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Fen ragwort *Senecio paludosus* L: a review of conservation work carried out under English Nature's Species Recovery Programme, 1991-2005

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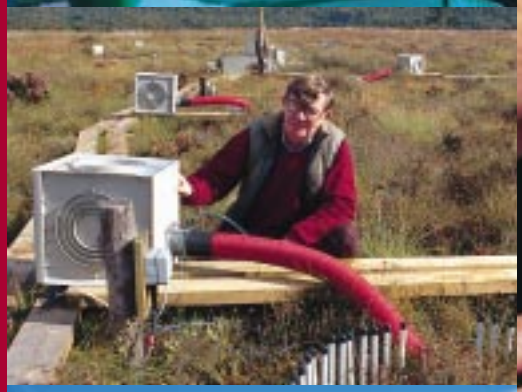

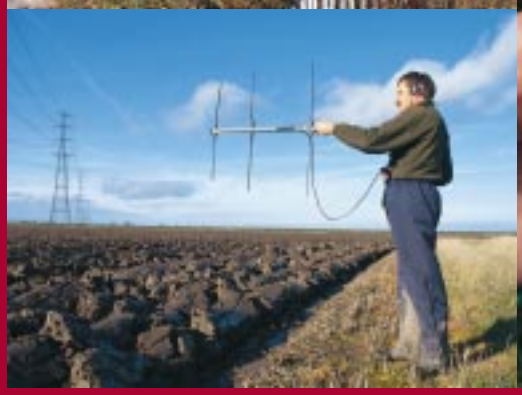

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Fen Ragwort *Senecio paludosus* L: a review of conservation work carried out under English Nature's Species Recovery Programme, 1991 to 2005

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Preface

Fen ragwort *Senecio paludosus* is regarded as Critically Endangered in Britain (Cheffings & Farrell 2005) and is protected by listing on Schedule 8 of the Wildlife and Countryside Act 1981.

In 1991 English Nature launched its Species Recovery Programme, which included action to conserve *Senecio paludosus*. The objectives of the three-year programme on this species were:

- verification of the exact ecological requirements of the plant;
- assessment of the sustainability of two former sites/areas for the reinstatement of a self-sustaining population;
- reinstatement of two strong populations of at least 50 plants in Cambridgeshire and Suffolk;
- collection of seed in liaison with Kew for future use in practical programmes, educational aspects and research.

The Institute of Terrestrial Ecology (ITE), Monks Wood, was contracted by English Nature to undertake research on *Senecio paludosus* under the Species Recovery Programme. Three annual reports on this work were submitted (Wells and others 1992, 1993, 1994).

Further work on *Senecio paludosus* was carried out by Dr. Terry Wells from 1995 to 1999, as an independent contractor to English Nature (Wells 1996, 1997, 1998, 1999, 2000). The focus of investigations changed over the years, as understanding of the plant's ecology developed and experimental introduction to new sites was carried out. The objectives of the work in 1995 (Wells 1996) were to:

- establish a second population at Stuntney, Cambridgeshire;
- establish a second population at Woodwalton Fen National Nature Reserve, Cambridgeshire
- monitor the performance of the original and introduced populations at Stuntney, Woodwalton and Wicken Fen National Nature Reserves and the Cam Washes;
- provide advice on the management of the extant and introduced populations;
- advise on further suitable sites for establishing additional populations in 1996 and beyond.

On Terry Wells' retirement from the project at the end of 1999, a contract was issued to Tim Pankhurst and Richard Lansdown to continue the work. A new set of objectives was agreed.

- Protect, maintain and enhance the stand of *Senecio paludosus* at its one known native site in the UK.
- Maintain and enhance the populations of the species at its established introduction sites.

- Provide a comprehensive ecological profile of the species, supported by data from natural populations in Europe.
- Establish and maintain a reserve population in appropriate form for the purposes of introductions and for experimental study.
- Identify two rivers in England which may be suitable for the experimental introduction of populations of *Senecio paludosus,* with a view to making introductions if the ecological profile supports it.

These contractors produced annual progress reports covering the work from 2000 to 2004 (Pankhurst 2000, 2003, 2004, 2005), also a draft ecological profile of *Senecio paludosus* (Pankhurst & Lansdown 2004).

This review of the work on *Senecio paludosus* carried out under English Nature's Species Recovery Programme, covers the period from 1991 to 2005. It is a collation and summary of information contained in contract reports produced by ITE, Terry Wells and Tim Pankhurst. In addition, it draws on the draft ecological profile of the species produced by Pankhurst & Lansdown.

Acknowledgements

The information collated in this review was produced by the Monks Wood team (T.C.E. Wells, C.D. Preston, R. Cox, J.M. Croft, A. Frost and D. Barratt) who worked on the Species Recovery Programme and by subsequent contactors (Terry Wells, Tim Pankhurst and Richard Lansdown). I am particularly grateful to Terry Wells and Tim Pankhurst for providing copies of their reports and answering queries.

I would like to thank Alan Bowley and Peter Stroh, of English Nature, for supplying me with information on Woodwalton Fen National Nature Reserve and the SSSI at Stuntney. Norman Sills, of the Royal Society for the Protection of Birds, gave me details of the translocation experiments at Lakenheath Fen RSPB Reserve. Henry Arnold provided me with records and a distribution map from the Biological Records Centre, Monks Wood. Janet Terry, Royal Botanic Gardens, Kew, kindly sent me a report produced from the Seed Bank database, giving details of the holdings of *Senecio paludosus* seed. Chris Gerrard, Owen Mountford and Mark Tarttelin provided information on fen restoration projects in Cambridgeshire and Lincolnshire.

I am grateful to Jill Sutcliffe, English Nature, for giving me the opportunity to produce this review and for supervising the contract.

Summary

Fen ragwort *Senecio paludosus* is Critically Endangered in Britain. This review summarises the work carried out on this plant in the period 1991 to 2005, under English Nature's Species Recovery Programme. The main sources of information were contract reports produced by the Institute of Terrestrial Ecology, Terry Wells, Tim Pankhurst and Richard Lansdown.

Although once widespread in the fens of East Anglia, *Senecio paludosus* is currently known as a native from one summer-dry roadside ditch in arable land near Ely, Cambridgeshire. The plant was discovered there in 1972 and is thought to have arisen from long-dormant seed. Only two large clumps of the plant now survive.

Cultivated populations have been established and seed from the UK population is stored in the National Seed Bank, Royal Botanic Gardens, Kew.

The following are key findings from the ecological research on *Senecio paludosus* carried out in the UK and in mainland Europe.

- *Senecio paludosus* is a very long-lived perennial.
- Seed may be capable of remaining dormant for many years, thus enabling the plant to survive unsuitable periods during which vegetative plant material dies off.
- Mature plants do not need a high summer water table, but prefer areas that have a high winter water table or are periodically flooded.
- Young plants require open areas in which to develop, but mature *Senecio paludosus* plants can compete successfully among tall vegetation.
- *Senecio paludosus* is not a ditch plant in mainland Europe; it grows on the margins of rivers and lakes and in mixed fen communities, usually in the floodplains of large rivers.
- In mainland Europe the principle agent of dispersal appears to be flooding, which breaks off plant fragments and carries them downstream, to develop in open areas on alluvial deposits. Populations around lakes along the Rhine valley probably serve as reservoirs from which downstream sections are supplied with propagules.
- The rarity of *Senecio paludosus* in the UK may be due to the fact that the large complexes of water bodies that once occurred in the fens are gone and rivers are no longer allowed to flood in their natural manner.

Numerous sites within the historical range of *Senecio paludosus* were examined for their suitability as re-introduction/introduction sites. Between 1992 and 2000 plants were translocated to nine sites in Cambridgeshire and Suffolk, but by 2005 it was believed that the only introduced populations that survived were at Woodwalton Fen National Nature Reserve and in newly-planted areas at Lakenheath RSPB Reserve.

In the light of repeated failures in the translocation programme and the landscape-level requirements for the long-term survival of *Senecio paludosus*, the question remains as to whether it is practicable to attempt to establish a fully self-sustaining population in the UK. The survival of metapopulations may depend on restoring mobile wetland systems such as those currently proposed for large areas of the Cambridgeshire fens.

Contents

Research Information Note

1 Morphology, identification, taxonomy and genetics

Fen ragwort belongs to the family Asteraceae. Twenty species of *Senecio* occur in Britain (Stace 1997) but *Senecio paludosus* is not easily confused with any other member of the genus. It is a robust, erect perennial, sometimes reaching over two metres in height, with a loose terminal panicle of yellow flowers and lanceolate, toothed leaves that are cottony underneath.

No hybrids are known from the UK. *Senecio paludosus* is replaced east of the Urals by *Senecio tataricus*, but the taxonomic relationship between these two species has no bearing on the conservation of *Senecio paludosus* in the UK (Pankhurst & Lansdown 2004).

2 Distribution and current status

2.1 World

Senecio paludosus is endemic to Europe (Pankhurst & Lansdown 2004).

2.2 Europe

The main range of this species extends from southern Scandinavia south to the Alps and east to the Urals. There are a few records from Iberia and Italy and the plant is largely absent from Scandinavia, apart from the southern Sweden (Pankhurst & Lansdown 2004). It is thought to be extinct in Denmark and has declined in north west Germany (Wigginton 1999), but is not regarded as threatened elsewhere.

2.3 United Kingdom

In the United Kingdom *Senecio paludosus* is currently known as a native only from a single roadside ditch in arable land at Stuntney, near Ely, Cambridgeshire. It was discovered there in 1972 (Walters 1974). The ditch had been dug in 1968, when a bypass was constructed on the A142.

Between 1660 and the mid-1800s the plant was recorded at scattered localities in ditches and fens in Cambridgeshire, Lincolnshire, Norfolk and Suffolk (Wigginton 1999). It was present in Wicken Fen and Lakenheath Fen for many years. The last confirmed nineteenth century record for the Wash catchment was in 1883 from Chatteris, Cambridgeshire (BRC database), and for nearly a century the species was thought to be extinct in the UK.

However, there is a specimen in the herbarium of the Royal Botanic Gardens Edinburgh, collected from a gravel pit near Ware, Hertfordshire in 1932, which has recently been identified as *Senecio paludosus* (D. McKean pers.com). This needs further verification. Pankhurst and Lansdown (2004) suggest the possibility that the plant might still survive in the complex of gravel pits and associated fen and marsh habitats in the Lea valley downstream of Ware. The 1972 record from Stuntney may, therefore, be the second reappearance of the plant in the 20th Century. It is possible that both populations originated from seed that had lain dormant for many years and was stimulated to germinate by disturbance of the soil.

Senecio paludosus is regarded as Critically Endangered in Britain (Cheffings & Farrell 2005) and has been included in English Nature's Species Recovery Programme since 1991. Numerous translocations to other sites have been made as part of this Recovery Programme (see Section 7.2.3).

A summary of native records for *Senecio paludosus* held in the Biological Records Centre (BRC), Monks Wood, is given as Table 1. Records for translocation sites are given in Section 7.3.3.

Table 1 A summary of records for *Senecio paludosus* held in the Biological Records Centre, Monks Wood (native records only)

County (and vice-county number)	Site and 10 km square	Years of records			
		Pre-1900	1900-1980	1981-1990	1991-2005
Cambridgeshire (vc. 29)	Chatteris TL38	1763 1883			
	Ely (near) TL58	1833			
	Littleport TL58	1820			
	Padnal Fen TL58	1831			
	Stuntney/Ely/near Ely TL57		1979	1982 1983 1984 1988	1992 1994
	Upware TL56	1857			
	Wicken Fen TL56/TL57	1800 1818 1857	1980*		
Lincolnshire (vc. 53)	Brayford Water SK97	1797 1838			
Norfolk (vc. 28)	Filby Broad TF41	1876			
	Old Podike TF50	1714			
Suffolk (vc. 26)	Lakenheath/Lakenheath Fen/Wangford TL78	1798 1799 1800 1850-			

* This is an anonymous record, which needs checking.

Figure 1 illustrates the UK distribution of *Senecio paludosus*. The map was produced by the Biological Records Centre, CEH Monks Wood, using Dr Alan Morton's DMAP software, from records compiled by the Botanical Society of the British Isles.

001801 1900 Senecio paludosus

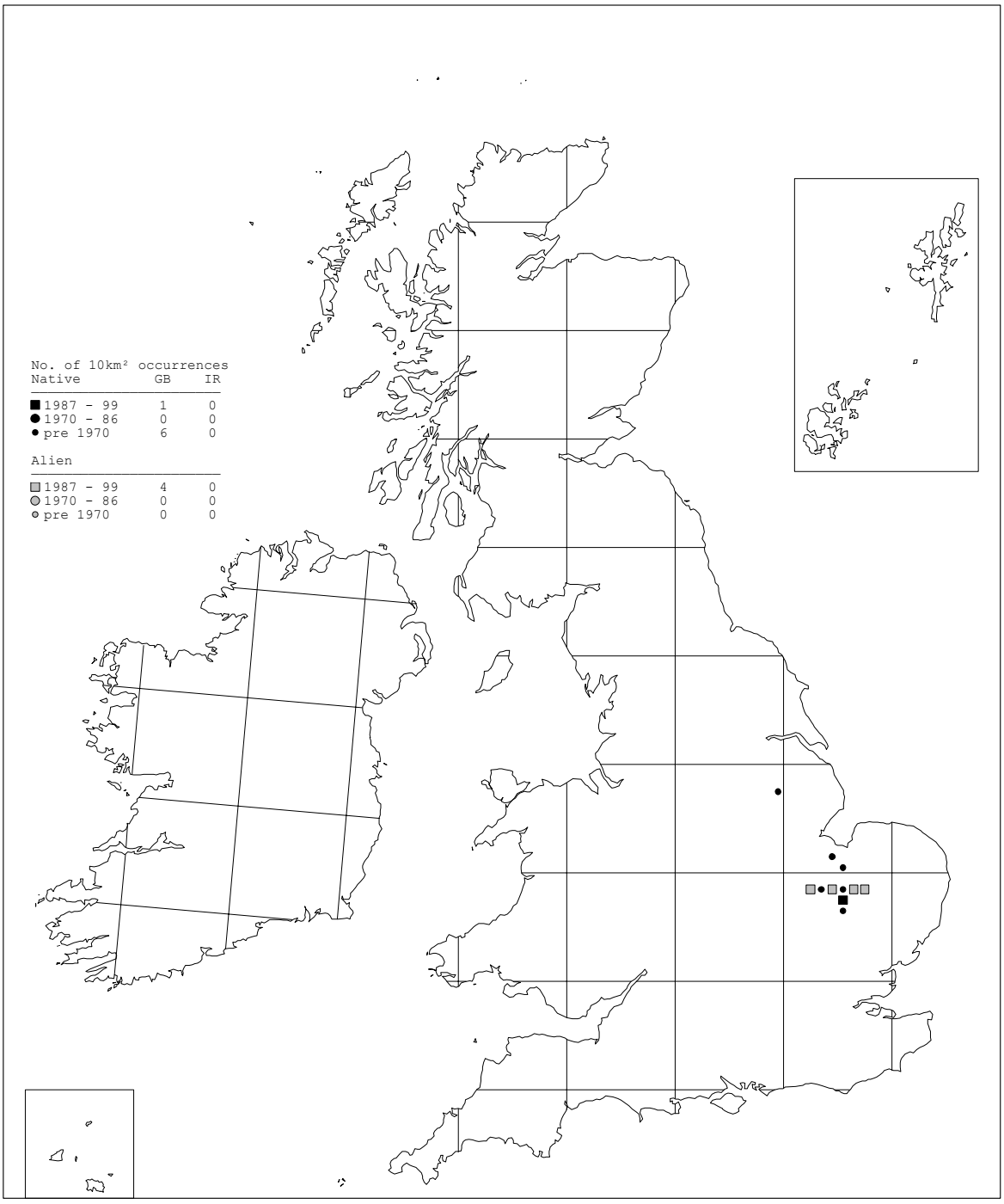

Figure 1 The UK distribution of *Senecio paludosus*

3 Ecology and life cycle

Senecio paludosus is a perennial plant that flowers annually and can propagate vegetatively via rhizomes and from broken-off fragments of rootstock and probably also stem. Young plants, up to about four years old, need open situations in which to develop and frequently succumb to competition from other plants. In favourable conditions, where competition is not too strong, plants generally flower in the season following germination, and a single plant goes on to produce an increasing number of shoots. Mature plants compete effectively with other tall vegetation. Where management such as cutting or grazing is carried out, the plant can live for decades and possibly even for centuries (Pankhurst & Lansdown 2004).

Insect pollination is believed to occur, but the plant may normally be apomictic, as is common in the Asteraceae (Pankhurst & Lansdown 2004). There has been no recorded germination from seed self-sown into the fen vegetation, but limited germination can occur on bare peat (Wells 1998). The spontaneous occurrence of the plant in Cambridgeshire, after a long period when it was regarded as extinct, suggests that seed can remain viable through many years of dormancy.

4 Habitat requirements

4.1 The landscape perspective

As fen ragwort is so rare in Britain, it is necessary to refer to its habitat requirements in countries where it is more common. In the Netherlands and Germany *Senecio paludosus* is widespread beside large rivers, often developing where alluvium is laid down during flood events. Plants can survive inundation, especially in the winter, but they do not need a high summer water table.

In plants growing along the Rhine and other European rivers the dominant form of reproduction appears to vegetative (Pankhurst & Lansdown 2004). Small pieces of the plant are broken off and dispersed during flooding, to be deposited on bare substrates where they develop free of competition from other plants. By the time these bare areas are colonised by other vegetation, the propagules of *Senecio paludosus* have developed into sturdy, perennial plants that may survive for many years.

In order to prevent ultimate extinction from a catchment through gradual downstream movement, there must be a self-sustaining population somewhere in the area acting as a source for recolonisation. Lansdown and Pankhurst (2004) point out that at the head of the middle Rhine, on the shores of the Bodensee (Lake Constance), there is a large population of *Senecio paludosus.* Young plants develop on bare substrate created by the abrasion of debris during the influx of melt-water from the Alps in the spring. Populations in the Bodensee and other lakes probably serve as reservoirs from which downstream sections of the Rhine are continually fed with propagules.

It appears that seed plays little part in the maintenance of dynamic populations. Lansdown and Pankhurst (2004) postulate that the role of seed is primarily for dispersal between catchments. Seed may also be capable of remaining dormant for many years, thus enabling

the plant to survive periods when conditions are unsuitable for growth and all vegetative plant material has died off.

Lansdown and Pankhurst (2004) observed that the fen meadow sites in the Netherlands where they found *Senecio paludosus* are not now subject to flooding by rivers. They postulate that these populations may be descended from single or very few colonists that arrived decades or even centuries ago, as a result of extreme flood events or as wind-blown seed.

Probably the reason why *Senecio paludosus* is now so rare in the UK is because the large complexes of water bodies that once occurred in the fens have gone and large rivers are no longer allowed to flood in their natural manner.

4.2 Communities and vegetation

The only extant native site for *Senecio paludosus* in the UK is the side of a summer-dry ditch that holds a few centimetres of water in the winter. The plant is rooted above the water level among coarse vegetation that includes false oat-grass *Arrhenatherum elatius*, common couch *Elytrigia* (*Agropyron*) *repens*, stinging nettle *Urtica dioica* and greater reed-mace *Typha latifolia.*

In 1992, the team from ITE collected a substantial set of quadrat data from 15 sites in the Netherlands and Germany where mature *Senecio paludosus* was found (Wells and others 1993). In 2001, Pankhurst and Lansdown collected a further set of data from 16 European locations, 15 around mature *Senecio paludosus* plants and one around a stand of young plants. The data were matched against National Vegetation Classification (NVC) types (Lansdown & Pankhurst 2004). Despite a considerable amount of variation in the vegetation associated with *Senecio paludosus*, analysis showed affinities with two main communities (Rodwell 1991 and 1995).

S26 *Phragmites australis-Urtica dioica* tall-herb fen community

The match of the samples with S26, the common reed-stinging nettle community, is mitigated by the prominence of reed canary-grass *Phalaris arundinacea,* which is more typical of the S28 *Phalaris arundinacea* tall-herb fen community. S28 is characteristic of situations that are inundated in winter but have a summer water table below the surface for most of the season (Rodwell 1995). This mix of S26 and S28 is to be expected in riparian fens in the fertile floodplains of large, calcareous rivers that flood extensively in winter but drop below their banks in summer.

M24 *Molinea caerulea-Cirsium dissectum* fen-meadow community

Two sites in the Netherlands where *Senecio paludosus* grew as a prominent component of the vegetation were matched with the M24 fen-meadow community. M24 occurs on moist to fairly dry peats and peaty mineral soils, typically on the fringes of fens and bogs or on the margins of wet hollows and flushes (Rodwell 1991).

Vegetation from the site of the young plants was different from that associated with mature plants. The young plants were shaded by overhanging trees and were sprouting from a bed of organic debris left behind when the previous winter's flood waters receded. A mixture of fen

herbs and low woodland plants was starting to colonise, but the vegetation did not match well with any NVC type.

4.3 Summary of habitat requirements

The habitat requirements of *Senecio paludosus* are summarised in Table 2.

Table 2 Habitat features important to *Senecio paludosus*

Type	Description
Physical and topograpical	Lowland The only remaining native UK site is a roadside ditch. Formerly the plant was widespread in the fens of East Anglia. In mainland Europe, it occurs beside rivers, backwaters and fluctuating lakes, or in fen meadows. On loam, silt, alluvium, clay or peat
Vegetational and structural	Usually found in S26 *Phragmites australis-Urtica dioica* tall-herb fen community, but with *Phalaris arundinacea* more prominent than usual. In mainland Europe, occasionally in M24 *Molinea caerulea-Cirsium dissectum* fen-meadow community. Young plants in organic flood debris or alluvium on the Continent.
Processes	A fluctuating water level and summer-dry soil typifies the habitat. In mainland Europe *Senecio paludosus* occurs in floodplains of large rivers subject to winter flooding. The plant can reproduce vegetatively and propagules are spread during flooding and develop as primary colonisers on bare substrates where competition is negligible. The mature plant is robust and can persist in tall wetland vegetation. Mowing and grazing help to perpetuate established stands.
Chemical	Beside base-rich waters Nutrient enrichment tolerated

5 Threats / factors leading to loss or decline or limiting recovery

The drastic eighteenth and nineteenth century decline of *Senecio paludosus* resulted from drainage of the fens. Even though stands could have survived in remaining pockets of suitable habitat for very long time, the plant would have been expected to die out eventually unless it had the means to spread from place to place.

Wells and others (1992) found that although plants from the native UK population of *Senecio paludosus* produced plenty of seed, fertility was much lower than for seed from the Continent.

Senecio paludosus requires bare substrate for the establishment of young plants and therefore some means of dispersal of propagules from the thickly vegetated areas in which the mature plant grows. Observations that the species thrives in Europe around large rivers prone to flooding support the assertion made by Pankhurst and Lansdown (2004) that *Senecio paludosus* is rare in the UK because there are now no naturally flooding rivers along which it can spread by vegetative means.

The single small native colony remaining at Stuntney could be wiped out by accident. For instance, rubbish could be dumped on it or a car crash on the busy A142 could result in a vehicle landing on the clump of plants and destroying them. Such an event look place in December 2005 just missing the plan (pers. com. Peter Stroh, English Nature Area Team). Indeed, in 1998 a large lorry left the road and crashed into the ditch, missing the plants by only a few metres. In 2001 four sacks of rubbish, a large piece of board, three lubricant drums, a road sign and a traffic cone were removed from the ditch. Stems also appear to have been snapped by eddies created by passing lorries. Another threat to young plants is from herbivores, as fen ragwort is palatable to slugs, snails and deer.

6 Management implications

Pankhurst and Lansdown (2004) observed that fen meadows in the Netherlands supporting stands of *Senecio paludosus* were mown or grazed and that this appeared to encourage vegetative spread by means of shoots from the rhizome. Mowing and aftermath grazing may also cause cut plant fragments to be trodden into the ground, where they shoot.

Even though mature stands can survive for very long time, the plant would be expected gradually to dwindle away unless it has the means to spread from place to place. In the long term, it may only be possible to establish a fully self-sustaining population of *Senecio paludosus* in eastern England by restoring a river to its naturally mobile course, thus enabling the plant to spread by vegetative means (Pankhurst and Lansdown 2004).

7 Conservation measures

7.1 *In situ* measures

7.1.1 Legislation

Senecio paludosus has been listed under Schedule 8 of Part I of the Wildlife and Countryside Act 1981 (as amended) since 1988. The length of ditch in which the plant grows is scheduled as a Site of Special Scientific Interest (SSSI).

7.1.2 Management at the native site

For many years it seems that little or no management was carried out on the ditch at Stuntney, so it has become progressively drier and its vegetation more rank. In 2001, Tim Pankhurst cut vegetation back from around the shoots of *Senecio paludosus*. There are now plans to remove sediment from the bottom of the ditch ('slub it out') in February 2006, avoiding the section directly around the *Senecio paludosus* clumps (Peter Stroh, English Nature, pers. com.). Vegetation around the plants will be removed by hand-pulling.

7.2 *Ex-situ* measures

7.2.1 *Ex situ* cultivation and seed preservation

In 1991, seed of *Senecio paludosus* from the native site at Stuntney was deposited in the National Seed Bank held at Wakehurst Place by the Royal Botanic Gardens, Kew. The Seed Bank also holds seed from Stuntney collected on several occasions between 1972 and 1976 by staff of the Cambridge University Botanic Garden (Janet Terry pers. com.).

A cutting from a *Senecio paludosus* plant at Stuntney was grown on in Cambridge University Botanic Garden in 1972 (Walters 1974). Between 1991 and 1993 plants were raised from seed and stem cuttings originating from the Stuntney population, and cultivated in tanks outside at ITE Monks Wood. More plants were propagated later and grown on in pots in Terry Wells' garden at Upwood, Cambridgeshire and in Tim Pankhurst's garden in Leighton Bromswold, Cambridgeshire. From 2002, Tim Pankhurst successfully propagated plants from sections of rhizome. Seed collected in 2002 from introduced stock at Lakenheath RSPB Reserve was grown on in pots in a greenhouse in Mildenhall, Suffolk, and in a garden at Hockwold, Norfolk. In 2005, cultivated populations still existed at all six locations.

7.2.2 Experimental work

Investigations into germination success and the fertility of seed from populations in the UK, the Netherlands and Germany, were carried out at ITE Monks Wood between 1991 and 1993 (Wells and others 1992, 1993 and 1994) and by Terry Wells in 1999 (Wells 2000). The main findings were as follows.

- Seed has no dormancy mechanism. In the laboratory, newly harvested seed began to germinate after six days at room temperature. 80% of fertile seed from Stuntney germinated. Seed stored at low humidity and low temperature retained its viability.
- At 15^{o}C, seed from mainland Europe germinated less well than did seed from UK stock. This may be because British populations are adapted for development at lower temperatures than plants on the Continent.
- Only about 7% of the Stuntney seed was fertile, compared with 75% of seed collected from plants in the Netherlands and 53% of seed from German plants.
- The percentage of fertile achenes in samples taken from individual plants in three of the introduced populations in Britain varied from 0% to 41.3%.
- Cross-pollination may be necessary to produce fertile seed, but whether the requirement is for pollen from different plants or from different flowers was not established.

In 1992 leaves of *Senecio paludosus* collected from Stuntney and from sites in the Netherlands and Germany were sent to the Royal Botanic Gardens, Kew for genotype analysis using genetic finger-printing. No results could be traced and it is not known at Kew whether the analysis was ever carried out (John Dickie, Royal Botanic Gardens, pers. com.).

7.2.3 Translocations to the wild

Extensive survey was carried out to decide on the most suitable sites for introduction/re-introduction of *Senecio paludosus*. Plants grown from Stuntney stock were introduced to the following sites in Cambridgeshire, Peterborough and Suffolk (Wells and others 1992, 1994 and 1994; Wells 1996, 1997, 1998, 1999, 2000; various reports for English Nature files by Tim Pankhurst 2000, 2003, 2004, 2005).

Wicken Fen

Wicken Fen is a National Nature Reserve in Cambridgeshire, owned and managed by the National Trust. There are records of *Senecio paludosus* at Wicken Fen in the 1800s and in

1980 (BRC database). The area chosen for the first reintroduction was an old pond in the northern part of the Reserve. The pond margins were prepared by cutting back encroaching scrub and removing herbaceous vegetation. In May 1992, 50 one-year-old plants were inserted into the peat around the pond, in three rows. In one row the water was on a level with the top of the basal rosette of leaves, the second row was about 15 centimetres higher up and a third was on slightly higher ground. Half the pond was fenced against deer and half was left open to grazing.

In June 1997, a further introduction of ten one-year-old plants was made at the edge of a water-filled ditch cleared of marginal vegetation. Plants were placed in plastic tubes as a protection against grazing animals. In 1993, 270 *Senecio paludosus* seeds were sown onto an area of two square metres of bare peat at Wicken Fen, to investigate the possibility of germination and establishment in the field. Heavy rain followed the sowing.

Woodwalton Fen

Woodwalton Fen is a National Nature Reserve in Cambridgeshire, administered by English Nature. The area chosen for the first introduction (Jackson's Bridge) was in tall fen vegetation near the main entrance ride, and provided a gradient of water depths. The existing vegetation was cut to about 5 centimetres in height and the cuttings were removed. In August 1992, 50 one-year-old *Senecio palusosus* plants were introduced, using the same planting process as at the Wicken Fen pond. The population was badly hit by flooding in the following winter, so in August 1993 it was reinforced with 40 additional two-year old plants. Vegetation in the planting area is cut on a three-year rotation and the fen ragwort plants are occasionally included in the cut.

In 1998, an area adjacent to the introduction site was cleared of vegetation and the surface of the peat was scuffed, to encourage seed to germinate.

In May 1995 an introduction of 12 two-year-old plants was made to a new site on the eastern bank of the Central Dyke, amongst mixed fen vegetation including common reed *Phragmites australis.*

Bradford's Farm, Stuntney

A deep drain at Stuntney, near the native population, was chosen as the third introduction site. This drain was bounded by a grass track on one side and the grassy bank of an arable field on the other. In July 1995 twelve two-year-old *Senecio paludosus* plants were planted along the northern part of the ditch, about 2 centimetres above the bottom. At the time of planting the bottom of the ditch was damp but there was no standing water in it.

Cam Washes

The Cam Washes site is a wet ditch near Wicken, which at the time of the introduction supported an almost pure stand of reed sweet-grass *Glyceria maxima.* In July 1995 12 two-year-old *Senecio paludosus* plants were inserted into holes dug into the northern bank of the ditch.

Welches Dam, Ouse Washes

Two areas with a high water table were chosen in the RSPB Reserve on the Ouse Washes, Cambridgeshire. The Washes are dry in summer but flooded up to a depth of at least a metre in winter and spring. In April 1996, 12 one-year-old *Senecio paludosus* plants were planted in a fenced-off area in species-poor grassland cut annually for silage ('First Singing Wash'). Six other plants were introduced to an area of *Arrhenatherum elatius* grassland used as rough grazing for cattle ('The Triangle'). Stock were excluded from the latter area by an electric fence.

Kingfisher Bridge

This site is on private farmland in which an extensive wetland, including areas of open water, had been recreated beside the River Cam, near Wicken. In July 1997, 14 one-year-old *Senecio paludosus* plants were planted at the edge of two lakes that had been excavated the previous year and where little colonisation from other plants had occurred. The introduced plants were protected from grazing by plastic tubes. In 1998 12 more one-year-old plants were introduced at the lake edge.

Lakenheath Fen

There are 18th and 19th century records for *Senecio paludosus* in the Lakenheath area (BRC database). In 1998, 12 one-year-old plants were introduced in two groups of six to the sides of newly dug ditches in peat (Site 1 and Site 2) on the RSPB Reserve at Lakenheath Fen, Suffolk.

In 1999, 12 one-year old plants were introduced to another peaty ditch side (Site 3). All the plots were protected with chicken wire fences. In 2001, 13 one-year-old plants were introduced to two further plots (Sites 4 and 5).

Seed collected from Site 3 in 2002 was grown in pots and in April and May 2005, 90 three-year-old plants were introduced in batches of ten to nine new plots. A new approach was used, as the plants were older than those used for previous translocation attempts and some of the plantings were on the banks of the Little Ouse. The other sites were on ditch sides in bare ground or amongst *Glyceria.* The plants were positioned at various heights above and below the water surface, some as high as 20 centimetres above water level and others as deep as 18 centimetres below it.

Flag Fen, Peterborough

The aim was to establish, over a number of years, a reserve nursery population of *Senecio paludosus* at Flag Fen, a site of outstanding archaeological interest where excavation is ongoing. The site contained scraped areas of bare peat with the soil surface close to the water table, which were accessible for management. In May 1996, in conjunction with the site owner, Anglian Water Services, an introduction of *Senecio paludosus* was made to Flag Fen. The area chosen was a pond and marsh created to enhance the environment for conservation. Twelve two-year-old plants were planted at the edge of the pond about 10 centimetres above the water level and protected from rabbit grazing by plastic guards. Because this introduction failed, a further six plants were introduced in 2000 to the original site.

Barway

In 1999, five two-year old plants were introduced to the side of a clay pond in a farm at Barway, two kilometres south of Stuntney. Four of the plants were flowering. They were protected with a small chicken wire fence.

7.3 Monitoring

7.3.1 Native site

The performance of the native population of *Senecio paludosus* at Stuntney has been monitored since 1972.

Data up to 1990 (given in Wells and others 1992) are shown in Table 3, together with data collected in the years of the Recovery Programme (Wells and others 1993 and 1994; Wells, 1996, 1997,1998, 1999, 2000; Pankhurst 2000, 2003, 2004 and 2005).

Table 3 The status of *Senecio paludosus* at Stuntney, 1972 - 2005

Year	No. of groups of plants	No. of flowering stems	Total no. of stems
1972	?	3	5
1974	5	6	8
1975	3	5	6
1976	4	5	6
1978	5	4	8
1979	5	22	24
1982	Present	?	14
1983	3	?	51
1984	3	?	82
1985	5	?	39
1986	2	?	52
1988	1	3	16
1989	1	1	13
1991	1	26	28
1992	1?	28	28
1993	1?	32	37
1994	Present	?	?
1995	1	49	53
1996	1	15	32
1997	1	25	28
1998	1	6	10
1999	1	16	19
2000	1	?	17
2001	1	?	28
2002	1	?	25
2003	2*	?	44
2004	2	?	23
2005	2	At least 15**	22

* The original plant had divided into two separate clumps of shoots.

** The site was visited in November 2005 by Margaret Palmer. The two plants had died back but the remains of at least some of the tall flowering stems were still visible: nine stems on one plant, six on the other.

7.3.2 Translocation sites

The contractors working for the Species Recovery Programme monitored the introduced populations of *Senecio paludosus* from the time of their establishment. Recent information for Lackenheath Fen was obtained from the RSPB Warden, Norman Sills.

Wicken Fen

Monitoring data for the introduced plants are given in Table 4.

Table 4 Results of monitoring *Senecio paludosus* at Wicken Fen

Pond site

Year	No. of plants	Other observations
1992	50	50 plants introduced. 90 shoots. 43 plants survived the first few months. 75% of them flowered.
1993	34	42 plants were present in March but many were severely damaged by slugs. 71 shoots. By July only 34 remained. 24% of these flowered
1994	20	51 shoots. 80% of the plants flowered. Surrounding vegetation was over 2.5 metres high.
1995	20	32 shoots. 65% flowered
1996	13	10 plants flowered. 22 shoots. Pond dry. Vegetation in and surrounding the pond cut and removed.
1997	11	15 shoots. 5 plants flowered. Water level high throughout the year.
1998	6	12 shoots. 1 plant flowered. 3 plants badly damaged by slugs.
1999	6	8 shoots. 3 plants flowered
2000	3	4 shoots
2001	?	No monitoring because of foot and mouth epidemic
2002	0	No plants found
2003	0	All the introduced plants had disappeared.

Ditch site

Year	No. of plants	Other observations
1997	10	10 plants introduced. 4 plants flowered
1998	7	9 shoots, 3 flowering. 2 plants severely damaged by slugs/snails. Water table high in the spring. *Phragmites* cut back by hand.
1999	6	8 shoots. 3 plants flowered. Vegetation around the stems removed. Surrounding trees encroaching on the ditch.
2000	6	10 shoots
2001	?	No monitoring because of foot and mouth epidemic
2002	0	No plants found
2003	0	All the introduced plants had disappeared

The failure of the translocations was thought to be due to the low water table, competition from surrounding vegetation and severe grazing by slugs and snails.

Following the sowing of seed onto bare peat in 1993, no seedlings were found in 1994, but 2 small plants were seen in 1997, both of which had been grazed by molluscs and were threatened by competition from other vegetation. These survived into 1999 but from 2000 onwards no *Senecio paludosus* plants were recorded on the scrape, which became recolonised by fen vegetation.

Woodwalton Fen

Jackson's Bridge. Results of monitoring the introduced plants at Jackson's Bridge are given in Table 5.

Table 5 Results of monitoring *Senecio paludosus* at Woodwalton Fen

Year	No. of plants	Other observations
1992	50	50 plants introduced. Soon after planting the site was flooded and the plants were constantly inundated for four months
1993	52	Only 12 of the original plants survived. 40 more plants were introduced
1994	?	No detailed recording done. Some plants flowered. Surrounding vegetation over 200 centimetres high.
1995	29	79% of plants flowered. 34 stems.
1996	26	20 plants had inflorescences. 6 were grazed by deer
1997	34	27 flowered
1998	29	Plants survived being flooded for 6 weeks in spring and covered with debris. 27 produced flowering shoots. Evidence of grazing by deer and slugs/snails.
1999	29	Most plants flowered. Some shoots grazed by deer. Mixed fen vegetation dense. Water table near the surface.
2000	26	145 shoots
2001	?	No monitoring because of foot and mouth epidemic
2002	19	Plot cut in the autumn
2003	?	Stand of *Senecio paludosus* in excellent condition
2004	?	Plants present.
2005	?	Plants present and flowering

Vegetation around the *Senecio paludosus* stand is cut annually and the plants themselves are cut about every three years. The adjacent cleared area was examined for seedlings in 1999, 2000 and 2001. No plant identifiable as *Senecio paludosus* was found before the vegetation grew back and made the area unsuitable for germination.

Central Dyke. At the Central Dyke site the 12 plants introduced in 1995 were severely defoliated by slugs and Chinese water deer and Muntjac deer. Two plants remained in 1996 but by 1997 all of them had disappeared.

Bradford's Farm, Stuntney

Of the 12 plants introduced in 1995 only two survived to August 1996. Later that year both disappeared, probably as a result of rabbit grazing.

Cam Washes

Of the 12 plants introduced in 1995 only three survived into 1996. None were found in 1997. Their demise was attributed to cattle grazing and/or excessive competition from *Glyceria maxima*.

Welches Dam, Ouse Washes

The results of monitoring *Senecio paludosus* at Welches Dam are given in Table 6.

Table 6 Results of monitoring *Senecio paludosus* at Welches Dam

First Singing Wash

Year	No. of plants	Other observations
1996	12	12 plants introduced
1997	11	3 inflorescences
1998	6	All the plants flowered and were vigorous Standing water from November to mid-July.
1999	6	All the plants flowered. Site flooded until end of March. A build-up of litter around the base of the plants.
2000	0	No plants recorded
2001	?	No monitoring because of foot and mouth epidemic
2002	0	
2003	0	

The Triangle

Year	No. of plants	Other observations
1996	6	6 plants introduced
1997	5	No plants in flower. Plants small and etiolated. Surrounding grassland cut by hand to reduce competition.
1998	2	
1999	0	No plants remained. Failure of the translocation was attributed to competition from coarse vegetation and a low water table.

Kingfisher Bridge

The results of monitoring *Senecio paludosus* at Kingfisher Bridge are given in Table 7.

Table 7 Results of monitoring *Senecio paludosus* at Kingfisher Bridge

Year	No. of plants	Other observations
1997	14	14 one-year-old plants introduced
May 1998	4	4 plants in May Planting sites under about 40 centimetres of water
August1998	12	All the original plants had disappeared, probably because of grazing by wildfowl.12 new ones planted.
1999	0	No sign of the plants. Water 40 cm. deep
2000	?	No information
2001	?	No monitoring because of foot and mouth epidemic
2002	1	Plant under pressure from surrounding vegetation
2003	?	No survey, but the habitat had become unsuitable and it was assumed that the plant had died.

Lakenheath Fen

The results of monitoring *Senecio paludosus* at Lakenheath Fen are given in Table 8.

Table 8 Results of monitoring *Senecio paludosus* at Lakenheath Fen

Site 1

Year	No. of plants	Other observations
1998	6	6 plants introduced
1999	3	10 shoots. All the plants flowered. Competition from surrounding vegetation slight. Water table 5 cm below ground level.
2000	3	13 shoots
2001	?	No monitoring because of foot and mouth epidemic
2002	0	No plants found
2003	0	No plants found. The demise was probably due to the dryness of the site and encroachment of nettle and thistle.

Site 2

Year	No. of plants	Other observations
1998	6	6 plants introduced
1999	6	5 plants flowered. 14 shoots. 50% of the ground was still bare peat.
2000	5	12 shoots
2001	?	No monitoring because of foot and mouth epidemic
2002	3	Grazed. Strong competition from surrounding vegetation
2003	0	No plants found. Population assumed to have died out as a result of shading by *Phragmites australis*.

Site 3

Year	No. of plants	Other observations
1999	12	12 plants introduced
2000	12	30 shoots
2001	?	No monitoring because of foot and mouth epidemic
2002	8	
2003	0	No plants found. Demise probably due to shading by *Phragmites australis*.
2004	0	No plants found. Water level lowered to try to resuscitate the population.
2005	0	No plants found. Population assumed to have died out.

The 13 plants introduced to Sites 4 and 5 in 2001 survived until 2002, but then disappeared. Of the 90 plants introduced to the wild in the spring of 2005, 77 were still alive in July and the majority of these flowered.

Flag Fen, Peterborough

Of the 12 plants introduced to a pond in 1996, five survived into 1997, but these died in 1998. Their loss was attributed to the fact that the pond dried out. The second introduction of six plants, made in 2000, succumbed in 2002 as a result of excessive competition from surrounding vegetation.

Barway

The five plants introduced in 1999 had all disappeared by 2002.

Summary of translocation experiments

By 2005, the only remaining introduced populations of *Senecio paludosus* were believed to be the well-established one at Woodwalton Fen and the planting made at Lakenheath Fen in spring 2005. It would be wise to continue checking all the other translocation sites from time to time, to confirm that the plant is extinct. Information produced from monitoring the translocations is summarised in Table 9.

Table 9 Summary of translocation experiments for *Senecio paludosus*

Site	Year trans-located	No. of plants	Result
Wicken Fen:			
Pond	1992	50	By 2003 all plants had disappeared
Bare peat	1993	seed	By 2000 all plants had disappeared
Ditch	1997	10	By 2003 all plants had disappeared
Woodwalton Fen:			
Jackson's Bridge	1992, 1993	50 + 40	Plants still present in 2005
Central Dyke	1995	12	By 1997 all plants had disappeared
Stuntney drain	1995	12	All plants disappeared in 1996
Cam Washes	1995	12	By 1997 all plants had disappeared
Ouse Washes:			
First Singing Wash	1996	12	By 2000 all plants had disappeared
The Triangle	1996	12	By 1999 all plants had disappeared
Kingfisher Bridge	1997	12	By 2003 all plants were thought to have died
Lakenheath Fen:			
Site 1	1998	6	By 2002 all plants had disappeared
Site 2	1998	6	By 2003 all plants had disappeared
Site 3	1999	12	By 2003 all plants had disappeared
Sites 4 and 5	2001	13	By 2003 all plants had disappeared
Nine new 2005 sites	2005	90	77 of spring planting alive in July 2005
Flag Fen:			
First introduction	1996	12	All plants died in 1998
Second introduction	2000	6	All plants died in 2002
Barway pond	1999	5	By 2002 all plants had disappeared

7.4 Investigations abroad

In 1992, members of the ITE team visited five sites in the Netherlands and eight in Germany to investigate the ecology of *Senecio paludosus.* The sites included areas of fen vegetation in the floodplain of the Rhine, a cattle-grazed area adjacent to a polder, the margins of several rivers and lakes, and two riverine poplar plantations. At each site quadrats were laid out and the following data were collected: vascular plant associates and their relative abundance; the average height of the vegetation; the number of *Senecio paludosus* plants and their height. General notes were made on the habitat and a soil sample was taken. Capitula were collected to estimate the proportion of fertile to sterile achenes (see Section 7.2.2 for the results of experiments). Observations from the fieldwork were as follows (Wells and others 1993).

- *Senecio paludosus* is not a ditch plant in mainland Europe. It grows on the margins of rivers, lakes and artificial water bodies, under poplar or willow and in mixed fen communities. It is sometimes found on bare mud or silt.
- There was more reed canary-grass *Phalaris arundinacea* than common reed *Phragmites australis* in the quadrats.
- Mature *Senecio paludosus* plants can compete successfully among tall vegetation.
- Mature plants do not need a high summer water table, but the species seems to prefer areas that are periodically flooded or that have a high winter water table.
- Small populations are common. Only one population with over 100 plants was found and most sites had fewer than 20 plants.

- All the colonies visited consisted of mature, flowering plants, often growing as large clumps. No young plants were found.
- There was no significant difference in height between plants on the Continent and those at Stuntney.

Three hypotheses were suggested to account for regeneration of *Senecio paludosus* from seed (Wells and others 1993):

- plants regenerate from seed in small gaps *in situ*;
- plants regenerate *in situ* from seed in open ground after major disturbance;
- plants do not regenerate from seed *in situ*; populations arise in open ground and plants persist as vegetation closes up.

In 2001, Tim Pankhurst and Richard Lansdown visited 16 sites in the Netherlands, Germany and France and made further observations on the ecology of *Senecio paludosus*. Most of the sites were near rivers, two were beside lakes and two were fen meadows. Fieldwork was focused on locating young plants, with a view to characterising the habitat in which germination occurs. The results of matching the quadrat data collected in 1992 and 2001 with National Vegetation Classification communities are given in Section 4.2. Although young plants were located, these had not germinated from seed but had developed from fragments of root deposited by floodwaters. Pankhurst and Lansdown (2004) postulate that seed would also germinate in riverine alluvial deposits.

Information gained in 1992 by ITE and from the 2001 visit, together with a literature search covering France, Germany and the Netherlands, was used in the production of an ecological profile of *Senecio paludosus* (Pankhurst and Lansdown 2004).

8 Review of progress and suggestions for the future

The following objectives of the Recovery Programme for *Senecio paludosus*, as revised in 2000, have been satisfied.

- Protect, maintain and enhance the stand at its one known native site in the UK.
- Provide a comprehensive ecological profile of the species, supported by data from natural populations in Europe (see Pankhurst & Lansdown 2004).
- Establish and maintain a reserve population in appropriate form for the purposes of introductions and for experimental study.

The remaining objectives have been only partly met.

- Maintain and enhance populations at established introduction sites.
- Identify two rivers in England which may be suitable for the experimental introduction of populations of *Senecio paludosus*, with a view to making introductions if the ecological profile supports it.

The native population appears to be stable, but is vulnerable to accidental destruction. The only introduced population that has survived for any length of time is the one at Woodwalton Fen, Cambridgeshire. The latest plantings at Lakenheath Fen, Suffolk, were only carried out in 2005, so is too early to tell whether this translocation will be successful. The Little Ouse was considered suitable for an experimental introduction, so some of the plantings at Lakenheath Fen are on the banks of this river.

Pankhurst and Lansdown (2004) assert that a fully self-sustaining population of *Senecio paludosus* can only be maintained in the long term by restoring the natural flooding regime to a river system, thus providing the means by which the plant can spread vegetatively. Given the difficulty of achieving such a radical change at present, especially in East Anglia, there are a number of important issues to be addressed.

- Is it practicable to establish a self-sustaining population of *Senecio paludosus* in the UK?
- Is it acceptable to translocate the species to an area outside the Wash catchment, and if so, where is the most appropriate place?
- Should English Nature accept that *Senecio paludosus* has no future in the UK and abandon its Recovery Programme?
- Or should English Nature accept that in the present circumstances the species requires direct management if it is to propagate itself, and that resources should continue to be committed to its conservation?
- Should *Senecio paludosus* be added to the UK Biodiversity Action Plan priority species list?
- In the foreseeable future, climate change and sea level rise, together with a growing interest in wetland restoration schemes, may transform large parts of the East Anglian fens. Could this present an opportunity to restore more mobile river systems and to provide the conditions needed for the long-term survival of *Senecio paludosus*?

Two long-term projects in Cambridgeshire, the Great Fen Project (Anon 2005) and the proposed expansion of Wicken Fen (Colston & Friday 1999), aim to restore large wetland complexes with near-natural flooding regimes. The Great Fen Project is an ambitious plan to revert 3700 hectares area of arable fenland to pre-drainage condition, thus linking Woodwalton Fen with Holme Fen National Nature Reserve and providing extensive fen habitat devoted to wildlife conservation. The National Trust has an equally ambitious plan to extend fen habitat at Wicken up to 4000 hectares. The Baston and Thurlby Fens Restoration Project, a smaller-scale initiative by the Lincolnshire Wildlife Trust, aims to provide 800 hectares of fen habitat with an existing 57 hectare SSSI at its core (Mark Tarttelin pers. com.). The potential for introducing and conserving *Senecio paludosus* should be borne in mind during the development of these projects.

9 Links

Senecio paludosus is not mentioned in the Local Biodiversity Action Plan for Cambridgeshire. However, reference is made to the protection of all Schedule 8 plants, including *Senecio paludosus*, in Cambridgeshire County Council's Structure Plan (see www.Cambridgeshire.gov.uk).

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ENGLISH NATURE

Research Information Note

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Fen Ragwort *Senecio paludosus L*: a review of conservation work carried out under English Nature's Species Recovery Programme, 1991-2005

Report Authors: Edited by Margaret A Palmer Date: November 2005
Keywords: Fen ragwort, SRP, review

Introduction

Fen ragwort *Senecio paludosus* is Critically Endangered in Britain. This review summarises the work carried out on this plant in the period 1991 to 2005, under English Nature's Species Recovery Programme. The main sources of information were contract reports produced by the Institute of Terrestrial Ecology, Terry Wells, Tim Pankhurst and Richard Lansdown.

Although once widespread in the fens of East Anglia, *Senecio paludosus* is currently known as a native from one summer-dry roadside ditch in arable land near Ely, Cambridgeshire. The plant was discovered there in 1972 and is thought to have arisen from long-dormant seed. Only two large clumps of the plant now survive.

Cultivated populations have been established and seed from the UK population is stored in the National Seed Bank, Royal Botanic Gardens, Kew.

What was done

This review of the work on *Senecio paludosus* carried out under English Nature's Species Recovery Programme, covers the period from 1991 to 2005. It is a collation and summary of information contained in contract reports produced by ITE, Terry Wells and Tim Pankhurst. In addition, it draws on the draft ecological profile of the species produced by Pankhurst & Lansdown.

Results and conclusions

The following are key findings from the ecological research on *Senecio paludosus* carried out in the UK and in mainland Europe.

- *Senecio paludosus* is a very long-lived perennial.
- Seed may be capable of remaining dormant for many years, thus enabling the plant to survive unsuitable periods during which vegetative plant material dies off.
- Mature plants do not need a high summer water table, but prefer areas that have a high winter water table or are periodically flooded.

Continued……

- Young plants require open areas in which to develop, but mature *Senecio paludosus* plants can compete successfully among tall vegetation.
- *Senecio paludosus* is not a ditch plant in mainland Europe; it grows on the margins of rivers and lakes and in mixed fen communities, usually in the floodplains of large rivers.
- In mainland Europe the principle agent of dispersal appears to be flooding, which breaks off plant fragments and carries them downstream, to develop in open areas on alluvial deposits. Populations around lakes along the Rhine valley probably serve as reservoirs from which downstream sections are supplied with propagules.
- The rarity of *Senecio paludosus* in the UK may be due to the fact that the large complexes of water bodies that once occurred in the fens are gone and rivers are no longer allowed to flood in their natural manner.

Numerous sites within the historical range of *Senecio paludosus* were examined for their suitability as re-introduction/introduction sites. Between 1992 and 2000, plants were translocated to nine sites in Cambridgeshire and Suffolk, but by 2005 it was believed that the only introduced populations that survived were at Woodwalton Fen National Nature Reserve and in newly-planted areas at Lakenheath RSPB Reserve.

In the light of repeated failures in the translocation programme and the landscape-level requirements for the long-term survival of *Senecio paludosus*, the question remains as to whether it is practicable to attempt to establish a fully self-sustaining population in the UK. The survival of metapopulations may depend on restoring mobile wetland systems such as those currently proposed for large areas in the Cambridgeshire fens.

English Nature's viewpoint

Excellent summary of work undertaken up to and including 2005. This is a rare plant which English Nature is committed to conserving although the conditions it requires – fast moving waters – so not occur where it currently resides.

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Peter Wakely/English Nature 17,396
Middle left: Co_2 experiment at Roudsea Wood and Mosses NNR, Lancashire.
Peter Wakely/English Nature 21,792
Bottom left: Radio tracking a hare on Pawlett Hams, Somerset.
Paul Glendell/English Nature 23,020
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