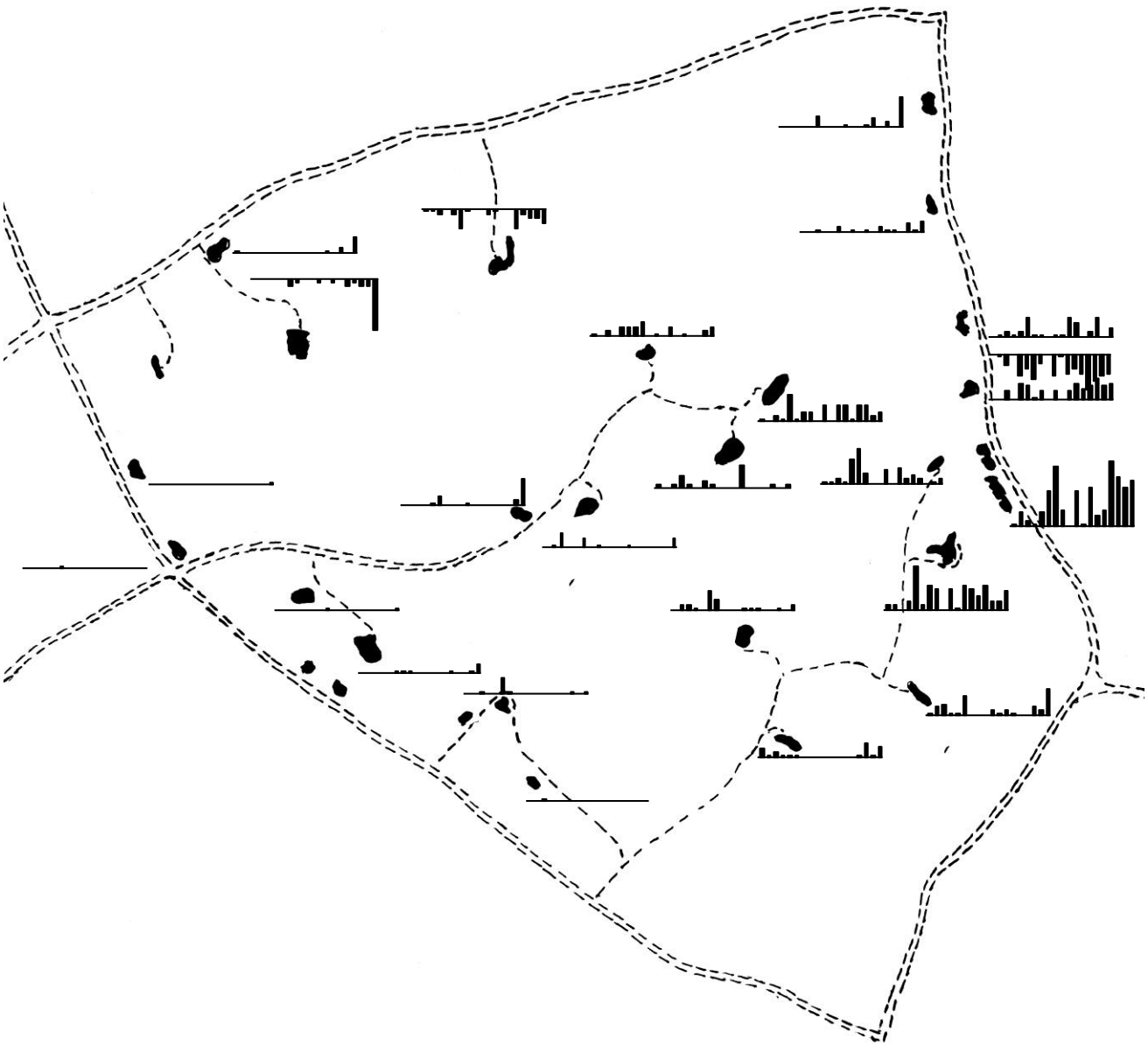
3.2 Abundance

Since census work began in 1991, the size of the *D. plantarius* sub-populations on both Little and Middle Fens has varied substantially, and in some cases significantly, between the years but at no time has there been any evidence of sustained or significant recovery (Table 3, Fig. 5). In 2010 numbers on Little Fen were the highest recorded although they were not significantly higher than in most recent years. On Middle Fen they were slightly lower than in 2009 but were well within the range of variation since 1993.

Separate analysis of the 20 year data set for the Little and the Middle Fen sub-populations shows that, in both cases, the annual time effects models gave a better description of the data (lowest AIC values) than either the linear-trend or no-time-effects models. For Little Fen this model had an AIC value of -171.42 (Wald test for significance of deviation from linear trend: 111.01, $p<0.001$, df=16). Linear-trend and no-time-effects models had AIC values of 26.92 and 124.7 respectively. For Middle Fen the annual time effects model had an AIC value of –139.74 (Wald test for significance of deviation from linear trend: 169.1, $p<0.001$, df=18). Linear-trend and no-time-effects models had AIC values of 174.11 and 179.92 respectively.

Inclusion of the data for both fens in the population models showed that, as in previous years when such comparison was possible, there was a highly significant difference in the annual pattern of variation between Little and Middle Fen (analysis of data for 1991-'99 and 2002-'10: Wald test for difference between fens: 97.87, $p<0.001$, df=17).

Fig. 3 Little Fen census area showing relative numbers of *D. plantarius* recorded at each pond in late July between 1993 and 2010. Bars represent maximum counts for consecutive years (highest count=24 :no July data were collected in 2000 and 2001). Where ponds have no chart, *D. plantarius* has never been recorded during these censuses.



3.3 Breeding indicators

On **Little Fen** the number of adult females and of nurseries encountered during the July census was the highest ever recorded (Table 3). Sedge cutters working in the core areas in late July also encountered relatively high numbers of nurseries.

In contrast, on **Middle Fen,** only one adult female was encountered and no nurseries were found (Table 3). Since there was no sedge cutting (Fig. 2) or casual recording on Middle Fen, no impression was gained of whether nurseries were in evidence later in the breeding season.

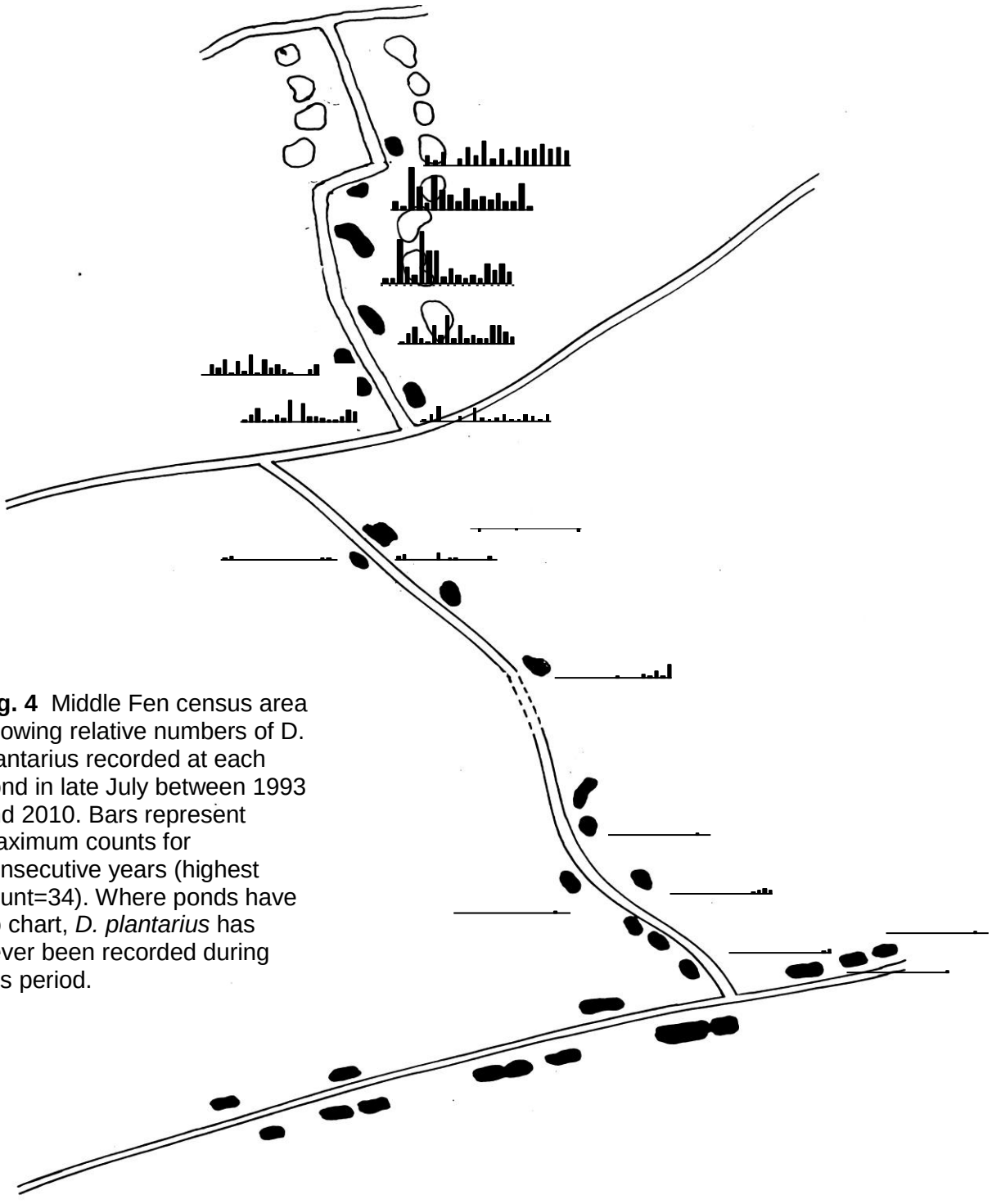


Fig. 4 Middle Fen census area showing relative numbers of D. plantarius recorded at each pond in late July between 1993 and 2010. Bars represent maximum counts for consecutive years (highest count=34). Where ponds have no chart, *D. plantarius* has never been recorded during this period.

Table 2 Number of census ponds on which *D. plantarius* was recorded in July each year. Numbers are given separately for ponds that were and were not influenced by the irrigation supplied between 1993 and1999. The 2000 data for Little Fen are based on two, rather than three replicate counts, made in September rather than July: no data were collected on Little Fen in 2001 (see Smith 2005)

Year	**'93**	**'94**	**'95**	**'96**	**'97**	**'98**	**'99**	**'00**	**'01**	**'02**	**'03**	**'04**	**'05**	**'06**	**'07**	**'08**	**'09**	**'10**
Little Fen																		
'Irrigated' n=15[1]	8	8	12	9	12	14	11	-	-	12	6	12	11	9	8	12	11	16
'Unirrigated' n=14[1]	2	2	4	0	1	6	4	-	-	2	1	2	0	4	2	4	3	7
Total	**10**	**10**	**12**	**9**	**13**	**20**	**15**	**(11)`**	**-**	**14**	**7**	**15**	**11**	**13**	**10**	**16**	**14**	**23**
Middle Fen																		
'Irrigated' n=7	6	7	7	5	6	7	6	7	6	7	7	7	7	7	6	6	7	7
'Unirrigated' n=23	2	3	0	0	0	0	1	2	0	2	1	0	0	1	2	6	5	6
Total	**8**	**10**	**7**	**5**	**6**	**7**	**7**	**9**	**6**	**9**	**8**	**7**	**7**	**8**	**8**	**12**	**12**	**13**

[1] Prior to 2003, n=16 irrigated and 15 unirrigated ponds respectively

Table 3. Proportions of *D. plantarius* in different size classes, and maximum counts of all individuals, adult females and nursery webs, in the standard annual census ponds on Little and Middle Fen at the July census from 1993 to 2010. * The number of adult females given is based on identification of individuals and may be a higher figure than the maximum count of spiders in the large size category.

	1993	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Little Fen																		
% Large	36	21	20	65	30	5	8	-	-	9	29	4	10	14	18	11	45	27
% Medium	57	37	66	15	41	50	53	-	-	57	43	68	88	45	73	68	34	67
% Small	7	42	15	20	29	45	39	-	-	34	28	28	2	41	9	21	21	6
Max. spider count	**14**	**19**	**41**	**20**	**66**	**94**	**62**	**-**	**-**	**53**	**7**	**68**	**40**	**42**	**66**	**75**	**47**	**124**
Adult females*	0	1	6	6	16	4	4	-	-	4	2	3	4	7	10	10	15	20
Nursery web count	0	2	0	0	9	0	4	-	-	0	0	1	2	4	4	0	3	14
Middle Fen																		
% Large	29	30	3	17	47	5	15	6	20	6	10	5	13	10	19	12	16	30
% Medium	33	48	62	34	53	32	46	49	30	55	48	50	45	63	50	46	58	54
% Small	38	22	35	49	0	63	39	45	50	39	42	45	42	27	31	40	26	16
Max.spider count	**21**	**44**	**102**	**41**	**15**	**99**	**52**	**112**	**20**	**72**	**29**	**42**	**31**	**30**	**54**	**56**	**70**	**63**
Adult females*	0	8	1	5	6	5	7	7	0	2	2	1	4	3	8	5	9	1
Nursery web count	1	3	1	0	0	0	7	0	0	0	0	0	3	1	2	1	2	0

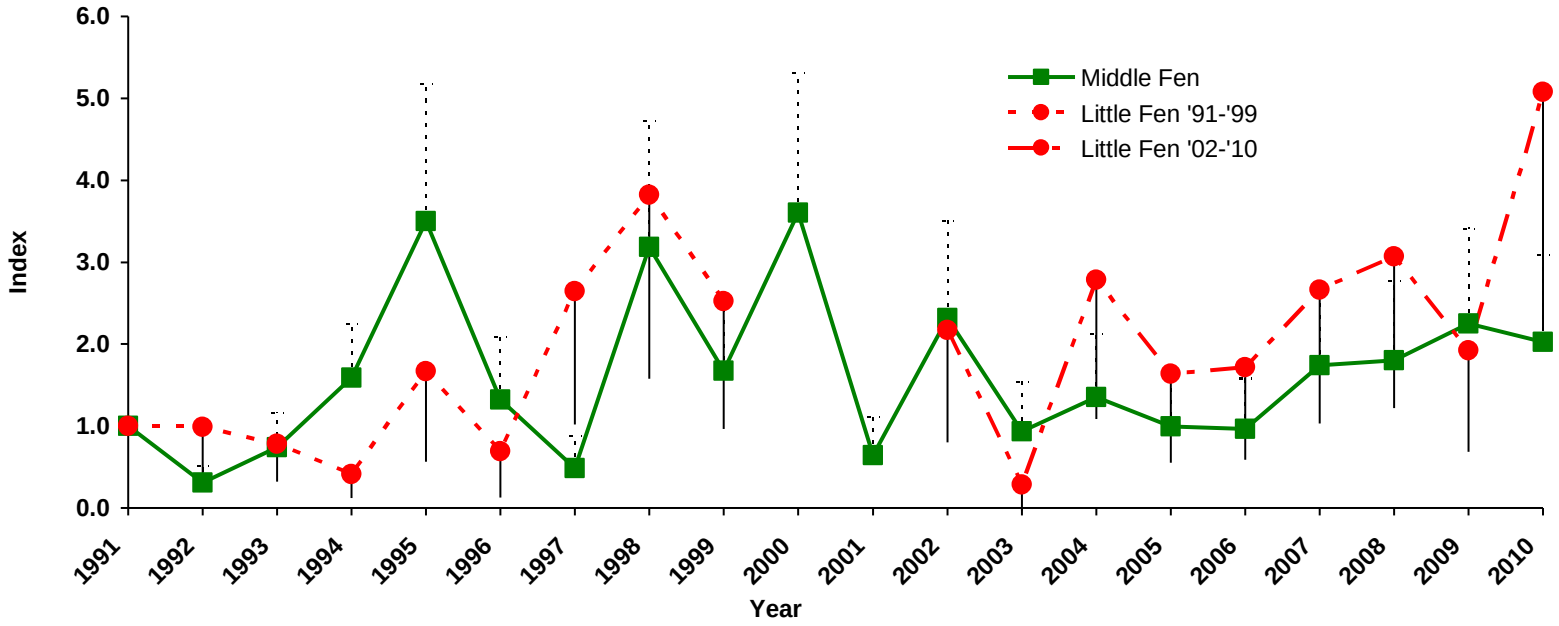


Fig. 5 Annual population indices for *D. plantarius* on Middle and Little Fens in July 1991-2010, generated by a log-linear Poisson regression model and plotted on a linear scale. No data were collected on Little Fen in 2001-2001 (see text). 2SEs shown by positive vertical bars for Middle Fen and negative bars for Little Fen.

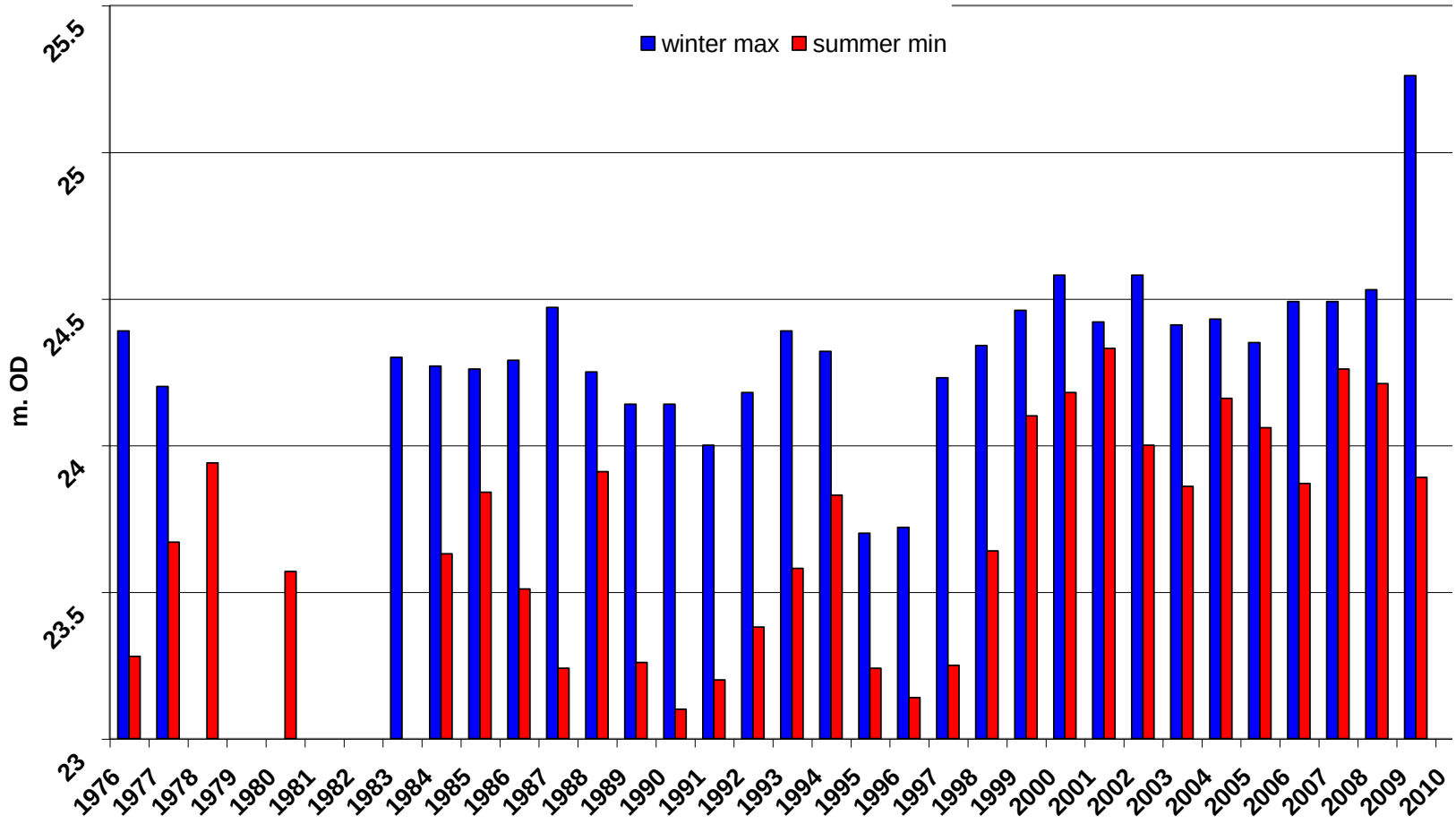


Fig. 6 Mean winter maximum and summer minimum water levels in piezometers on Redgrave & Lopham Fen NNR, 1976-2010

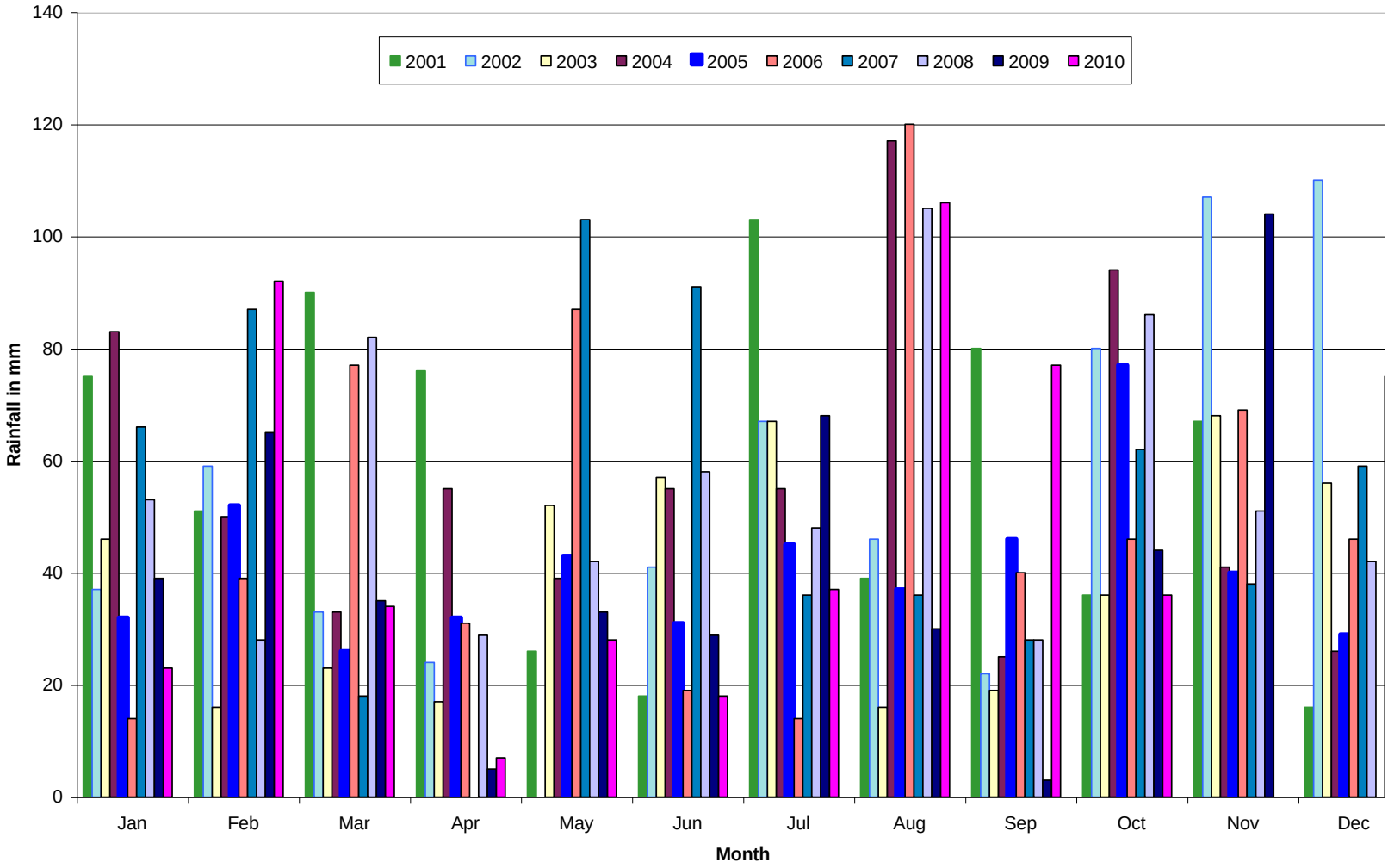


Fig. 7 Monthly rainfall totals for Redgrave & Lopham Fen NNR 2001- 2010

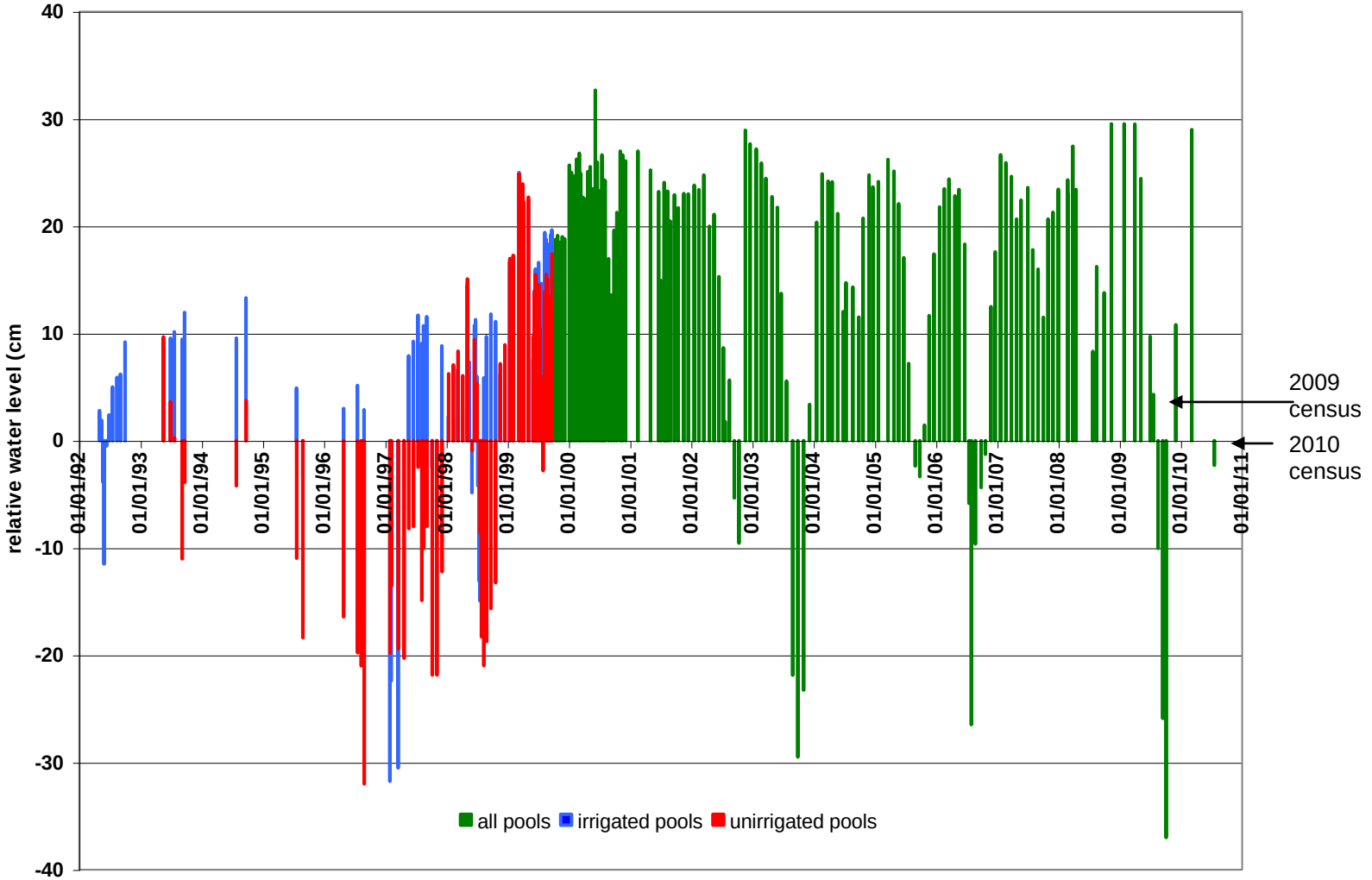


Fig. 8 Water levels in Little Fen ponds 1992-2010. Horizontal line represents the April 1992 datum. Blue and red lines represent mean levels in irrigated and unirrigated ponds respectively : summer irrigation stopped in 1999 (see text). Arrows show the water levels at the time of July census in 2009 and 2010.

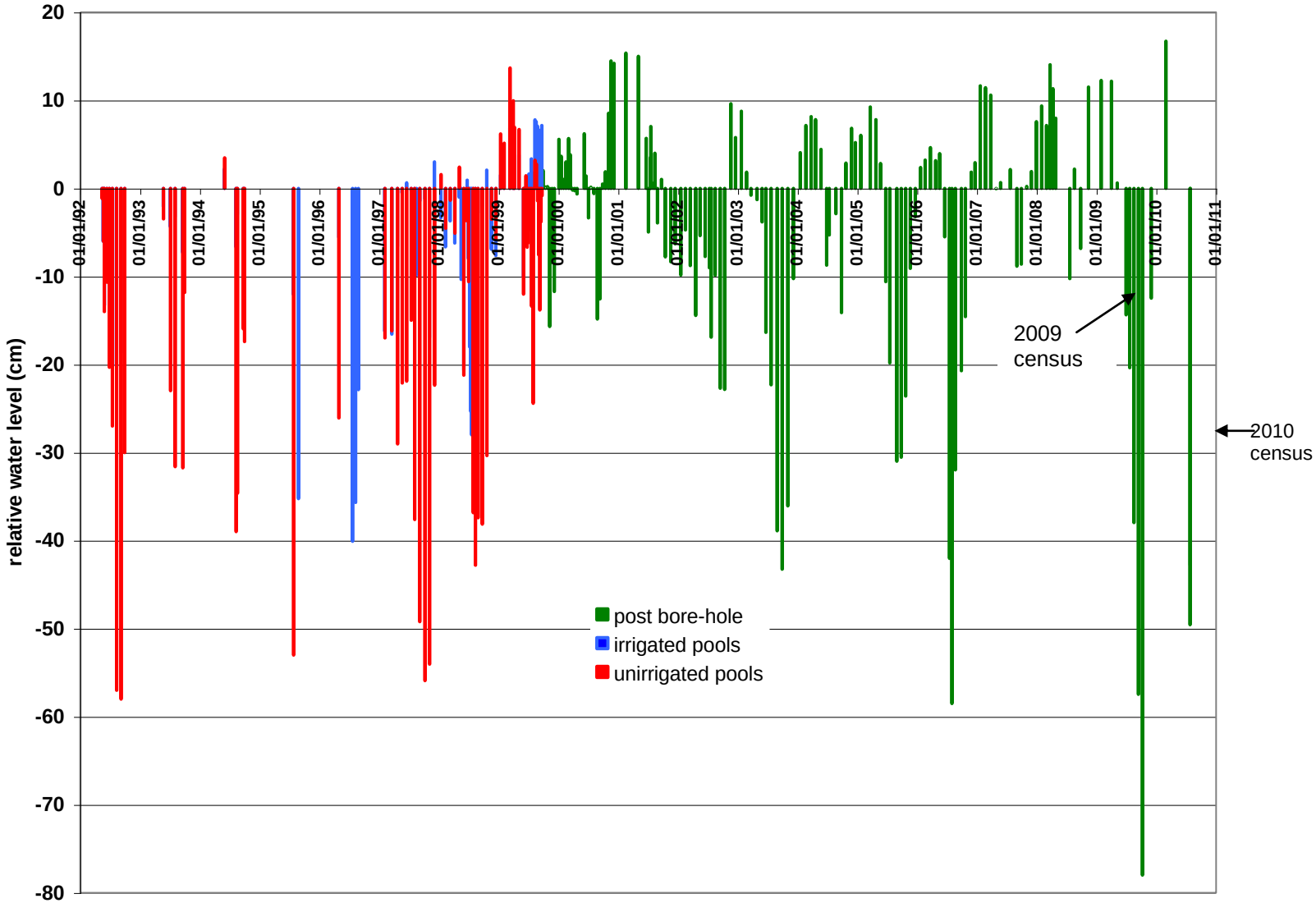


Fig. 9 Water levels in Middle Fen ponds 1992-2010. Horizontal line represents the April 1992 datum. Blue and red lines represent mean levels in irrigated and unirrigated ponds respectively: summer irrigation stopped in 1999 (see text). Arrows show the water levels at the time of July census in 2009 and 2010.

3.4 Water Levels

Winter water levels, recorded in the dipwells, saw a short-lived peak in December 2009 - the highest recorded level since records began in 1993 (Fig. 6). Rainfall amounts in April 2010 were well below the average, and in June were the lowest recorded in the last 10 years (Fig. 7). By mid-July water levels in the spider ponds on both Little and Middle Fen were lowest recorded at this time of years since the drought of 2006 (Figs. 8 and 9). Middle Fen appeared to be relatively worse hit than Little Fen but this was partly because the measurements were made five days later. The water levels fell very rapidly; a 7cm fall in levels was recorded over a period of five days in the Middle Fen pools. Although the drought of 2009 was eventually more severe, its impact was greater much later in the season, in September and October (Figs. 8 & 9).

4 Habitat management

4.1 Rotational mowing of *Cladium mariscus*

Since 2004 it has been SWT's policy to cut *C. mariscus* stands judged to be most in need of management, rather than on a regular rotation, both within and beyond the core area for *D. plantarius* (see Smith 2004). This need varies according to the wetness of the season and the effectiveness of stock grazing.

Fig. 10 Die-back of *Cladium mariscus* on Little Fen in 2010

In 2010, on Little Fen, an east-west strip of *C. mariscus*, which included the most of the consistently occupied spider ponds, was cut during the last week of July. This incorporated, and extended west, most of the block last cut in 2003 (Fig.1). As in previous years, occasional clumps of emergent and marginal *C.mariscus* were left uncut around the turf ponds to provide shelter for the spiders and support for nursery webs. Regeneration of sedge over much of the extensive area cut in 2009 (Smith 2010) was very poor throughout 2010 (Fig. 10).

On Middle Fen no *C. mariscus* was cut for the second successive year. The block cut in 2008 (Fig. 2) that showed poor recovery and substantial die-back in 2009 (Smith 2010), started to recover during summer 2010.

4.2 Grazing

As in all previous years, the grazing management of areas occupied by *D. plantarius* on **Middle Fen** was more successful than on Little Fen (full records of stock types, rates and movements are maintained by the SWT). However, stock rarely entered areas of tall, dense mature sedge unless they were recently cut (Fig.2).

In the western part of the census area, away from the dense *C. mariscus* beds that dominate the core range for *D. plantarius,* the grazing regime initiated in 2001 continued to have a substantial and positive impact on the vegetation. Shorter, more open, mixed associations, with a poached, tussocky structure, largely replaced tall dense reed which had deeply shaded of many of the ponds. Although no dense beds of *C. mariscus* remain in this area, the residual patches, particularly around the margins of the turf ponds, were healthy.

On **Little Fen**, as in previous years, the stock made relatively few incursions into the areas occupied by *D. plantarius* and had relatively little effect on the vegetation (e.g. Smith 2007).

4.3 Deepening of turf ponds

In the third week of September a mini-excavator was used to deepen and remove solid plumes of rotting Charophytes from *ca* 40 turf ponds on Little Fen and Middle Fen. This work extended a pond cleaning programme started in 2009 (Smith 2010) targeting ponds within the core spider areas but including some that are not part of the standard census sample. Their selection was a compromise between the need to provide more open and deep water, and avoidance of disturbance to spiders when they were likely to be aestivating during a drought period. For this reason, adjacent ponds were rarely excavated.

4.4 Excavation of new turf ponds on Middle Fen

At the same time, twenty new turf ponds were excavated on Middle Fen in an area immediately west of the core area for *D. plantarius* (Fig. 11). This area was identified in 2008 as having suitable vegetation but no ponds deep enough to support expansion of the population (Smith 2009). The new ponds varied in size and were profiled to encourage growth of emergent *C. mariscus*, particularly on their south-facing banks. Their maximum depth was between 1 and 1.2m - slightly below the water table during this drought period.

Fig. 11 New ponds excavated on Middle Fen in September 2010 (brown). Pools marked in black are at the western boundary of the standard census area (see Fig. 4).

5 Discussion

In 2010, the *D. plantarius* population at Redgrave & Lopham Fen NNR remained small and confined to two, spatially separate areas of the reserve. However, although the annual population index still showed no evidence of any sustained or significant change, the year saw positive changes in both of these areas.

On Little Fen, both overall numbers, and numbers of adult females and of nurseries, were the highest recorded since census work began 20 years ago. The number of ponds on which spiders were recorded (23) also increased, to the highest since the current census method was started in 1993. *D. plantarius* was recorded on three more ponds than in the previous peak year of 1998. This increased occupancy of the census area may have resulted from increased mobility when water levels were high water levels in late summer 2009 and early spring 2010. Although none of the previous peaks in *D. plantarius* numbers have been sustained and the 2010 population index was not significantly greater than the indices in recent years, the combination in 2010 of high numbers, increased breeding success and increased occupancy of the area all suggest the potential for a more sustained increase. In many previous years, droughts during the breeding season are thought to have reduced breeding success (eg Pearson 2008, Smith 2010). In 2010 the census on Little Fen was completed at a time when water levels were dropping rapidly in an early summer drought. However because many nurseries had already been produced that stage, and the drought ended in late July leaving the potential for more successful breeding attempts, the impact of the 2010 drought on this sub-population may have been relatively limited.

On Middle Fen the numbers of ponds occupied during the July census was also higher, although only by one, than in all previous years. This reflected consistent occupancy of the ponds constituting the new spur of the population that started to develop in 2006, to the west of the core area (Smith 2007, 2008, 2009, 2010). There was no evidence of any further expansion in range in 2010. All of the spiders found in this spur were juveniles, perpetuating an annual alternation between adult and juvenile cohorts since juveniles were first found in this area in 2006. Since it is thought that almost all *D. plantarius* at Redgrave & Lopham Fen breed when they are two years old, and then die, this pattern suggests that the initial colonisation may have been a single event, perhaps involving ballooning from a nursery web in the core area to the east. Shed skins have been collected from the new spur of the population every year to allow eventual genetic analysis of its origins.

Although persistence of new spur of the Middle Fen population into a fifth year is encouraging, the population index for the area remains very static despite this addition. Numbers of spiders in ponds in the core area have been well below those in peak years in the 1990s. The relatively poor performance of the Middle Fen population compared with that on Little Fen is reflected in the continuing significant difference between the annual patterns in their population indices. Two factors may have contributed to the relatively low numbers recorded in the core area in the last two years. First, of the seven ponds in the random sample within the core area, five were within the block of sedge cut in 2008 that showed very poor recovery until late in 2010. The very sparse cover of depauperate *C. mariscus* in this area may well have made it less favourable for *D. plantarius.* The spiders would have been more exposed to predators and there was a particular shortage of both the plant cover and structure needed by breeding females. Secondly, although the 2010 census on Middle Fen was undertaken only five days later than on Little Fen, water levels in most ponds had dropped to a point where they contained only a plume of liquid mud and a dense, often stranded, mat of Charophytes. During the census, water levels were falling by over a centimetre a day. These conditions make it difficult to search for spiders and also lead to a real reduction in both numbers of spiders on the ponds and in breeding attempts. Pearson (2008) found that in drought conditions marked spiders were more likely both to disappear temporarily from the population (probably by aestivation) and to move between ponds.

At the end of 2009 it was concluded that, whilst an increasing area of the fen complex was developing suitable vegetation to support *D. plantarius* (Smith 2009), re-colonisation was limited both by lack of suitable, deep turf ponds and by distance; further measures would be needed to ensure progress towards the BAP targets for this site. The 2010 results reinforce this conclusion. Once again, spread of the new spur of the population on Middle Fen was very limited, supporting research evidence that this population has a very low propensity and ability to disperse (Pearson 2008). The increased population size on Little Fen, although encouraging, appeared to be limited to the deep turf ponds occupied in at least some years since the census began in 1991.

Two measures were agreed in 2009 to promote expansion of the *D. plantarius* population into restored areas with suitable vegetation. First, the excavation of additional, deep turf ponds linking with the core areas for *D. plantarius*, should provide corridors along which the population can spread. The effectiveness of this has already been demonstrated by the spread of spiders along the existing chain of ponds that now hold the new spur of the population on Middle Fen. Two new chains of ponds have now been excavated to start to meet this need. Funding from the Higher Level Stewardship (HLS) scheme allowed the SWT to excavate new chains of ponds to both the east (smith 2010) and the west of the core *D. plantarius* area in Middle Fen.
The second measure being implemented to promote re-occupation of suitable habitat throughout the fen complex is the introduction of *D. plantarius* to new areas of the fen. The 2010 introduction of spiderlings to Great Fen is expected to continue in 2011 to ensure that the population has a natural age-structure. The results of post-translocation monitoring will be used to determine whether or not further introductions to this area, beyond 2011, are likely to be necessary. Establishment of a second new sub-population is planned in 2011, in one of the scrapes created when the fen was restored in the late 1990s. The target area is situated between the new Great Fen introduction site and the core area on Middle Fen.

Progress with the translocations will be kept under review by the project steering group and the plans modified in the light of monitoring results. The steering group will also keep under review the initial decision to introduce only spiders of Redgrave & Lopham Fen provenance. A 2010 introduction to Castle Marshes on the lower Waveney used spiderlings of mixed provenance (Smith 2011). These comprised pure stock from both Redgrave & Lopham Fen and the Pevensey Levels, Sussex, and hybrids between these two populations. The decision to use mixed provenance was based three factors: (1) the very close similarity of this site to the Pevensey Levels (2) its situation on the same river as Redgrave & Lopham Fen and (3) the results of an experiment to ascertain whether hybrids between the populations grew and survived as well as those of single site provenance (Smith 2011).

While these two measures to increase occupancy of suitable habitat at Redgrave & Lopham Fen should reduce the intrinsic vulnerability of the *D. plantarius* population, and result in progress towards the BAP target, summer droughts remain a threat to progress. The probability of severe drought continues to increase as the climate becomes warmer. Particularly when droughts occur in two or more successive years, they can devastate the population by preventing breeding and recruitment. A long-term programme is therefore needed to ensure the maintenance of adequate depth in existing turf ponds and the creation both of chains of new, deep ponds and of areas of deeper water near the *C. mariscus*-fringed margins of the larger scrapes (Smith 2010). Establishment of a sustainable, functional metapopulation on the Fen will only be possible when reliable, summer-wet links between the subpopulations have been re-established.

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