The plants

Inspired by the "amazing forest gardens" in Kerala, India, where he saw "plant-centred design" used to create 'edible landscapes' of food plants, at Penpol, Ken Fern endeavoured to place plants in environments naturally suited to them, where they would thrive and produce crops with minimal care and effort from the Field's human inhabitants. The ability of plants to thrive and yield well depends on many factors, not least the local climate and soil, which means that viability and productivity vary by region. Nearly all deciduous fruit trees need a period of cold winter temperatures to break down growth inhibitors in flower and vegetative buds, known as their "chilling requirement" and estimated as "chilling hours", based on average temperatures. If a cultivar's chilling requirement is not met, fruit-set may be reduced and quality affected. The southwest and most coastal areas of England "currently average about 1,600 chilling hours per annum" but chilling requirements vary widely between species and between cultivars (Crawford, 2010). Hours and intensity of summer sunshine are also a major factor in ripening fruit. Ken Fern mentions as an example the Siberian peashrubs in the Ornamental Area, which are twenty years old but have grown less than two metres tall, and are "straggly and struggling", despite bearing some seed each year. They are seedlings of one grown in the Cambridge Botanic gardens, where the summers are drier, hotter and sunnier, and the winters colder than in Cornwall, and where a tree of the same age would be "four to five metres tall and up to ten metres wide", and, in season, "absolutely laden with flowers and seeds" (Ken Fern, interview 2009).

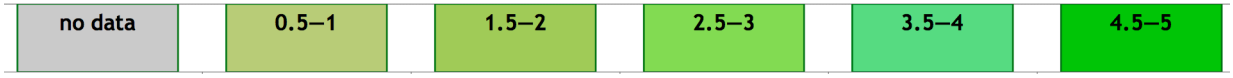
Many, though not all plants thriving at Penpol are particularly appropriate for areas with a temperate maritime climate; many are particularly suitable for environments where there is more shade than in an Orchard, such as a Forest Garden. Many are succeeding in difficult environments, where there is a lot of competition for water, light and nutrients. Some plants that are struggling in one environment on the Field might thrive in another. Overall, the majority of recorded plants are healthy, with some genera counting only healthy specimens. The specimens identified in this section are those that would be worth considering for propagation.

Ken Fern's list of "Best plants grown" (Appendix 2b), contains 779 specimens, belonging to 344 species. Of these specimens, 191 are confirmed as alive and 44 as dead; comments on their condition mainly date from the mid to late 1990s, although a few entries date from the mid 2000s. Where a plant mentioned in the text is on this list, it is followed by an asterisk *.

Condition ratings and information on genera with numerous specimens at Penpol

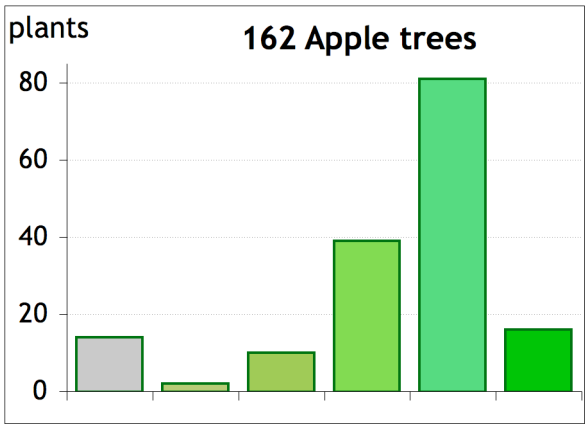
Where there are more than ten recorded specimens of a genus or species on the Field, the distribution of their 'condition ratings' is shown in bar charts below. As previously stated, these ratings equate to the qualitative assessment of health and general condition, as given below, and have been assigned the following colours in the bar charts:

No data gathered	0.5—1: dire	1.5—2: very poor	2.5: poor 3: moderate	3.5: reasonable 4: good	4.5: very good 5: excellent



The number of specimens included in the sample of each genus is given in the bar charts. The genera that have flourished most include the Seabuckthorns *Hippophae* species, which provide a harvest yearly, the *Elaeagnus* species, some of which fruit quite well, the *Amelanchier* species, whose fruit is nearly all taken by birds, and the Walnuts *Juglans* species which are mainly in the Arboreta, and whose fruit is not gathered. Plum trees *Prunus* species, Monkey Puzzle trees *Araucana araucaria*, *Berberis* species and *Crataegus* species are thriving overall; the Apple *Malus domestica*, Cherry *Prunus* species and *Sorbus* species trees are doing reasonably well, slightly better than the Dogwood *Cornus* spp, Pear *Pyrus* species and Hazel *Corylus* species trees, and Currant bushes *Ribes* species

Apples *Malus domestica*



Condition ratings of Apple trees at Penpol

There are in excess of one hundred and sixty Apple trees recorded at Penpol, and in excess of seventy cultivars identified there. The species is the most numerous of all the labelled plants; the fruits ripen between late July and November, and can keep until May or June. Most cultivars are not self-fertile, so need pollen from a different cultivar to set fruit. Quite a few were grafted by the Ferns with budwood from promising trees, many local, with some good results. The varietal scions on the Field are grafted onto two rootstocks, the semi-vigorous MM 106, which produces trees 60-70% of full size, and the vigorous MM 111, which produces trees 70-80% of full size. Both rootstocks confer hardiness and resistance to woolly aphids, tolerance of most soil conditions and excellent root anchorage. However, only MM 111 will tolerate wet soils and waterlogging; it also confers less susceptibility to powdery mildew (Crawford, 2001).

During the survey, Addy Fern repeatedly commented that the fruit from some Apple trees did not ripen or keep as well as previously, or as those from the budwood source tree, or had

become biennial rather than annual fruiters over time. Where the higher canopy shades Apple trees, health, fruit ripening and therefore fruit quality will be negatively affected; "shaded trees may also produce fruit of higher acidity" (Crawford, 2001). Nine Apple trees on the Field sometimes fruit prolifically, and eight are included in the lists below; fruit from the ninth, *var*. Alfreston (40-W1/T2/33), are not particularly nice, and often not eaten because of the availability of nicer fruit. Of the 162 Apple trees recorded at Penpol, 50% are in reasonable to good condition, and 10% are in very good to excellent health. Apple canker *Nectria galligena* is present in nearly all the apples in the orchards and some in other areas. Spores can be transferred by wind, water splash, or insects, and the severity of the infection depends both on cultivar, as susceptibility is genetic, and the number of cankers on neighbouring trees (Johnson, Doust and Eaton, 1982). Canker thrives in "moist, slow-moving air", such as is created by the effective windbreaks on the Field. Codling moth has not been mentioned as a problem; the nearby Native Woodland Area will provide habitat and roosts for bats, the moth's main predators. It also provides habitat for the rabbit and deer that gnaw the bark on the trunk, necessitating tree-guards to prevent too much bark damage, which can eventually compromise the tree's survival; the deer seem to like leaves and bark rather than the fruit. Apples are "heavy-cropping trees and require feeding to sustain cropping", requiring "extra sources of nitrogen and potassium in particular" (Crawford, 2010), although, as Addy Fern remarked "too much nitrogen in the orchards can reduce the storage life of apples" (Addy Fern, 2009 interview). Many of the Apple trees at the Field are crowded by other plants, or, particularly in the case of the Main and Addy's Orchards, shaded by the overgrown windbreaks. A line of hazel trees in the Main Orchard was pollarded because of the shade they cast over the nearby apple trees, and the two westernmost windbreaks (W1 and W2) were cut back or pollarded in 2008 and 2009, decreasing both the shade and root-space competition for the Apple trees. Addy Fern commented that, after the pollarding, the "apples are growing bigger, more quickly" (Addy Fern, 2009 interview).

The health of the Apple trees, noted in the survey, does not correlate absolutely with fruit quality but is a good indicator of the cultivar's ability to cope with the climate and conditions at the Field. Cornwall County Council has a list online of both local and national apple cultivars that it recommends as suitable for growing in the county (http://www.cornwall.gov.uk/default.aspx?page=13875). Some of these are grown at Penpol, but not all have flourished there. Those cultivars that have flourished under the very low input system of the Field, whether they are on the Cornwall County Council list or not, have done so where many other Apple cultivars nearby have not.

The specimens listed below are in very good or excellent condition and yield reasonable harvests of good quality fruit, so may be considered the best of the Apple trees at Penpol. The

last on this list is a tree grafted by the Ferns, with budwood from an early–bearing tree in Lerryn; all the others are named commercial cultivars.

26-W1/T2/14, ‘Duke of Devonshire’*

43-W1/T2/24, ‘Wyken Pippin’*

311-W1/T2/35, ‘Roundway Magnum Bonum’*

312-W1/T2/36, ‘Hambleden Deux Ans’*

154-W2/T4/9, ‘Crawley Beauty’

472-ARE/10, ‘Worcester cross’*

387-ORN1/T1/7, “Flowith early”

In addition, those trees that are reported as being at least moderately prolific and bearing pleasant–tasting apples are listed below.

230-ROB/19, unidentified

12-W1/T1/25, “Page Street”

14-W1/T1/27, ‘Laxton's Fortune’

19-W1/T1/48, ‘Ribston Pippin’*

3-W1/T1/50, ‘Ross Nonpareil’*

2-W1/T1/73, ‘Lord Lambourne’*

44-W1/T2/19, ‘John Standish’*

35-W1/T2/8, ‘Sam Young’*

36-W1/T2/30, ‘Allen's Everlasting’*

42-W1/T2/34, ‘Powell's Russet’*

57-W2/T1/11, ‘Red Roller’

56-W2/T1/17, “Tywardreath Big Yellow”

52-W2/T1/21, “Sherrif v. early”

143-W2/T3/14, “Bodinnick Late Red”

160-W2/T4/33, “Liskeard mini-cox seedling”

61-W2/T1/1, “Mouse”

20-W1/T1/76, ‘Adams pearmain’*

104-W1/T1/77, ‘Wagener’*

108-W1/T1/78, ‘Wagener’*

135-W2/T3/5, “Bodmin Late”

474-ARE/13, ‘Kidds Orange Red’

Finally, those trees that are in very good or excellent condition, although there is either no information on their fruit, or they do not yield prolifically, are listed below.

316-W1/T2/7, ‘Hambleden Deux Ans’

568-W3/T2/1, ‘Hambleden Deux Ans’

147-W2/T3/12, unidentified

174-W2/T4/13, unidentified

179-W2/T4/14, 'Crawley Beauty' (another specimen of this cultivar, W1/T3/37* fruits prolifically, although it is in poor health)

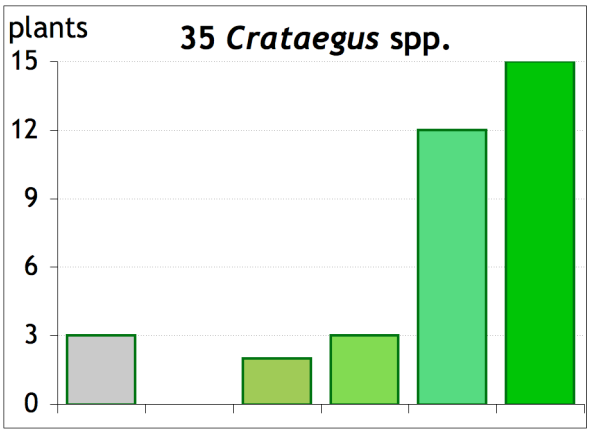
466-ARE/4, 'Belle de Boskoop'*

410-CO/5, 'Bess Pool'*

290-ORN5/6, 'Blenheim Orange'*

AW/T3/23, "Jugoslavian"

Thorns *Crataegus* species (spp.)



Condition ratings of *Crataegus* spp. at Penpol

Nearly all species of Thorn *Crataegus* species are hardy enough for the British climate, with the exception of the mountains of Scotland, and "are easily cultivated in good, well-drained garden soil with supplemental water in dry periods" (Phipps, 2003); when established many will tolerate drought. They thrive in Cornwall, and at Penpol, as well as in the East of the country. Of the 35 *Crataegus* species trees recorded at Penpol, 77% are in reasonable to excellent condition.

In Ken Fern's opinion, the best fruiting Thorn is a *Crataegus pedicellata* (officially known as *C. coccinea*) cultivar from Hilliers (Appendix 2b), in his garden at Lerryn. He also commends *C. schraderiana*, a Greek form, which bears "deep maroon melt-in-the-mouth fruit" (Ken Fern, 2009 interview), and *C. baroussana*, a Mexican form, that fruits very well. Although there is no recorded specimen of *Crataegus pedicellata* at Penpol, there is a fruiting *C. schraderiana** in the Ornamental Area (255-ORN6/16), and three young trees elsewhere in the Field, all in good to excellent condition. There is also a *C. baroussana** in the Ornamental Area (261-ORN6/21), bearing fruit that ripen in October and November; it is in good condition, unlike a younger, severely shaded tree, in the Drive Area. Also in the Ornamental Area are a moderately productive Chinese Haw *var.* 'Big Golden Star' (389-ORN1/T1/9), and a grafted Azarole* (265-ORN6/4), which bears small tasty fruit in September. There are two unidentified fruiting *Crataegus* trees in Addy's Orchard; one, possibly *C. durobrivensis** (129-W2/T1/23) is only in moderate health but bears very pleasant fruit, the other (123-W2/T2/5) is unidentified but in very good health and bears fairly large, pleasant fruit. There are two Tansy-leaved thorns* in the Veg and Nursery Area (562-OVN/T3/1 and 563-OVN/T3/2), which did bear pleasant fruit but are currently too shaded to yield much, and two healthy Scarlet hawthorns* in Arboretum

West (521-AW/T3/4 and 635-AW/T3/19), both in very good condition, although no information was recorded on how well they fruit.

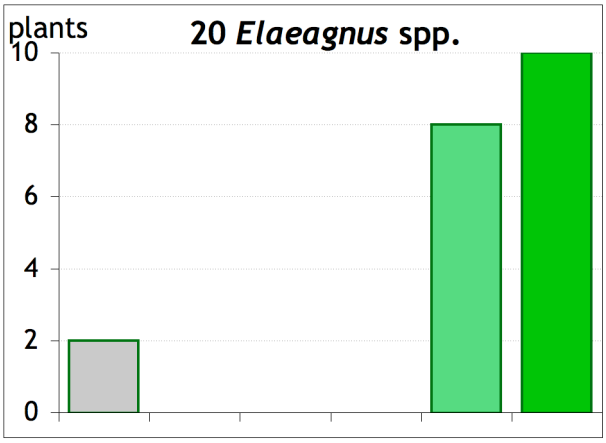
There are also innumerable wild Hawthorn trees in the Native Woodland and Arboreta Areas, amongst others; some are self-sown and quite young. This plant is used as a rootstock for other *Crataegus* species, although it has a suckering habit and will shoot from the rootstock if the grafted tree is stressed (Phipps, 2003).

Hawthorns can be propagated by seed, cuttings or grafting. However, as Ken fern points out, many will cross-pollinate, so raising plants from seed is unlikely to reproduce an identical plant to the parent, and cuttings are extremely difficult, "generally reckoned in the horticultural literature to be impossible to root" (Phipps, 2003), so grafting is preferable for desirable strains, with the possible exception of the Chinese Haw, the thin (3-5 mm) shoots of which may reach a 70.5% rooting potential as cuttings (Szabó *et al.*, 2008). The wild native Hawthorn is commonly used as rootstock, although it has a tendency to come up from the rootstock when stressed (Phipps, 2003), as has happened in Arboretum West; seedling Hawthorns can be found in the Native woodland Area.

The flowering shoots and fruit (known as haws) of the wild Hawthorn have long-established medicinal effects on the heart muscle and blood vessels, and, as stated in the PFAF website database, is used in the treatment of chronic heart failure, high blood pressure, arrhythmia, as well various digestive ailments (Skenderi, 2003), geriatric and antiarteriosclerosis remedies (Tadic' *et al.*, 2008); they also have anti-inflammatory, antimicrobial and anticancer activities (Tadic' *et al.*, 2008; Dong *et al.*, 2009); the fruit has been shown to be useful in the treatment of hyperlipidemia and prevention of atherosclerosis (Xu *et al*, 2009). Azarole buds and flowers have also been found to possess antioxidant activities (Bahri-Sahloul, 2009).

Elaeagnus species*

Ken Fern considers *Elaeagnus* species a "really important genus" for the Field. They fix nitrogen in the soil, make an 'amazing' hedge, and are the best shrubs for producing fruit that all children like, especially the deciduous species. Ken says that he has yet to find a child that doesn't like them, and would lead kids to the bushes when taking parents around the Field, leaving them there to eat the fruit, and they were happy to stay there (Ken Fern, 2009 interview). Rabbits also seem to love eating the young shoots (Addy Fern, 2009 interview). The genus is also highly recommended by Martin Crawford of the



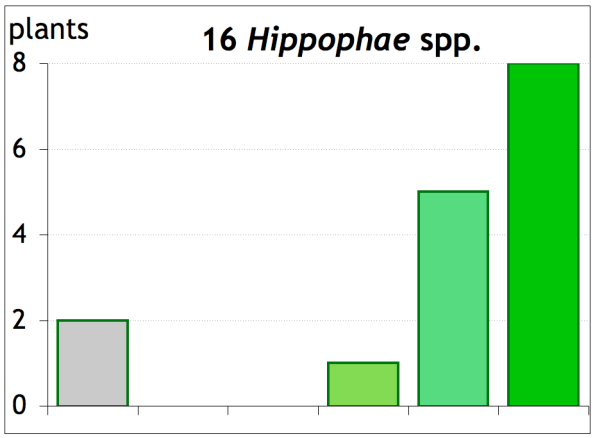
Condition ratings of *Elaeagnus* spp. at Penpol

Agroforestry Research Trust, although no specimen of his favourite species, the deciduous Autumn olive *E. umbellata*, is amongst those recorded at Penpol. The spring-fruiting evergreen *Elaeagnus* species are "smaller, less hardy and more shade-tolerant" (Crawford, 2010) than the summer-fruiting deciduous species. All Elaeagnus species are self-sterile and therefore need pollen from a different cultivar to set and fruit. Of the 20 *Elaeagnus* species shrubs recorded at Penpol, 90% are in reasonable to excellent condition (the other 10% had no condition rating recorded).

The most prolific fruiter of the genus at Penpol is the evergreen *Elaeagnus cordifolia** (407–ORN1/T1/6 and 404–ORN1/T1/10); also in the Ornamental Area are the evergreen *Elaeagnus x ebbingei* (341–ORN1/T1/19), which is not so prolific but bears "sweeter and nicer" fruit than *E. cordifolia*, and *Elaeagnus macrophylla** (274–ORN6/2), which flowers abundantly, and bears variable harvests of roundish red berries in September and October. In the Main Orchard are two cultivars of *Elaeagnus pungens*, *var*. "Maculata" (561–W1/T1/4), whose fruit "is a superfood, high in bioflavonoids" (Addy Fern, 2009 interview), and *var*. "Frederici" (579–W1/T1/7), both good fruiters. in the Robert Hart Garden is another evergreen *Elaeagnus* (233–ROB/2), possibly *E. x ebbingei*, grown from seed from South Mead hospital Bristol, which fruits well. There are two specimens of the deciduous Silverberry *Elaeagnus commutata*, *var*. 'Quicksilver' (W2/T1/14), a "really good summer-fruiting cultivar" bought from Bluebell nursery; the plant tops have been browsed by deer but they remain in reasonable condition. There is another deciduous *Elaeagnus*, Goumi*, in the Ornamental Area (277–ORN6/2A), in excellent condition, although no fruiting information is recorded. This species has antioxidant and anti-inflammatory properties (Lee *et al.*, 2007).

Seabuckthorns *Hippophae* species

The Seabuckthorns have been consistently prolific fruiters at the Field whilst, as nitrogen fixers, adding to the fertility of the soil around them. Of the 16 *Hippophae* trees recorded at Penpol, 81% are in reasonable to excellent condition. They are dioecious, so require a male of the species reasonably close to every five or six females to ensure fruiting (Fern, 1997). Whilst female plants of the genus sucker readily, the males do not, and Addy Fern is finding it harder to find new males for the females she plants; however, male seedlings are easy to distinguish from females (www.pfaf.org/database/).



Condition ratings of *Hippophae* spp. at Penpol

Addy Fern harvests from the Seabuckthorn

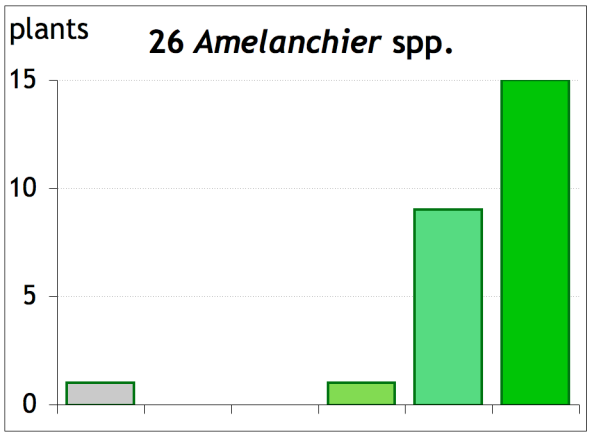
trees in the New Veg and Nursery Area (539–W3/T3/5) from August until October, when the fruit quality deteriorates. The Willow-leaved seabuckthorn trees are harvested from September until late winter, mid December to mid February, depending on bird predation; the Willow-leaved seabuckthorn trees in the Meadow (202–M3 and 621–M7) are harvested before the tree in the Main Orchard (194–W1/T3/27), which is of different origin from those in the Meadow. The other two trees in the Main Orchard appear to be of a different cultivar, and the quality of their fruit has waned over the years. Also fruiting well is a fast growing Willow-leaved seabuckthorn (232–ROB/27), in the Robert Hart Garden.

Willow-leaved seabuckthorn fruit on a tree in the Meadow

Seabuckthorns grow well under various extreme environmental conditions, such as drought, salt stress, altitude and cold. Its berries are used in cosmetics and pharmaceutical products (Chen *et al.*, 2009), including massage creams and a shampoo; it also yield good firewood (www.winrock.org/fnrm/factnet/factpub/FACTSH/hippo.htm). Extracts of the berries inhibit the proliferation of human colon and liver cancer cells (Grey, 2010), an extract of the seed residues (after pressing for juice) can prevent diabetic complications associated with hyperlipidemia and oxidative stress (Zhang *et al.*, 2010), the seed oil can protect the liver from toxin damage (Hsu, 2009), and an extract of the leaves protects the whole body from the effects of exposure to gamma radiation (Bala *et al.*, 2009 and Tiwari *et al.*, 2009).

Juneberries *Amelanchier* species

Ken Fern states that the various shrubs of this genus succeeded "reasonably well" in the early years of the Field but, with the increased tree cover, no longer fruit very well there (Ken Fern, 2009 interview). Members of the genus will tolerate partial shade but fruit best in full sun. They are self-fertile and fruit early in July, just after strawberries; those that do fruit well are subject to relentless bird predation. Of the 26 Amelanchier species shrubs recorded at Penpol, 92% are in reasonable to excellent health.

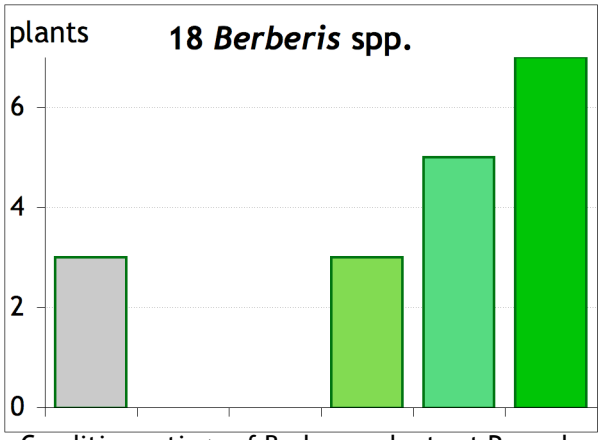


Condition ratings of *Amelanchier* spp. at Penpol

A seedling Saskatoon* from the Field was planted in his mother's garden in London, where it is far less subject to shade and predation by birds, and bears fruit twice the size of those at the Field, which taste "exquisite, really, really lovely". Ken states that shrubs of the genus "prefer colder winters and dryer, hotter summers", typical of continental areas (Ken Fern, 2009 interview). In its native Canada, the Sakatoon occurs more frequently in continental areas than in wetter, coastal ones (Klinka *et al.*, 1989), and some cultivars require in excess of 3 months (2100 hours) at temperatures of 0-4°C, to flower and fruit normally (Janick, 2007). There is only one Saskatoon shrub recorded at Penpol, in the Main Orchard (319-W1/T3/52); it is in very good health and bears very nice fruit, most of which the birds take.

The Quebec berry* apparently thrives better in Cornwall than at Kew; Ken has recorded it producing fruit in the first year of planting out at the Field, at only 9 inches tall (Ken Fern, 2009 interview). There is one recorded specimen in excellent health, growing in the Ornamental Area (303-ORN3/T1/1), which yields good quality fruit. There are two fruiting Juneberry shrubs, in Arboretum West, and four Apple Serviceberry bushes *var.* 'Ballerina'*, two in the Ornamental Area and two in Addy's Orchard. A further 18 unidentified *Amelanchier* species shrubs are growing in the Orchards, Arboretum West and the Drive Area, one of which (117-W2/T2/2) is recorded as yielding good fruit.

Barberries *Berberis* species



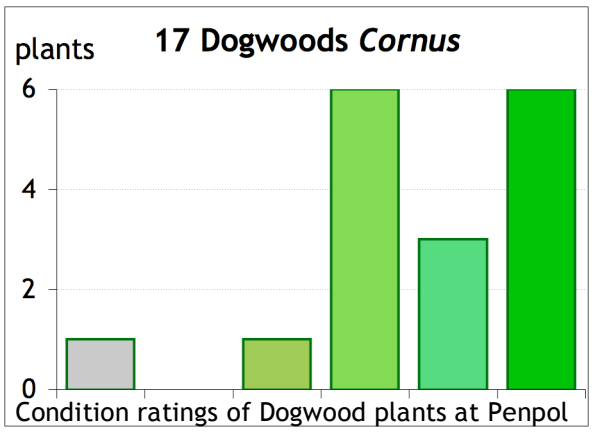
Condition ratings of Barberry plants at Penpol

Barberry shrubs have been used in several hedges at Penpol, in which form they need several metres width (Ken Fern, 2009 interview). Of the 18 Barberry bushes recorded at Penpol, two-thirds (67%) are in reasonable to excellent condition.

They may be evergreen or deciduous. There are three fruiting Barberry bushes in the Main Orchard, including an evergreen Darwin's Barberry* (595-W1/T2/28) that fruits in July and, sometimes, again in November-December from late summer flowers; the birds seem to prefer these fruit to raspberries, strawberries and currants. There is also a deciduous, prolific Salmon Barberry* (245-W1/T3/50), whose acid but pleasant fruit ripen in Autumn but can be picked early in Winter, as they do not suffer much predation by birds. Lastly, a Mrs Wilson's Barberry* (596-W1/T3/54) bears fruit of good quality, a little earlier than the Salmon barberry. Just north of the Shed is an unidentified evergreen Barberry, possibly *Berberis x stenophylla** (364-D/20), which yields well in July. In the Ornamental Area are several deciduous, native Barberry bushes* (ORN4/5 and 272-ORN6/3) that bear pleasantly acid fruit. In Arboretum East are two evergreen unidentified Barberry bushes, probably Darwin's Barberry, (500-ARE/39 and 501-ARE/40) that are "quite good".

Darwin's Barberry fruits contain lots of flavonoids (Ken Fern, 2009 interview). Nearly all species of the genus contain the alkaloid berberine, which is anti-bacterial, anti-fungal and anti-protozoal; the fruits of the native Barberry are used as a vitamin C supplement (Skenderi, 2003).

Dogwoods *Cornus* species



Condition ratings of Dogwood plants at Penpol

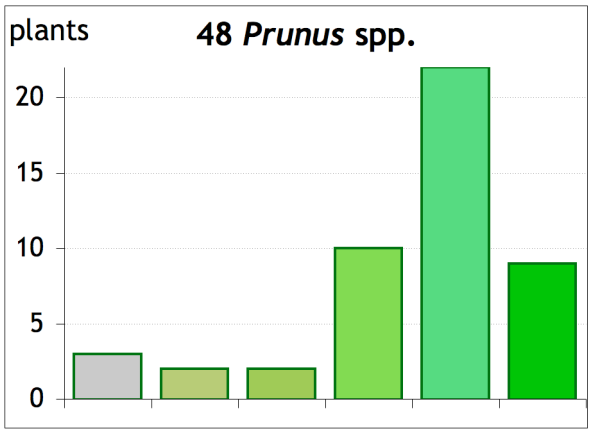
Of the 17 Dogwood plants recorded at the Field, 53% are in reasonable to excellent health. This genus has several species with edible fruit, at least five of which are growing at the Field but the only one producing pleasant-tasting fruit is the August-fruiting Japanese dogwood*, of which there are several in the Ornamental Area, of at least two different cultivars; one (331-ORN2/T1/1) bears pleasant, small fruit, with red skin and yellow flesh, the other (275-

ORN4/6) bears sparse fruit but large and tasty fruit. Also in the Ornamental Area is a Bentham's cornel tree*, planted from seed, whose somewhat bitter fruit ripens in November and December. Ken Fern knows of a Bentham's cornel tree in West Cornwall that fruits prolifically every year, with sweet fruit, of very similar in flavour to those of the Japanese dogwood; however, all seedlings grown from it, and from other Bentham's cornels he has tried, yield bitter fruit. This suggests that the species, and possibly the genus, needs vegetative propagation if fruit quality is to be maintained. There are several Cornelian cherry trees* in the Ornamental Area, including three named cultivars and a small variegated bush, but they are not very prolific and the birds take the fruit. There are also four Shan Zhu Yu shrubs* in the Ornamental Area; they have fruited well in some years.

Research has shown that an aqueous extract of Japanese dogwood leaves could make an effective treatment for Irritable Bowel Disorder (Babu *et al.*, 2009), and compounds found in the fruits inhibit the growth of colon, breast, lung and central nervous system tumours (Vareed *et al.*, 2007). Cornelian Cherry fruits are high in vitamin C and have antioxidant and antibacterial activity (Rop *et al.*, 2010; Krisch *et al.*, 2008). Bentham's cornel leaves have shown strong antiviral activity (Khan *et al.*, 1991; Bhakuni *et al.*, 1987). Shan Zhu Yu fruit have been used in traditional oriental medicine for treatment of inner ear diseases, such as tinnitus and hearing loss (Yu, H. *et al*, 2009), and in Western herbalism, for erectile dysfunction and to boost the immune sytem, amongst other things (Skenderi, 2003); they have anti-tumour, antioxidative, antidiabetic, anti-inflammatory and analgesic effects (Sung *et al.*, 2009), and contain compounds that can attenuate brain damage from strokes (Jiang *et al.*, 2009). Cultivars have been screened to maximise the medicinal qualities of the fruit (Yu, W. *et al*, 2009).

Plums and Cherries *Prunus* species

There are at least eight species of the genus *Prunus* growing at the Field, including Plum, Cherry and Cherry plum trees. Of the 48 trees of the genus recorded there, 65% are in reasonable to excellent condition; of the 11 Cherry trees (*P. avium* and *P. cerasus)*, 55% are in reasonable to excellent health, and 65% of the 23 Plum trees are. A slow-growing Morello Cherry tree, planted in Addy's Orchard (190-W2/T4/36) during the last decade, bore its first four cherries in 2009; other Cherry trees recorded at Penpol either bear disappointingly bitter fruit or have not been observed to fruit. There is no information on how well the three Plum

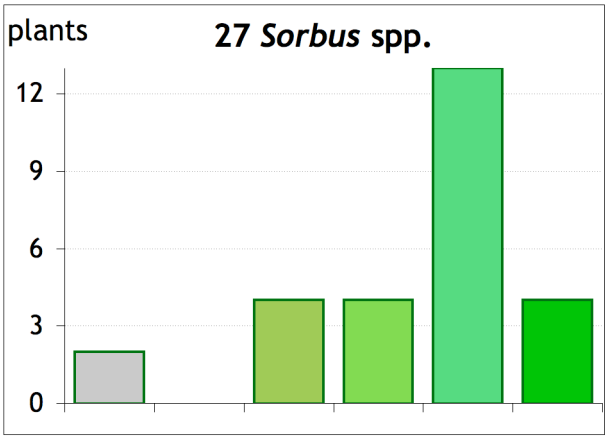


Condition ratings of *Prunus* spp. trees at Penpol

trees in the Robert Hart Garden are fruiting, and only one cultivar growing elsewhere is recorded as having reasonable harvests. This is on budwood from two local Plum trees, which appear to be the same cultivar, one at Bodinnick and the other from a tree between the toilets in the car park at Lerryn (hence named "Lerryn Loo"), which have been grafted onto rootstock at the Field. They have not proved reliably prolific but, from August, have a long harvest of very nice yellow, damson-sized plums. There are trees of this cultivar in Addy's Orchard (556–W2/T1/5 and 138–W2/T3/8), the Ornamental Area (286–ORN5/5) and the Central Orchard (418–CO1 and 419–CO1a). None of the Cherry plums are at all prolific but a Damson tree in the Robert Hart Garden (220–ROB/3) fruits well sporadically. Two suckers from this tree have been transplanted to the Main Orchard, in front of the Ribery (Bed 3111). A Japanese apricot (W2/T3/31), the healthiest of three trees planted in the early 2000s, has not yet fruited but may prove productive. Various extracts from the plant have shown significant anti-obesity and hypolipidemic effects (Xia *et al.*, 2010), antibacterial activity against many strains of Staphylococcus and Enterococcus, and E. coli (Li *et al.*, 2007), and inhibited the growth of liver tumour cells (Okada *et al.*, 2007); the fruit are pickled to make Umeboshi.

Sorbus species

There are at least five species of this genus growing at Penpol; of the 27 *Sorbus* species trees recorded there, 63% are in reasonable to excellent condition. However, only the two Whitebeam trees in the Robert Hart Garden (226–ROB/5 and 209–ROB/15) are known to be fruiting well, with pleasant-tasting fruit. Rowan trees have been planted throughout, including in the Main and Addy's Orchard. The fruit they bear is neither as good or as abundant as on trees in eastern England; the one named Rowan cultivar recorded, 'Beissneri', in Addy's Orchard, does not fruit or flower much, prompting the description: "this tree is rubbish". Two Service trees survive in Arboretum West but are in poor condition; there are also two Swedish Whitebeam trees in Arboretum Central, in better condition.

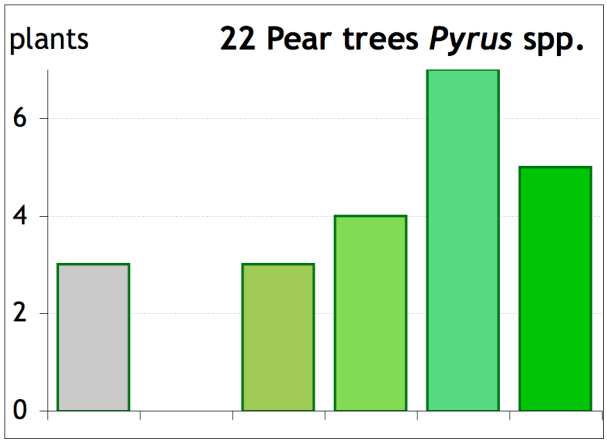


Condition ratings of *Sorbus* spp. trees at Penpol

Rowan flowers have higher antioxidant activity than the fruit or leaves (Olszewska and Michel, 2009), and the fruit are high in Vitamin C and antibacterial activity (Krisch, *et al.*, 2008); they are used fresh to treat constipation and cooked to treat diarrhoea (Skenderi, 2003). Service tree fruit have been suggested as "a promising way for lowering the incidence of long-term complications of diabetes mellitus" (Termentzi *et al.*, 2008).

Pears *Pyrus* species

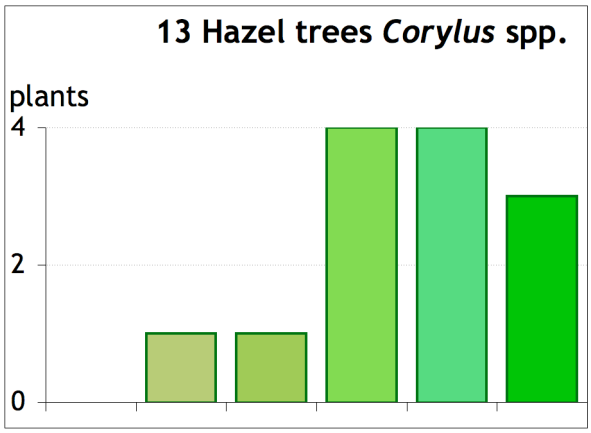
There are three or four species of Pear trees at Penpol, including several unidentified seedlings. Of the 22 Pear trees recorded there, 55% were in reasonable to excellent condition. Only one cultivated Pear tree* in the Main Orchard (114-W1/T1/17) yields well, although the fruit does not taste particularly good. Otherwise they bear poor yields of fruit that are barely edible or inedible, "even after cooking for hours".



Condition ratings of Pear trees at Penpol

Leaf extracts of *Pyrus communis* are effective against rice blast fungus (Anwar *et al.*, 2007).

Hazel *Corylus* species

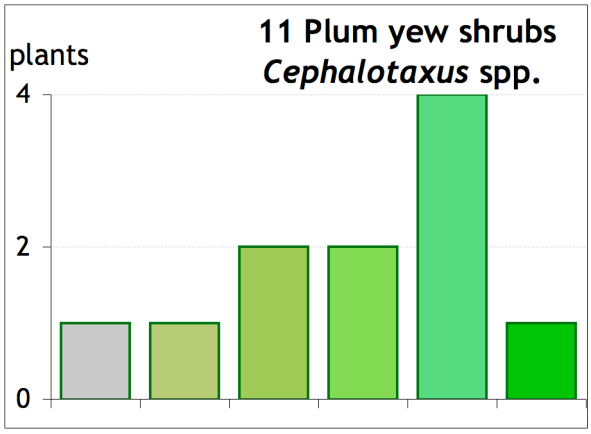


Condition ratings of Hazel trees at Penpol

There are two species of this genus growing at the Field, Hazel and Filbert. Of the 13 hazel trees recorded there, 54% are in reasonable to excellent health. Six trees are of named cultivars, all planted in Arboretum East. Only two trees are recorded as cropping, both Hazels: a 'Kentish Cob' in Arboretum East (478-ARE/14) that is in good condition and has sometimes produced good crops, and one unidentified cultivar in the Robert Hart Garden (222-ROB/4) that is in very good health and produced its first few nuts in 2009.

Extracts of Hazel leaves are astringent and anti-inflammatory (Skenderi, 2003; Tunón *et al.*, 1995), help protect against liver damage (Rusu *et al.*, 2005) and control *Ascaris* worm infestations in animals (Altug and Kaptan, 2002).

Plum yew shrubs *Cephalotaxus* species*

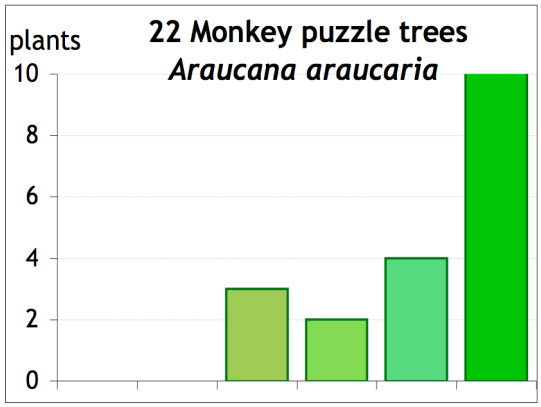


Condition ratings of Plum yew shrubs at Penpol

Of the 11 Plum yew shrubs at Penpol, 45% are in reasonable to excellent condition. There are nine species of this genus listed on the website database but none of the shrubs on the Field were identified. So far none have borne fruit; all the bushes mature enough to do so are apparently male. The healthiest specimen is in the Robert Hart Garden (207-ROB/21).

Monkey Puzzle trees *Araucana araucaria**

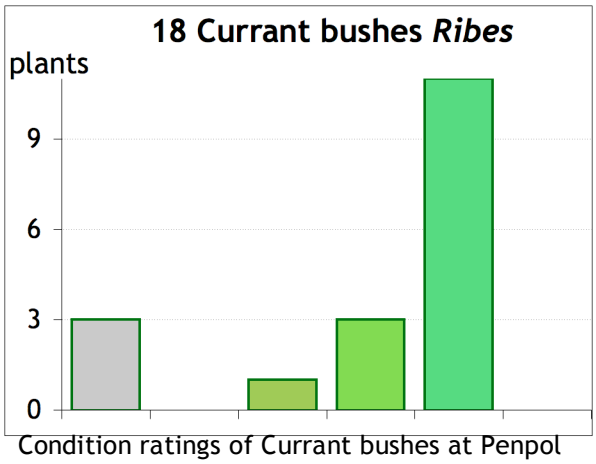
Of the Monkey Puzzle trees growing at Penpol, 77% are in reasonable to excellent health. There are 11 trees grown from seed sown in the early 1990s in Arboretum Central, of which seven are in good to excellent health, although none appear close to fruiting. Six young trees in the Robert Hart Garden, planted in the mid to late 2000s, are all in excellent condition.



Condition ratings of Monkey puzzle trees at Penpol

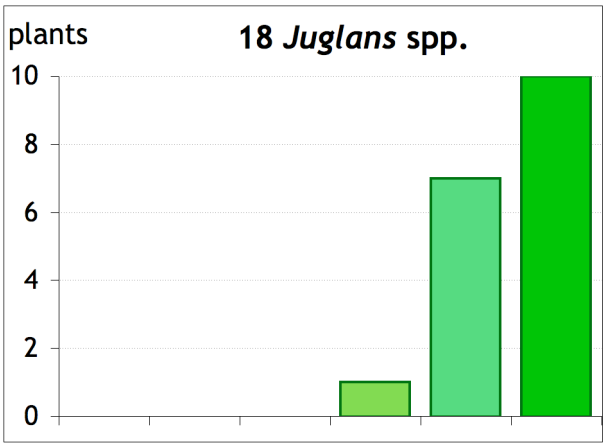
Monkey Puzzle trees are an investment in the future; none appear ready to fruit, although some are approaching 20 years of age. Grown from seed, the trees can take up to 40 years to produce nuts, although the Ferns "have often seen plants less than 20 years old produce cones" (PFAF website). Antifungal and antibacterial activities of Araucaria araucana heartwood lignans (Céspedes, 2006). The resin is used by the Mapuche Amerindians in southern Chile and Argentina to treat ulcers and has been shown to display a gastroprotective effect (Schmeda-Hirschmann, 2005).

Currant bushes *Ribes* species



Condition ratings of Currant bushes at Penpol

Of the 18 bushes of this genus recorded at Penpol, 61% are in reasonable to good health but none in very good or excellent condition.There are at least ten species still growing at the Field, with eight of the sixteen different species planted in the Ribery surviving, and six species amongst those recorded as specimen bushes, of which *R. stenocarpum* and *R. menzeii* are not deemed worth the effort of growing. Only the Blackcurrant bushes* in the Robert Hart Garden (224-ROB/12 and 547-ROB/30) and the Redcurrant* in the Ribery described as fruiting reasonably well. There is one Golden currant*, a species that Ken Fern particularly likes (Fern, 1997), surviving in the Ribery, and, in the Main Orchard, two Jostaberry or Worcesterberry bushes (just south of 586-W1/T1/41), and an experimental cultivar of Ken Fern's, probably a Gooseberry (606-W1/T3/21).



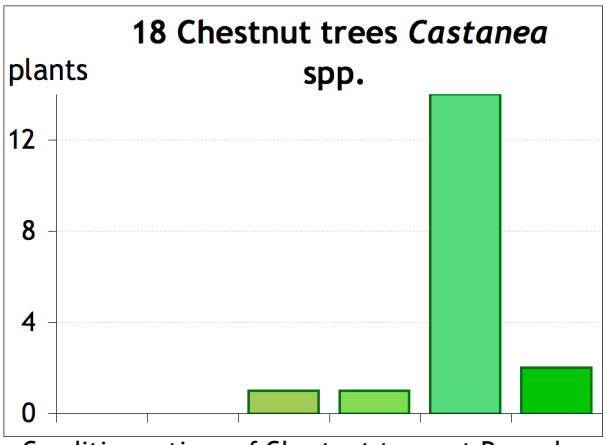
Condition ratings of Walnut trees at Penpol

Walnuts *Juglans* species

There are three species of Walnut tree at the Field: Walnut, Japanese walnut, and Heartseed walnut. All the trees of the latter two species are in Arboretum East, except for one Japanese walnut in the Robert Hart Garden. The Walnuts are in Arboretum Central and West, and the Main Orchard, with one unidentified member of the genus in the Ornamental Area. Of the 18 Juglans species trees there, 94% are in reasonable to excellent health. One Japanese walnut (481-ARE/22) has been fruiting for some years but the nuts are small and it is hard to extract much meat from the shell. One Walnut tree in Arboretum West (417-AW/T1/3) flowered for the first time in 2009.

Chestnuts *Castanea* species

There are two species of Chestnut tree at the Field, Chestnut and Chinquapin; the latter are growing in one group in the Ornamental Area, and are all in good condition. They have fruited but no information was recorded on current yields. Of the Chestnut trees, 78% are in reasonable to very good condition; two are growing at the northern end of Addy's Orchard, and the rest, including two 'Marron de Lyon' cultivars, in Arboretum Central. One of the unnamed trees there is bearing fruit, and the 'Marron de Lyon' cultivars have fruited in the past, but poorly (Appendix 2b).



Condition ratings of Chestnut trees at Penpol

Other genera of note at Penpol

Trees

Crab apples *Malus* species

With the exception of a 'John Downey' seedling (82-W2/T3/30) in Addy's Orchard, none of the five labelled Crab apple trees on the Field yields well. The Crab apple *var*. Neville Copeman (325-ORN2/T2/6A), in the Ornamental Area, bears pleasant-tasting dark red apples, and another (549-D/25) is a seedling that bears cherry-sized fruit, which taste like cooked apples; the tree is unproductive but might yield better in a different environment. Some Crab apple trees are kept for food for birds and for pollination, as they "are usually excellent pollinators for *Malus domestica*, flowering abundantly for a long period" (Crawford, 2001).

Japanese pepper tree *Zanthoxylum piperitum**

There are three specimens of this tree in the Ornamental Area, which bears orange berries that are a spicy pepper substitute. It is dioecious, so needs a nearby male for female trees to produce fruit. The healthiest specimen is mapped and tagged as 339–ORN2/T1/2.

Elder *Sambucus* species

There are at least three species of Elder growing at Penpol, including the unwanted *Sambucus ebulus* in the Main Orchard. A single American Elder*, also in the Main Orchard (38–W1/T2/46), is suckering profusely but not known to fruit. The flowers of this tree, borne from July to November and used to make drinks, are considered its main crop; it will not fruit unless

pollinated by another cultivar nearby. Of the native Elder trees that grow throughout the Field, some self-sown, the only one known to be fruiting well is a large, very healthy tree in the Robert Hart Garden (422–ROB/6).

Sassafras *Sassafras albidum**

All parts of this tree in the Ornamental Area (297–ORN3/T2/4) are aromatic; the leaves and flowers are used to flavour food and drinks. The tree is dioecious, so requires a male of the species reasonably close to the females to ensure fruiting.

Judas tree *Cercis siliquastrum* and Redbud *Cercis canadensis**

There are five Judas and Redbud trees in the Ornamental Area (279, 281, 282, 287– ORN4/3a–d); the pink flowers of both species and the pods of the Judas tree are edible and taste like sorrel. The identity of each tree has not been established.

Holm oak *Quercus ilex ballota*

There are at least two Holm oak trees in Arboretum East (499–ARE/41 and 498–ARE/42), in reasonable health. The acorns of this species are normally sweet, tasting very similar to sweet chestnut, but no information is available on these particular trees.

Vines

Kiwi vines *Actinidia* species*

There are two species of Kiwi vine growing at the Field; the best specimens of both are climbing around the Shed. Most are dioecious, so require a male of the species reasonably close to the females to ensure fruiting, although a few cultivars are hermaphroditic, and so self-fertile. Females of the dioecious Kiwi *var*. 'Hayward' (ORN1/T1/1 and 403–ORN1/T1/21) yield "incredibly well" (Ken Fern, 2009 interview) at the Field, except when late frost kills off the growing tips. The fruit are harvested in November and December and stored until ripe, which can be as late as March. The Hardy kiwi (236–ORN1/T1/3) is less prolific than the Kiwi, with smaller fruit, with edible skin that can be eaten straight off the vine in November.

Vines *Vitis* species

There are four vines at Penpol, one unidentified species growing into the Alder hedge at the northern end of Arboretum East, and three Grape vines, in the Drive Area and Addy's Orchard. The two vines in the Drive Area are two different cultivars, 'Brandt' (370–D14), which is in reasonable health, fruiting well in good years, and 'Isabella'* (373–D26), which is in good condition but too shaded by the Shed and its own leaves for its fruit to ripen. The third Grape vine grows along the windbreak between the Main and Addy's Orchards (618–W2/T3/11), is rampant and in excellent health but its fruit rarely ripens.

Shrubs

Berries *Rubus* species

There are several patches of various Raspberries on the Field, some in more beneficial situations than others. One cultivar that grows in both the Main Orchard (586–W1/T1/41) and Addy's Orchard (by 52–W2/T1/21 & 53–W2/T1/22) bears tasty red fruits twice yearly, although it reputedly carries a virus to which it is, itself, immune but other cultivars are not. There is a Japanese wineberry* (371–D/13) growing opposite the door to the Shed, which propagates by layering itself at the shoot tips. A vigorous, deciduous Himalayan giant blackberry (by 405–ORN1/T1/27) growing in the Ornamental Area fruits well. The Nepalese raspberry* is a good ground cover plant growing in the Drive area (under 367–D/23), that needs to be kept free of taller weeds, although it has regrown after apparently disappearing under grass and nettles. It also grows and thrives in the polytunnel, where there is little competition; it bears orange fruit, similar to those of the wineberry but with bigger drupes, in July and August.

Shallon *Gaultheria shallon**

This is a good, very shade-tolerant fruit plant for acid soils, which will bear even in quite deep shade. It suckers, making big clumps, and is self-fertile. There are two clumps in the Ornamental Area (300–ORN3/T2/2 and 269–ORN6/5), both in good health. Addy Fern finds the berries insipid but others enjoy their blueberry–like flavour (Crawford, 2010).

Mahonia species shrubs

There are shrubs of at least three species of this genus at Penpol, including an Oregon grape in the Ornamental Area (270–ORN6/8A), which yields somewhat acid edible fruit in early summer, despite being very overshadowed. In the Drive area a *M.* x *media* 'Lionel Fortescue' (384–D/2), is in excellent health and flowers although there is no information on fruit yields. Another *M.* x *media* 'Charity'* in the Main Orchard (125–W1/T1/85) is in excellent condition

despite its proximity to a Hazel hedge and flowers profusely but hardly fruits. This species can bear good crops of fruit in mid-spring if pollinated by insects, as "the unfertilized fruit often has a distinct bitterness" (PFAF website). Shrubs of this genus are "very tough, low-maintenance" bushes, "useful for shady areas" (Crawford, 2010).

Blue sausage fruit *Decaisnea fargesii**

There are two shrubs of this self-fertile species in the Ornamental Area (390, 391–ORN1/T1/12, 13), both in moderate health and bearing some fruit.

Bamboos

An unidentified species of Bamboo in the Main Orchard (359–W1/T2/22) has particularly pleasant-tasting shoots, free of bitterness even when raw. It is also quite a vigorous spreader, producing numerous shoots. There are two clumps of the Umbrella bamboo (342–ORN1/T1/32 and by 427–AW/T3/29), which also has shoots nice enough to eat raw, and makes good garden canes. Another bamboo, Ringal (east of Japanese pepper tree 339–ORN2/T1/2) is also good for garden canes, as is the Arrow Bamboo growing in the hedge around the Old Veg and Nursery Area; the shoots of the latter are edible but somewhat bitter but it can be grown along river edges to protect the banks from erosion.

Ground layer plants

Bellflowers *Campanula* species*

The hardy, shade-tolerant evergreen perennial Harebell is Addy Fern's favourite member of this genus, which bears edible flowers. It grows in the fenced bed at the northern end of the second compartment in Addy's Orchard (W2/T2), along with the Trailing bellflower. The Chimney bellflower and the Clustered bellflower are growing in Arboretum West, in a previously cultivated clearing area, near an unidentified Rhamnus tree (530–AW/T3/27). They are self-fertile and can be propagated from seed or by division of clumps in spring or autumn.

Day lily *Hemerocallis* species

Several different cultivars of Day Lily are growing in the medicinal plant bed (Bed 3016) in the Ornamental Area. Their young leaves and shoots are edible cooked, and the flowers raw or cooked. The flower on the cover of the book, "Plants for a Future", is a Day lily *Hemerocallis fulva* 'Kwanso', "the most exquisite tasting and beautiful flower you could possibly eat" (Fern, 1997); it still grows in the Ornamental Area.

Abutilon *Abutilon vitifolium**

This evergreen shrub growing in the Ornamental Area (405–ORN1/T1/27) bears white and lilac edible flowers, in profusion from May to July.

French scorzonera *Reichardia picroides**

French scorzonera is a dandelion-type plant that thrives at the Field but bolts easily, so must be picked hard during the summer; it will also provide leaves all winter. The leaves are very mild and slightly sweet, even when going into flower. It is perennial but will tend to die off in a very cold and wet winter; however, it self-seeds and comes back from seed the following year. It never suffers much slug damage, probably because of the white dusty coating on the leaves, which may repel the slugs (Ken Fern, 2009 interview). It is growing in the fenced bed east of the path in the first compartment of the Main Orchard (W1/T1), and is easy to grow and to propagate from seed.

Perennial buckwheat *Fagopyrum dibotrys**

There is a thriving patch of Perennial buckwheat, which has edible leaves and flowers, in the Nursery area, which is very vigorous but does not set seed; it may be self-sterile. It has also been planted as woodland understorey in Arboretum West (by 427–AW/T3/29), along with Butterbur.

Musk mallow *Malva moschata**

There is a patch of this plant with edible leaves, flowers and seeds in the fenced in bed in the Main Orchard (587–W1/T1/38).

Babbington's Leek *Allium ampeloprasum babbingtonii*

The bulbils of this wild leek are the part most often used, as the leaves are somewhat tough and many preferred alternatives, such as Ramsons, are available when these leeks are. They grow and seem to thrive under trees and hedges in the Main and Addy's Orchards.

Pink Purslane *Claytonia sibirica**

This low-growing winter salad plant has naturalised in various places in the Field, including Addy's Orchard and grows quite happily under trees.

Three-cornered leek *Allium triquetrum**

Addy Fern collects and sows the seeds of this pretty member of the onion family, which is growing in the Ornamental Area and Addy's Orchard. This productive vegetable bears edible leaves in winter and flowers in spring and dies back down in summer. The root can also be dug up and eaten but this would kill the plant.

Yacon *Polymnia edulis**

This close relative of the sunflower grows two types of root; a clump of quite small tubers at the base of the stem and, running down from that, storage roots that can weigh two kilos each; despite containing almost no calories, these are quite sweet and juicy, with the texture of a really crisp apple. The main starch in these roots is inulin, which provides soluble fibre, and is used as a prebiotic, amongst other things. The roots can be baked but are usually eaten raw. It grows in the Polytunnel in the first compartment of the Main Orchard (89–W1/T1/64).

Tree genera not principally recorded as specimens

Wych elm *Ulmus glabra*

This fast growing tree bears crunchy and pleasant-tasting young fruit. There are Wych elms growing in the windbreak (W3) between Addy's Orchard and the New Veg and Nursery area. They were grown from seed gathered from a tree on Penglais Hill, just outside the main campus at Aberystwyth University in Wales.

Willow trees *Salix* species

There are at least three species of Willow at Penpol, the most numerous being the native Goat willow, a pioneer tree planted throughout the more wooded parts of the Field and also found self–sown there. In some places other trees have overtopped them and shaded them out, following the natural succession of pioneer to established woodland. Trees of four species of Willow were planted throughout most of the Native woodland and in the northern part of the Coppice; only Goat willow and Osier were seen during the survey, both are in good condition overall. There is a single large Osier, planted for basketry canes, in the Ornamental Area (271–ORN6/15) in excellent condition, and a Willow coppice between that area and the southern end of the Meadow. The windbreak to the east of the Central Orchard is of White willow* at

the northern end and Osier *var*. 'Bowles hybrid' at the southern end. This fast-growing, high-yielding biomass tree is easily propagated by semi-ripe cuttings.
There are several species of Poplar at the Field, some are used in hedges, such as the northernmost one of the Main and Addy's Orchard, and some in free-standing groups. In the south of the Meadow are numerous moribund Balsam poplar trees*, with Jelly ear fungus and Oyster mushrooms fruiting on their trunks. Nearby a large number of tall Aspens and other poplars that have been coppiced, are thriving. In the second subcompartment of Arboretum West is a tall Black Poplar tree* (427–AW/T3/29), in excellent condition. Eleven hybrid Balsam Spire Poplar trees *var*. 'Tacatricho 32' were planted as a hedge in the south and west of the Coppice area, and are in good condition. An extract, made by steeping the diced shoots in cold water for a day, can be used as a rooting hormone for all types of cuttings (PFAF website).

Alders *Alnus* species

Trees of this wind–tolerant, nitrogen–fixing genus were planted in many of the windbreaks and hedges at Penpol, and have all grown well. These species are the preeminent windbreak and hedge tree at Penpol. For the first few years at the Field, when growth was "incredibly poor" on most things, and even the native trees would die back in the winter because of the wind, the Alders flourished. The windbreak on the Western boundary was planted in response to a threat from the neighbouring farmer that the hedge on that edge of the land would be cut down, which it has not been. The Italian alder trees were planted because that land is free–draining, and it likes drier conditions than other Alders. Some Red alders were included because they were available and surplus to requirements elsewhere; it was theoretically too well drained for them to thrive but they did. They were planted as first year seedlings, with stem diameters of less than a half-centimetre, 15 to 25 cm tall, with no ostensible chance of surviving "at all". At the end of the first year's growth they were some 1.5 metres tall; the Italian alders grew almost as well (Ken Fern, 2009 interview). A few hundred were also planted as windbreaks between Arboretum West and Central and in the eastern boundary hedge of the Field; Italian alders were planted as a windbreak between Arboretum Central and East, and between Honeyland East and West. The Alder hedges were meant to be short term, and cut down, but the manpower to do so has not been available. The native Alders also grew well but were never planted in a hedge; one hundred of them were planted in the Native Woodland and the Coppice, and are in good health overall.
Addy Fern has noticed good growth in plants near these trees, aided by the nitrogen they fix; they are some of the tallest trees on the Field.

Companion planting

As Ken Fern points out, there are different concepts of companion planting. One relates to plants that improve the health or yield of others, by physical or phytochemical interactions. This would include deep-rooting plants aiding shallow-rooted ones by "opening up the soil", and the effect of volatile compounds from herbs such as rosemary, wormwood and peppermint protecting cabbage plants from the cabbage white butterfly (Philbrick and Gregg, 1966). It is also relevant to the nitrogen-fixing capacity of many of the species planted at Penpol. Another way of companion planting is by having plants of different growth habits, for instance, climbing plants and taller shrubs or trees, with similar or complementary vigour, so that they can cohabit without one dominating the other. A third way is to disperse individual plants and interplant them, sometimes with 'sacrificial' ones, to protect yields from predation. Ken Fern put this into practice at Penpol, and believes that in an established woodland garden, bird predation would not be a problem. However, in Addy Fern's experience, dispersed plants do not keep their fruit much longer than elsewhere on the Field; fruit from isolated Barberry bushes in the Arboreta still do not have time to ripen properly before being taken. Dispersed plants also tend to increase maintenance requirements, sometimes making it almost impossible. Many Gooseberry bushes, dug up from an area that birds seemed to flock to and transplanted to various locations, have been overgrown; some are lost and some have died (Addy Fern, 2009 interview).

Addy Fern has done her own interplanting experiments, creating two mixed beds, which she has found interesting to watch the plant relationships change over time. She has found that the main problem with mixed plantings has been that the more vigorous plants expand and suppress the less vigorous ones, unless cut back. The best arrangement is an accidental one, of Raspberry canes, dug up from a bed by accident and planted under a Plum tree at the southernmost end of the Main Orchard (W1/T1). The partial shade of the Plum tree has inhibited the grass and nettles but not the spreading Raspberries; Elaeagnus bushes either side supply nitrogen, which they appreciate. They have been the "most successful, least-work Raspberries". It doesn't always work, she has tried the same combination elsewhere but the situation was too shaded and the raspberries died (Addy Fern, 2009 interview).

The Breeding bird and Invertebrate surveys

The wildlife surveys have found the Field far more wildlife friendly than the "species poor" agricultural countryside surrounding it, and commented on the thoughtful design and structural diversity there. Peter Kent remarked that it made "a valuable contribution to supporting bird communities", and Patrick Saunders described it as "a site of conservation interest". In conversation, both said they really liked the place and were impressed with its transformation.

Breeding bird survey

This survey, in which the number of territories for each species of breeding bird at the site was estimated by the presence of singing or calling males, was carried out on 19/4/09 and 31/5/09 by Peter Kent B.Sc., M.Sc., of the Cornwall Wildlife Trust; he also wrote the report (Appendices 7 and 8). Undergrowth restricted access to some parts of the site but bird song can travel some distance, so under-recording is unlikely to have biased the results; to avoid any bias from double recording, effort was made during the visits to map the location and movements of birds aurally.

The Field "contains good numbers of birds", "fairly representative" of a typical community in established woodland or "scrub land containing established field, scrub and tree layers", and including resident species alongside migrant warblers. In an area dominated by "improved farmland", which holds few resources for birds, Penpol makes "a valuable contribution to supporting bird communities", and is "an attractive place for birds to settle", in part because of "the structural diversity of the vegetation within the site" and year-round availability of both wild and cultivated food. The Field contains good nesting habitats, with low levels of disturbance to birds. Of the 25 species of birds recorded, all bar the Yellowhammer will be breeding locally, and 22 species are likely to be breeding within the site. Five of these species, including the warblers, will only be there for the breeding season.

The survey estimated that the most numerous territories on the Field were those of Robins and Wrens, each with ten, whilst Blackbirds and Dunnocks each had nine territories; all of these species were heard in all areas of Penpol, and all will eat fruit. Wood pigeons, Great tits and Blue tits, all with six or more estimated territories, will also take fruit, especially small berries. The "main culprits in summer" are likely to be Blackbirds, Songthrushes, Wood pigeons and Bullfinches, the only finches there that will take fruit. The finches will form mixed flocks in winter but they will target seeds and grains, rather than fruit. The four corvid species recorded, Magpies, Jays, Crows and Rooks, will probably be interested in any windblown fruit on the ground, as will Blackbirds and Songthrushes. Commenting on Frank

Schuurmanns' list of birds observed at the Field some years ago, Mr. Kent considered it likely that Goldcrests would be living there and that the Barn owl seen was roosting locally, and hunting over the rough grass areas for small mammals, voles in particular.

Invertebrate survey

This survey was carried out on 6/8/09 and 7/8/09 by Patrick Saunders, Leon Truscott and John Nicholls, and the report (Appendix 6) written by Patrick Saunders, who was recommended by the Cornwall Wildlife Trust. Because the sampling was non-destructive, the species recorded are members of groups that are easily identified in the field, which unfortunately excludes the majority of invertebrates. Species observed were also restricted by "three very poor summers" and "very cool weather" for moth sampling. The survey recorded one species of cricket, the Speckled Bush Cricket, two species of dragonfly, the Southern Hawker and the Golden-ringed Dragonfly, eight species of bee, nine species of butterfly, including two migrant species, the Red Admiral and the Painted Lady, 14 species of hoverfly, and 35 species of moth, of which 24 are common, three are local and one, the Silver Y, is a migrant. No rare species were seen.

The survey classifies and summarises the site by habitat, describing five types, many of which overlap. The grassland habitats, which would include the understorey of many of the garden and orchard areas, are relatively small and fragmented, are very low in botanical diversity, although Hogweed and tussocky grassland, which supports grasshoppers and bush crickets, generate a degree of structural diversity. The woodland edge habitats are typified by the rides through the Native woodland, most of the garden areas, especially their edges, and large areas of Brambles. These support a range of species, including the Comma butterfly, the Early bumblebee and foraging dragonflies, but the woodland rides are gradually shading over, which will compromise their value to butterflies. The orchard habitats have the potential to be very important for conservation, although this depends somewhat on the ability of rarer invertebrates to disperse from old orchard sites in the vicinity. The woodland habitats supported few invertebrate species, partly because the woodand proper is very evenly aged with little dead wood, and has "very poor representation of native woodland ground layer plants"; nonetheless the Speckled Wood butterfly was seen "where some light penetrated". For wildlife, the wide range of planted species in the woodlands is likely to be both beneficial, as the diversity of tree species is likely to enhance invertebrate diversity, and detrimental, because some of these species are of poor wildlife value and may become invasive. The small areas of wet habitat, such as the Ponds, are important for dragonflies and hoverflies. Invertebrates "can be considered the best basis for both assessing and conserving general wildlife on a site", and this survey views the Field as "a site of conservation interest", focusing the wildlife sanctuary function rather than that of edible landscape. The report

states that further investigation, including a Bat and Dormouse survey, is needed, and concludes that a "management plan is necessary to safeguard and enhance the biodiversity of the site", observing that "letting things go to wild woodland …is not the best form of management for the wildlife of the site", particularly in view of the "large amounts of non-native and planted species" and the degraded "species poor" agricultural desert it replaced. It recommends "targeted and timed management to create a botanically and structurally diverse site", although, as the author assumes a purely wildlife function for Penpol, some of the suggestions, such as killing or removing non–native trees by ring-barking or felling, seem inappropriate unless the Field is to be managed purely as a wildlife sanctuary. In the brief management recommendations, the report highlights "key areas of concern", including "a gradual loss of open areas through shading and scrub … of structural and botanical diversity in all the habitats" because of encroaching scrub and tussocky grass, and "poor regeneration of a native seed bank". It further notes signs of "deer activity" and "a substantial rabbit population in the woods" both "positive factors", although it warns that excessive numbers of these animals would have negative impacts. Ring–barking of trees by Grey squirrels "is probably a small positive influence in developing the invertebrate fauna reliant on dead wood" but they may also suppress regeneration of Hazel from seed.

The report makes several other noteworthy suggestions, including the thinning of trees in the woodland to encourage diversity of structure and age ranges, introducing native woodland plant species of local provenance to the woodlands, and Yellow rattle *Rhinanthus minor*, a hemi-parasite, which weakens grasses that otherwise out-compete flowering plants, to the grassland areas, along with wildflower plugs, preferably of Cornish or southwest provenance. It also recommends setting up and sustaining cutting regimes for different areas of grassland and for Brambles, coppicing woodland edge and scrub every four years, and designating areas into management compartments. The report also suggests ongoing surveying and monitoring which may be informal. A list of recorded invertebrates is given at the end of the report.

The report comments that "the structural diversity, range of edge habitats, and balance of open ground, woodland edge and orchard greatly enhance" the wildlife interest and value of the site. Mr Saunders has also offered to give further advice and assistance on the management of the site for wildlife.