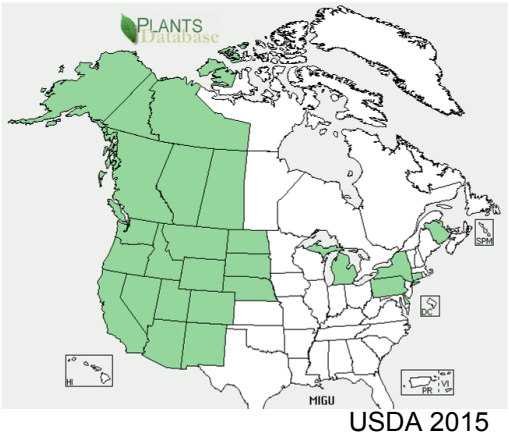
# Monkey flower (*Mimulus guttatus*)

- Introduced to GB as an ornamental garden plant.
- Established throughout most of GB.
- May impact on native riparian plant communities.
- Potential increase in future threat due to climate change.


## History in GB

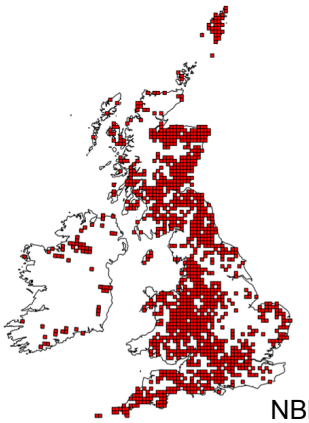
Originally introduced to GB as an ornamental garden plant. First recorded in cultivation in GB in 1812 and in the wild in 1824. Initial spread was very slow but between 1986 and 1999 the number of 10km squares in which this species was recorded increased from 150 to 780. By 2010 this figure had reached over 1300, and now the only extensive areas where it is absent are in East Anglia and the East Midlands.

## Native distribution




USDA 2015

## Distribution in GB



NBN Gateway 2015

## Impacts

Environmental

- Occasionally forms dense monospecific stands, may displace native riparian plant communities.

Economic

- None known

Social

- None known

## Introduction pathways

Ornamental - present in trade.

## Spread pathways

Natural - produces abundant seed, also able to regenerate from plant fragments. Climate change may result in increased frequency of high water flow events which would spread seeds and fragments greater distances.

Human - strong link between rapid spread over last 35 years and anthropogenic influence (availability in garden centres, garden escapes etc).

## Summary

| | Risk | Confidence |
|---|---|---|
| Entry | VERY LIKELY | VERY HIGH |
| Establishment | VERY LIKELY | VERY HIGH |
| Spread | INTERMEDIATE | HIGH |
| Impacts | MODERATE | MEDIUM |
| Conclusion | MEDIUM | HIGH |

**Information about GB Non-native Species Risk Assessments**

The Convention on Biological Diversity (CBD) emphasises the need for a precautionary approach towards non-native species where there is often a lack of firm scientific evidence. It also strongly promotes the use of good quality risk assessment to help underpin this approach. The GB risk analysis mechanism has been developed to help facilitate such an approach in Great Britain. It complies with the CBD and reflects standards used by other schemes such as the Intergovernmental Panel on Climate Change, European Plant Protection Organisation and European Food Safety Authority to ensure good practice.

Risk assessments, along with other information, are used to help support decision making in Great Britain. They do not in themselves determine government policy.

The Non-native Species Secretariat (NNSS) manages the risk analysis process on behalf of the GB Programme Board for Non-native Species. Risk assessments are carried out by independent experts from a range of organisations. As part of the risk analysis process risk assessments are:

- Completed using a consistent risk assessment template to ensure that the full range of issues recognised in international standards are addressed.
- Drafted by an independent expert on the species and peer reviewed by a different expert.
- Approved by an independent risk analysis panel (known as the Non-native Species Risk Analysis Panel or NNRAP) only when they are satisfied the assessment is fit-for-purpose.
- Approved for publication by the GB Programme Board for Non-native Species.
- Placed on the GB Non-native Species Secretariat (NNSS) website for a three month period of public comment.
- Finalised by the risk assessor to the satisfaction of the NNRAP.

To find out more about the risk analysis mechanism go to: www.nonnativespecies.org

**Common misconceptions about risk assessments**

To address a number of common misconceptions about non-native species risk assessments, the following points should be noted:

- Risk assessments consider only the risks posed by a species. They do not consider the practicalities, impacts or other issues relating to the management of the species. They therefore cannot on their own be used to determine what, if any, management response should be undertaken.
- Risk assessments are about negative impacts and are not meant to consider positive impacts that may also occur. The positive impacts would be considered as part of an overall policy decision.
- Risk assessments are advisory and therefore part of the suite of information on which policy decisions are based.
- Completed risk assessments are not final and absolute. Substantive new scientific evidence may prompt a re-evaluation of the risks and/or a change of policy.

**Period for comment**

Draft risk assessments are available for a period of three months from the date of posting on the NNSS website*. During this time stakeholders are invited to comment on the scientific evidence which underpins the assessments or provide information on other relevant evidence or research that may be available. Relevant comments are collated by the NNSS and sent to the risk assessor. The assessor reviews the comments and, if necessary, amends the risk assessment. The final risk assessment is then checked and approved by the NNRAP.

*risk assessments are posted online at:
https://secure.fera.defra.gov.uk/nonnativespecies/index.cfm?sectionid=51
comments should be emailed to nnss@apha.gsi.gov.uk

**Rapid Assessment of:** *Mimulus guttatus,* Monkey Flower
**Author:** Jonathan Newman

**Version:** Final (April 2016) – Draft 1 (March 2012), Peer Review (October 2013), NNRAP 1st review (October 2013), Draft 2 (January 2015), NNRAP 2nd review (February 2015), Draft 3 (March 2015)
**Signed off by NNRAP:** February 2015
**Approved by Programme Board:** September 2015
**Placed on NNSS website:** November 2015

**GB Non-native species Rapid Risk Assessment (NRRA)**

**1** - What is the principal reason for performing the Risk Assessment? (Include any other reasons as comments)

**Response:** The Water Framework Directive Alien Species Group has identified this species as an unknown risk and has requested a risk assessment be produced.

**2** - What is the Risk Assessment Area?

**Response:** Great Britain

**3** - What is the name of the organism (scientific and accepted common; include common synonyms and notes on taxonomic complexity if relevant)?

**Response:** Mimulus guttatus L., Monkey Flower

Synonyms:
*M. luteus* auct. - non L. 1763;
*M. arvensis* Greene;
*M. bakeri* Gandog.;
*M. brachystylis* Edwin;
*M. clementinus* Greene;
*M. cordatus* Greene;
*M. cuspidata* Greene;
*M. decorus* (A.L. Grant) Suksdorf;
*M. equinnus* Greene;
*M. glabratus* Kunth var. *ascendens* Gray;
*M. glareosus* Greene;
*M. grandiflorus* J.T. Howell;
*M. grandis* (Greene) Heller;
*M. guttatus* ssp. *arenicola* Pennell;
*M. guttatus* ssp. *arvensis* (Greene) Munz;
*M. guttatus* ssp. *haidensis* Calder & Taylor;
*M. guttatus* ssp. *litoralis* Pennell;
*M. guttatus* ssp. *micranthus* (Heller) Munz;
*M. guttatus* ssp. *scouleri* (Hook.) Pennell;
*M. guttatus* var. *arvensis* (Greene) A.L. Grant;
*M. guttatus* var. *decorus* A.L. Grant;
*M. guttatus* var. *depauperatus* (Gray) A.L. Grant;

*M. guttatus* var. *gracilis* (Gray) Campbell;

*M. guttatus* var. *grandis* Greene; *M. guttatus* var. *hallii* (Greene) A.L. Grant;
*M. guttatus* var. *insignis* Greene;
*M. guttatus* var. *laxus* (Pennell ex M.E. Peck) M.E. Peck;
*M. guttatus* var. *lyratus* (Benth.) Pennell ex M.E. Peck;
*M. guttatus* var. *microphyllus* (Benth.) Pennell ex M.E. Peck;
*M. guttatus* var. *nasutus* (Greene) Jepson;
*M. guttatus* var. *puberulus* (Greene ex Rydb.) A.L. Grant;
*M. hallii* Greene;
*M. hirsutus* J.T. Howell;
*M. langsdorfii* Donn ex Greene;
*M. langsdorfii* var. *argutus* Greene;
*M. langsdorfii* var. *arvensis* (Greene) Jepson;
*M. langsdorfii* var. *californicus* Jepson;
*M. langsdorfii* var. *grandis* (Greene) Greene;
*M. langsdorfii* var. *guttatus* (Fisch. ex DC.) Jepson;
*M. langsdorfii* var. *insignis* (Greene) A.L. Grant;
*M. langsdorfii* var. *microphyllus* (Benth.) A. Nels. & J.F. Macbr.;
*M. langsdorfii* var. *minimus* Henry;
*M. langsdorfii* var. *nasutus* (Greene) Jepson;
*M. langsdorfii* var. *platyphyllus* Greene;
*M. laxus* Pennell ex M.E. Peck;
*M. longulus* Greene;
*M. luteus* L. var. *depauperatus* Gray;
*M. luteus* var. *gracilis* Gray;
*M. lyratus* Benth.;
*M. maguirei* Pennell;
*M. marmoratus* Greene;
*M. micranthus* Heller;
*M. microphyllus* Benth.;
*M. nasutus* Greene;
*M. nasutus* var. *micranthus* (Heller) A.L. Grant;
*M. paniculatus* Greene;
*M. pardalis* Pennell;
*M. parishii* Gandog. - non Greene;
*M. petiolaris* Greene; M. prionophyllus Greene;
*M. procerus* Greene;
*M. puberulus* Greene ex Rydb.;
*M. puncticalyx* Gandog.;
*M. rivularis* Nutt.;
*M. scouleri* Hook.;
*M. subreniformis* Greene;
*M. tenellus* Nutt. ex Gray;
*M. thermalis* A. Nels.;
*M. unimaculatus* Pennell.

There are also 5 groups of hybrids identified (NBN Gateway)

*M x burnetii* S. Arn, (304 records) including
*Mimulus cupreus x guttatus* *Mimulus guttatus x cupreus = M.* x *burnetii* S. Arn.,

*Mimulus guttatus x cupreus = M. x burnetii* *Mimulus guttatus x cupreus = M. x burnetii* S. Arn.,

*M. x robertsii* Silverside (2396 occurrences) including
*Mimulus guttatus x luteus* *Mimulus guttatus x luteus = M. x robertsii* Silverside,

*Mimulus cupreus x guttatus x luteus* *Mimulus guttatus x luteus x cupreus,* 23 records including
*Mimulus guttatus x luteus x cupreus* *Mimulus guttatus x luteus x cupreus,*

*Mimulus guttatus x luteus x variegatus (M. x caledonicus ined.)* *Mimulus guttatus x luteus x variegatus (M. x caledonicus ined.),*11 records

*Mimulus guttatus x M. variegatus* *Mimulus guttatus x M. variegatus,* 0 records yet, including
*Mimulus guttatus x luteus x variegatus* *Mimulus guttatus x luteus x variegatus,*

**4** - Is the organism known to be invasive anywhere in the world?

**Response:** Yes The species now occurs in western and central Europe; mainly the British Isles, northern France, the Netherlands, Germany, Switzerland, Poland, and in some areas of northern and eastern Europe; Iceland, Scandinavia, Estonia, Latvia, Lithuania and the European part of Russia (Tokarska-Guzik & Dajdok, 2010) and in other parts of Europe (CABI, http://www.cabi.org/isc/datasheet/115609)

**5** - What is the current distribution status of the organism with respect to the Risk Assessment Area?

**Response:**
There were 973 records in the NBN Gateway (when accessed in March 2012). The species has been observed from Cornwall to the Shetland Isles. As of 20 January 2015, there are 5,663 records, an apparent increase of nearly six times in two years.(https://data.nbn.org.uk/Taxa/NBNSYS0000004084)

**6** - Are there conditions present in the Risk Assessment Area that would enable the organism to survive and reproduce? Comment on any special conditions required by the species?

**Response:** Yes (see comments under 'establishment' below)

**7** - Does the known geographical distribution of the organism include ecoclimatic zones comparable with those of the Risk Assessment Area or sufficiently similar for the organism to survive and thrive?

**Response:** Yes. The species is already surviving and thriving in the risk assessment (RA) area.

**8** - Has the organism established viable (reproducing) populations anywhere outside of its native range (do not answer this question if you have answered 'yes' to question 4)?

| |
|---|
| **Response:** Not applicable |

**9** - Can the organism spread rapidly by natural means or by human assistance?

| |
|---|
| **Response:** Yes (see comments under ‘spread’ below) |

**10** - Could the organism itself, or acting as a vector, cause economic, environmental or social harm in the Risk Assessment Area?

| |
|---|
| **Response:** Yes (see comments under ‘impact’ below) |

**Entry Summary**

Estimate the overall likelihood of entry into the Risk Assessment Area for this organism (comment on key issues that lead to this conclusion).

**Response:** *very likely*

**Confidence:** *very high*

**Comments (include list of entry pathways in your comments):**

Already present, as are four of the five known hybrids, all introduced by trade. Available on the RHS plant finder website from a total of five nurseries and from four offering mail order (January 2015) (https://www.rhs.org.uk/Plants/Nurseries-Search-Result?query=11145&name=%3Ci%3EMimulus+guttatus%3C%2fi%3E&view=listView&cbMailOrder=f/plant_finder_nurseries_mail_order/y&context=). There are ten suppliers on Google shopping (accessed 31st March 2015). Five are available as seeds (including Unwins, Marshalls, Plant World Seeds) and five as plants.

**Establishment Summary**

Estimate the overall likelihood of establishment (comment on key issues that lead to this conclusion).

**Response:** *very likely*

**Confidence:** *very high*

**Comments (state where in GB this species could establish in your comments, include map if possible):**
(Truscott et al., 2008)showed that the abiotic factors of presence of boulders and sediment availability determined the presence of the species but biotic factors including inter-specific competition and grazing determined the local area of the infestation and the stem density within isolated patches.

**Spread Summary**

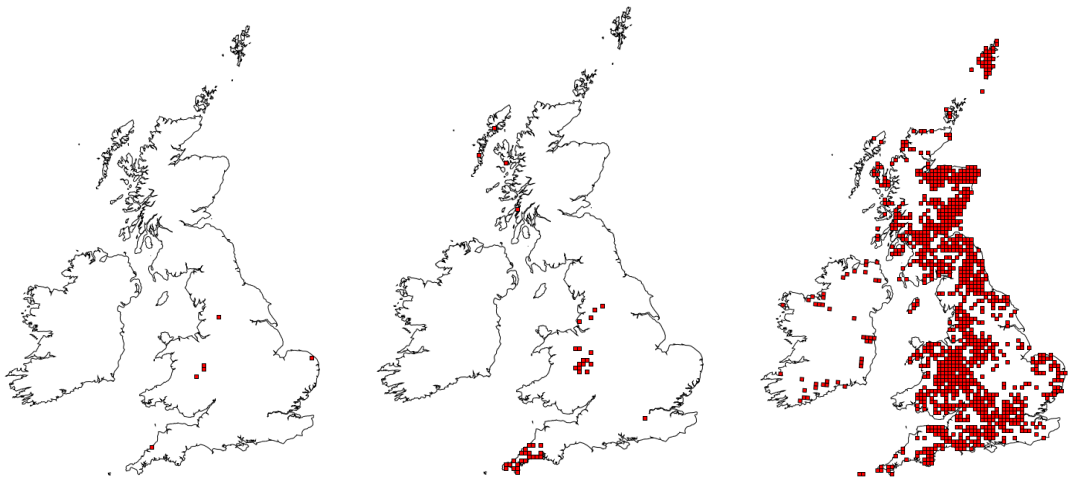
Estimate overall potential for spread (comment on key issues that lead to this conclusion).

**Response:** *intermediate*

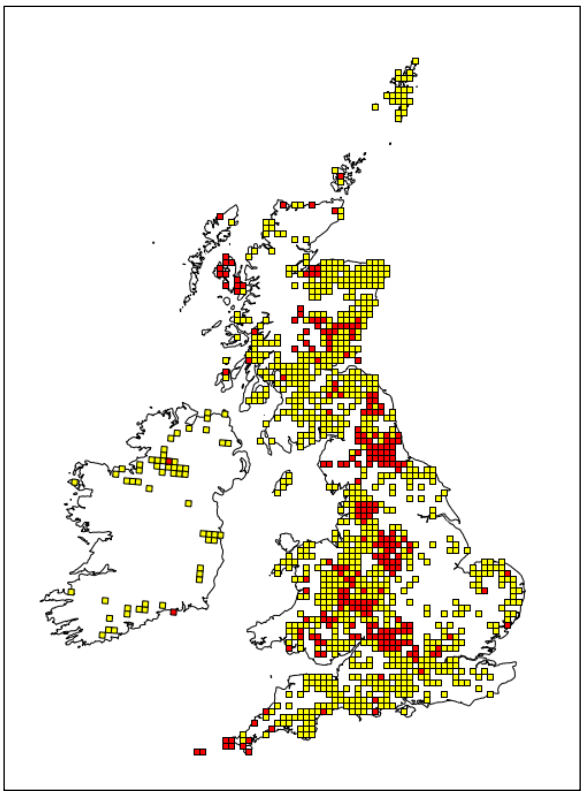
**Confidence:** *high*

**Comments (include list of spread pathways in your comments):**
(Truscott and Soulsby, 2008) demonstrated that increased occurrence of high-flow events as a result of climate change may affect the dispersal success of *M. guttatus* and may result in range expansion. *M. guttatus* was found to fragment readily under velocities typical of high

flow conditions and even small fragments had high survival, regeneration and colonization capacity. Large numbers of small (<0.02 mg) seeds are produced; however, seeds have a short buoyancy period so the timing and magnitude of high discharge events is crucial in determining potential dispersal distances. Seeds germinate readily both in water and on sand with a mean germination of 33% within nine days. The dual strategy of dispersal by vegetative fragments and seeds, together with the opportunity of dispersing the two types of propagules during different periods of the year, facilitates local dominance by *M. guttatus* as well as long-distance colonization. As a result, the rate of spread of *M. guttatus* into inundation communities along rivers is likely to increase with more frequent high-flow events, especially if these coincide with the growing season. Vickery *et al.* (1986) showed upstream spread of seed was possible by deer to distances of 1 km from parent plants. They also listed other sources reporting on seed dispersal by birds, wind and water dispersal of a few hundred metres.



1800-1900 1900-1950 1950-2015



The rate of spread is greatest following WII (see figures above). Of greater interest is the relatively rapid spread since 1980. In the figure to the left, the red squares indicate observations made between 1950 and 1979, and the yellow squares the observations made between 1980 and 2015. There is a far greater number observed in the last 35 years than in the previous 70 years, indicating a very strong link with anthropogenic influence (garden centres, garden escapes etc.) Source NBN gateway (accessed January 2105)

## Impact Summary

Estimate overall severity of impact (comment on key issues that lead to this conclusion)

**Response:** *moderate*

**Confidence:** *medium*

**Comments (include list of impacts in your comments):**

Moderate impacts are anticipated from such a large number of occurrences and a very high rate of spread. (Truscott et al., 2008) showed that there was a marked negative association between *M. guttatus* cover and plant species richness identified through correlative multi-site comparisons and that this was consistent with experimental removal studies which indicate *M. guttatus* significantly alters the structure of riparian plant communities.

Total C and N and soil moisture were marginally higher in invaded than in un-invaded disturbed sediment plots.

Following *M. guttatus* removal, there was an increase in the occurrence and abundance of another non-native species, *Claytonia sibirica*, as well as germination and establishment of *M. guttatus* seedlings. The impact of *M. guttatus* appeared restricted to disturbed sediment riparian communities, as addition experiments into herb-grass communities were relatively unsuccessful in establishing *M. guttatus*. These patterns were consistent with the distribution of the species in riparian plant communities.

## Climate Change

What is the likelihood that the risk posed by this species will increase as a result of climate change?

**Response:** *high*

**Confidence:** *medium*

**Comments (include aspects of species biology likely to be effected by climate change (e.g. ability to establish, key impacts that might change and timescale over which significant change may occur)**

Truscott *et al.* (2006) and (Truscott and Soulsby, 2008)) demonstrated that increased occurrence of high-flow events as a result of climate change may affect the dispersal success of *M. guttatus* and may result in range expansion. *M. guttatus* was found to fragment readily under velocities typical of high flow conditions and even small fragments had high survival, regeneration and colonization capacity. In contrast, Wu *et al.* (2010) showed that *M. guttatus* was not tolerant of drought conditions and given the current drought in the south east of the RA area, this may restrict the impact of this species in future to narrow riparian wetted zones. These areas would be most vulnerable to the effects of high flow events predicted as a consequence of altered rainfall patterns under climate change scenarios, resulting in greater spread of *M. guttatus* in future. Elderd (2003) showed that changes in riparian habitat

structure altered the seedling success and morphology of *M. guttatus*, but did not examine the effects of climate change directly.

## Conclusion

Estimate the overall risk (comment on the key issues that lead to this conclusion).

**Response:** *medium*

**Confidence:** *high*

**Comments:**

A riparian plant of limited to moderate impact in current climatic conditions with the capacity to dominate local conditions. A potential future threat with increasing stochastic flood flows, but susceptible to drought conditions.

**Management options (brief summary):**

**1** - Has the species been managed elsewhere? If so, how effective has management been?

**Response:**
There is no experience with species-specific control measures.

**2** - List the available control / eradication options for this organism and indicate their efficacy.

**Response:**
Mechanical pulling or digging, herbicide application using 2,4-D amine, weed wiping using glyphosate. Some mollusc herbivory limits seedling establishment, no known biological control agents.

**3** - List the available pathway management options (to reduce spread) for this organism and indicate their efficacy.

**Response:**
Not applicable, already established.[discussion of current trade/further introduction of novel genotypes/hybrids necessary]

**4** - How quickly would management need to be implemented in order to work?

**Response:**
Not applicable, already established. It is likely that small infestations could be easily removed, and because seed dormancy is short (Waser *et al.* 1982) localised intensive efforts could be rewarded by eradication of the species.

**References** Provide here a list of the references cited in the course of completing assessment

**List:**


Elderd, B. D. (2003), "The Impact of Changing Flow Regimes on Riparian Vegetation and the Riparian Species *Mimulus guttatus* ," *Ecological Applications*, 13, 1610-1625.

Elderd, B. D., and Doak, D. F. (2006), "Comparing the Direct and Community-Mediated Effects of Disturbance on Plant Population Dynamics: Flooding, Herbivory and *Mimulus guttatus* ," *Journal of Ecology*, 94, 656-669.

Tokarska-Guzik, B. and Dajdok, Z. (2010): NOBANIS – Invasive Alien Species Fact Sheet – *Mimulus guttatus*. – From: Online Database of the European Network on Invasive Alien Species – NOBANIS www.nobanis.org, Date of access 20/01/2015.

Truscott, A.M., Palmer, S. C., Soulsby, C., Westaway, S. & Hulme, P. E. 2008. Consequences of invasion by the alien plant Mimulus guttatus on the species composition and soil properties of riparian plant communities in Scotland. Perspectives in Plant Ecology, Evolution and Systematics, 10, 231-240.

Truscott, A. & Soulsby, C. 2008. Dispersal of the invasive plant Mimulus guttatus and the role of high flow events. Geophysical Research Abstracts, Vol. 10, EGU General Assembly 2008

Truscott, A. M., Soulsby, C., Palmer, S. C. F., Newell, L., and Hulme, P. E. (2006), "The Dispersal Characteristics of the Invasive Plant *Mimulus guttatus* and the Ecological Significance of Increased Occurrence of High-Flow Events," *Journal of Ecology*, 94, 1080-1091.

Vickery, R. K., Phillips, D. R., and Wonsavage, P. R. (1986), "Seed Dispersal in *Mimulus guttatus* by Wind and Deer," *American Midland Naturalist*, 116, 206-208. http://www.jstor.org/stable/pdfplus/2425955.pdf

Waser, N.M., Vickery, Jr., R.K. and Price, M.V. (1982) Patterns of Seed Dispersal and Population Differentiation in *Mimulus guttatus*. *Evolution*, 36: 753-761