

## *Fallopia japonica* (Houtt.) Ronse Decr. (Japanese knotweed) – an underrated threat to riparian zones in Australia

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**Summary** *Fallopia japonica* (Polygonaceae) is well known as an invasive and troublesome species in many countries. A perennial with tall (3 m) annual stems it out competes native plants and damages infrastructure and amenity. Due to a large and persistent rhizome system it is highly resistant to control efforts. Climate matching shows it is capable of spreading across large areas of Australia. Although present in Australia for around 100 years and naturalised a number of times in New South Wales, Tasmania and Victoria it appears to have so far achieved only very limited spread. Based on the information presently available, eradication of this species from Australia appears both feasible and highly desirable.

**Keywords** Eradication, risk assessment, hybridisation.

### INTRODUCTION

*Fallopia japonica* (Houtt.) Ronse Decr. (Polygonaceae), known as Japanese knotweed, is a widespread weed in mainland Europe, the British Isles, North America and New Zealand. Its history is one of large-scale deliberate introduction as an ornamental, potential forage plant or soil stabiliser, rapid naturalisation, a long period during which it remained apparently restricted in distribution, then, finally, recognition as a rapidly increasing and troublesome weed (Townsend 1997, Child and Wade 2000). It is unclear why Australia has so far escaped problems with this plant, although it does not seem to have been as widely promoted here. Although it is an important species overseas *F. japonica* is unknown to most Australian weed managers. Nevertheless, a small number of naturalised occurrences of *F. japonica* do exist in Australia, including some that have been recently discovered or rediscovered and are proving as difficult to control here as overseas. The aims of this paper are to provide a brief introduction to the species, to document its status in Australia, provide an assessment of its potential weediness, and to briefly assess the feasibility of eradication.

### TAXONOMY

A number of scientific names have been applied due to multiple independent description and generic revisions, see Beerling *et al.* (1994) for details. The most widely accepted is now *F. japonica* with the species placed within Section *Reynoutria* of this genus.

Synonyms are: *Reynoutria japonica* (Houtt.), *Polygonum cuspidatum* (Siebold & Succarini), *Polygonum sieboldii*, *Polygonum japonicum*, *Polygonum zuccharini* Small, *Pleuropterus zuccharinii* Small, *Polygonum reynoutria* (US horticultural trade) and *Tiniaria japonica*. Apparently all the *F. japonica* present in the UK, and possibly throughout Europe, is a single male-sterile clone; this contrasts with the considerable genetic variation present in the native range (Hollingsworth and Bailey 2000). A dwarf form (0.7–1 m), *F. japonica* var. *compacta*, has also been sold for ornamental uses, but is considered less vigorous and not prone to naturalise. Other horticultural cultivars are sold in the USA. Both var. *compacta* and var. *japonica* have hybridised in a number of countries with the closely related *F. sachalinensis* (giant knotweed). *F. sachalinensis* has been introduced outside its native range on a smaller scale and is in most places considered less invasive than *F. japonica*. A fertile hybrid between *F. japonica* and *F. sachalinensis* known as *Fallopia* × *bohemica* has been recorded in several countries and sometimes seems competitively superior to its parents (Mandak *et al.* 2001).

### OVERSEAS DISTRIBUTION

The native range of *F. japonica* is Japan, Taiwan, northern China and Korea. *F. sachalinensis* occurs naturally in northern Japan and Sakhalin island. Introduced to the UK in 1825, *F. japonica* was first recorded as naturalised in 1886. Naturalisation in a number of European countries occurred around the same time. *F. japonica* was widely sold in the USA by the late 1800s, and naturalisation was recognised by 1913. The species is now widespread in the USA, Canada, UK, Eire and many countries of mainland Europe (Child and Wade 2000). *F. japonica* was originally mostly used as an ornamental, although it has also been promoted for its ability to stabilise sandy soils, river banks and mining wastes and as fodder for stock. Records in the UK show slow spread during the first 50 years after naturalisation then rapid expansion from about 1940 onwards (Beerling *et al.* 1994). *F. japonica* was first recorded as naturalised in New Zealand in 1935; it is now widespread, and locally very common in parts of South Island; whereas *F. sachalinensis* is considered only a very occasional escape (Webb *et al.* 1988).

## ECOLOGY

*F. japonica* is a tall (to 3 m) rhizomatous perennial, which, in its native range, is thought to be gynodioecious i.e. male-sterile and hermaphrodite individuals occur. Hollow stems are produced annually with extremely rapid (>4 cm per day) spring growth leading to dense monospecific stands. The species is most frequent on volcanic slopes and other open areas disturbed by natural processes or human activities. It shows a large response to additional nutrients. High seed production and seedling densities occur in Japan but establishment of new plants from seeds is considered rare to non-existent in Europe and N. America due to scarcity or absence of male fertile plants. Seed production is apparently common in NZ; spread by seed is recorded there and the seeds are considered moderately persistent (Craw 1999). Spread by seed elsewhere in the world may become more problematic as fertile hybrids with *F. sachalinensis* become more common. Spread also occurs by rhizome extension of several metres per year or by dispersal of rhizome fragments, making riverbanks especially prone to invasion. Stem fragments may also establish new plants in moist conditions (De Waal 2001). *F. japonica* is tolerant of low nutrient status and a wide range of soil pH short of highly calcareous, but intolerant of prolonged drought, late frosts, persistent waterlogging or shade. Annual rainfall of at least 500 mm seems to be required (Beerling *et al.* 1994). A rhizome biomass of 30 tonnes dry wt ha<sup>-1</sup> has been recorded and a large proportion of the biomass is still below ground, even at the peak of summer stem growth (Callaghan *et al.* 1981). Outside the native range it is little affected by pathogens or invertebrate herbivores (Beerling *et al.* 1994).

## WEED IMPACTS AND CONTROL

Intolerant of grazing or frequent cultivation *F. japonica* is not considered to be a weed of agriculture. It has become a major threat to biodiversity by displacement of native species, causes physical damage to roads, paths and buildings (Japanese knotweed control forum, 2002), and can cause loss of amenity and also flooding when dense stems impede water flow. The Japanese common name of *itadori* means 'strong plant' and the emerging shoots are known for their ability to penetrate roads and walls. An early common name in the UK was 'Hancock's curse', relating to the loss in value of a property that became infested. In the City of Swansea alone the treatment of *F. japonica* has cost £240 000 since 1992, which has been insufficient even to stabilise the total area infested (Renals *et al.* 2001). Physical control by slashing or mowing must be frequent over several seasons to exhaust rhizome reserves, and is better suited to suppression than to eradication (Seiger

and Merchant 1997). Digging the plant out is generally unsuccessful because the rhizomes break up and even small fragments can regrow. Total removal and deep burial of contaminated soil is sometimes done, at great expense. Various herbicide treatments exist (Child and Wade 2000) using selective or nonselective systemic products but several applications are needed, generally over two years to achieve initial reduction, with further follow-up after that. Best results are achieved at the time of maximum foliage development, but treating tall dense stands presents practical problems. Herbicide options are further restricted when the weed occurs in riparian zones. Biological control has been given serious consideration in the UK but has not so far been attempted (Shaw 2000).

## FALLOPIA JAPONICA IN AUSTRALIA

**New South Wales** The earliest record of *F. japonica* is from Albury in 1957; it had apparently been present for at least 10 years in a private garden and was reported to the District Agronomist with a request for eradication. Several specimens were collected from a small roadside occurrence in Sydney (Wahroonga) from 1970 onwards, and there is a record from Cooma (southern tablelands) in 1977 of 100 sq. ft. infested. *F. sachalinensis* was recorded from an orchard at Penrose in 1949, where it occupied half an acre and had apparently been present for some years. Conolly (1998) states that a specimen of *Fallopia* × *bohemica* collected from 'a Sydney suburb' was found at the Canberra herbarium, but this has not been confirmed. Considering the spectacular size of these species and their association with settlements, the absence of further herbarium records or mention in weeds publications strongly suggest that they are not widely distributed.

**Tasmania** The presence of *F. japonica* in Tasmania was first recorded in 1979 in the Ilfraville region, West Tamar (Groves and Hosking 1997). A search for it was conducted by the Department of Primary Industries, Water and Environment (DPIWE) in 1998 but no plants were found. A further inquiry by DPIWE in November 2001 found that three Tasmanian Herbarium records then existed in the Beauty Point region, the original 1979 record, plus records from 1998 and 1999. Differences in the coordinates suggested multiple infestations in the area. A thorough search in November 2001 located the species within the town of Beauty Point. Four different properties were affected, including vacant Crown Land, over an area of approximately 500 m × 200 m. One landowner states that the plant arrived 50 years ago and her family had been attempting to control it for 30 years. A local spraying contractor had sprayed the infestation,

then much larger, for several years about five years earlier. Spraying was discontinued when West Tamar Council relinquished responsibility for the roadside. All landowners are now cooperating with eradication efforts. Unfortunately a further naturalised occurrence has since been found in Tasmania at Cataract Gorge Reserve in Launceston. *F. sachalinensis* has not been recorded from Tasmania.

**Victoria** *F. japonica* was listed as naturalised in Victoria by Spencer (1997) but until recently no populations were known to the Department of Natural Resources and Environment (DNRE). In 2001 an infestation was reported at Narbethong in Central Victoria, in a large private garden adjoining the Yarra Ranges National Park. Japanese knotweed is thought to have been introduced there around 1904 via the Seychelles, for stock feed. Interestingly, the Sydney herbarium has a record of *F. sachalinensis* from 'near the summit of the Great Dividing Range' in Victoria in 1901. The Narbethong *F. japonica* site is so close to the summit that they may well be the same place. The plant appears to have been contained here for a long period by the control efforts of the owners, and suppression by the shade of surrounding trees. It has now spread into a steep wooded area where recent removal of holly and other exotics may allow better growth. The infestation occupied approximately one ha at varying densities by summer 2001 and was approaching a road and a small creek. Slashing was then undertaken to deal with the largest stand of the plant. DNRE then arranged for spraying of the entire infestation with glyphosate in January and has committed to funding several treatments per year with the aim of eventual eradication. A low number of seeds was observed on these plants but no sign of seedlings. The initial spraying achieved good results, although by April 2002 regrowth was evident. A small amount of *F. japonica* was also found in the Melbourne suburb of Bulleen in an old garden

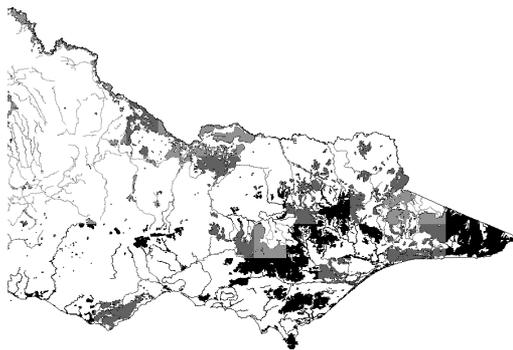
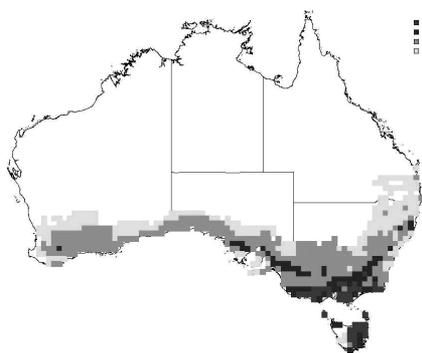
in 2001. Changes in management make its history here uncertain, but it is now being removed. *F. sachalinensis* is listed by Spencer (1997) as naturalised at just one location in Victoria, but is no longer known there. There appears to be no commercial trade in *Fallopia* spp. in Australia. The only recent reference we are aware of was a listing of var. *compacta* in the 'Aussie plant finder' 1999–2000; both suppliers listed apparently no longer have it. Consideration is being given to adding *F. japonica* to the Victorian noxious weeds list. Victoria's weed risk assessment process (Weiss and McLaren 2002) rated it as highly invasive.

#### POTENTIAL DISTRIBUTION

Climate matching using CLIMATE<sup>®</sup> was used to estimate the potential range of this weed in Australia and Victoria (see Figures 1 and 2) and showed a large part of the State south of the Great Dividing Range to be suitable for it. Despite intolerance of summer drought the species might also spread to riparian zones and wetlands of inland regions. Since the species is found over a wide range of climate and soils in Europe and North America there seems no doubt that a large part of Australia is suitable for its growth.

#### CONCLUSIONS

*F. japonica* has already naturalised several times in Australia but until recently attracted very little concern beyond the affected properties, despite overseas experience of eventual severe impacts. Large parts of southern Australia are probably suitable habitat for this species. Although lack of spread by seed decreases the problem of containment in many countries it is very hard to control once established on a large scale. Possible hybridisation with *F. sachalinensis* further increases the risk by making spread from seeds more likely and creating potentially weedy genotypes. Eradication of the current small and reasonably accessible infestations appears to be possible and in



**Figures 1 and 2** Climate prediction of areas in Australia and Victoria where *F. japonica* would be able to establish. Darker shaded areas indicate higher likelihood of establishment.

fact control activities with this aim are under way in Tasmania and Victoria. There is a need to coordinate efforts across land ownership boundaries and to sustain commitment for years, even when the problem seems to have disappeared. As far as have discovered so far there are few naturalised occurrences, it is not widely grown in gardens or sold commercially and there are no other beneficial uses in Australia. Furthermore, the plant is large and obvious for most of the year and not easily confused with any desirable species. We suggest that a program should be undertaken to seek other unrecorded naturalisations of *F. japonica* that may exist in Australia and to discover how common it is in older private gardens. Unless the plant is much more widespread than currently thought, the effort required for eradication throughout Australia would be amply repaid by the long-term benefits of avoiding probable future impacts of this species.

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