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CONSERVATION STUDIES OF THE LUNDY CABBAGE BETWEEN 1994 AND 2000

By

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ABSTRACT

Fluctuations in abundance of the endemic Lundy cabbage *Coincya wrightii* are summarised for the period back to 1972 and described in detail from 1994 to 2000. Recorded populations seem to have varied from around 320 to 10,400 plants in flower (ca. 7000 - 70,000 plants overall including seedlings etc), although the earlier counts are thought to be under-estimates. Its detailed distribution on Lundy is mapped and described as is its relationship with the physical and biological environment and discussed with respect to the conservation of the plant and its associated fauna of endemic invertebrate taxa. Bracken is discounted as a threat to the plant. The effect of grazing by wild and domestic livestock is described as a important limiting factor in the plant's dynamics and its visibility to the visiting public. Analysis of the plant's distribution in relation to that of the non-native rhododendron *Rhododendron ponticum* indicates that Lundy cabbage could in theory be totally ousted by this invasive species, and work to alleviate that threat is described.

Keywords: *coincya, endemic, population fluctuation.*

BACKGROUND

Lundy's famous endemic plant, the Lundy cabbage *Coincya wrightii* (O.E. Schultz) Stace, has existed on the island probably since the immediate post-glacial period, including periods of arable and pastoral agriculture and the introduction of rabbits, goats, deer and various sheep. No doubt its distribution and numbers on Lundy have waxed and waned over the centuries, unrecorded until recent attempts to count it and study its ecology.

It is listed as Vulnerable Endemic in the British Red Data Book of Vascular Plants (Wigginton, 1999) and is protected under Schedule 8 of the 1981 Wildlife & Countryside Act. It is unique in Britain as the only endemic plant with associated endemic insects. It supports an endemic species of flea beetle *Psylliodes luridipennis* Kutschera, an apparently unique but undescribed island race of the related species *Psylliodes napi*, and the 'variety' *pallipes* Crotch of the weevil *Ceutorhynchus contractus* Marsham. Along with the 'Lundy cabbage Flea Beetle' *Psylliodes luridipennis*, the cabbage is listed on the UK Biodiversity Action Plan (BAP) (UK Steering Group, 1995), the UK's response to imple-

ment the World Convention on Biodiversity at Rio de Janeiro (JNCC, 1992). Within the BAP it has a 'Species Action Plan' which lists various targets and actions in order to secure its conservation. The National Trust has taken on the role of 'Lead Partner', coordinating the implementation of the plan in association with English Nature, Leeds University and the Landmark Trust.

One of the targets within the plan is to monitor its population. Routine monitoring of short-lived, pioneer species such as Lundy cabbage is particularly important, because their population sizes have the potential for rapid change. Overall trends in population size are not likely to be very easy to detect, given the 'boom and bust' character of the species. Species with highly variable population numbers are nonetheless considered to be more prone to extinction than those with relatively stable populations, hence the need to keep a regular check on the status of the species. Our counts of Lundy cabbage have, on a number of occasions, shown that casual observation by visitors or residents of Lundy can be very unreliable, for example the very low number flowering in 1996 was described by inhabitants of the island as "a good year for cabbage flowers".

We are unlikely ever to have any way of knowing whether the plant is faring well or badly compared with the last few thousand years. There have, however, been a number of descriptions of the distribution and abundance of the Lundy cabbage made over the last three decades (Table 1). The first rough estimate of numbers was made by Marren (1971 & 1972), who counted the numbers of plants in some of the sub populations only, while describing others as "in quantity", "a few" etc. The first count was made by Randall (1978), followed by Cassidi (1980), Irving (1984), and Farrell (1993).

Between 1993 and 2000, Leeds University and English Nature have been undertaking a study on the conservation biology of the Lundy cabbage under English Nature's Species Recovery programme (Compton *et al.*, in press). This has included assessment of the species' population dynamics, its relationships within the plant communities in which it occurs, its response to abiotic factors such as soil type, disturbance etc. in its environment, the diseases that affect it, and its relationship with vertebrate and invertebrate herbivores. Results to date are included in a 'Biological Flora' for Lundy cabbage, published in the Journal of Ecology (Compton *et al.*, 2000). We are assisting with continuing parallel studies on the population genetics of the plant, undertaken by Dr Denise Costich of the Thompson Institute in Ithaca, N.Y. in the USA and taxonomic studies on the endemic flea beetles associated with the plant by Mike Cox, (Cox, 1998) and genetic studies of all the associated beetles by Ross Piper of Leeds University. The Species Recovery project has also assisted in publicity and interpretation regarding the Lundy cabbage, producing an interpretive poster for St Helena's church and the Oldenburg, a leaflet about the cabbage and a postcard.

MONITORING METHODS

Direct monitoring of all plants, including seedlings and non-flowering first year rosettes is impractical owing to the very large numbers in some years and the inaccessibility of many subpopulations necessitating remote counting with binoculars. An attempt was

made to count all plants in flower in each year, aiming to coincide our annual counts as far as possible with the peak flowering period in late May/early June. The counts are, however, slight underestimates of the numbers of flowering individuals. Certain populations of plants are only visible from the sea and, owing to weather conditions and the availability of boats, we were only able to make counts of these in 1997 and 1998. It was estimated that between 85-97% of the total population is visible from terrestrial viewpoints, so the under-estimation is not likely to be too great. Also, in years with a late spring, some plants may not have quite reached flowering at the time of the counts, while some very small plants in their first flowering season may not flower until the late summer. In addition, plants that have had their flowering stems grazed off were not included; these can recover to flower later in the summer if grazing intensity is reduced.

The whole of the Eastern Sidelands was divided into a series of hierarchically coded blocks for counting purposes, extending slightly beyond the current range of the plant (Appendix in Compton *et al.*, in press). Plants in flower were counted by eye or using binoculars and estimates of the same aggregations of plants by different observers were within 10% of each other. It is therefore likely that our estimates are reasonably accurate. Representative estimates of the ratio of flowering to non-flowering plants (seedlings' first year non-flowering rosettes and grazed-off plants) were made to extrapolate an estimate of the total population in each year. Counts of non-flowering individuals are possible only at a small number of accessible locations (Victoria Beach, Millcombe, Quarry Bay and one of the Halfway Buttresses) and are therefore unlikely to be typical of the majority of the population. A 'mean' ratio was obtained by combining the counts at the four sites and using the overall ratio. However, Millcombe usually has far more plants than the other three sites, and the estimates based on mean ratios therefore tend to be biassed towards what is going on there. A ratio based on the median between the highest and lowest ratios found at individual sites was calculated. This is usually not so heavily influenced by Millcombe (however, see results below), but is highly responsive to extreme ratios at individual sites.

Fixed point photographic monitoring was started in 1993 using a variable focal length zoom telephoto lens between 28 and 200mm to produce 35mm transparencies and has been continued annually (although many shots were lost in 1999 through camera failure). Such photographic monitoring does not give estimates of numbers, but illustrates very well the differences in performance of the Lundy cabbage between years and has revealed other changes in the vegetation as well as new sheep or goat tracks, landslips and rock falls. A specific photo-monitoring route has been devised, which takes about 4 hours to complete. This is described in detail (Compton *et al.* in press) to facilitate others to undertake similar monitoring in the future. Monitoring shots up to 1995 have been transferred to Kodak PhotoCD for secure backup and all transparencies will eventually be archived with the Lundy Field Society. Conversion of the yellow of the Lundy cabbage to black in the digitised images and 'ghosting' of the background image to pale grey in particular illustrates the changes between years (Figures 1 to 4). These dramatically illustrate the 'boom and bust' nature of the plant's populations. In years such as 1998 most of the plants were flowering massively, resulting in areas of the Sidelands that were

yellow-over, while in other years far fewer plants were in flower and fewer flowers appear to be produced per plant.

A series of 25 irregular vegetation plots, averaging around 64 m^2 in area, were sited so as to include, as far as possible, the full range of vegetation types occupied by the plant, and the percentage cover of both bare substrate and individual plant species recorded for a number of years in some of the plots.

DISTRIBUTION

Early observations (Goss, 1874; Wright, 1936) implied that Lundy cabbage was limited to the loose slates at the extreme south east of the island. The 1970s and 1980s studies showed that it occurs as far north as Knights Templar Rock. The distribution was recorded each year and the individual patches of Lundy cabbage mapped using the GIS software MapInfo® in 1997 (Figures 5 to 7). We have confirmed that the Lundy cabbage occurs mainly along the south to central eastern coast of Lundy as far north as the Knight's Templar rock, such areas being sheltered from the Atlantic gales, with a few plants also occurring on the cliffs above Lametry Bay on the south coast.

The plant's total range is approximately 2500 m north to south and 600 m east to west, although only 40% of this rectangle is land. In 1997 it was estimated to be present in 60% of the 100 x 100 m squares in this area (Figure 8) which include at least some land. Using MapInfo®, we estimated that the total plan area occupied by the plant to be approximately 0.12 ha, although the actual area will be rather higher as the majority of the land occupied by the plant is steeply sloping to almost vertical.

It occurs mainly on the sea cliffs in inlets below combes on the eastern Sidelands, but is also present on rocky outcrops and buttresses, grasslands subject to occasional landslips and, at Millcombe, on the sides of a well-vegetated stream valley and on a gorse-covered knoll. Two or three plants have been found in one of the quarries in most years. Particularly significant subpopulations are the slate cliffs above Landing Beach up to the Castle, within Millcombe, around the Miller's Cake, the inlets in the cliffs below the various combes on the Eastern Sidelands, and the cliffs at Quarry Bay and at Halfway Wall Bay. The more inaccessible of these subpopulations were almost certainly missed by earlier studies. It was also formerly recorded on gently sloping bracken covered grassy Sidelands around Millcombe and around the Halfway Buttresses (Marren, 1971; Irving, 1983), but no longer does so, almost certainly because of grazing pressure.

RELATIONSHIP WITH ENVIRONMENTAL VARIABLES

Lundy cabbage has an altitudinal range from around 0.5m above sea level, with occasional plants just above the strandline at Victoria Beach and Quarry Bay, to 120m on the Knight's Templar Rock. It reaches its furthest point 300m inland, growing on a dry-stone revetment about half way between Millcombe House and the village. It prefers, but is not restricted to, south- and east-facing cliffs and slopes.

The northern limit of the plant, on the Knight's Templar rock, appears not to correspond

closely with changes in geology as it extends throughout the first and slightly into the second of the two granite types on Lundy distinguished by Dollar (1941). Changes in coastal topography on the east coast towards the north of the island, with shallower slopes and less steep cliffs accessible to grazing animals appear to be the most likely factor limiting its distribution.

The soils upon which it occurs are rarely subject to water-logging. Soils on Lundy are well-drained, loamy podsols (Dawes, 1979) and are generally more acid in the north, reflecting the change from underlying slate to granite, but there is considerable local variation. Recorded pH values of soils on which it grows range from 4.9 to 6.2 on the slates, and 2.9 (beneath Rhododendron ponticum) to 6.5 on the granite (Richardson *et al.*, 1998).

It rapidly colonises areas of soil disturbance, including new land-slips which are a regular feature on the slates in the south of its range. The large land-slip above Victoria Beach in May 1994 was immediately colonised by Lundy cabbage, which had survived being carried down with the soil and rocks. Seedlings were already present by September of the same year. Continuing disturbance in this area through to 1997 severely inhibited colonization by other plants and the cabbage has remained one of the most numerous colonists. A smaller slippage occurred approximately 100m to the south in March 1997 and the cabbage was again amongst the first species to colonise. Rabbits, larger grazers and human activity also contribute to small-scale soil disturbance which is sometimes colonised by the plant.

Frosts on Lundy are typically infrequent and mild, yet Lundy cabbage growing in gardens on the mainland can survive frosts as severe as -15°C. Adult plants appear to be fairly drought-tolerant, although we found that the severe drought of 1995 did coincide with high late-summer mortality rates among mature plants in Millcombe. This followed intense flowering activity and subsequent recruitment of young plants was exceptionally high, suggesting that drought may favour Lundy cabbage through reduced competition. Exceptionally high population levels were recorded in 1993, another year preceded by several warm and dry summers.

Within its narrow range, the plant appears to occupy almost the full range of plant communities that are present, although it does not figure in the National Vegetation Classification (Rodwell 1993-95). The eastern Sidelands support communities corresponding to the coastal extremes of NVC communities W24 (*Rubus fruticosus-Holcus lanatus* underscrub), W25 (*Pteridium aquilinum-Rubus fruticosus* underscrub) and MC12a (*Festuca rubra-Hyacinthoides non-scripta* cliff bluebells) (A. Malloch, in Compton and Key, 2000). Our 25 vegetation plots, sited to include as far as possible the range of vegetation types occupied by Lundy cabbage, contained 82 associated species (full list and analysis given in Compton & Key, 2000). In descending order of degree of association, bramble *Rubus fruticosus*, English stonecrop *Sedum anglicum*, woodsage *Teucrium scorodonia*, wall pennywort *Umbilicus rupestris*, Yorkshire fog *Holcus lanatus*, common cat's ear *Hypochaeris radicata*, cocksfoot *Dactylis glomerata*, foxglove

Digitalis purpurea, bracken *Pteridium aquilinum* and honeysuckle *Lonicera periclymenum* were the most frequently occurring associated species, with many of the other species recorded rarely and/or at low cover values. We found the communities containing Lundy cabbage to be very dynamic in terms of their turnover of species and changes in total vegetation cover but the association with bramble is likely to reflect the protection Lundy cabbage gains from grazing animals.

Lundy cabbage seems to be fairly tolerant of competition, persisting under gorse and deep bramble and also seeding into bracken-covered slopes, although it rarely survives here to flower due to grazing. It rarely occurs, however, in areas where grass cover is consistently 50% or higher and is unable to persist under or among rhododendron *Rhododendron ponticum* (see below).

FLUCTUATIONS BETWEEN YEARS

The 1970s and 1980s counts all suggest that populations of the cabbage at the time were much smaller than when they were resurveyed in 1993, the lowest recorded number being 324 flowering plants in 1979, compared with around 4000 in 1993. However, these surveys almost certainly missed a majority of the plants growing in more inaccessible locations but, even so, they suggest that in the southern part of its range, where it is readily visible, the plant had a major increase between the early 1980s and 1993. The reasons for this can only be guessed at.

No major changes were detected in the distribution of the plants between 1993 and 1999. The number of plants in flower varied greatly between years, ranging from slightly over 1300 in 1996 to over 10000 in 1998 (Table 2 and Figure 9). There was no consistent upward or downward trend, although there has been a steady decline in numbers in most subpopulations since a boom year in 1998. The number flowering in a particular year is determined by the number of plants that are present (influenced by weather conditions and recruitment in the immediately preceding years), and the survivorship (dependent again on weather conditions and grazing pressure).

Some changes in the relative importance of different sub-populations were found between years and most of the sub-populations showed roughly similar trends between years. Particular exceptions were the populations at Quarry Bay and especially the Halfway Wall cliffs which almost consistently 'bucked the trend' elsewhere. Also, in 2000, there were considerable differences between the northern areas occupied by the plant, where the population was fairly stable or, in the case of the Halfway Wall, increasing, and the south, where there was a considerable downturn, largely attributable to grazing. It was also apparent that disturbance on cliffs below St Helena's Combe resulting from clearance activities enabled a boom in numbers in this population in 1999, much of which was grazed off again in 2000. 1998 was an exceptionally good flowering year for almost all the sub-populations, while 1996 produced relatively few flowers.

Estimates of total population size based on ratios of non-flowering to flowering individuals at four sites (Table 3 and Figure 10) are clearly far less accurate than the counts of

just plants in flower, but they do provide a good indication of approximate population size and patterns of recruitment of young plants. Typically there was a majority of non-flowering plants sometimes vastly outnumbering the plants that were in flower. Clear differences in the ratios were present between years and 1998 was an exceptional year, with most of the plants in flower.

Except in 1998, when very few non-flowering plants were present, the estimates based on mid points were consistently higher than those based on the mean. The mid-point estimate in 2000 was grossly and inaccurately skewed upwards by very heavy levels of grazing in Millcombe, such that 95% of the plants that might have flowered were prevented from doing so. Together the two estimates suggest that the total population of Lundy cabbage has varied between about 5000 and perhaps 70,000 over the seven year period.

The proportion of non-flowering individuals showed an interesting inverse relationship with the number of plants that were in flower. For example, although 1996 was the poorest recent year for Lundy cabbage, based on flower counts, it also had the highest proportion of plants that were not in flower. Similarly, 1998 was the year that had the highest recorded number of plants in flower, but the high ratio meant that only average total numbers of plants were present. In the following year, the number of plants in flower was much reduced, but the estimated total number of plants was far higher than that recorded in any previous year. Clearly the mass flowering in 1998 had resulted in huge recruitment, but most of the new plants were too young to flower.

SEED BANK

By collecting soil samples (15x15x10cm deep) beneath populations of the cabbage and incubating it in ideal germination conditions, the existence of an extensive seed bank was demonstrated. Seed densities varied between 32 and 670 seeds m^{-2} dependent on proximity to a source population. The discovery of an extensive seed bank on the grassland above a cliff population at Halfway Bay indicated that updrafts are capable of dispersing seeds upwards as well as down cliff faces. Successful germination of seed from soil from areas where the cabbage had not been seen for as long as four years indicated that the seed bank can last at least this long.

CONSERVATION OF THE LUNDY CABBAGE

The Species Action Plan (UK Steering Group, 1997) identified the spread of bracken and rhododendron and grazing by herbivores as the main potential threats to the Lundy cabbage.

a BRACKEN

We found that bracken was a regular associate in successful stands of the cabbage and that the cabbage regularly germinated in stands of quite dense bracken with deep litter layers. The absence of the cabbage in the large areas of bracken on the Sidelands is attributable to a combination of competition from dense swards of grasses beneath the bracken and the effects of grazing animals, and bracken can be discounted as a significant threat to the species.

b. RHODODENDRON

The spread of rhododendron has been recognised as a potential major long term threat to the survival of Lundy cabbage (Compton *et al.*, 1998 & 1999). Phytosociological analysis of the plant communities currently occupied by both rhododendron and Lundy cabbage suggests that rhododendron is capable of occupying the full range of habitats of the cabbage and, without control, it appears capable of encompassing most if not all of the cabbage's habitat range. Despite heroic control efforts, rhododendron is still slowly increasing its range on the island and, most significantly for the Lundy cabbage, is slowly spreading from the cliff top Sidelands down onto the cliff face (see Plate at the front of the Annual Report).

While rhododendron growing on the slopes of the eastern Sidelands has probably denied Lundy cabbage some areas of potential habitat, it has so far probably had little actual effect on the overall numbers and distribution of the plant because these slopes are readily accessible to grazers. Small numbers of plants manage to establish temporarily along the path through the rhododendron and in areas where rhododendron is cleared but they rarely manage to flower and are soon grazed off. There is also a small flowering population of around half a dozen plants on one emergent rocky buttress deep within one of the big patches. The impact of the spread of rhododendron is perhaps most obvious in Quarry Bay, where we have observed some Lundy cabbage subpopulations to have been encircled and engulfed since 1994. Rhododendron spreading down the sea cliffs, in Millcombe, and the fairly recent establishment below Marisco Castle is much more mallign and, were it left unchecked, it could eventually lead to the extinction of the Lundy cabbage.

Rhododendron spreads rather slowly down the cliffs, however, and the threat it poses to the cabbage can be countered. Clearance of cliff-side rhododendron under English Nature's Species Recovery programme began in early 1998 to complement work already under way on the Sidelands funded by M.A.F.F.'s Countryside Stewardship scheme, with the removal of a large block of rhododendron just south of St Helena's Combe and continued in 1999. It has clearly had a beneficial impact on the cabbage growing there but these dramatic early benefits are likely to be transient. The long-term benefits of the rhododendron clearance measures will be seen in the continuing survival of the Lundy cabbage in areas in which it otherwise would surely have been overwhelmed.

c GRAZING ANIMALS

Sheep, goats and probably rabbits all eat Lundy cabbage and it seems to be a favoured food of sheep and goats (both sheep and goats have been observed consuming one Lundy cabbage plant after another, apparently ignoring grass and other herbs). One trio of goats was seen to eat 17 plants in half an hour in 1997, about 0.5% of the world population of the plant reproducing that year. It is unclear to what extent Sika deer and Soay sheep feed on the cabbage, while the ponies rarely, if ever, graze in areas with the plant. Experimental exclosures on the Sidelands below the Halfway Wall buttresses and close to The Ugly have confirmed that the cabbage rapidly colonises and reaches flowering size within a single season in areas of soil disturbance (though not closed dense grass

swards) on these Sidelands once the grazing animals are excluded. These are further described in Compton *et al* (in press). The exclosures also indicate that the ubiquitous rabbit probably feeds on the cabbage to some extent, but the results are equivocal and the effect of rabbit grazing may not be significant. The most obvious way that the plants are protected from being eaten is by growing on steep cliffs and outcrops where the animals cannot reach them and by dense bramble and gorse bushes such as in Millcombe.

Sheep graze on the plateau of the island, but quite regularly escape down the main road into Millcombe or down from the castle along various sheep tracks. The frequency with which the sheep are herded back on to the plateau (which must be a thankless task!), is probably the main determinant of how many Lundy cabbage are lost to sheep each year. Losses of cabbage plants to grazing in the south of the island was particularly apparent in 2000, with 95% of the plants above Millcombe failing to flower.

Feral goats are far fewer in number than sheep and mostly live in the north of the island, although occasional family groups come further south along the eastern Sidelands. Being more agile than sheep they probably have a much more significant effect on the cabbage in the northern part of its range, keeping it restricted to the steepest rocks of the buttresses and cliffs. A combination of grazing animals now probably keep the Sideland grasslands free of the cabbage. The last report of it flowering there was in 1983 but there are no records of the distribution of livestock in that area at that time.

In 2000, a highly subjective "index of accessibility" was derived for each of the monitoring compartments, estimating by eye and from experience of the presence of grazers, and accessibility on a 0-3 scale (0 = inaccessible to any grazing animals, 1 = accessible to goats but probably not to sheep, 2 = accessible to sheep, 3 = easily accessible even to humans!). Although this is highly subjective, there is quite good relationship between reduction in numbers between 1999 and 2000 and this index (Figure 11). The distribution of livestock on the island is likely to be much more important in its effect on the cabbage than absolute numbers.

However, these grazing effects are not a recent development, as Randall (1978) concluded that Lundy cabbage occurs in areas "which are mostly inaccessible to grazing animals". Stock have been maintained on the island for centuries, so this does not imply any recent contraction in range of Lundy cabbage. Occasional soil disturbance caused by grazers may even be beneficial in stimulating germination from the seed bank, although this is dependent on subsequent survival of the progeny which may well be grazed off again. It is, however, likely that, before human colonisation and the introduction of grazing animals, the cabbage would have had a wider distribution along the Sidelands, possibly occurring further north and even on parts of the plateau.

Grazing certainly does not threaten the plant with extinction but it is equally certain, however, that grazing is a very limiting factor in the plant's dynamics and distribution. The effects of grazing also reduces visitors' opportunity to view this rare plant other than at a distance, as, in some years, most accessible plants are grazed off (as happened in 2000).

DISCUSSION

Lundy cabbage has been shown to be a typical 'weedy' species which does best as a pioneer of recent soil disturbance or on sea cliffs with abundant exposed rock for germination sites. However, it has also been shown to occur in a wide variety of vegetation communities, including later seral stages under mature bracken, gorse and bramble. It has 'boom and bust' dynamics that are typical of ruderal colonisers and its performance seems to be closely related to weather conditions around the time of germination and the survivorship to flowering that is, in most cases, dependent on the impact of grazing animals. The presence of an extensive and possibly long-lived seed bank means that the species is well able to overcome short periods of adversity, such as incidents of very severe grazing.

Parallel studies of the endemic invertebrate fauna associated with the plant are less well advanced, and will be published separately, but many invertebrates, lacking any form of long term dormant stage equivalent to a plant's seed bank, are usually regarded as more vulnerable to periods of adversity (Kirby, 1992). Two of the endemic taxa, the island forms of *Psylliodes napi* and *Ceutorhynchus contractus*, were found to be completely flightless, increasing their vulnerability to localised extinction events. It may be, therefore, that the plants' associated invertebrate fauna may be more at risk than the plant itself from the effects of grazing animals and future studies will concentrate on this fauna.

However, were it not for the presence of rhododendron on the island, with its potential to occupy the whole of the Lundy cabbage's range, its population would no doubt be safe, regardless of the activities of man and his animals, until climatic conditions, probably the next glacial period, no longer favoured it. It is extremely unlikely that rhododendron would ever be allowed to overwhelm the plant and current intensive clearance activities are slowly reducing the immediate threat to it, but there will be constant need for large-scale resources to maintain the plant's habitat free of the rhododendron in perpetuity. The Lundy cabbage and its fauna is in this way typical of island species of plants and animals throughout the world which have repeatedly been shown to be peculiarly vulnerable to the impact of the introduction of non-native species.

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Location	Surveys				
	Marren 1971/2	Randall 1978	Cassidi 1980	Irving 1983	Farrell 1993
The Cove	"a few"	11	no mention	0	4
Landing & Victoria Beaches	More than 48	166	189	160	1473
Millcombe & Ladies' Beach	"in quantity"	225	41	70	1947
Sugar Loaf & Quarter Wall	small numbers	119	28	70	40
Quarries	"common"	47	0	130	312
Halfway Buttresses	"very local"	136	66	150	101
Northern cliffs	no mention	no mention	no mention	no mention	no mention
Grand Total	no estimate	693	324	580	3919

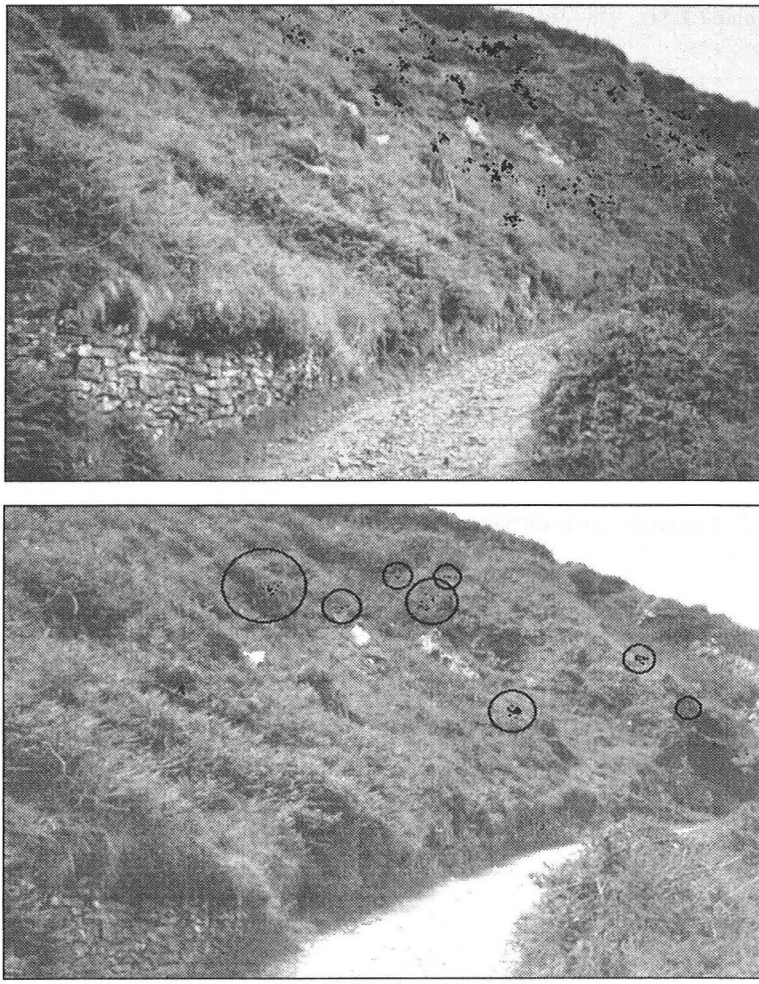
Table 1: Estimates of Lundy Cabbage population sizes 1971-1993.

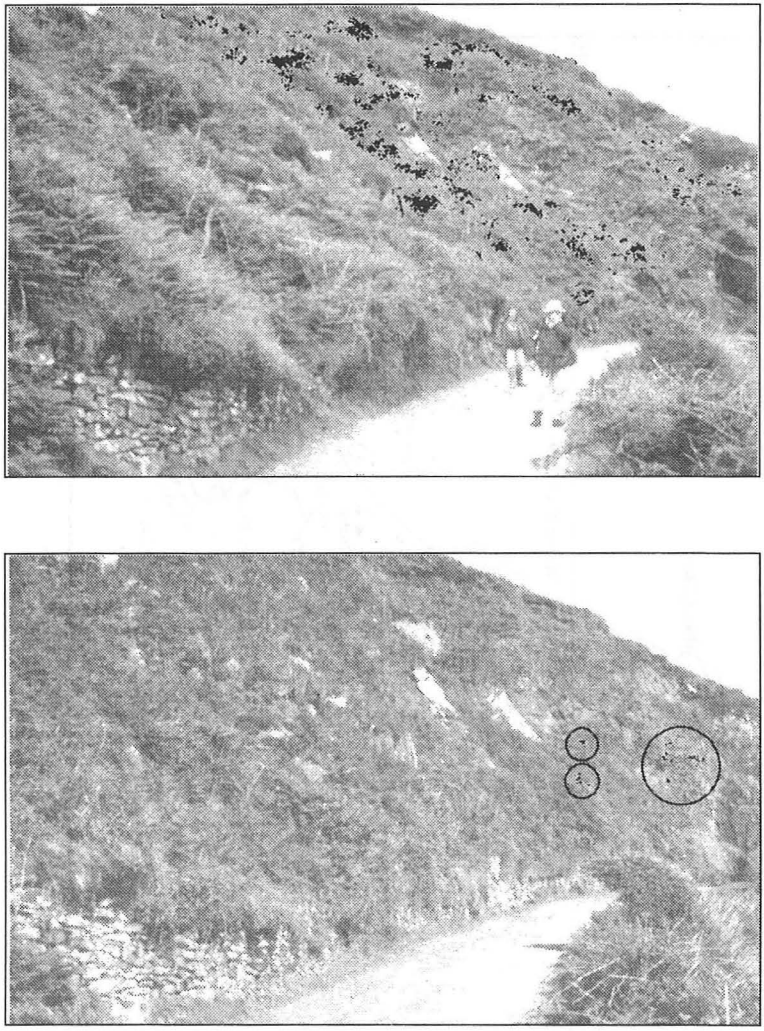
Location	1994	1995	1996	1997	1998	1999	2000
Cliffs above Cove/ below South Light	0	0	0	2	27	4	0
Cliffs above Lametry Bay	-	4	3	p	1	2	3
Cliffs - Sadde le Millcombe Mouth	426	432	172	656	1907	1151	744
Millcombe & St. John;s Valley	164	162	191	336	914	534	128
Cliffs - Millcombe to Quarter Wall Bay	872	1337	636	1384	5277	2840	1283
Quarry Bay & Quarries	237	118	87	202	864	331	345
Northern cliffs to Halway Wall Bay	59	126	217	258	944	108	468
Halfway Buttresses	89	76	32	167	322	112	88
Total	1847	2255	1338	3005	10394	5083	3059

Table 2: Counts of Lundy cabbage in flower 1994-1000 (p=present, but not flowering).

	1994	1995	1996	1997	1998	1999	2000
Total population based on mean	4200	10600	9050	23900	18100	68500	27800
Total population based on median	5060	25200	39200	30400	18600	62400	(114000)

Table 3: Estimates of total plant population based on mean and median flowering plant ratio.





Figures 1-4: Fixed point monitoring of Lundy cabbage has been carried out at 56 points alson the east coast. Here, the yellow colour of the cabbage flowers has been digitally altered to black and the rest of the image 'ghosted' to indicate the extent of the plant above the road up from Landing beach in the last week in May in 1993, 1994. 1999 and 2000.

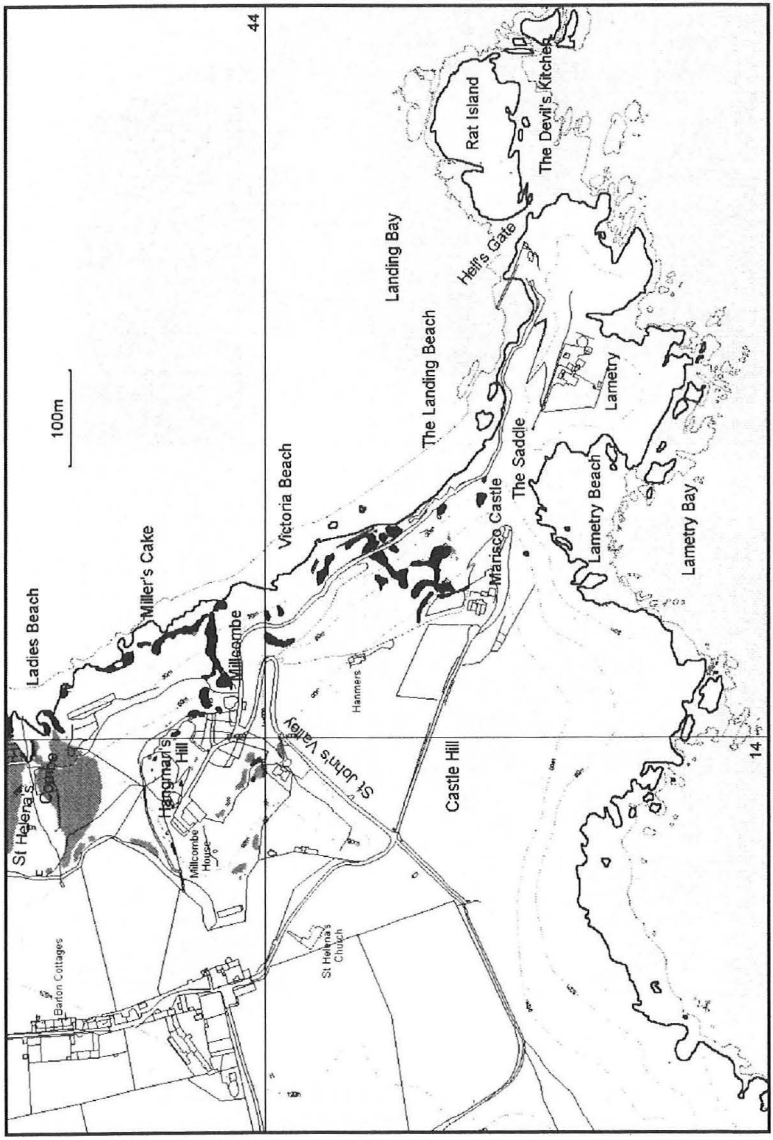


Figure 5: Distribution of Lundy cabbage (black) in the south of the island in 1997. (Rhododendron patches shown in grey.)

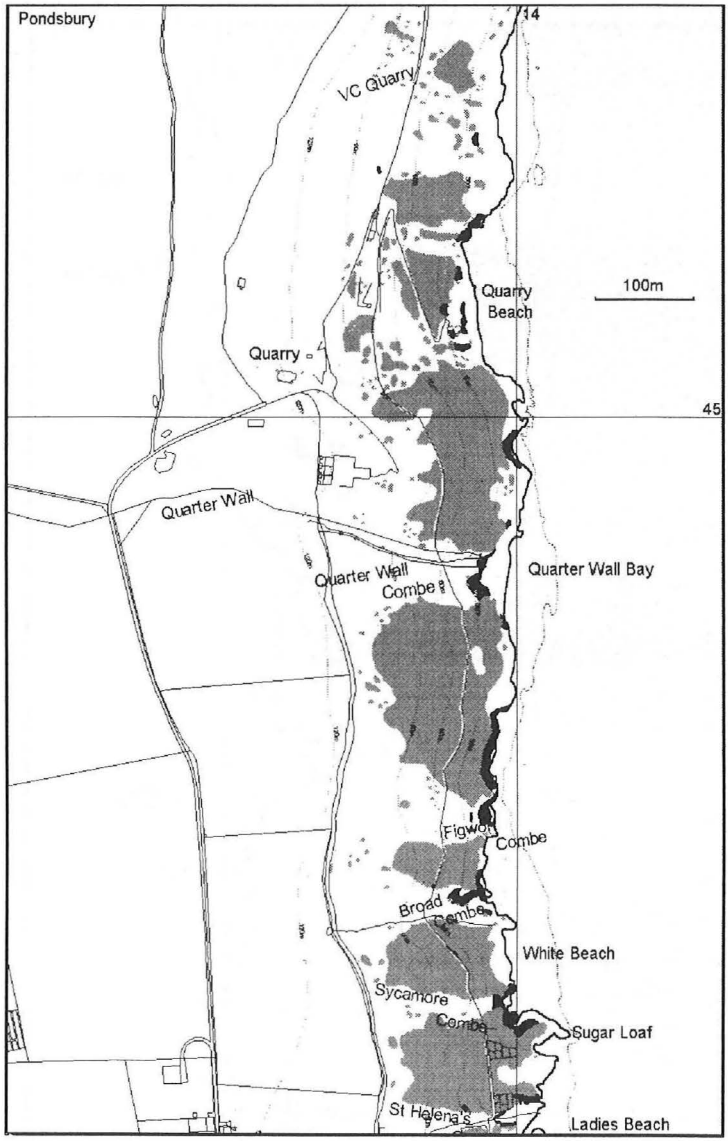


Figure 6: Distribution of Lundy cabbage (black) in the middle part of its range in 1997. (Rhododendron patches shown in grey)

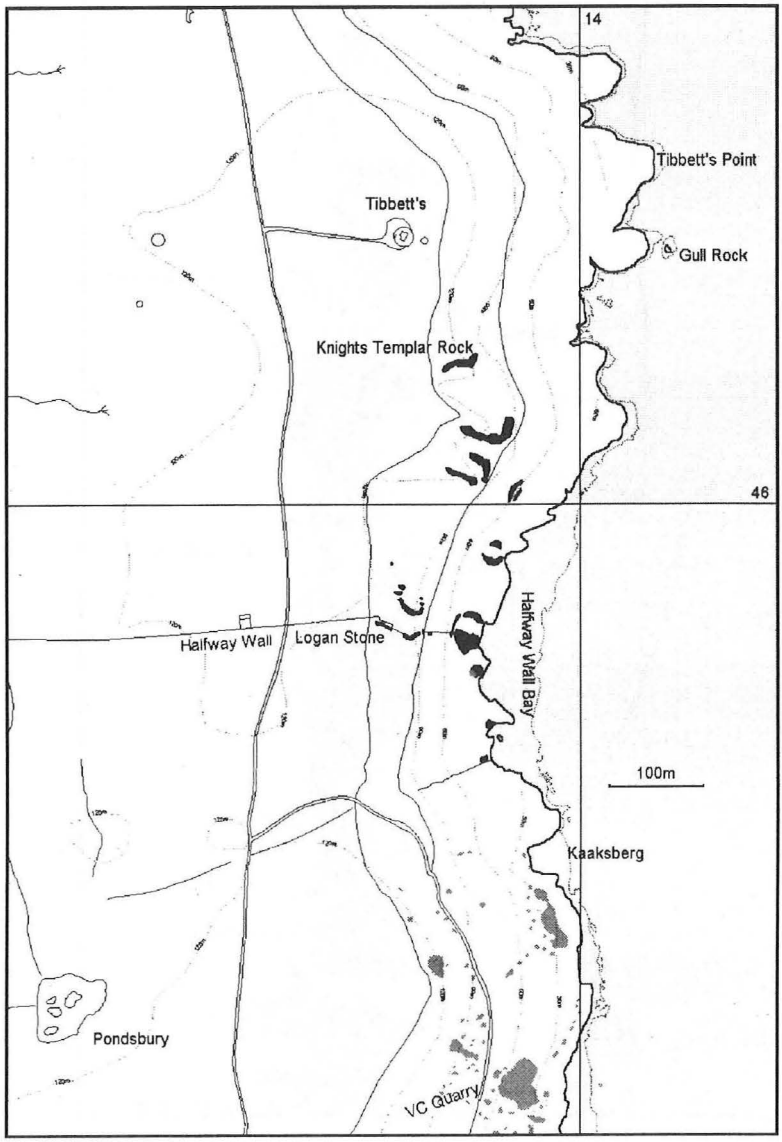


Figure 7: Distribution of Lundy cabbage (black) in the northern part of its range in 1997. (Rhododendron patches shown in grey.)

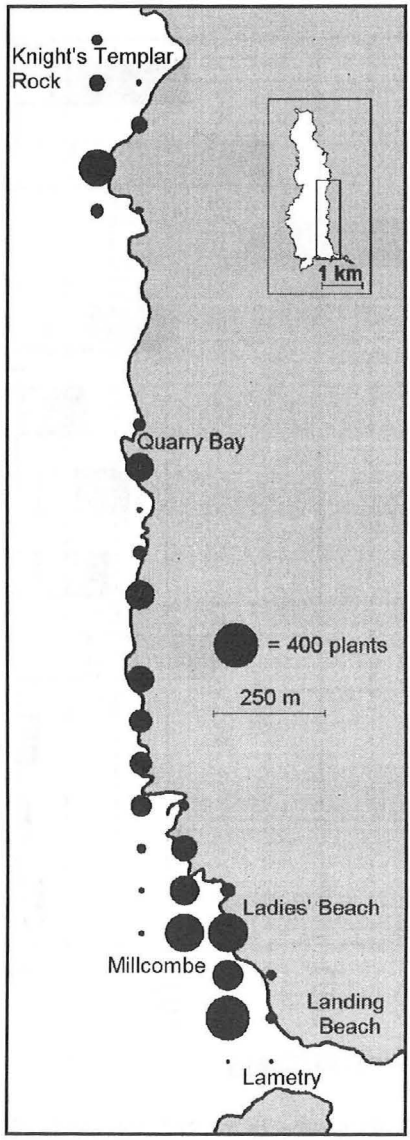


Figure 8: Number of Lundy cabbage plants in flower per 100x100 square in 1997.

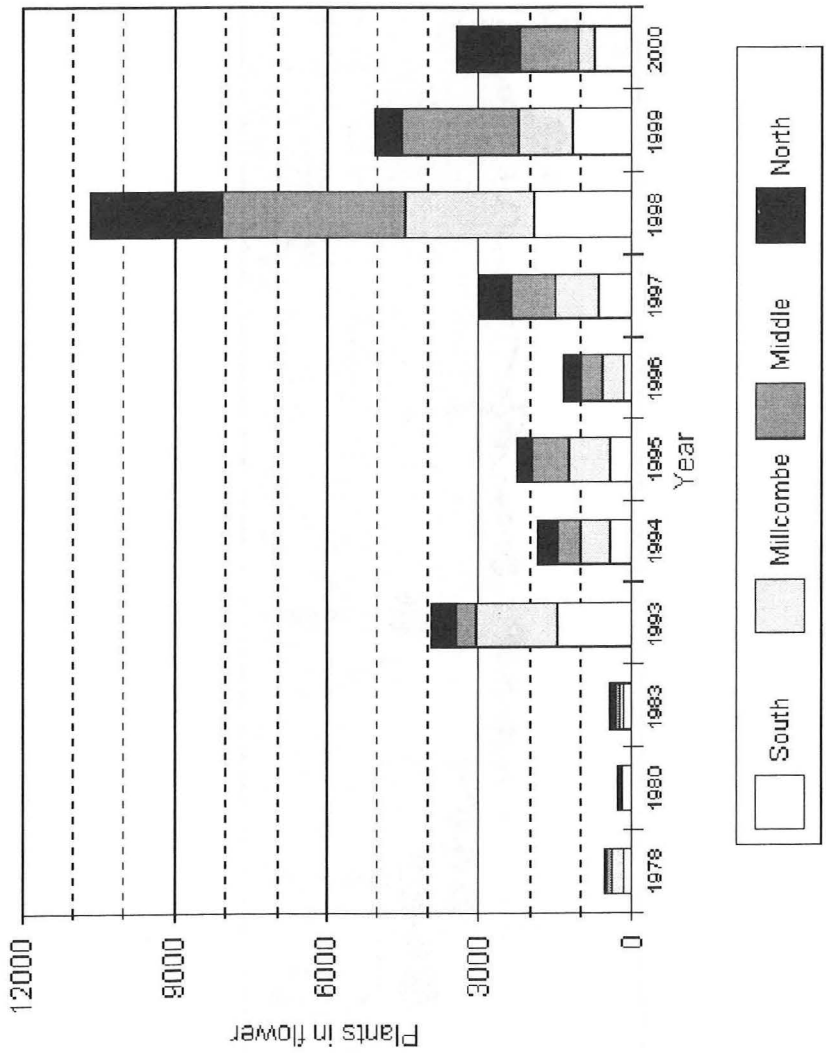


Figure 9: Number of plants recorded in flower each year that a count has been made.
South = south of Millcombe Mouth, Middle = Millcombe Mouth to Quarter Wall Bay,
North = Quarry Bay to Tibbett's Point.
Subdivision of pre-1993 population is estimated.

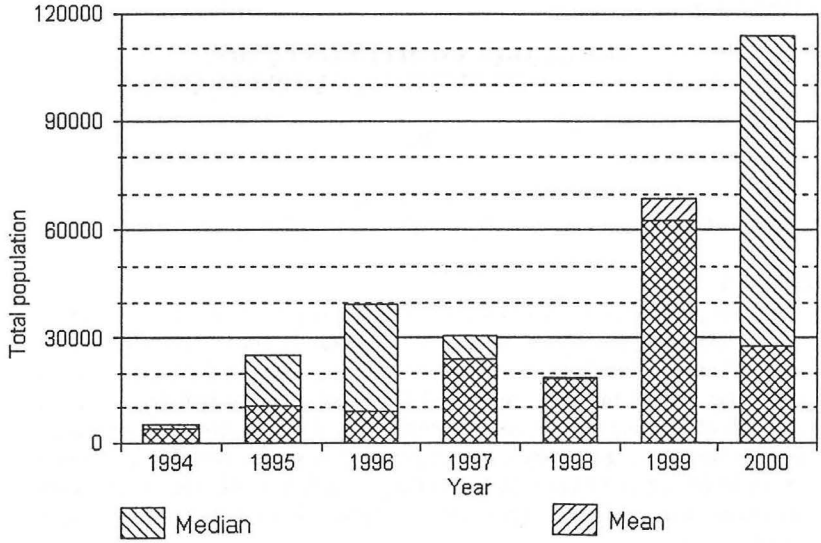


Figure 10: Estimated number of plants of Lundy cabbage derived from mean and median non-flowering ratios.

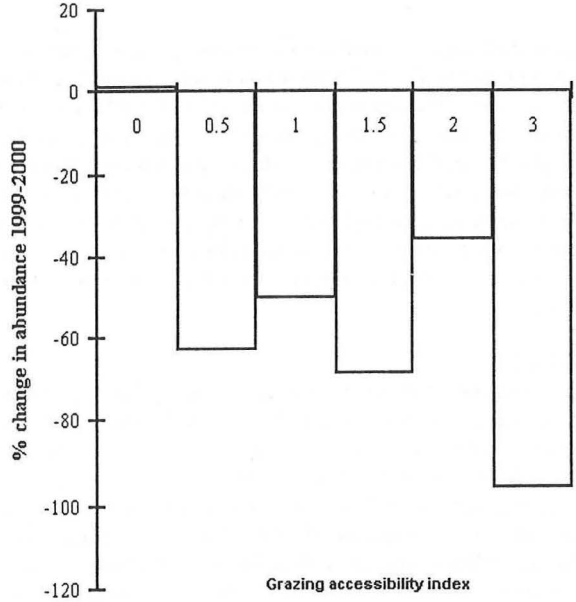


Figure 11: Change in Lundy cabbage (numbers of plants in flower) against 'grazing accessibility index" - half figures are where recording unit includes areas with more than one index.