RISK ASSESSMENT SUMMARY SHEET

Updated July 2018

Danaus plexippus (Monarch butterfly)

- Native to North America, rare migrant to the UK
- Ceremonial releases and private collections are pathways of introduction
- Climate and host plant requirements (milkweed) likely to restrict the establishment of the butterfly within the UK
- Greatest risk is spread of pathogens to native species, especially from captive bred populations

History in GB

Monarchs are a rare migrant to the UK, usually arriving after strong Atlantic storms, though ceremonial releases and private collection are potential entry pathways. The nearest established populations are in the south of the Iberian peninsula where numbers are low. Climate and host plant specificity (milkweed) limit risk of establishment in the UK.

Native distribution

Ranges from southern Canada through northern South America. Overwinters in Mexico, California, Gulf Coast, Florida, and Arizona.

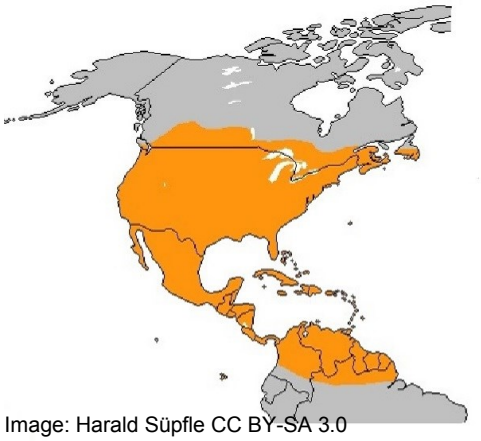

Image: Harald Süpfle CC BY-SA 3.0

Distribution in GB

Rare migrant to the UK. Also introduced as ceremonial releases from captive bred stock. Not currently resident anywhere in Great Britain.

Not resident in the UK

Impacts

Environmental (minor)

- Risk of pathogen spread to native butterflies, especially via captive bred populations
- Could affect genetic makeup of establishing populations of naturally arriving individuals via migration

Economic (minor)

- Larval damage to ornamental plants

Social (minor)

- Releases could interfere with understanding of natural migration and distribution patterns

Introduction pathway

Rare migrant to Great Britain, usually arriving after Atlantic storms. Most likely pathway is unsolicited releases from private collections or ceremonies.

Spread pathways

Natural (very slow) - climate and host plant requirements restrict spread

Human-aided (intermediate) – ceremonial releases and cultivation of milkweed host plants in gardens could increase spread

Summary

	Risk	Confidence
Entry	LIKELY	HIGH
Establishment	VERY UNLIKELY	HIGH
Spread	SLOW	HIGH
Impacts	MINOR	MEDIUM
Conclusion	LOW	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: http://www.nonnativespecies.org/index.cfm?pageid=143
comments should be emailed to nnss@apha.gov.uk

GB Non-native Species Rapid Risk Assessment (NRRA)

Rapid Risk Assessment of: *Danaus plexippus* (Monarch butterfly)
Author: Marc Botham, CEH

Version: Draft 1 (*Jan 2018*), Peer Review (*Mar 2018)*, NNRAP 1st review *(Feb 2018)*, Draft 2 (*May 2018*), NNRAP 2nd review (*May 2018*), Draft 3 (*Aug 2018*)
Signed off by NNRAP: *August 2018*
Approved by Programme Board: *June 2019*
Placed on NNSS website: TBC

Introduction:
The rapid risk assessment is used to assess invasive non-native species more rapidly than the larger GB Non-native Risk Assessment. The principles remain the same, relying on scientific knowledge of the species, expert judgement and peer review. For some species the rapid assessment alone will be sufficient, others may go on to be assessed under the larger scheme if requested by the Non-native Species Programme Board.

Guidance notes:

- We recommend that you read all of the questions in this document before starting to complete the assessment.
- Short answers, including one word answers, are acceptable for the first 10 questions. More detail should be provided under the subsequent questions on entry, establishment, spread, impacts and climate change.
- References to scientific literature, grey literature and personal observations are required where possible throughout.

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

Response: To rapidly assess the risk associated with this species in Great Britain following an apparent increase in the number of ceremonial releases

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: *Danaus plexippus* (Linnaeus, 1758). Accepted common name: The Monarch. Old synonym: *Papilio plexippus* Linnaeus, 1758. Also known, less frequently, as 'The Wanderer' in some of its non-native range.

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

Response: No – has naturalised after introduction but not classified as invasive or as yet having any negative impact on native biodiversity in introduced ranges.

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

Response: Rare migrant to the UK (Asher et al., 2001, Thomas & Lewington, 2014) predominantly to the south coast of England (most frequently south-west). Also introduced as ceremonial releases (and private collections) from captive bred stock. Not currently resident anywhere in Great Britain.

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: Both climate and host plant specificity limit the distribution and likely spread of *D. plexippus*. It feeds on a range of plants known broadly as 'Milkweeds' which come from a number of genera in the Apocynaceae family, and within the subfamily Asclepiadoideae. These plants themselves are not native to GB and many species are not suited to the climate in GB – they are highly frost-sensitive and are associated with highly disturbed areas with moist soils and high annual sunshine hours (Fernandez Haeger et al., 2010). However, they are planted as ornamentals in gardens and private collections and there is a single record of *Vincetoxicum cf. nigrum* outside of gardens (Clement & Foster, 1994).

Further and sustained climate warming and continued planting of suitable host plants (e.g. *Asclepias* spp and plants from other genera in the Asclepiadaceae) in urban areas could enable the butterfly to survive and reproduce (Lemoine, 2015). Naturalisation of plants from Asclepiadaceae in the wider countryside would further facilitate this but this is unlikely without changes to current climate. Under current climatic conditions in GB naturalisation and spread of both host plant and the butterfly are unlikely.

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. *D. plexippus* is well established on the eastern coast of Australia and in New Zealand which are classified similarly to the UK on the Koppen-Geiger Climate Classification, having a warm temperate and humid climate with warm summers. The UK is probably still on average cooler during the summer and finer resolution data on the distribution in eastern Australia would be useful to ascertain whether it is found in the upland areas most climatically similar to the UK. *D. plexippus* is also found in temperate North America although the most climatically similar areas appear to be the Appalachians which monarchs migrate across rather than reside in (e.g. Miller et al., 2010) further suggesting that the UK climate is not yet fully suitable. Furthermore, eastern North American populations of the butterfly are the result of migration from overwintering sites in Central and southern North America suggesting *D. plexippus* could not survive year round in the UK and would

need to undergo annual migration from an overwintering population in warmer climates. The nearest known populations are found in the south of the Iberian peninsula where numbers are currently low. Here the butterfly mostly uses *Gomphocarpus fruticosus*, *G. physocarpus* and *Asclepias curassavica*. These plants are all non-native in Spain but have successfully naturalised, though their distribution is generally restricted to riparian habitats with high disturbance in coastal regions of southern Spain and Portugal (Fernandez Haeger et al. 2011, Obregon et al., 2018). These species are easily outcompeted by native plants where high levels of disturbance from grazing are not maintained and are largely restricted to coastal areas because they are sensitive to frosts (Fernandez Haeger et al., 2010). *Cynanchum acutum*, a species of milkweed native to southern Europe, is also used by *D. plexippus*, but is again restricted in range and unlikely to become naturalised in GB Gil-T (2006).

8 - Has the organism established viable (reproducing) populations anywhere outside of its native range (answer N/A if you have answered 'yes' to question 4)?

Response: Yes: *Danaus plexippus* is now established in many countries outside of its original native range including Hawaii, Australia, New Zealand, the Pacific Islands, the Canary Islands, The Azores, Madeira, southern Spain and Portugal (Zalucki and Rochester, 1999; GBIF, 2017).

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

Response: Potentially under suitable climatic conditions and with continued releases and planting of host plants. In addition, human activities provide the suitable conditions for the germination and spread of suitable host plants (Obregon et al., 2018).

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

Response: There is a significant risk of *D. plexippus* spreading pathogens to native Lepidoptera. While this risk is extremely low in terms of individuals arriving naturally as migrants from native populations it is a much greater issue with the release of captive bred individuals. Natural diseases are often more prevalent in the high densities present in rearing cages for captive breeding of butterflies (e.g. Lindsey et al., 2009). Many of these diseases can be generic across different genera and therefore there is a concern that released individuals of *D. plexippus* could spread pathogens and their diseases to native Lepidoptera (Boppre and Vane-Wright, 2012).

Captive bred individuals often have low genetic variability through generations of inbreeding and are also genetically suited to breeding in captivity and not in the wild. While this reduces the chances of them surviving in the wild and therefore interacting with any natural populations of *D. plexippus*, there is a small risk that i. released individuals could migrate or be transported to native populations where they could interbreed and affect the genetic makeup of natural populations - this has certainly been listed as a major concern to native populations of *D. plexippus* in North America by The Xerces Society for Invertebrate

Conservation (http://www.xerces.org/wp-content/uploads/2015/10/Captive-Breeding-and-Releasing-Monarchs_oct2015.pdf) and ii. released individuals could interbreed with any naturally establishing populations from true migrants to GB in the future, affecting the genetic makeup of subsequent populations.

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: *likely*
Confidence: *high*

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

D. plexippus is a rare migrant to Great Britain (Asher et al., 2001) with individuals usually arriving after large atlantic storms. Even then the number of individuals arriving in GB are very few. The most likely pathway of entry for this species is by unsolicited releases either from private collections or as part of ceremonial releases as discussed by Butterfly Conservation (https://butterfly-conservation.org/search.html?q=Monarch). Currently there seems to be fairly few companies that offer *D. plexippus* for ceremonial releases in the UK (an internet search on 16/05/2018 using google found two companies who offer *D. plexippus* for ceremonial releases, while a third company sells them individually for private collections etc., rather than for ceremonial releases: there are other companies offering live butterflies for ceremonial releases but these are largely restricted to native species, in particular Painted Lady, *Vanessa cardui*, though the origin of these butterflies is not specified). The extent of ceremonial releases of butterflies is currently unknown as this is a fairly recent phenomenon in the UK but appears to be more widely practised in the USA with quite a number of companies offering *D. plexippus* for ceremonial releases: currently these companies do not appear to post live butterflies to the UK). A wedding planning site suggests it is a relatively modern ritual that is becoming a popular part of today's wedding ceremonies (https://www.easyweddings.co.uk/articles/advice-on-a-wedding-butterfly-release: accessed 11:45 17/05/18). This company also promotes the use of Monarchs in releases in the UK, suggesting it is the best species to use. Butterfly Conservation also note ceremonial releases as a growing interest suggesting it is not currently a very common practise but is becoming more common (https://butterfly-conservation.org/48-17657/releasing-butterflies-at-weddings.html: accessed 11:46 17/05/18). John et al (2015) also discuss an increasing trend in wedding releases in Europe in recent years which have been responsible for recent sightings of *D. plexippus* in Cyprus, Ibiza and Northern Spain. Several companies offer live butterflies for ceremonial releases in other European countries and these are more likely to offer delivery to the UK.

Establishment Summary

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

Response: *very unlikely*
Confidence: *high*

Comments (state where in GB this species could establish in your comments, include map if possible):

D. plexippus is spreading in some of its non-native range and with climate warming this expansion is likely to continue (Lemoine, 2015, Obregon et al., 2018). However, migration to the UK still remains rare and thus from this pathway it is unlikely to establish in the near future. The other main pathway is by releases from private collections and via ceremonial releases such as weddings as 'living confetti'. Again, individuals released this way are highly unlikely to establish because of climatic unsuitability and because the host plants are rare in the UK, currently mostly restricted to gardens as ornamentals (only *Vincetoxicum* cf. *nigrum*, has been recorded outside of gardens in Great Britain (Oliver Pescott, personal communication)). If ceremonial releases and planting of host plants increases and is not controlled, there is potential for temporary establishment but this is likely to be highly localised and very short lived. Natural establishment, which would be most likely to occur through migration from current established populations, would be most likely on the south coast of England, in particular in the South-west, but this can only occur if and where suitable host plants are grown e.g. garden centres, public and private gardens. In addition, it should be noted that the closest population of *D. plexippus* and thus the most likely to provide individuals that could arrive in the GB, is that in southern Spain for which studies have shown the population does not exhibit the migratory behaviour of, and is more sedentary than, the North American populations, and more like the populations in Mexico (Obregon et al., 2018). This further reduces the chances for establishment in GB via migration. Establishment through artificial releases could technically occur anywhere where there is suitable host plant planted and ceremonial releases or releases from private collections. Because of climatic suitability this is only really at all likely in southern England.

Spread Summary

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

Overall response: *slow*
Confidence: *high*

Sub scores:

Natural spread only:
Response: *very slow*
Confidence**:** *high*

Human facilitated spread only:
Response: *intermediate*
Confidence**:** *medium*

Comments (in your comments list the spread pathways and discuss how much of the total habitat that the species could occupy has already been occupied): Since most of GB is climatically unsuitable and suitable host plants are restricted to parks and gardens natural spread would be slow. Additionally, the spread of host plants out of urban areas is highly unlikely considering the conditions these plants require: they are highly sensitive to frosts,

require high annual sunshine hours, moist soils and high levels of disturbance as they are pioneer species that are easily displaced by native plant species as habitats undergo succession where they have naturalised (Fernandez Haeger et al., 2010). Human facilitated spread through illegal releases could speed this process up but only if releases co-occur with the very restricted distribution of suitable host plants. However, it is worth bearing in mind that *D. plexippus* is a long distance migrant with a long lifespan as an adult which could help if find 'island' sources of host plants and with human induced, and therefore facilitated, climate warming increased migration of Lepidoptera (Sparks et al., 2007) and northward expansion (Batalden et al., 2007) could increase the rate of spread.

Impact Summary

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

Overall response: *minor*
Confidence: *medium*

Sub-scores

Environmental impacts:
Response: *minor*
Confidence**:** *medium*

Economic impacts:
Response: *minor*
Confidence: *high*

Social impacts:
Response: *minor*
Confidence: *high*

Comments (include list of impacts in your comments):

In GB *D. plexippus* is unlikely to have much if any impact, primarily because it is unlikely to become established and if it does it is unlikely to spread and/or reach high population levels. In addition its larvae feed on non-native host plants and competition for other resources e.g. nectar is likely to be negligible.

Impacts to consider include:

1. Environmental: spread of pathogens and their diseases to native Lepidoptera. Any migrant species can bring with them pathogens and diseases and while some of these are host specific a number are more generalist and could be passed on to native Lepidoptera (Boppre and Vane-Wright, 2012). The risk from migrant individuals of *D. plexippus* is currently extremely low given the rarity of immigration. In addition it has been shown that long-distance migration in *D. plexippus* is negatively correlated with infection level i.e. butterflies with

heavy pathogen loads are less likely to survive long-distance migrations than healthier individuals (Altizer et al., 2015). However, ceremonial releases greatly increase these chances, firstly because high numbers of individuals are released at once, and secondly because captive bred insects often harbour more pathogens because of the conditions in which they are reared (Lindsey et al 2009). As with any non-native species there is also the chance that non-native pathogens can be introduced. However, there is a large knowledge gap in this area which constrains the ability to assess this particular risk (Roy et al., 2016).

2. Environmental: releases of captive bred individuals could affect the genetic makeup of any establishing populations consisting of individuals naturally arriving via migration from native populations – there is also danger that released captive bred specimens could migrate to native populations where they could affect the genetic makeup of natural populations. This will largely depend on the origin of the captive bred stocks – for example, if the origin is populations from southern Spain then the migratory behaviour is known to be lower than if they are from populations from North America which are highly migratory. The companies offering *D. plexippus* for ceremonial releases in the UK do not state the origin.

3. Economic: larval damage to ornamental plants in the horticultural trade. Currently the suitable host plants are not widely planted and so the economic risk to the horticultural trade is low. However, where *D. plexippus* has naturalised, for example in southern Spain, the larvae can completely consume the host plants (Obregon et al., 2018).

4. Social: releases of this butterfly will interfere with our understanding of natural migration activity and obscure distribution patterns. Great Britain has an impressive recording community with millions of records submitted annually. These data are widely used to inform about the state of the environment in GB, for example, biodiversity indicators, determining species and habitats of conservation concern, and surveillance and detection of non-native species. There has long been a history of illicit introductions of Lepidoptera and odd escapes from tropical houses and private collections which already obscure our understanding of natural population distributions and ceremonial releases threaten to exasperate this greatly given the large numbers that are often released. In addition, culturally this sends a poor message: firstly that it is acceptable to release non-native species into the environment despite section 14 of the Countryside and Wildlife Act 1981, and secondly that it is a good thing to release large numbers of butterflies into an alien environment where they are unlikely to survive.

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):

Without climate change it is unlikely *D. plexippus* will ever become established at all in GB. Therefore, it is unlikely to pose any risk without climate change. It follows therefore, that any risk at all associated with the butterfly will increase greatly as more habitat becomes climatically suitable as a result of climate change (Zalucki and Rochester, 1999). Many invertebrates adapt over time and with climate change. For example, *Aricia agestis* in GB has undergone significant range expansion in recent decades as a result of climate warming facilitating the use of host plant species rarely used previously (Pateman et al., 2012). While not inconceivable that this could occur with *D. plexippus*, there is currently little evidence to suggest a host switch and most host plants used within both its native and non-native range belong to a family of plants not native to GB – there are however, records of larvae found feeding on plants outside of the Apocynaceae, including several *Euphorbia* species (Euphorbiaceae) and *Gossypium arboretum* (Malvaceae) on the Canary Islands (Neves et al., 2001) and a number of others listed by the Natural History Museum in their HOSTS database (Robinson et al., 2010): but these accounts are of late instar larvae suggesting young larvae at least, are dependent on plants from the Apocynaceae . In addition, climate change may facilitate the establishment of suitable host plants planted in GB as ornamentals, currently restricted to urban habitats (e.g. private and public gardens).

Conclusion

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

Response: *very low*
Confidence: *high*

Comments:

D. plexippus is unlikely to become established in GB because it is restricted by both climate and host plant availability, which in turn is also restricted by climate. Even upon any establishment it is not a species likely to become invasive and economic damage would be restricted to a limited selection of ornamental plants in the horticultural trade. Perhaps the greatest risk posed by *D. plexippus* is the transmission of pathogens and their diseases to native species of butterfly in GB. This is particularly likely from captive bred stock released from private collections and as part of ceremonial releases. While these release are unlikely to result in any established populations of *D. plexippus*, the butterfly is long-lived and if released during the GB summer can survive long enough to interact with other species of native butterfly. Captive bred specimens are also known to be more likely to carry pathogens because of the high densities under which they are often reared to produce high enough numbers for such releases. In addition, further risk is posed from these individuals migrating to known established populations of *D. plexippus* where they may interbreed and affect the genetic makeup, as well as spreading species specific pathogens, though this is highly unlikely.

References

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

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