

## PRIORITISATION FOR THE CONSERVATION OF CULTIVATED PLANTS – A NEW APPROACH

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### ABSTRACT

In this paper, the case for the conservation of plants that have arisen in cultivation is provided and the mechanisms for extinction discussed, with examples. The approach to cultivated plant conservation over the past 30 years is reviewed and a basis for revising that approach explained. A new, far more comprehensive and rigorous method for prioritisation is proposed. This has been developed for the Plant Heritage Threatened Plants Project.

### INTRODUCTION

The need for the conservation of wild species is commonly accepted; that of plants and animals that have been selected by man, less so. It is evident, therefore, that a great deal of effort has been put into the methods used to establish the level of threat to wild species which is then used to concentrate effort on action to conserve them. The literature on threat assessment for wild species is extensive (IUCN, 2001) and the methods used to compile lists of threatened plants globally, regionally and nationally are detailed in Red Data books. The Growing Heritage Action Plan (RHS & NCCPG, 2007) observed that as it is not possible, or even desirable, to conserve every cultivar, ways need to be found to evaluate, prioritise and decide what should be conserved. The Action Plan identified two key actions arising from this. First, that the criteria for prioritisation of cultivated plants needs to be agreed and second, that there is a need for a Red Data Book equivalent for cultivated plants to be produced. Since the publication of the Action Plan, Plant Heritage (then the National Council for the Conservation of Plants and Gardens, NCCPG), the Royal Horticultural Society (RHS), the National Trust (NT) and Cambridge University Botanic Garden (CUBG) have been working together on developing new protocols to address these key actions. These protocols need to be far more rigorous than has been the case in the past

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and it is anticipated that as a consequence of introducing a more transparent and objective method of assessment, there will be a greater understanding and acceptance of the need for the conservation of cultivated plants alongside that of wild species. The protocols were the basis of what has become known as the Threatened Plants Project.

#### WHY CONSERVE CULTIVATED PLANTS?

Cultivated plants have been selected by man to supply a need, whether that is for food, medicine, shelter, manufacturing or even aesthetic pleasure. All of these contribute to the well-being of mankind, and any threat to them needs to be recognised, assessed and, where possible, addressed. We should be conscious of the need to preserve the oldest wild species and cultivars for three reasons which are described below.

First, as the climate changes, plants we have selected over the past 100 years are likely to be less well adapted to altered environmental conditions, and we may need to go back to earlier selections or to the original wild species to develop new cultivars that are better able to cope with the change.

Second, breeding programmes are by their very nature targeted towards developing or enhancing very specific traits, and as a result other traits can be lost. Many of these traits have been developed as a response to fashion or commercial need and as such can be ephemeral. Without retaining at least the most significant earlier cultivars, these traits can be lost altogether and can thus reduce our capacity to develop new plants.

Finally, we should also be conscious of the cultural heritage bound up in our garden plants. There is, for instance, a renewed interest in the surprising diversity of local varieties of apples, many of which are restricted to one area and are often adapted to thrive in that area or are grown for specific uses.

#### MECHANISMS OF PLANT LOSS

Most frequently, plant loss has been due to external factors. Plants have proved vulnerable to changes of fashion in horticulture or to economic factors, or they have been superseded by products of a later breeding programme (Brickell & Sharman, 1986). Particular cultivars may be lost as a result of uncontrolled hybridisation, where seedlings in plant groups known to outcross routinely are distributed under the name of the cultivar, and over time the original cultivar is lost. An example of this is provided by *Dahlia* 'Bishop of Llandaff', the original of which seems to have been lost to cultivation in the 1950s. The current plant sold under this name is a seedling of the original but no longer identical to it. Such plant losses are rarely recorded as the process is largely invisible. Ironically, because of the all-too-frequent errors in naming garden plants, a plant can be thought to still be in cultivation when in reality the cultivar is lost and the plant known by that name is a different one.

However, plant loss can occur without any of these factors being involved, as cultivated plants that are propagated vegetatively (agamospermy), and are thus clonal,

are liable over time to lose vigour and can die or fall out of favour with gardeners or nurserymen as a result of their poor performance. Richards (1997) has enumerated the four main disadvantages to agamospermy as follows:

1. an inability to dispose of accumulated disadvantageous but non-lethal mutants, as would normally occur in the processes of recombination arising from sexual reproduction ('Müller's ratchet', Müller, 1964)
2. an inability to recombine novel mutants that would otherwise allow for advantageous mutations to be selected and the plant to adapt to changing environments ('Red Queen hypothesis', Van Valen, 1973)
3. a very narrow population niche width which potentially limits the tolerance of the plants to slightly different habitats
4. hybrids, as agamospermous species usually are, tend not to be adapted to a specific environment.

A further disadvantage, although not genetically inherent as in the above four, is the accumulation of viral infections through repeated vegetative propagation. Viral infections in plants are often low-grade and only slightly debilitating, but over time multiple infections by different viruses can seriously weaken a plant. However, of course, some viral infections are essential to a cultivar, as can be the case in variegation.

It is points 1 and 2 and viral infection that are considered most significant in cultivated plant conservation. Richards (2002) suggests that the sudden disappearance in the early 1980s of the once widely grown hybrid *Primula scapigera* × *P. bracteosa* was due to the accumulation of virus in the vegetatively propagated clone.

#### DETECTING EXTINCTIONS IN CULTIVATED PLANTS

It is remarkably difficult to prove conclusively that a cultivated plant is extinct. Even if it is not known to be in commerce, or to be held in any of the well-documented plant collections or even in a National Plant Collection, it is not normally possible to rule out the chance that a plant persists in someone's back garden or in some abandoned nursery. Examples of where this has happened include *Chrysanthemum* × *superbum* 'Fiona Coghill' (Growing Heritage Action Plan, 2007), *Narcissus* 'Weardale Perfection' (The Plantsman, 2007) and *Gladiolus* × *brenchleyensis* (Tooley, 2010). Even if it is not found to be in cultivation in the UK, there is always the possibility that the plant has been maintained in another country. The examples that we have found can be established because the original cultivar was not widely distributed and was therefore particularly vulnerable to catastrophic circumstances such as an extreme weather event or the destruction of the garden in which the plant was grown.

Research by one of the authors into bulbous plants has revealed two examples. The illustrations (Figs 1 & 2) are two paintings of cultivars that were raised in the 1920s and received awards from the RHS. The first, *Lachenalia* 'Monte Carlo', was raised

by the Rev. Joseph Jacob and received an Award of Merit from the RHS in 1924. Since it was a plant that needed to be grown under glass, it appears to have been lost during World War II, when glasshouses either were not heated or were used for growing food, coupled with two severe winters (1940 and 1947) (David, 2009a). The second example is *Nerine* 'Glitter', raised by C. Smith, a nurseryman on Guernsey, which also received an Award of Merit from the RHS. There is no record of this cultivar being grown after World War II, and it is known that during the war much of the horticultural stock was lost (Vandertang, 2003). As far as the authors have been able to establish neither cultivar was widely distributed by its raiser.

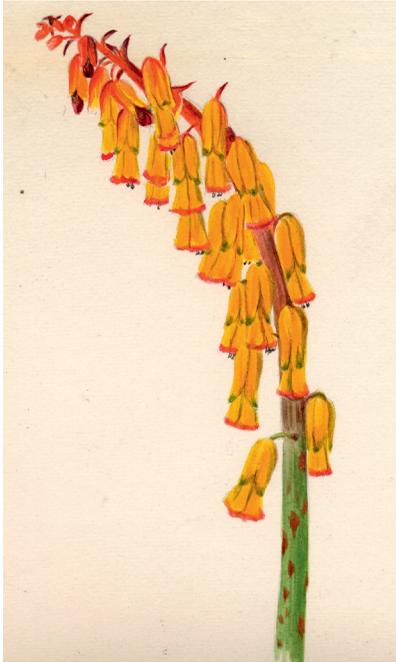


Fig. 1 *Lachenalia* 'Monte Carlo' AM, shown by Messrs Carter Page & Co., 9 March 1926. Artist: Elsie Katherine Dykes. Credit: RHS Herbarium.



Fig. 2 *Nerine* 'Glitter' AM, shown by Messrs Barr & Son, 31 October 1926. Artist unknown. Credit: RHS Herbarium.

Further examples in *Cistus* are provided by R. Page (April 2008, pers. comm.), where two recorded cultivars raised by Collingwood Ingram, *C. × fernandesiae* 'Jane' and *Cistus* 'Laddie' were lost after Ingram's death in 1981 and the subsequent conversion of his house and garden to other uses. In both these and the previous examples, limited distribution of the cultivars has been a major factor in their extinction. Fashion also plays a part. Malmaison carnations, once so popular in the late nineteenth and early twentieth centuries as greenhouse plants, are now rare, and many, such as *Dianthus* 'Lord Roseberry' and *D.* 'Duc de Montpensier', are deemed to be extinct (J. Marshall,

April 2010, pers. comm.). Extinction should not be thought of as something that only happened in the distant past; there is evidence of recent extinctions. In one case, *Iris* ‘Benton Baggage’, raised by Sir Cedric Morris and registered in 1945, is thought to have still been grown as recently as six to eight years ago (S. Cook, April 2010, pers. comm.). It is highly likely that examples from Irish gardens can be found in Nelson (2000) although these are not explicitly identified in this book.

Another approach is to arrive at a broader, less specific estimate of extinction. An example is provided in the daffodils. In the *International Daffodil Register and Classified List* (Kington, 2008), there is information on 29,000 cultivars, of which fewer than 6 per cent are in the current *RHS Plant Finder* (Cubey *et al.*, 2010). It should be pointed out that the register has international coverage and, since it began in 1908, it might be expected that a considerable number have been lost and superseded since that time and would not have been kept in commerce. Even so, between the two National Plant Collections® for daffodils, only 153 cultivars are held. It is only possible to guess the proportion of extinct cultivars in a given genus – for some, an estimate of 15–20 per cent is probably reasonable, while for others it is likely to be more than 70 per cent. Estimates are based on the percentage of a particular breeder’s cultivars for one genus that are still known to be in circulation.

#### CULTIVATED PLANT CONSERVATION IN THE UK

None of these issues is new, and gardeners have been aware of plant loss since at least the beginning of the twentieth century (Brickell & Sharman, 1986). Following a conference organised by the RHS in 1978 to address these issues, the NCCPG, now Plant Heritage, was set up. For the last 30 years the main vehicle for its conservation activities has been the National Plant Collections®. The collections scheme is successful, but as recruitment is passive, new collections are added on the grounds of what applicants want to collect, not what is in need of conservation.

In addition, one of the main issues in the field of cultivated plants is the lack of data. It is not possible to assess conservation activities as there have never been sufficient records kept of which plants were in existence; hence there is a difficulty in specifying cultivars that have become extinct.

This is not to say that there has been no previous attempt to address the threat of rarity in cultivated plants. In the past, Plant Heritage has addressed the issue using what was referred to as the ‘Pink Sheet’. This began in 1981 with a list of plants compiled by Chris Brickell, Roy Lancaster and Graham Stuart Thomas which was then modified by Duncan Donald in 1982 adding desiderata from National Collection Holders (NCHs) and uncommon plants requested by members of the public for which no listing could be found in nurseries or gardens. This became the ‘Pink Sheet’, so known because it was produced on pink paper, and the method of compilation was changed over the years. A Missing Genera list is also held, composed of genera known to be cultivated in the UK that are not represented in the National Plant Collections®. It currently includes over 1,000 names.

The emphasis of the Pink Sheet was on individuals nominating plants that they knew were missing. The emphasis of the Threatened Plants Project, however, is a systematic, genus-by-genus approach, using an objective process to determine both rarity and merit. The information needed is straightforward: which plants are in existence, where and in what number. To carry out this research in the field would not be possible, even if it were desirable; there are simply not enough volunteers to survey every garden in the UK and the resources do not exist to track down, identify and maintain all the cultivars that have ever existed. We are faced with making choices and they need to be based on evidence and be arrived at by following meaningful and prioritised criteria.

#### SETTING THE CRITERIA FOR PRIORITISATION

The need for prioritisation is brought out sharply by comparing the numbers of taxa listed in the seven International Cultivar Registers for which the RHS is responsible with the number of varieties held by Plant Heritage National Plant Collection Holders for those genera (Table 1).

Plant group	Approx. number of names included in Register	Plant Heritage National Collection(s) in 2009	Number of taxa held	Number of taxa in RHS Plant Finder 2009–10
<i>Narcissus</i>	30,000	2	153	1,968
<i>Rhododendron</i>	28,000	20	2,150*	2,455
<i>Dianthus</i>	27,000	5	354*	599
<i>Dahlia</i>	14,000	1	2,000+	580
<i>Delphinium</i>	4,200	3	480	232
<i>Lilium</i>	10,000	1	17	311
<i>Clematis</i>	2,500	7	448*	885

\* May well be duplications between collections

Table 1 A comparison of the seven plant genera for which the RHS is the International Cultivar Registration Authority with the number of taxa known to be grown in the UK. Figures from David (2009b).

For 'wild' plants the most significant criterion is rarity, and an evaluation procedure has been developed to determine the categories, such as extinct, critically endangered, vulnerable and so on. For horticulture, while rarity is a priority as it represents a measure of risk, it cannot be a basis alone for any decision. Other criteria that allow the value of that plant to horticulture to be established need to be brought into the assessment. To do this, the RHS, in consultation with Plant Heritage, undertook to carry out a survey of specialist nurseries, raisers and breeders in 2008. The process and results of the survey were published last year (David, 2009b).

The aim of the survey was to answer some key questions that would inform thinking on how to assess the conservation priority for individual taxa of cultivated plants. The questions were essentially:

1. What are the conservation priorities of those engaged in the commercial aspect of horticulture?
2. Are older (and by implication more threatened) cultivars of value and, if so, how valuable are they?
3. How important is long-term maintenance of cultivars?
4. What should we be prioritising in conservation that would be important for retailers and wholesalers?

There was a strong perception that older cultivars are of value and some people would value them highly enough to go to some lengths to obtain them. This confirms the need to ensure that significant older cultivars are maintained in cultivation, even if no longer widely used in horticulture. For retailers rarity, novelty and popularity are the three key attributes. Of these, only rarity is a question for conservation.

For breeders, however, there was an appreciation of the need for a wider range of attributes. When the results of the survey were considered, four elements that contribute to an assessment of value or horticultural merit emerged and are listed below:

- an indication of how much of a new break the cultivar was when it was first introduced and how critical it has proved to be to the development of further cultivars
- whether the plant received awards and, if so, how significant these awards were and whether they were given in only one country or were more widespread
- distinctive attributes such as exceptional disease resistance or ability to survive through climatic stress
- heritage value – although not valued by growers and breeders, it is still important to maintain local varieties or those varieties that are associated with people or places that form a part of our national heritage.

Overall this leads to a concept of horticultural significance and represents one of the two axes that define conservation priority, the other being rarity or level of threat, as discussed above, and incorporated into an assessment method described in the next section.

#### THREATENED PLANTS ASSESSMENT METHODOLOGY

##### *The National Trust approach*

As a direct response to the Global Strategy for Plant Conservation (GSPC), the risk to the National Trust's (NT) plant collection from climate change and the threat posed by the potential outbreaks of major pests and diseases, the NT developed its own Policy Paper *Garden Plants and Policy Collections – Curation/Conservation* (Malecki, 2005). The document highlighted the need to survey, record, analyse and produce individual property plant collection conservation policies. This policy, in conjunction with the

GSPC and the Growing Heritage Action Plan (RHS & NCCPG, 2007), provided a clear way forward in the field of cultivated plant conservation. The response of the NT to the need for prioritising conservation was developed in parallel with the Threatened Plants Project (TPP), but with additional weighting placed upon the heritage value of individual plants as can be seen from the flow chart (Fig. 3). This is the procedure now used to prioritise the conservation of plants in NT gardens.

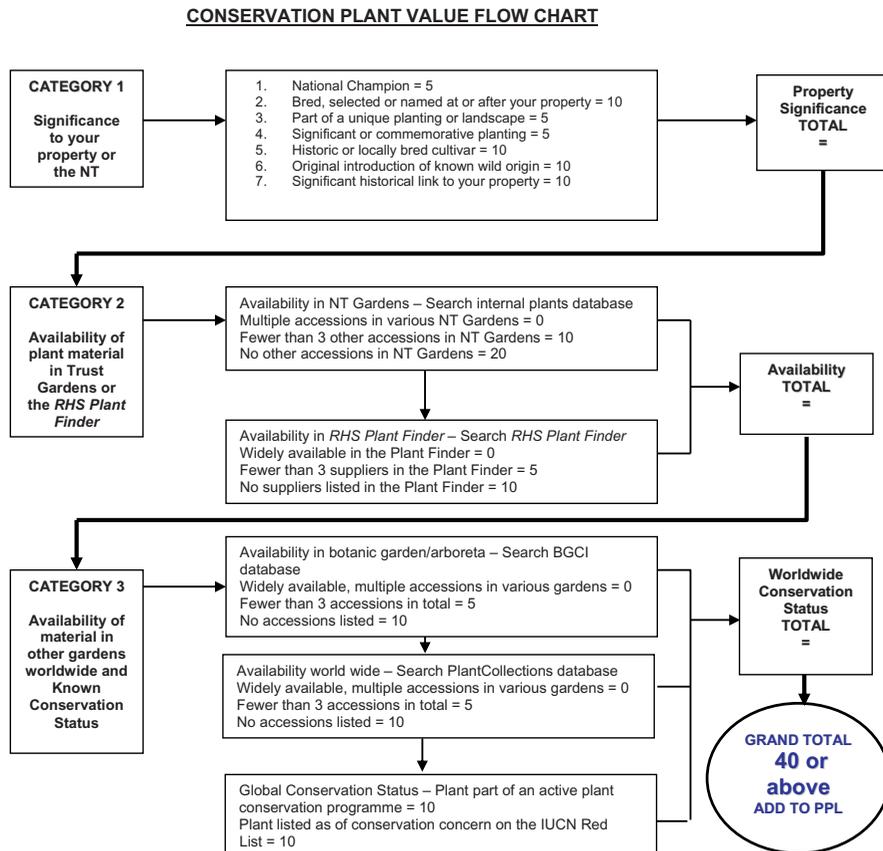


Fig. 3 The flow chart developed by the National Trust for the process used to prioritise the conservation of plants in their gardens. Reproduced from Buffin (2009).

*Threatened Plant Project approach*

From the background described grew the TPP, a method of determining an objective value in terms of rarity and horticultural merit for taxa in cultivation in the UK. It was designed to be applicable across the range of cultivated plants, by amateurs and professionals.<sup>5</sup>

The project adapts the familiar categories of the IUCN *Red List of Threatened Species* (IUCN, 2001), but not the methodology. It is broken down into stages and is undertaken on a genus-by-genus basis.

The *RHS Plant Finder* (Cubey *et al.*, 2010) is the only reliable source of data on the availability of cultivated plants in commerce in the UK. It has been produced annually for 22 years and therefore provides an extensive record of plant availability over that period. It covers a wide range of garden plants, collating information from a large range of sources. It is also rigorously edited from a nomenclatural perspective. This makes it a very useful baseline from which to commence any research into cultivated plants in the UK.

**Stage 1 Initial Assessment:** A genus, part-genus or group of plants is selected. An initial list of the taxa shown in the last five years of the *RHS Plant Finder* is created and the number of suppliers are noted for each taxon. The resulting list can be added to from other published reputable sources (cultivar registers, nursery catalogues or plant collection lists). For those plants not listed in the *RHS Plant Finder* an alternative source will be used. From this information the plants<sup>6</sup> will be categorised as shown in Table 2.

Category	Description	Indication	Action
<b>Least Concern in cultivation (LCic)</b>	The best available evidence indicates that these plants are widely available	Greater than 3 points (comprising an average of nursery listings in the last five annual editions of the <i>RHS Plant Finder</i> and the number of occurrences in the NPCs)	No further consideration at this stage
<b>Near Threatened in cultivation (NTic)</b>	The best available evidence indicates that these plants may become threatened in the future	Between 1 and 3 points	Reassessed at an appropriate interval
<b>Threatened in cultivation</b>	The best available evidence indicates that these plants are already threatened or no longer in cultivation	Less than or equal to 1 point	Those that are designated 'Threatened' will move on to Stage 2

Table 2 Categories of risk for plants in cultivation, Stage 1.

5. Should a taxon already be categorised by the IUCN this will take precedence; it is not intended to independently assess the rarity of wild-origin plants. Should they be assessed as threatened in Stage 1, reference will be made to the IUCN list; if they are categorised there, no further work will be done on this taxon. If they are not categorised they are assumed not to be rare and are thus removed from the assessment process.

6. For the purposes of this project a plant is classified as a free-living plant growing in a garden or nursery, from which propagules can be obtained.

**Stage 2 Detailed evaluation:** The second stage involves a closer assessment of the threatened plants. It is carried out by those who are known to have an in-depth knowledge of the genus or group. Initially a brief scan of the list is required to remove plants incorrectly created as a result of nomenclatural errors, mis-spellings and translations, as well as any plants that are known to be well-represented in cultivation but have not been eliminated in Stage 1.

The remaining list will then be assessed for two criteria: rarity and merit. It is anticipated that fine-tuning will be required for each selection to make sure that it is fully relevant.

*Evaluation of rarity:* The rarity of the plant is then evaluated using the categories listed in Table 3.

Category	Description	Indication
<b>Vulnerable in cultivation (VUic)</b>	A taxon is vulnerable in cultivation when the best available evidence indicates that it meets the following criterion and it is therefore considered to be facing a high risk of extinction in cultivation	A single source listing in the last five annual editions of the <i>RHS Plant Finder</i> (or other commercial listing) and is a named taxon, cultivar, hybrid or landrace (not a collection number or a location)
<b>Endangered in cultivation (ENic)</b>	A taxon is endangered in cultivation when the best available evidence indicates that it meets both of the following criteria and it is therefore considered to be facing a very high risk of extinction in cultivation	No listings in the last five annual editions of the <i>RHS Plant Finder</i> (or other commercial listing) and is a named taxon, cultivar, hybrid or landrace (not a collection number or a location) and present in more than five collections <sup>1</sup>
<b>Critically endangered in cultivation (CRic)</b>	A taxon is considered to be critically endangered when the best available evidence indicates that it meets both of the following criteria, and is therefore considered to have an extremely high risk of extinction in cultivation	No listings in the last five annual editions of the <i>RHS Plant Finder</i> (or other commercial listing) and is a named taxon, a cultivar, hybrid or landrace (not a collection number or a location) and present in fewer than five collections

Table 3 Categories of rarity showing the criteria for assessment.

*Evaluation of merit:* Plants are then evaluated for their merits according to the criteria listed in Table 4.

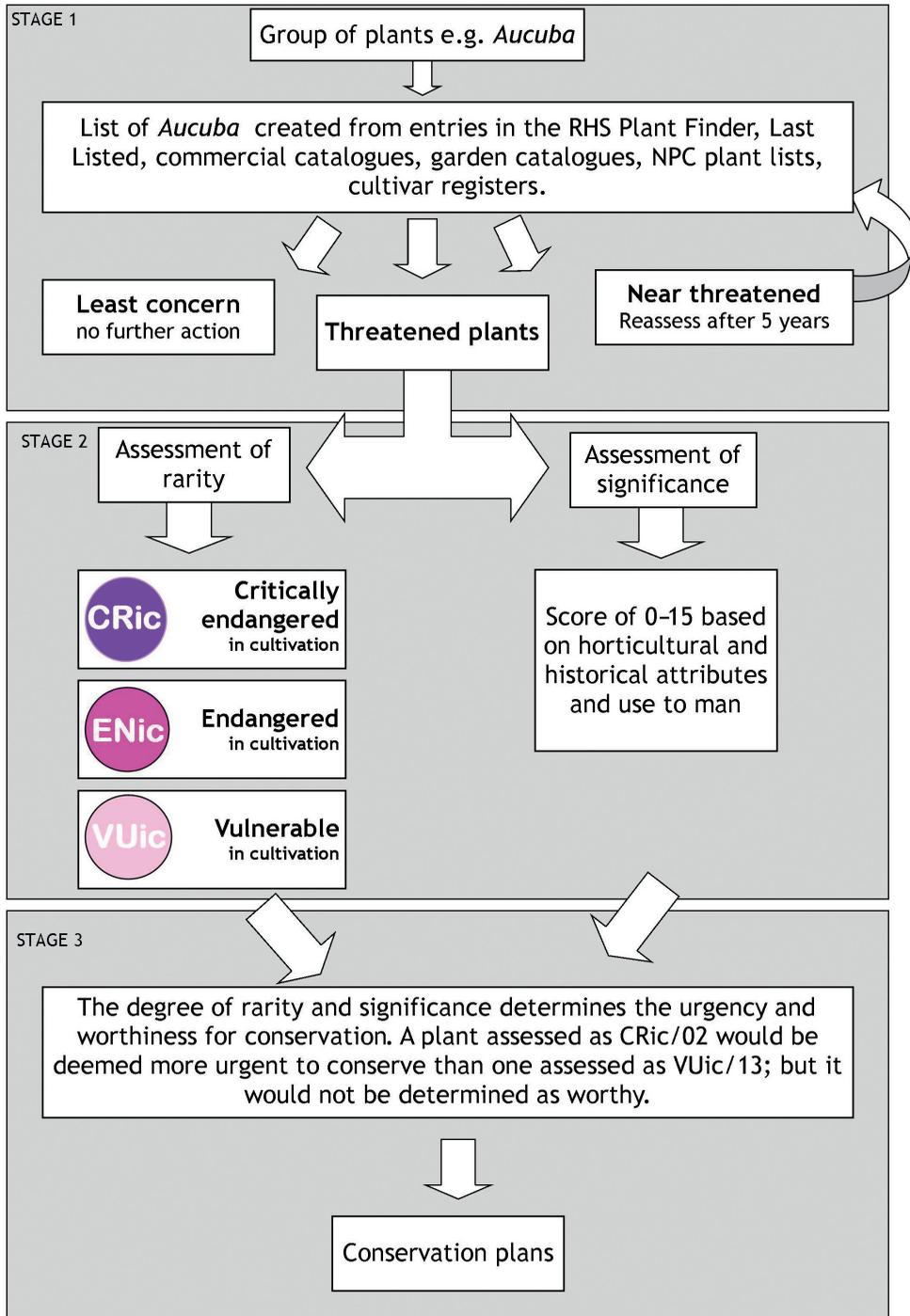


Fig. 4 The flow chart developed by the Threatened Plants Project showing the process of assessment for the conservation of cultivated plants.

Area of merit	Characteristic or quality
<b>Horticultural merit</b> A total score of 0–5 reflecting the importance of the following criteria:	<ul style="list-style-type: none"> <li>– Number and significance of awards received</li> <li>– Distinctive attributes or traits</li> <li>– Hardiness/drought resistance/resistance to waterlogging etc.</li> <li>– Representative of an improvement in breeding (a new break)</li> </ul>
<b>Benefit to man</b> A total score of 0–5 reflecting the importance of the following criteria:	<ul style="list-style-type: none"> <li>– Culinary use</li> <li>– Commercial use</li> <li>– Cosmetic use (actual or potential)</li> <li>– Medicinal use (actual or potential)</li> </ul>
<b>Historical importance</b> A total score of 0–5 reflecting the importance of the following criteria:	<ul style="list-style-type: none"> <li>– Link to specific significant property/person</li> <li>– Distinctive local variety</li> <li>– Taxon bred or raised in the UK</li> <li>– Taxon bred prior to 1900 (or earlier, as appropriate)</li> </ul>
This will give an overall merit score for each taxon assessed out of 15.	

Table 4 Evaluation of merit and the qualities used for assessment.

### *Overall priority score*

The two assessments of rarity and merit will then be combined to give each taxon its conservation value. This will indicate the urgency of need for conservation (the rarity) and its worthiness (the merit). Those taxa that are indicated to be most worthy of conservation and urgently in need of it will be addressed first in the conservation plans. The process is summarised in the flow chart provided in Fig. 4.

The degree of rarity and significance determine the urgency and need for conservation. Therefore, a plant that is assessed as CRic/02 would be deemed more urgent to conserve than one assessed as VUic/13, although it may not merit the effort.

## CONCLUSION

While the threat to plants in cultivation that have been raised or selected by humans has been recognised for some time, to date there has not been a systematic or rigorous method of quantifying the level of threat to that diversity. Both in the UK and in other countries this threat has been addressed by the creation of bodies such as Plant Heritage, which has been specifically tasked with the job of halting the loss of our horticultural diversity. Further, unlike with plants in the wild, it is not a simple case of assessing the rarity of the plant to decide the level of threat. Numerous plants have been raised or selected by humans and it is highly likely that a substantial number have already been lost; however, not all those that remain need to be conserved.

To our knowledge this paper presents the first systematic method of evaluating the priority for the conservation of cultivated plants. It is intended that approaching cultivated plant conservation on a more rigorous basis will not only enable the limited resources to be deployed more effectively, but will also promote the recognition of the value of conserving this part of man's heritage by more science and botanical organi-

sations. Although the method will undoubtedly need further refinement, it is hoped that other like-minded organisations will adopt it and test it, and so contribute to that refinement process.

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