THE UPS AND DOWNS OF LUNDY CABBAGE, A 25-YEAR STUDY

by

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ABSTRACT

Uniquely in Britain, *Coincya wrightii* is an endemic plant and the only foodplant of two endemic insects. Between 1994 and 2016, we monitored all the plants in flower each year across its entire range. Both the total number and proportion of plants in flower varied greatly between years. In earlier years the number in flower was clearly correlated with fluctuating rabbit numbers driven by the cycle of myxomatosis outbreaks. In recent years rabbit numbers have remained low and flowering has varied more erratically between years and the threat to the cabbage from rhododendron was eliminated by its almost complete clearance.

INTRODUCTION

Lundy cabbage (*Coincya wrightii*) (Plate 1) is a short-lived perennial crucifer known only from Lundy. Its taxonomy and ecology is summarised by Compton *et al.* (2000). It is unique in Britain because it is an endemic plant that is also the only host of an endemic plant-feeding insect, the leaf beetle *Psylliodes luridipennis*, and is the major host of a second beetle known only from Lundy, a weevil currently named *Ceutorhynchus contractus* '*var. pallipes*' but which is likely to be recognised as a distinct species in the near future (Compton *et al.*, 2002; Key *et al.*, 2021). Lundy cabbage is probably a neo-endemic that diverged post-glacially on Lundy from Isle of Man cabbage (*Coincya monensis monensis*) after its original sand dune habitat disappeared (Compton *et al.*, 2007). Associated with this change in habitat it adapted to life on steep coastal slopes and cliffs and switched from an annual to a perennial life-style. Lundy cabbage is a 'weedy' plant that likes the bare, disturbed ground found naturally on the cliffs, inland buttresses, and steep, clifftop slopes ('sidelands') on the more sheltered east side of Lundy (Plates 2, 3 and 4). Its range is restricted to about a 3.2 km length of the island's south-east coastline (Figure 1).

POPULATION MONITORING – METHODS AND LIMITATIONS

We began systematic monitoring of the entire population of Lundy cabbage in 1994 after an initial scoping visit in 1993. A census of the number of plants in flower was then carried out in late May/early June each year, at the time of year when most plants were in flower. Flowering by Lundy cabbage peaks towards the end of May, though the overall flowering period starts as early as February and can extend into the Autumn for plants

Plate 1. Flowers and young fruits of the Lundy cabbage, *Coincya wrightii*, above Miller's Cake. 28 May 2012. Image: R.S. Key.

Plate 2. Lundy cabbage occupying cliffs just to the south of Quarry Bay on 5 June 2013. Image: R.S. Key.

Plate 3. A familiar view of Lundy cabbage on the sidelands on the north side of Millcombe Valley viewed from the beach road. 3 June 2013. Image: R.S. Key.

that have been damaged by grazing. The counts therefore represent an estimate of the likely maximum number of plants in flower each year, rather than the total number of plants that flowered. We only counted the numbers of plants in flower, rather than all the plants, as most grow on inaccessible sea cliffs which meant that most counts had to be made from a distance using binoculars. Where dense, continuous stands were present, numbers of plants had to be estimated. To standardise as far as we could, the same observers counted the same areas each year, standing in the same place. This methodology is more appropriate for recording changes in the number of plants in flower each year rather than the number of plants *per se*.

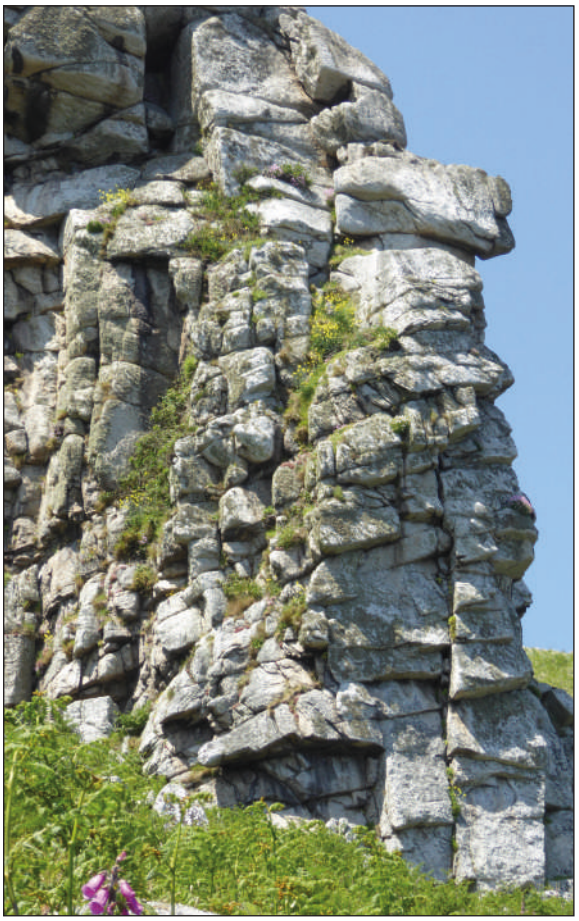


Plate 4. Lundy cabbage on the granite buttress of Knights' Templar Rock on 3 June 2016. Image: R.S. Key.

The overall population was split into convenient count areas, the number of which eventually reached 89 as Lundy cabbage occasionally colonised new areas (usually temporarily). Count areas where plants were present, but none were in flower, were included in our distribution summaries but did not contribute to the flower counts. Sub-populations of Lundy cabbage at some cliff-side and cliff-top sites could not be viewed every year, especially in the earlier years when they were screened from the land by dense blocks of rhododendron. Whenever possible, counts of these and other populations on the cliffs were made from a boat cruising parallel to the east coast of the island. More plants are visible from the sea than from the top of the cliff at any one site and, where cliff-side counts were possible from both land and sea in one year, we accepted whichever count was the higher.

The annual census of the total number of plants was extrapolated from counts of *all* the plants (not just those in flower, but including seedlings, young rosettes, mature plants yet to flower and those decapitated by grazers) present in three small areas where close access was possible (in Millcombe, at the buttress above Halfway Wall and in Quarry Bay). Cabbage populations were much larger in one of the three areas (Millcombe, Plate 3), so our extrapolations are inevitably biased towards what was happening there.

RESULTS

The distribution of Lundy cabbage

The geographical limits of Lundy cabbage's distribution along the East coast of Lundy hardly changed during the 25-year survey period. This probably reflects environmental constraints that limit the northern and southern boundaries – possibly accessibility to grazing animals on the gentler northern cliffs and slopes, and the northerly aspect of the cliffs in the far south east. In most years a few plants were also recorded at the eastern edge of the south facing cliffs on the west side of the Castle and hence on the west side of the island. However, these plants were only a few metres over a saddle from a large population facing eastwards below Lundy Castle. A small extension in range or colonisation event was detected in 2009 when two flowering individuals were present just above sea level on the north (i.e. south-facing) side of the bay immediately south of Gull Rock, approximately 150 m beyond what had been the plant's northern border for at least the previous 20 years. The plants were not seen to flower there again in subsequent years.

Within its overall range, the distribution of Lundy cabbage can be divided into core areas where it was present during every or almost every year of our surveys, and satellite, usually smaller count areas where plants were only recorded intermittently. Temporarily-occupied count areas were often slightly inland on gentler slopes, whereas the permanently occupied areas were on the buttresses, sea cliffs and steeper sidelands. Occupation of the temporary sites probably resulted from either colonisation events (usually within a few tens of metres from where plants had flowered in earlier years) or local disturbance that enabled seeds to germinate from the soil seed bank (Compton *et al.*, 2010).

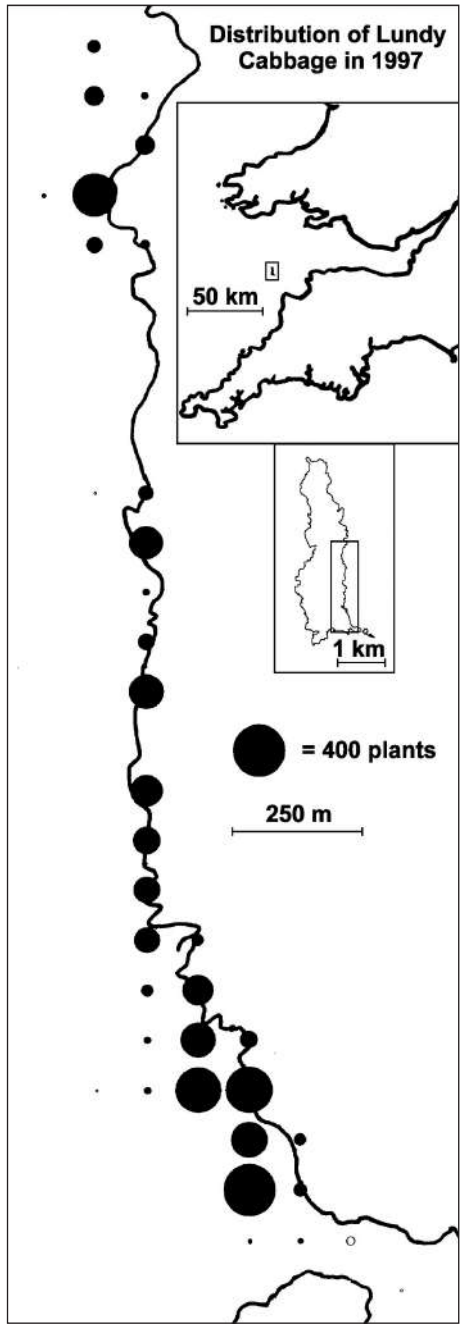
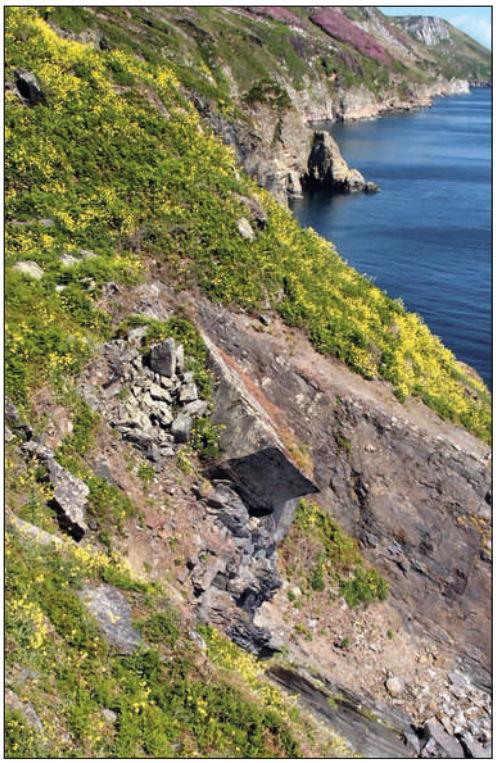
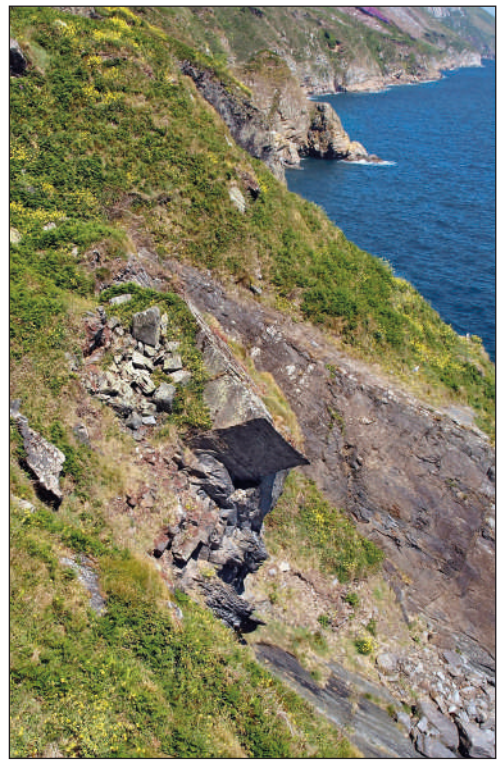


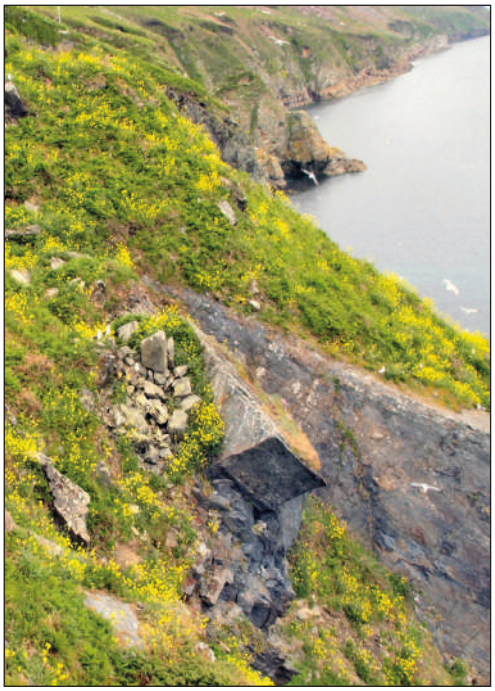
Figure 1. The total distribution and relative numbers of Lundy cabbage in flower on Lundy by hectare grid squares in 1997, when about 3,000 individuals were flowering. Open circles depict subpopulations where the cabbage was present but no plants were in flower.



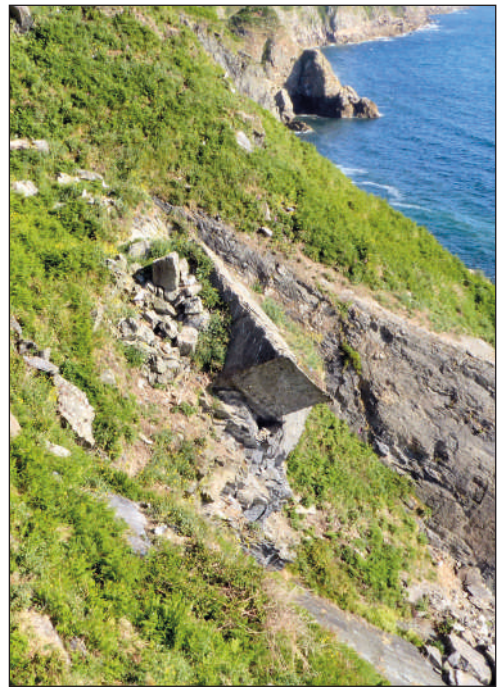
2005



2009



2012



2016

Plate 5. Examples of variation in the extent of flowering of Lundy cabbage in different years. Looking northwards to Miller's Cake. Images: R.S. Key.


2006


2011


2014


2016

Plate 6. Examples of variation in the extent of flowering of Lundy cabbage in different years. Looking northwards along the Eastern Sidelands. Images: R.S. Key.

The largest Lundy cabbage populations were usually on the cliffs in the central part of the plant's range, followed by Millcombe and its nearby sidelands and cliffs (Figure 1). Fixed point photographs illustrate the extent of between-year variation in Lundy cabbage flowering intensity (Plate 5). Our lowest total plants-in-flower count was about 880 (in 2002) and our highest was about 13000 (in 2013), a roughly 15-fold difference (Figure 2). Changes in numbers between years were often well synchronised across count sites, but there were usually exceptional sub-populations that bucked general trends in any one year.

Drivers of annual variation flowering intensity

Larger Mammals The larger mammals on Lundy, in particular the wild goats and domestic sheep but also Sika Deer, ponies and (probably) cattle will all eat Lundy cabbage if they are allowed access to it and are very likely to limit the distribution of Lundy cabbage in areas where they have access, goats particularly so in the north of the island. Over the years improvements to fences, good stock control and the targeted culling of excess goats and deer has had a positive impact on overall numbers of Lundy cabbages in particular areas, especially in the south.

Rabbits In the earlier part of the study period the numbers of Lundy cabbage in flower showed a cyclic pattern (Figure 3) that was closely linked to the numbers of rabbits on the island, with short-lived but dramatic flowering peaks two years or so after

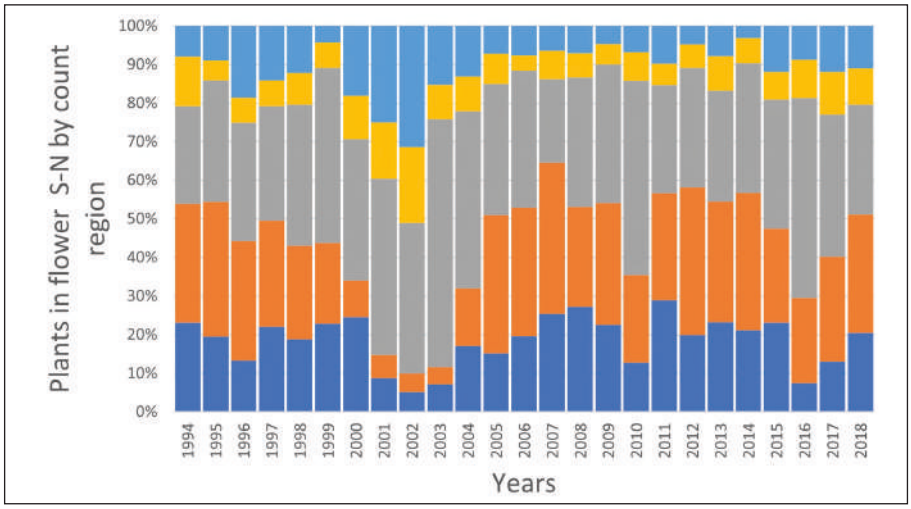


Figure 2. Annual variation in the relative numbers of Lundy cabbage in flower in different parts of the island. Place names follow maps of Lundy. The count regions (from south to north) were (1) South of Millcombe (dark blue), (2) Millcombe to Miller's Cake (orange), (3) Miller's Cake to Quarter Wall (grey), (4) The quarries and cliffs below, including Quarry Beach (yellow) and (5) North of the quarries (pale blue).

myxomatosis outbreaks (Compton *et al.*, 2004). This was a feature of the first two major disease outbreaks we monitored and Lundy warden's reports suggest the same pattern had occurred earlier, around 1983. Peak rabbit populations depressed Lundy cabbage numbers as a result of their very high grazing pressure. In other years, temporary sub-populations often appeared during years when rabbit populations were low, after they had previously created bare soil and reduced competition from grasses. The eventual collapse of rabbit numbers due to myxomatosis then released the plant from grazing at a time when there are many micro-sites suitable for colonisation. If this scenario is correct then the spectacular numbers of Lundy cabbage recorded in 1998 and 2013 would not have been seen on Lundy in the centuries prior to the introduction of myxomatosis about thirty years ago.

By combining information from National Trust standardised mammal counts, Lundy warden's annual reports and our own observations it is possible to produce a rough estimate of changes in rabbit numbers on Lundy since 1994 (Figure 4). They are calibrated by estimates produced by Leeds University students using pellet counts and decay rate estimates (Taylor & Williams, 1956) for 1996, 2000 and 2005. The three counts illustrate the dramatic swings in rabbit numbers that were occurring on the island, with an estimated 20,000 rabbits recorded in January 1996, 1,800 in 2000 and 15,000 in early 2005. Regular winter rabbit culls may have had some effect on their numbers (at least 7000 rabbits were removed in 2004/2005), but disease appears to have been a more important mortality factor.

In a previous publication (Compton *et al.*, 2004) we hypothesised that if rabbit numbers remained low for a long period, then Lundy cabbage abundance would stabilise

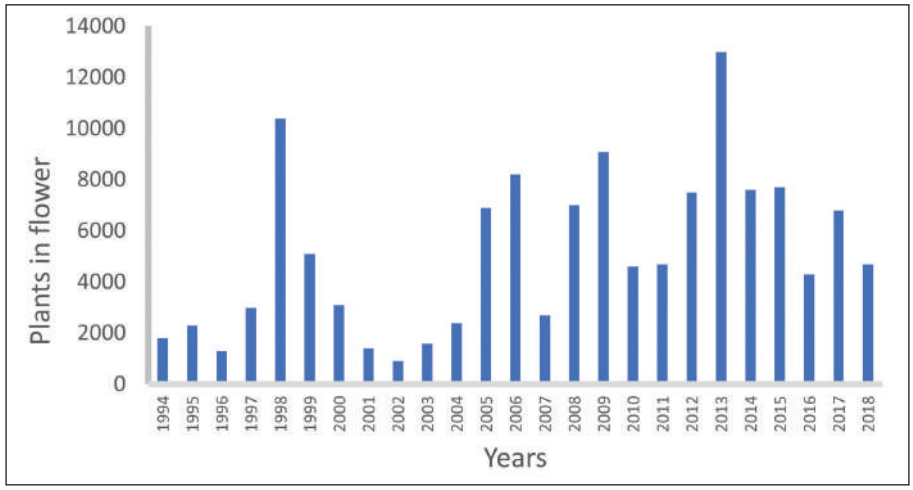


Figure 3. Estimates of total numbers of Lundy cabbage in flower in late May/Early June in the years 1994 to 2018.

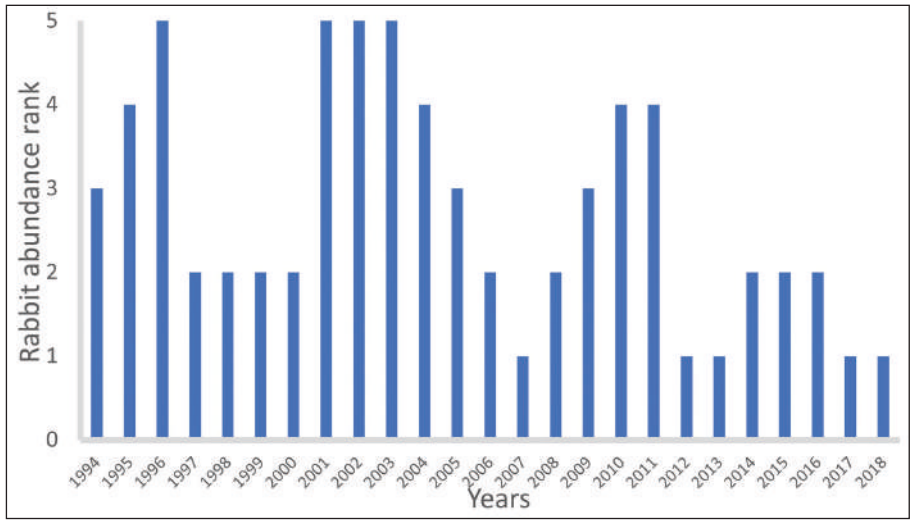


Figure 4. Estimated annual variation in estimated abundance of rabbits on Lundy. 1 = 'very low', 2 = 'low', 3 = 'medium', 4 = 'high' and 5 = 'very high'. Numbers estimates based on late winter pellet counts were 20,000 in 1996, 1800 in 2000 and 14,500 in 2005.

at a level somewhere between the extremes were had been recording. Coincidentally, rabbit numbers remained low or very low since 2011, following the arrival of Rabbit Haemorrhagic Disease (RHD) on the island. It initially seemed to have a limited effect on the rabbit population, but Kevin Welsh, the island's farmer reported (personal communication) over 1000 had died from the disease in 2003/2004. If the change in rabbit numbers is attributable to RHD then the dynamics of this disease seem very different to Myxomatosis, with none of the 'boom-and-bust' in rabbit numbers seen in earlier years. In this later period of our study there were no extremely low Lundy cabbage flowering counts, because rabbit numbers never exploded again, and a baseline

of at least 4000 flowering plants each year seems to have become established. However, above this value, the total number of plants in flower has been unstable, unpredictable, and highly variable between years.

Pollen Beetles Flower counts during 2007 were exceptionally low despite there being only small numbers of rabbits present that year. Adult flower beetles (*Meligethes*, Nitidulidae) feeding on the flowers and flower buds of Lundy cabbage were common in every year of our study, but were remarkably abundant in 2007 (Key *et al.*, 2018). When they were identified, they were not the usual *Meligethes* species present on the island *Meligethes viridescens*, but *Meligethes aeneus*, which is a major pest of oilseed rape on mainland Britain. A guide for farmers suggests a density threshold of *M. aeneus* beyond which chemical sprays are advised (Key *et al.*, 2018). Mean densities per Lundy cabbage *flower* that year were higher than the number suggested as an economic spray threshold per whole plant of oilseed rape.

Other Factors Other factors may also have had a more localised influence on flower numbers. Since 1994 the most significant change in the vegetation of the East side of the island has been the clearance and near-eradication of *Rhododendron ponticum* from the sidelands and cliffs. In the local areas where rhododendron was cleared, the bare ground this created initially favoured Lundy cabbage, along with other early successional plants such as foxgloves (*Digitalis purpurea*) (Plate 7). These local booms in Lundy cabbage numbers were short lived due to rapid increases in competition from grasses and bracken. Clearance of Rhododendron on the cliffs themselves has had a very positive, more long-lasting effect in removing what was considered to be the biggest threat effecting the long-term survival of the Lundy Cabbage. (Compton *et al.*, 1999; Compton *et al.*, 2016).

The relationship between plants in flower and overall population size

There were only three areas where we were confident of counting all the Lundy cabbage, not just those in flower. In every year, the majority of plants were not flowering. Some

Plate 7. Growth of Lundy cabbage and foxgloves after rhododendron clearance on the sidelands. 1 June 2008. Image: R.S. Key.

of the non-flowering individuals were seedlings or small immature rosette plants, others had been damaged by grazing mammals to varying extent, some of which are likely to have come into flower later in the year if grazing pressure was relaxed. The ratio of non-flowering to flowering plants in different years was highly variable, from about 2:1 to 24:1 (Figure 5). In years with high flowering counts almost half the plants may have been in flower, whereas in years with low flowering counts there was often a majority of individuals that had not flowered by early June. These included seedlings and many plants that would never manage to flower because of repeated grazing or competition. Clearly our counts of plants in flower were underestimating the size of the total population of Lundy cabbage and perhaps also overemphasising the extent of year to year variation in overall population numbers, because in years when flowering counts were very low there was usually a higher proportion of additional plants that were not flowering. Counts of plants in flower are nonetheless the only option for routine monitoring of population trends and for informing management decisions. Counts of Lundy cabbage in flower are continuing thanks to members of the Lundy Field Society.

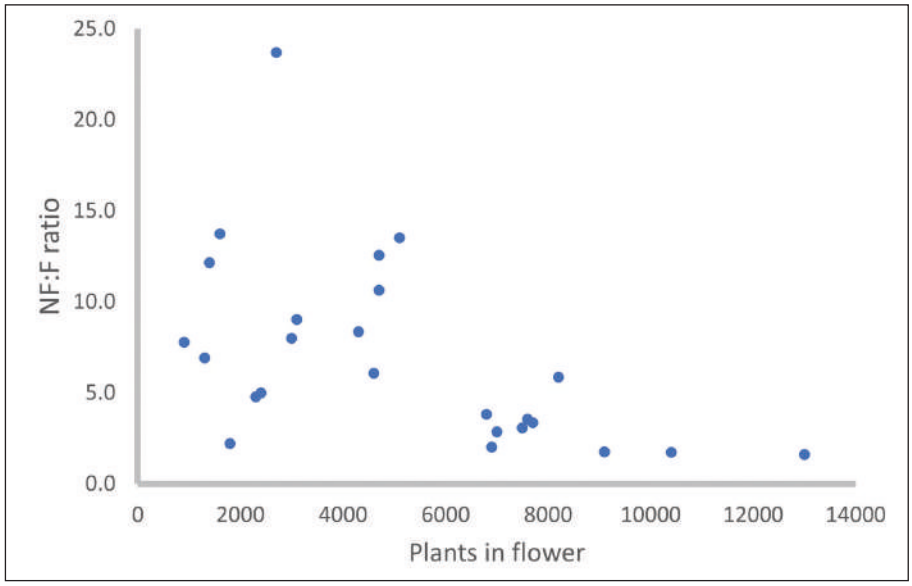


Figure 5. The relationship between the proportion of flowering Lundy cabbage in early June and the total number of flowering plants recorded at that time in the years 1994 to 2018. NF = Non-flowering, F = flowering.

CONCLUSIONS

Over the 25-year period the year-to-year variation in the numbers of flowering Lundy cabbage at first followed an almost regular series of peaks and trough and subsequently became more chaotic. This was linked to grazing by mammalian herbivores, mainly, though not exclusively linked to the large annual variation in grazing intensity by rabbits. In the first few years, cycles in rabbit abundance that were driven by myxomatosis outbreaks and recovery were reflected in delayed peaks and troughs in the flowering

success of the Lundy Cabbage, but the dynamics changed in later years, apparently due to the arrival on Lundy of a second rabbit disease. For the rest of our study period rabbit numbers remained relatively low and Lundy cabbage flowering became less predictable. Our results emphasise the value of long-term autecological studies, both on Lundy and elsewhere.

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REFERENCES

Compton, S.G., Craven, J.C., Key, R.S. & Key, R.J.D. 2007. Lundy Cabbage: past, present and future. *Proceedings of the 60th Anniversary Symposium of the Lundy Field Society*, 161-178.

Compton, S.G. & Key, R.S. 2000. *Coincya wrightii* (O.E. Schulz) Stace. *Journal of Ecology* 88, 535-547.

Compton, S.G., Key, R.S & Key, R.J.D. 1999 *Rhododendron ponticum* on Lundy - beautiful but dangerous. *Annual Report of the Lundy Field Society* 1998, 49, 74-81.

Compton, S.G., Key, R.S & Key, R.J.D. 2002. Conserving our little Galapagos – Lundy, Lundy cabbage and its beetles. *British Wildlife* 13, 184-190.

Compton, S.G., Key, R.S. & Key, R.J.D. 2004. Lundy cabbage population peaks – are they driven by rabbits and myxomatosis? *Annual Report of the Lundy Field Society* 2003, 53, 50-56.

Compton S.G., Key, R.S. & Pratt, S. 2016. Progress towards eradication of *Rhododendron ponticum* on Lundy. *Journal of the Lundy Field Society* 5, 19-34.

Compton, S.G., Norton, R., Straker, R., Walker, C. & Key, R.S. 2010. Lundy cabbage seed dispersal, seed banks and seed germination after rhododendron clearance. *Journal of the Lundy Field Society* 2, 45-52.

Taylor, R.H. & Williams, R.M. 1956. Use of pellet counts for estimating density of populations of the wild rabbit, *Oryctolagus cuniculus*. *New Zealand Journal of Science and Technology* 38B, 236-256.

Key, R.J.E., Key, R.S. & Compton, S.G. 2018. Pollen Beetles and reproductive success of the endemic Lundy cabbage: the consequences of an apparent invasion event in 2007. *Journal of the Lundy Field Society* 6, 77-84.

Key, R.S., Key, R.J.D., Craven, J.C. & Compton, S.G. 2021. Colour variation linked to host plants in the endemic beetle currently known as *Ceutorhynchus contractus* form *pallipes* on Lundy. *Entomologist's Gazette* 72, 147-156.