SPECIES ACTION PLAN
FOR THE MADEIRAN SPECKLED WOOD
Pararge xiphia

Butterfly Conservation Europe

Madeira Fauna & Flora

SPECIES RECOVERY PLAN
FOR THE MADEIRAN SPECKLED WOOD
Pararge xiphia

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Contents

INTRODUCTION

This document presents a summary of all the information available for the Madeiran Speckled Wood *Pararge xiphia* and the results of the field surveys undertaken during the field season of July to October 2021.

Species Recovery Plans (SRPs) are documents which bring together relevant information about a given threatened species, present an analysis of the threats that the species faces, and list actions needed to reverse these threats. If successful, these actions will help protect the species from extinction and greatly improve its conservation status. SRPs are vital tools for the conservation of highly threatened animal and plant species. However, in Madeira, recovery plans have never been produced for endemic butterfly species, and therefore one of the aims of this document is to fill this gap and provide for the first-time guidance for the conservation of threatened endemic butterflies.

This Species Recovery Plan is one of the outputs of the *Conservation of Madeira's Threatened Endemic Butterflies* partnership project by Butterfly Conservation Europe and Madeira Fauna & Flora, funded by LIFE4BEST.

The production of this SRP involved three steps. First, we gathered all the information available for the species in the form of scientific papers, reports and distribution records. Second, fieldwork was planned to survey a selection of areas within the Madeira Nature Park (KBA MAD1) recording the distribution and abundance of the adult butterfly using a standardised methodology. Casual observations were also made of the species' ecology (e.g., nectar sources, larval hostplants), as well as any threats to the butterfly at each survey site. Photographs of typical habitat and identified threats were also taken at each survey site regardless of whether the species was present. Finally, we met with local stakeholders to develop appropriate measures and discussed possible conservation actions with experts on Madeira and from Butterfly Conservation Europe during a workshop in 2022.

The document is divided into three main sections. The first section summarizes the available information for the species and shows new data gathered during the project. A second section deals with information that is relevant for the conservation of the species, particularly an analysis of the threats that have been mentioned for the species and those that were detected during fieldwork. The final section explains in detail the specific actions that are proposed for an improvement of the species' conservation status. At the end of the document there is a comprehensive list of references and an acknowledgement section.

IDENTIFICATION

The morphological characteristics are based on Fernández-Rubio and García-Barros (1995). Several notes are based on other authors and field observations.

Wing morphology

The Madeira Speckled Wood butterfly *Pararge xiphia* has a wingspan of 50 – 60 mm, but most commonly 50 -52 mm. The base colour of the upperside is dark brown with orange or tawny speckles. The base brown colour is dominant. The forewing has one black ocellus with a white dot in the centre which is visible on both upper and under sides. The forewing margin is convex unlike other butterflies in the genus *Pararge*. The hindwing upperside base colour is orange/brownish orange with three large black ocelli with a white dot in the centre, over larger orange speckles. The margin is brown, sometimes with faint orange lunules. On fresh young specimens the outer wings margins are bordered by whitish/creamy cilia, while in the thorax is covered in greenish blue/turquoise iridescent cilia. The forewing underside is mostly orange with irregular dark brown streaks. In males the outer margin is bright orange while in females the margin is pale brown/creamy with hints of orange (Figure 1).

Figure 1. Male upperside (upper left, photo C. van Swaay) and underside (lower left, photo S. Teixeira) and female upperside (upper right, photo S. Ellis) and underside (lower right, photo S. Ellis) of *Pararge xiphia* imagos.

The Speckled Wood *Pararge aegeria* is smaller with 35 – 40 mm in breadth. The forewing margin is concave and although the base colour is also dark brown with orange speckles, the orange speckles larger and predominant. Therefore in *P. aegeria*, orange is the most conspicuous colour. The underwings are creamy with some dark brown streaks and ocelli. The thorax cilia are mostly brown.

Immature stages

Upon oviposition, the eggs of *P. xiphia* are pale yellow to whitish yellow, mostly round, between 1.10 -1.30 mm in length and 1.10 – 1.30 mm in width/diameter. *P. aegeria* eggs are smaller with 0.75 – 0.95 mm in length and 0.70 – 0.95 mm in diameter. *P. xiphia* eggs also present differences from *P. aegeria* in the reticle and egg volume (Fernández-Rubio & García-Barros 1995). The egg of *P. xiphia* is notably larger than the eggs of *P. xiphioides* and *P. aegeria*, with 0.9 – 1.1 mm^3 in volume, while *P. aegeria* as roughly half the volume with only 0.4 – 0.5 mm^3. *P. xiphioides* is only slightly larger than *P. aegeria* but with the reticle with similarities to *P. xiphia* rather than with *P. aegeria.* Therefore, eggs of *P. xiphia* are easily distinguishable from *P. aegeria*, especially if laid next to each other as reported by Shreeve & Smith (1992) and is commonly observed in the field (Gibbs *et al*., 2004; Bland & Lace, 2020)

Larvae of the Madeira Speckled Wood can be green or light brown, with dark dorsal and sub-dorsal bands and with developed tails on the tenth urotergite. On first instar larvae, the body is cylindrical with black tactile setae and black sclerotized heads. Also, the tails are not developed, and the sub-dorsal bands are pale coloured and not visible afar. On fifth instar larvae, the tails are long and usually with the dorsal band along its length. On the green larvae, the bands are dusky green to dark green. on the light-brown or chestnut-coloured caterpillars, the dorsal and sub-dorsal bands are inky-brown or grey.

Similarly, to the larvae, the pupa can be green or chestnut brown, thus *P. xiphia* is the only speckled wood butterfly to exhibit pupal colour dimorphism. Pupae have a double mid row of moderately prominent yellow dorsal tubercules with several small scattered rusty specks. The pupa yellow mid-dorsal tubercles in *P. xiphia* are moderately prominent and without black stain.

TAXONOMY

Common name: Madeiran Speckled Wood (English) or Ariana da Madeira (Portuguese)

Latin name: *Pararge xiphia* (Fabricius, 1775)

Phyllum: Arthropoda

Class: Insecta

Order: Lepidoptera

Family: Nymphalidae

Three species belonging to the genus *Pararge* occur in Europe. The Speckled Wood *Pararge aegeria* (Linnaeus, 1758) is distributed all over Europe and most of central north Asia, Asia Minor and North Africa. There are two subspecies, *aegeria* in Southern Europe, south of the Alps and north Africa, and the subspecies *tircis* north of the Alps and eastwards to Asia. The Macaronesian archipelagos of Madeira and Canaries hold the other two species, the Madeiran Speckled Wood *Pararge xiphia* (Fabricius, 1775) restricted to Madeira Island and the Canary Speckled Wood *Pararge xiphioides* Staudinger, 1871, occurring in the Islands of La Gomera, La Palma, Tenerife and Gran Canaria (Wiemers 1995). Recently, the island of El Hierro was also colonized from Tenerife (Mérit 2014; Hutsebaut 2021). The evolution of the genus and its species is still not clear. The most accepted hypothesis is that 5 million years ago the Pararge ancestor colonized North Africa, ater colonizing the Cnary Islands and Madeira (Weingartner *et al*., 2006). According to the same authors, an alternative hypothesis is that the Madeiran Speckled Wood *P. xiphia* may be the oldest within the genus, having evolved almost five million years ago from a palearctic ancestor, while *P. aegeria* and *P. xiphioides* diverged from *P. xiphia* two million years later when colonizing the Canary Islands, North Africa and Europe.

DISTRIBUTION

Historical distribution

P. xiphia is an endemic to the Madeira archipelago and restricted to Madeira Island. The butterfly is not found on the other Islands in the archipelago (Wakeham-Dawson et al. 2002), most likely due to the devastation of habitats and loss of native plant communities as a result of human activities on these smaller islands over several centuries. In Madeira, the species was widely distributed and was recorded even in southern coastal areas like Funchal and Machico. A collection of all records, including unpublished data by Wakeham-Dawson *et al.* Between 1850 and 2000 the species was recorded in 108 Km^2 (Cockerell 1923; De Worms 1964; Wakeham-Dawson et al. 2002) (Figure 2).

P. aegeria was observed the for the first time near Mote in 1967 by Hoegh-Guldberg (Oehmig 1983). However, since *P. aegeria* colonized Madeira Island from Africa, *P. xiphia* has been declining in most areas of the Island. In some areas the *P. xiphia* has completely disappeared (Wiemers, *pers. comm*.; Teixeira, *pers. comm*.; Bland & Lace, 2020), such as the southern coastal locations where the butterfly was recorded and captured in the early 20^{th} century (Wakeham-Dawson et al. 2002). Between 1996 and 2010 *P. xiphia* went from the most abundant speckled wood species, accounting 71% of the observations of *Pararge* butterflies, down to 35% of the observations (Bland & Lace 2020) or even lower than 25% (Wiemers, *pers. comm.*).

Current distribution

Recent survey studies made by Wiemers in 2016, 2017, Teixeira 2012-2020 and Bland & Lace in 2018 show that both species are found all over the Island, with *P. xiphia* more abundant on the northern high-altitude areas and humid primary laurel forests, whereas *P. aegeria* is more common in the areas at lower altitudes, in exotic forests, scrub and farmland.

To ascertain the current distribution of *P. xiphia* and the observation ratio between the two species of speckled wood, we designed 58 transects to sample all habitat types on the Island, of which 49 were surveyed. Transects were based on published literature and unpublished research made by local partner MF&F. Transects were about 5 km long and were recorded on both the inward and return walks (i.e., 10 km sample length per transect) in order to account for the detectability of each species.

Both butterfly distribution and abundance of all species were recorded using the 15-minute Count function in the ButterflyCount app (see *https://butterfly-monitoring.net/bms-methods* for method details); this app is especially useful for gathering butterfly data even in remote areas. The app records the routes sampled and the exact location of each butterfly through the phone's GPS. This can also be done manually by drawing the recorded area but was not necessary in our study. A total of 648 timed counts were made and the data were then analysed using R software to model the distribution of the 14 species of butterfly recorded.

Some transects were surveyed in the same areas as Bland & Lace and previous surveys by Wiemers or know occurrence areas by MF&F. Other areas were included to increase the representation of other island habitats such as mixed exotic forests of *Eucalyptus*, *Pinus* and *Acacia*, farmland, and suburban areas. Both butterfly distribution and abundance of all species were recorded using the 15-minute Count function in the ButterflyCount app, with a total of 648 counts undertaken and 533,8 km surveyed over 41 days between July and October of 2021. A total of 10,114 individual butterflies of fourteen species were recorded during the surveys, of which 2059 individuals were *Pxiphia* (20.4%). The Madeiran Speckled Wood was recorded on 39 routes (80% of recorded survey routes) and on 29 survey days (70.7% of survey days).

These data obtained through field surveys were plotted on a 1 km^2 grid ETRS and the density of butterflies recorded as number per 1000m (Figure 5). In total *P. xiphia* was recorded from one hundred and forty one 1 km^2 squares. The density of adult butterflies varied from 0.1 to 63.8 per 1000m. Highest densities recorded were all in humid laurel forest areas, with densities between 7.2 up to 63.8 butterflies per 1000 m. A total of 14 areas were identified as Key areas for this butterfly, which are shown in figure 3:

1. Encumeada
2. Chão dos Louros
3. Achadas de São Vicente
4. Fajã da Ama
5. Ponta Delgada

6. Boaventura
7. Caldeirão Verde
8. Fajã da Nogueira
9. Ribeiro Frio
10. Chão da Ribeira in Seixal
11. Ribeira da Janela
12. Rabaçal
13. Santa do Porto Moniz
14. Ponta do Sol

Most of the highest density areas were in the north and northeast areas of Encumeada, Chão dos Louros, Achadas de São Vicente, Fajã da Ama, Ponta Delgada, Boaventura, Caldeirão Verde, Fajã da Nogueira and Ribeiro Frio. In less extend, only four areas of the northwest had high densities of *P. xiphia*. These areas were Chão da Ribeira in Seixal, Ribeira da Janela, Rabaçal and Santa do Porto Moniz. Unexpectedly, *P. xiphia* was also recorded with densities up to 7.2 in Ponta do Sol on the south side of the Island. This area is one of the few southern localities with significant laurel forest patches, proving that *P. xiphia* is associated with this type of habitat. (Figure 5).

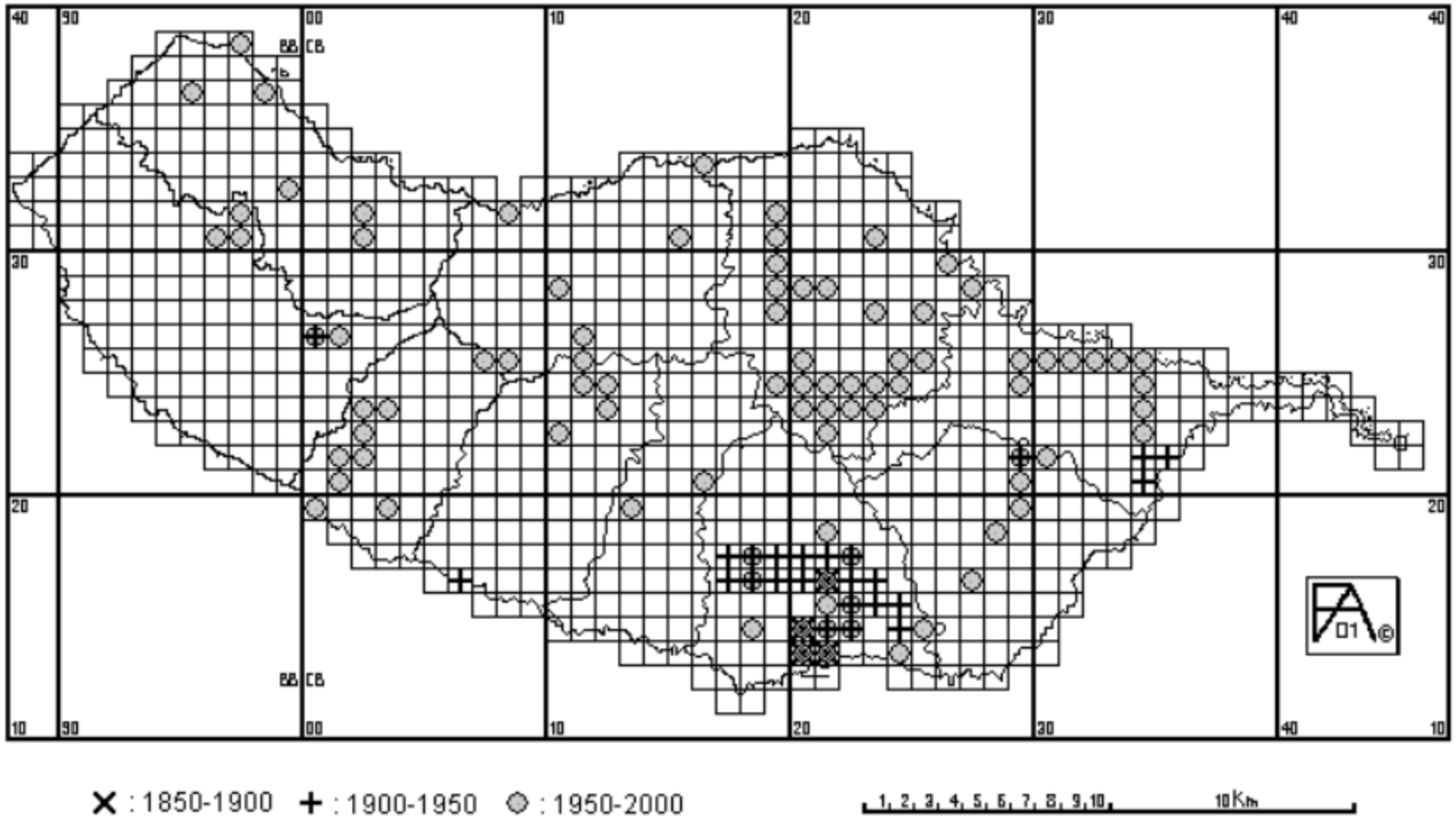

Figure 2 - Distribution of adult *P. xiphia* on Madeira Island between 1850 and 2000. Source: Wakeham-Dawson et al. (2002) Reproduced with the kind permission of the authors and the publisher.

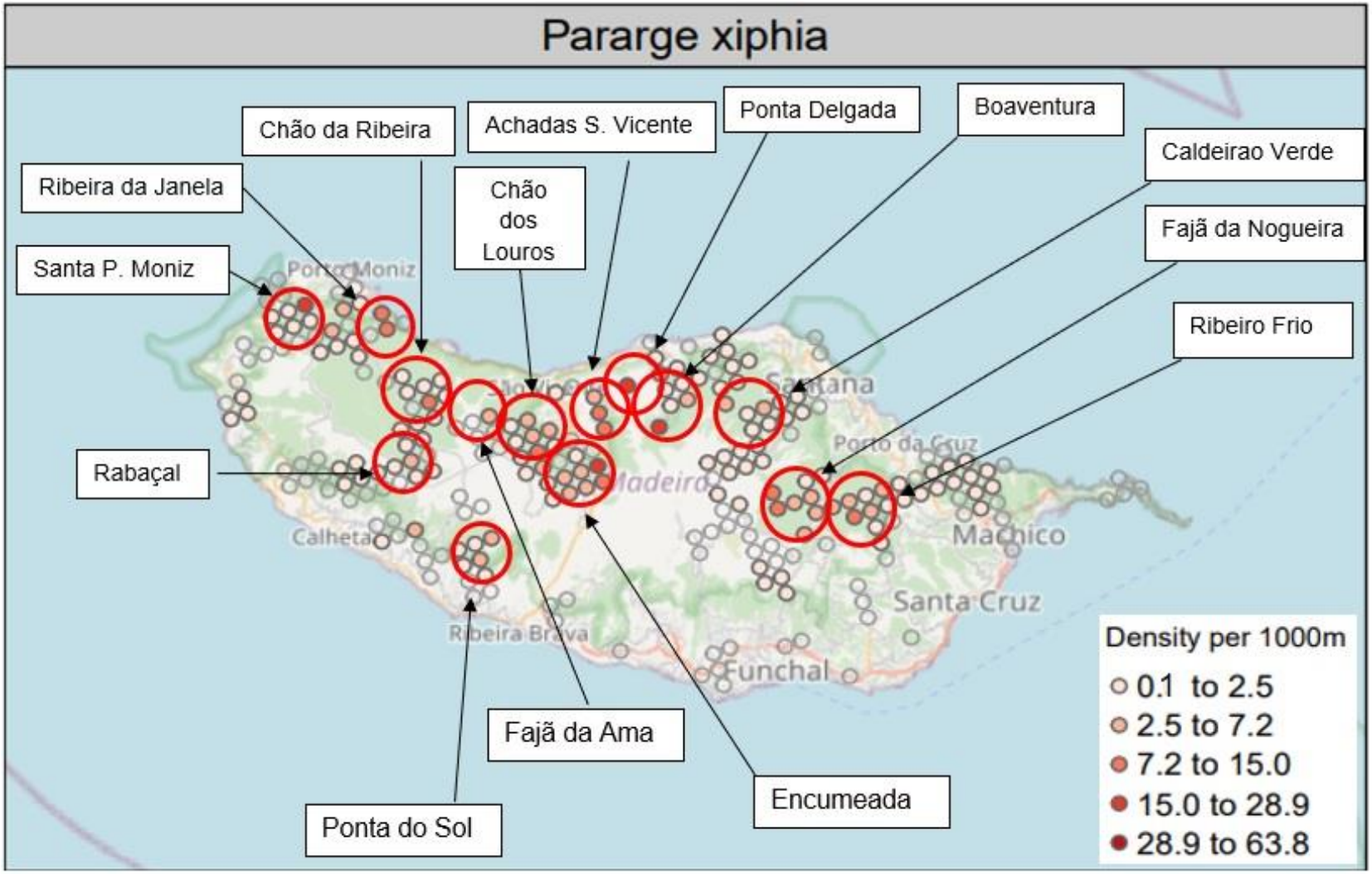

Figure 3: Distribution and relative abundance of *P. xiphia* on Madeira at 1 km^2 scale during 15-minute Count surveys of pre-defined transect routes August-September 2021. Empty circles represent squares survey where the species was not recorded. Fourteen key areas for the butterfly are highlighted in red circles.

HABITAT

Habitat description

P. xiphia is restricted to dense, humid and dry laurel forests (*laurisilva*) and also mixed forests above 200 m a.s.l, where the grasses (*F.donax* and *B. sylvaticum*) used as larval foodplants by this species, are abundant. The larvae live on the larval foodplants, mainly False Brome *Brachypodium sylvaticum* and Madeira Fescue *Festuca donax*.

Typically, *P. xiphia* imago is found flying in pristine humid laurel forest areas, laurel forests canopy gaps, tree canopies, levadas and other sunspots in the middle of humid forests and forest clearings with intermixed grasslands, where the endemic grass *F. donax* is very common (Figure 4).

P. xiphia is also seen in mountainous mesophylous grasslands and heathlands, above the 1400 m a.s.l., laurissilva forest altitudinal threshold. *P. xiphia* was also observed in farmland and old eucalyptus plantations in the vegetation belt of the humid laurel forests, between 500 and 1400 m a.s.l.

Figure 4 - Typical *P. xiphia* habitat in humid Laurel forests' small grassland areas and clearings (S. Teixeira)

Species distribution model

In order to identify other potentially suitable locations for each butterfly species on Madeira, species distribution models were built using three environmental variables considered crucial in determining distribution: elevation, distance from rivers and landcover. To create the landcover map, the following land covers were extracted from Google maps: bare ground, water bodies, agricultural areas, urban areas, laurisilva forest, eucalyptus forests, grassland and *Erica maderensis*. Elevation was derived for each 100m square by the R-package elevatr (cran.r-project.org/web/packages/elevatr/vignettes/introduction_to_elevatr.html). The elevation and distance from rivers are expressed in meters, while the land cover is expressed as presence/absence, so the values range between 0 (absent) and 1 (present). Considering the quantity of variables and their possible correlations, the Generalized Linear Model was discarded for this study and a Random Forest model was used instead.

All the analyses were carried out in R, using the randomForest package (Breiman 2001). 70% of the set of records of each species was used to train the model, while the other 30% to test it. Besides predicting the probability of occurrence of the species, a threshold was applied to display presence/absence maps, based on the prediction of the model. For abundant species, a threshold of 0.3 was applied, that is with a probability higher than 30% the species was considered present in a certain area. For rare species, the threshold was lowered at 0.10 or 0.15. Moreover, the variable importance was calculated as the percentage contribution of each variable to the model. This enabled evaluation of which variables were more significant in determining the species distribution, and how this distribution changes with the change in variable values.

Figures 5 and 6 show the predicted distribution of *P. xiphia* based on the results of the species distribution models. In Figure 5 the model shows the Probability of Occurrence (POO) across the island, whereas Figure 6 displays the data as a presence/absence map. Whichever way the results are displayed, the model predicts the distribution of *P. xiphia* to be mostly on the northern localities with well-preserved humid laurel forests.

Figures 5 and 6 are insufficiently detailed for use by recorders in the field wishing to search for new *P. xiphia* localities. For this reason, we have produced dynamic maps as a html file (Figure 7) which can be downloaded and opened in a browser. Geographical base layers can be added and the zoom function enables users to focus in on potential search areas. These dynamic maps will be made available on BCE and MF&F webpages regarding the Madeira Butterfly Monitoring Scheme (maBMS).

Figure 5: Probability of occurrence of *P. xiphia* on Madeira Island as a result of the Species Distribution Model.

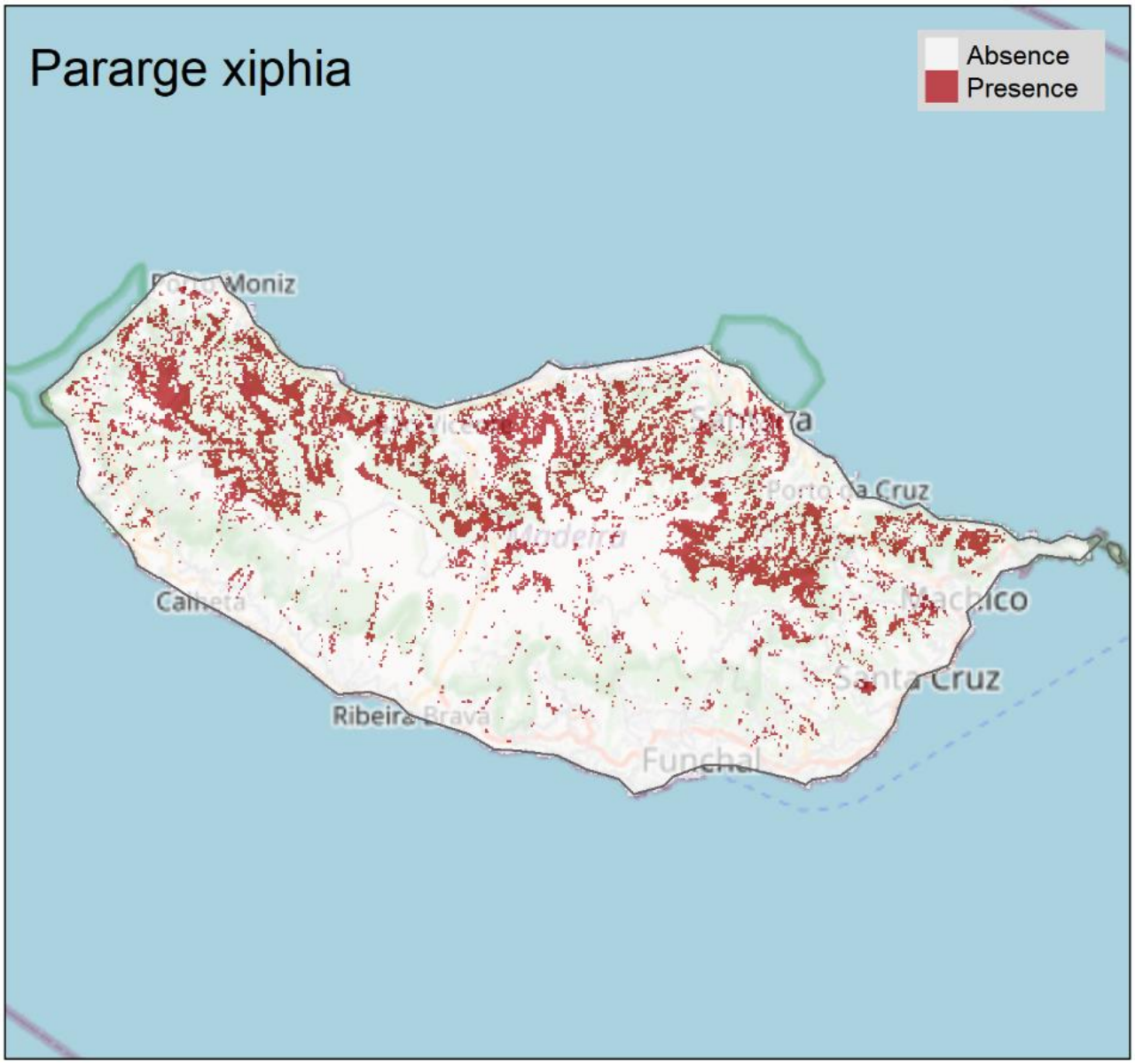

Figure 6: Binary distribution map for *P. xiphia* on Madeira Island as a result of the Species Distribution Model.

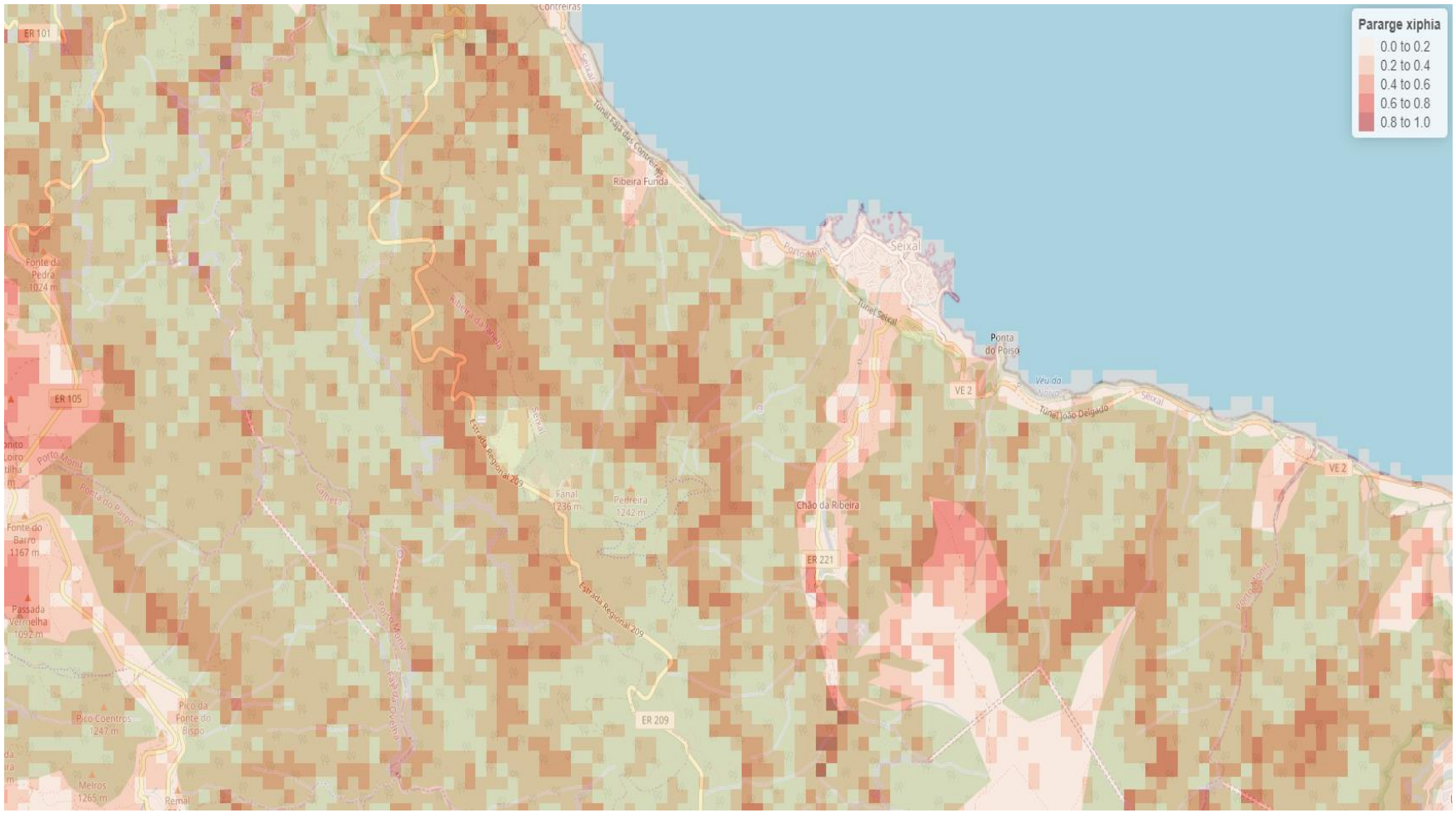

Figure 7: Probability of occurrence of *P, xiphia* on Madeira Island. Data displayed as a dynamic map (html file) showing Probability of Occurrence within a small geographical area suitable for recorders to undertake surveys.

BIOLOGY

Phenology and behaviour

P. xiphia is on the wing all year round and has been recorded in every month (Wakeham-Dawson *et al.* 2002, Wiemers pers. obs.; Teixeira pers. obs.). Wakeham-Dawson *et al.* (2002) reported most observation records are between April and September, mainly in May, July and August when the butterfly is seen in higher densities. However, many of these records were made by foreign observers while staying on the island for short periods of time between spring and late summer (Higgins, 1977; Ohemig, 1980) and therefore their observations match their stays and thus some caution should be made regarding the correlation between Island visits, field trips and recorded observations. Records made by local observers since 2012 by the Madeira Fauna & Flora butterfly monitoring scheme with tourists on Butterfly watching tours, have observed several *P. xiphia* imago between October and March, even early November. During October and early November, *P. xiphia* was frequently recorded nectaring in humid laurel forests on the endemic *Muschia wollanstonii* even amidst fog, rain, and cold weather (S. Teixeira *pers*. *obs.*, Figure 8). Therefore, taking all records into account, *P. xiphia* is a multivoltine species. However, short diapause may exist in larvae and pupae during the coldest days in the winter months (Fernández-Rubio & García-Barros 1995, Wiemers, *pers. obs.*).

Figure 8: *P. xiphia* feeding on blooming Wollaston's Muschia *Muschia wollastonii* on October 23rd, 2013 (S. Teixeira). Raindrops are visible on the flower.

Shreeve & Smith (1992) found that *P. xiphia* activity is affected by microclimatic conditions, namely temperature and light conditions and it may affect habitat use seasonally. This may explain the lower activity and records between October and March when the island is under the influence of west Atlantic storms, temperatures may fall below 0º C in the humid laurel forest highest altitudes, and have hail and snowstorms (S. Teixeira, *pers. obs.*). Considering that *P. xiphia* is active even at lower temperatures (T_{min} = 9ºC), while *P. aegeria* requires higher temperatures (T_{min} = 14º C) (Shreeve & Smith, 1992), may explain the higher abundance of *P. xiphia* on the highest and darker primary laurel forest areas.

Territorial defence and mate search are typically made by *Pararge* butterflies with patrol flights. However, there are marked differences between *P. xiphia* and *P. aegeria*, with *P. xiphia* being more active, with longer, faster, rectilinear flights than *P. aegeria* (Fernández-Rubio & García-Barros 1995). Additionally, the Madeiran Speckled Wood prefers the sunny high branches of laurissilva (Fernández-Rubio & García-Barros 1995) and spends a considerable amount of time flying close to the laurel forests tree canopies of Macaronesian laurels *Laurus novocanariensis*, fetid laurels *Ocotea foetens* and endemic Lilly-of-the-Valley *Clethra arborea* trees than other trees and bushes such as the Wax Myrtle *Myrica faya* or even the heathers *Erica arborea* and *Erica platycodon maderincola* (Teixeira *pers. obs.*).

Regarding the Madeiran Speckled Wood early stages, there are few observation records, but should occur during the warmer months due to temperature effects on egg laying of Pararge butterflies, as observed by Shreeve (1986) on its congener *P. aegeria*. This is supported by field observations made by Oehmig (1979), Wiemers (ref?), and Bland & Lace (2020) of eggs and larvae of both species on the same plant. Predominantly, P. *xiphia* females oviposit one single egg per plant, sometimes two and rarely three or four eggs (Bland & Lace 2020) and distribute them more widely over larval foodplants (Gibbs *et al.* 2004). *P xiphia* larvae are larger and less mobile than *P. aegeria* when searching for new food sources (Fernández-Rubio & García-Barros 1995, Gibbs *et al.* 2004).

During this project surveys, we observed that *P. xiphia* continued flight even under heavy rain in Laurissilva (Teixeira pers. obs.) showing that the species is well adapted to the humid laurissilva cloud forest climatic conditions. This supports the observations made of *P. xiphia* on the wing and nectaring in late October and early November under unfavourable climatic conditions.

Larval foodplants

Pararge butterflies select several species of grasses from the family Poaceae to oviposit. *P. xiphia* was found to oviposit on *Brachypodium sylvaticum* (Beauv., 1762), *Holcus lanatus* L., *Agrostis gigantea* Roth and the endemic *Festuca donax* Lowe (Shreeve & Smith, 1992; Fernández-Rubio & García-Barros, 1995; Gibbs *et al*., 2004;

Aguiar & Karsholt 2006, van Swaay *et al*., 2010a, b; Bland & Lace 2020). Most studies have collected eggs on *Brachypodium sylvaticum* (Beauv., 1762), thus being the main larval foodplant used by the Madeira Speckled Wood. So far, *P. xiphia* oviposition has not been observed on any other grass species.

P. xiphia, as well as *P. aegeria* seem to prefer small isolated LFPs that grow on sheltered conditions, either in depressions or protected by banks, tree trunks and rocks and under bushes as ideal egg-laying sites. Adults only searched for plants growing in those conditions (Owen et al., 1986; Shreeve & Smith, 1992).

Eggs

The first egg data observations for *P. xiphia* were made by Oehmig in 1979 based on eggs collected in August of 1976. In April 1985, Owen et al. (1986) collected one egg on *Holcus lanatus* and two on *Brachypodium sylvaticum*. Shreeve & Smith (1992) collected nine eggs in September of 1989 and nine eggs in April 1990. Fernández-Rubio & García-Barros (1995) collected eggs in August 1992, seven from an undisclosed location and one from Serra d' Água. Harrisson (2001) collected eggs in March 1997. In July 2016, Wiemers observed egg-laying in Barranco da Ribeira do Inferno (*unpublished*). Lastly, Bland & Lace (2020) collected eggs between July and August of 2018. These data collectively suggest that *P. xiphia* oviposition occurs between March and September. Eggs are laid on the blades of larval food grasses.

Larva

The larvae live on the broad grass leaves and feeds on the leaf blade only partially. This behaviour makes it easy to spot the plants with larvae, which are visible even during daytime. Larvae build a silk webbing to protect themselves.

Pupation

P. xiphia pupates by hanging down by the cremaster, as all *Pararge* species. Pupa are frequently observed on older brownish leaves.

Nectar sources

Imagoes search for nectar on several typical laurissilva forest plant species. In laurissilva forests *P. xiphia* is commonly found nectaring on many endemics such as brambles *Rubus grandifolius* and *Rubus bollei,* Pride of Madeira *Echium candicans*, Madeira Daisy *Argyranthemum pinnatifidium*, giant dandelions *Sonchus fruticosus* and *Sonchus pinnatus*, Lily-of-the-Valley tree *Clethra arborea*, pericallis, *Pericallis aurita* and Wollaston's Muschia *Muschia wollastonii.* The latter is a common nectar source during autumn months of October and November (Teixeira *pers. obs.* Fig.8).

Natural enemies

Parasitoid wasps are known to parasitise several species of Lepidoptera (Lozan *et al*. 2008). In 2004, the chalcidoid wasp *Trichogramma gicai* was observed parasitizing *P. xiphia* eggs and became the first known *P. xiphia* parasite (Gibbs *et al*., 2004). No other species are known to parasite the Madeiran Speckled Wood.

POPULATION

P. xiphia populations have been declining since the mid 1980's, 10 years after the colonization of Madeira Island by African *P. aegeria*. Data collected via census in six different areas of the Island have shown that the species went from 78% relative proportion to *P. aegeria* in 1986, down to 25% in 2018 (Bland & Lace, 2020). Despite this intrageneric ratio decline, *P. xiphia* is still the second most abundant butterfly species in Madeira Island, accounting for 19% of the records (Bland & Lace, 2020). This is corroborated by the data obtained in the current surveys, which showed that *P. xiphia* accounted for 20.4% of all butterfly records. Therefore, despite the decline regarding its congeneric *P. aegeria*, in absolute numbers of recorded individuals *P. xiphia* population is still remarkably high among butterfly populations on Madeira Island.

Regarding the *P. xiphia/P. aegeria* ratios, our data has shown that *P. xiphia* represented 44,1% of the *Pararge* butterflies, whereas *P. aegeria* represented 65,9%. These results confirm the data obtained by Bland & Lace (2020) and Martin Wiemers in 2016 and 2017 (Unpublished data). However, our data suggests that *P. xiphia* has increased in numbers when compared with data collected in previous years (Wiemers, pers. obs., Teixeira, pers. obs). Nevertheless, globally the invasive *P. aegeria* is more common than the endemic *P. xiphia*, mainly in costal areas. However in well-preserved humid laurel forest areas such as Ribeira da Janela, Chão da Ribeira, São Vicente valley, Fajã da Nogueira, Ribeiro Frio and Queimadas *P. xiphia* is dominant, with ratios between 75% and 100% (Fig. 9).

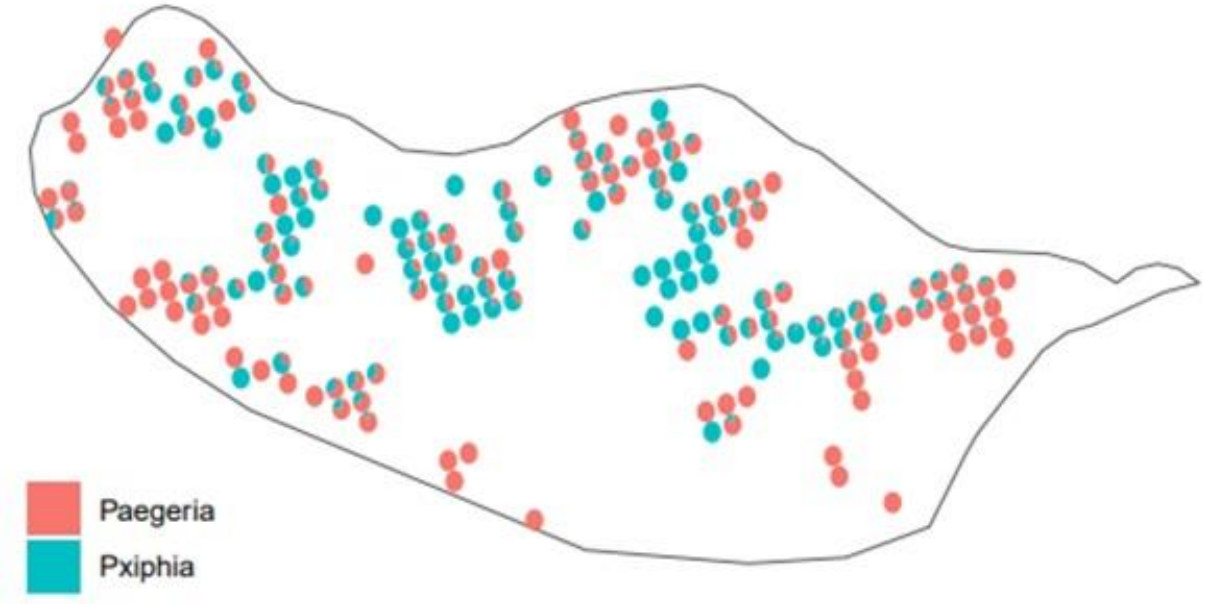

Figure 9 – Ratios between *P. xiphia* and *P. aegeria* on surveyed areas. Circles represent relative abundance of *P. xiphia* (Blue) and *P. aegeria* (Orange) on Madeira Island at 1 km^2 scale during 15-minute Count surveys of pre-defined transect routes.

CONSERVATION

Legal protection

P. xiphia and all other Madeira endemic Lepidoptera are not directly or specifically protected by any national or regional laws or other legislative acts by national or regional parliaments. However, about two thirds of the Island are included in the Parque Natural da Madeira, which comprises several types of nature reserves and protected areas, including *P. xiphia* habitats. Some areas of pristine primary Laurel Forest are strict nature reserves and fully protected. Additionally, the native laurel forest which is the main habitat for *P. xiphia*, is also listed as SAC PTMAD0001 'laurissilva da Madeira' in Natura 2000 Ecological Network under the Habitats Directive. Therefore, although *P. xiphia* is not specifically addressed by any legal protection, it is indirectly protected by several legislative acts. Their main habitats are protected and under the surveillance of the Regional Authority IFCN.

Conservation status

P. xiphia was assessed in 2009 on the IUCN Red List as an Endangered species at a global, European and EU27 level (van Swaay et al., 2010). The population decline, extent and quality of habitat, competition with *P. aegeria*, and being restricted to Madeira Island with an extent of occurrence less than 5000 km^2 determined its conservation status.

According to the International Union for Conservation of the Nature, the global conservation status of *P. xiphia* is Endangered B1ab (iii,v); *The IUCN Red List of Threatened Species* 2010; downloaded on 27th August 2021).

Conservation actions proposed by van Swaay *et al*. (2010) were:

1. More research is needed urgently on the distribution and ecology of the species and the interactions with *P. aegeria*.
2. The trend of both species should be monitored by Butterfly Monitoring Schemes.

THREATS

Globally, the species is threatened by habitats loss, habitat change and potentially competition.

The species is mostly restricted to primary "laurissilva" laurel forests. This habitat is under pressure of Invasive Alien Species (IAS) such as *Solanum mauritianum, Ailanthus altissima, Eucalyptus globulus, Acer pseudotsuga, Tradescantia fluminensis, Ageratina adenphora, Ageratina riparia, Crocosmia x crocosmiiflora, Acacia mearnsii, Cytisus scoparius, Ulex europaeus, Ulex minor, Hedychium gardnerianum, Passiflora molissima, Hydrangea macrophylla* and *Fuschia magellanica*.

Ground dwelling species such as *Tradescantia fluminensis* cover large areas of soil in laurissilva forests, thus hindering the growth of *P. xiphia* larval foodplants. Other IAS species such as *Ageratina adenophora* and *Ageratina riparia* grow in high densities and have the same effect on larval foodplant growth. This may affect the availability of ovipositing sites and larval food for *P. xiphia*. Other species threaten the habitats itself, such as *Passifora molissima* that grows over the canopy of laurissilva trees.

Additionally, some boundary areas between native laurel forest and abandoned land or mixed forests are under synanthropic pressure due to land reclamation to agricultural use. During vegetation clearing it is a standard to cut and burn the vegetation or even use agrochemicals (i.e., herbicides and insecticides) which will destroy the larval foodplants or kill any eggs, larvae, or pupa in such sprayed areas. Other farmers use grazing livestock like goats which feed on *P. xiphia* larval foodplants and thus reduce the suitability of the breeding habitat.

One new threat identified during the current project concerns the possible impact on *P. xiphia* of the export of eucalyptus wood. During the project surveys, we found that old eucalyptus exotic forests growing in the laurissilva belt on the southern coast also harbours many *P. xiphia* butterflies within their butterfly community. These records were mostly made on places close to water and with native vegetation. In fact, on the southern side of the Island, these exotic forests had the highest number of *P. xiphia* records. However, these large eucalyptus forests have been the primary target for the wood industry, one of the largest economic sectors on the Island. Therefore, it would be advisable to include a monitoring programme in these forests and compare abundance data before and after timber is harvested.

The population of *P. xiphia* has been steadily declining due to competition with *P. aegeria*, which in 1976 colonized the island from Africa. Both species compete for larval foodplants and habitats and the higher capacity of *P. aegeria* on egg-laying and larvae dispersal is increasing the pressure on *P. xiphia* (Shreeve & Smith, 1992; Gibbs et al., 2004, Bland & Lace, 2020). Additionally, harassment of *P. xiphia* females by

low flying *P. aegeria* males may lead to decreased number of eggs being laid (Wiemers, pers. obs.).

Also, the parasitic wasp *Trichogramma gicai,* the first predator known, was observed predating on *P. xiphia* eggs (Gibbs *et al*., 2004). Although it may not be a threat on its own, it surely adds ecological pressure on the population of this endangered species, mainly on earlier stages such as *P. aegeria*.

SPECIES ACTION PLAN

One of the main objectives of the project LIFE4BEST 2020-M37 was to integrate the local butterfly monitoring scheme into the European Butterfly Monitoring Scheme (eBMS) and ensure both threatened endemic and non-threatened butterfly species are adequately monitored on Madeira. Data collected through the project allowed the team to select 15 Key Butterfly Areas which were integrated into the Madeira Butterfly Monitoring Scheme (maBMS) as new transects to be monitored by a network of volunteers and IFCN Nature Rangers on a regular basis or by visiting tourists. Data collected will be uploaded into the eBMS database and analysed yearly to produce an annual monitoring report. The maBMS annual reports will be used to update the action plan every 10 years.

The maBMS will meet the conservation and research priorities set by IUCN to achieve the conservation goals for this species, by assessing the population size, its distribution and trends.

A cooperation between the maBMS/Madeira Fauna & Flora and Madeira University Entomological Unit and Insect collection is already in place. Students and volunteers will collect data to increase knowledge on threats, life history and ecology of the endemic butterflies and thus answer IUCN's research priorities for the conservation of *P. xiphia*.

The maBMS will gather together a panel of representatives of the different stakeholder groups, as well as the governmental units involved in biodiversity conservation, protected area management, forestry, and agriculture. The panel will include the maBMS Regional Coordinator Sérgio Teixeira, BCE eBMS Representative, University of Madeira – Head of Entomology Dora Pombo, University of Madeira - Organic Farming Course Director, IFCN Head of Biodiversity Conservation/CITES Duarte Barreto or representative, DRADR Regional Director Paulo Santos or representative, DRAAC Regional Director Manuel Ara or representative, President of the Young Farmer's association AJAMPS or representative, President of the Association of Farmers AAM or representative and members of the IUCN MAIISG Group butterfly experts António Franquinho Aguiar and Martin Wiemers.

The panel will meet yearly after the annual report is produced to discuss population trends, habitat management and other issues regarding the conservation of the archipelago's butterflies, their relationship with economic activities, as well as awareness raising initiatives.

The panel will also assess the need to legislate specific conservation measures to halt negative interactions and guarantee the conservation of the threatened endemic butterflies, namely unlicensed capture, killing and transport of alive or dead

specimens. Depending on the population trends, the panel may define *in situ* and *ex situ* conservation actions such as propagation and plantation of larval foodplants in areas where IAS are completely covering the soil, namely areas in laurissilva forest dominated by *Tradescantia fluminensis, Ageratina adenphora* and *Ageratina riparia* which completely cover the soil leaving no space for *P. xiphia* LFPs or even areas covered by *Cytisus scoparius, Ulex europaeus, Ulex minor* in degraded and abandoned pastures and farmland. Therefore, in the areas within identified Key Butterfly Areas, control of IAS should be made to prevent their spread into *P. xiphia* pristine habitats and any other measures that may be required to stop the extinction of the endemic butterflies.

Legal protection

No specific legal protection is proposed. Maintain the current license system for wild species captures for research used by the IFCN, to control and monitor captures of the endemic butterfly species.

Protected areas

There is no evidence to support the need to extend the protected areas. All 14 *P. xiphia* identified Key Butterfly Areas are within protected areas under several legislative acts. The Species Distribution Models predictions match field observations, which foresees P. xiphia on well conserved Laurel Forest patches.

Conservation measures

The main actions for the conservation of the species can be summarized as follows:

HABITAT MANAGEMENT

The *P. xiphia* larval foodplants are relatively abundant in the different habitats used by the butterfly. However, it seems that *P. xiphia* and *P. aegeria* only select some plants in specific conditions and do not egg-lay on all available plants, thus making only a smaller fraction of the available LFPs suitable as food. Oviposition by both species in the same plant has been observed by Lace (2020), thus proving that these species compete for LFPs. Therefore, IAS control should be undertaken in the Key Butterfly Areas identified during the project. Given the known competition for larval foodplants between both *Pararge* species, availability of larval foodplants in key *P. xiphia* areas is paramount to maintain strong populations of the butterfly.

Considering that many of these areas are within Natura 2000, funds for Natura 2000 payments to farmers should be used to pay for relevant habitat management operations undertaken by landowners. This would have multiple advantages by:

- Improving habitat quality and connectivity for the endangered *P. xiphia*

- Decreasing the overburden on IFCN on land management operations
- Controlling IAS spread
- Increasing awareness about *P. xiphia* conservation amongst the farming community.

Survey and monitoring

The distribution of *P. xiphia* has been retracting over time due to habitat loss and fragmentation and by competition with the sympatric *P. aegeria*. This is illustrated by the Species Distribution Model (Figures 5 and 6) which confirms the present records of *P. xiphia* and highlights it is missing from the areas where it was recorded in the early 20th century, when the species was commonly observed on coastal areas all over the Island. *P. xiphia* is absent from urban areas, farmland, and abandoned land plots.

To ascertain changes in the species' distribution and abundance, the maBMS will allow collection of critical data to answer these fundamental questions. The maBMS is structured to allow a constant data flow to the eBMS database using the many tourism guides and other volunteers to collect data. Although the scheme is at an early stage, the local coordinator expects to have enough volunteers to monitor the transects located on the Key Butterfly Areas, as well other areas using the 15-minute Counts. However, other volunteers will require training with the app and field identification. To reach those targets, Madeira Fauna & Flora in partnership with the IFCN, will organize volunteer training at least twice per year.

The project has trained Tourism guides, Nature guides, mountain guides, farmers, IFCN Nature rangers, Forest Service, DRAAC, IFCN and DRADR technicians to survey butterflies using the ButterflyCount app. Several will use the app upon deployment in the field, nature reserves and when possible, the maBMS transects in the Key Butterfly Areas.

Several tourism guides are already using the App and undertaking butterfly counts on a regular basis.

The first tourist has already joined the monitoring scheme and has participated on counts with MF&F. The tourist visits the island regularly and is a former Butterfly Conservation UK member and normally undertook butterfly watching tours with MF&F.

Research

Madeira Fauna & Flora has established a partnership with the University of Madeira's Entomology Unit coordinator which runs the Madeira Insect project. Meetings taken place during the LIFE4BEST 2020-M-37 project between the two partners, have allowed several university students to begin collecting baseline data about the

Island's butterflies. Research will include competition between the two sympatric *Pararge* butterflies, oviposition preferences, success of early stages, habitat and biotype preferences, nectaring, among other important life-cycle information to help define more targeted strategies for the conservation of *P. xiphia*.
Additionally, several Nature guides and nature guide students have shown interest in participating in data collection as well. This will allow for several teams in different municipalities to collect data simultaneously.

The research priorities will be established between the maBMS coordinator and the Madeira University Entomology Unit coordinator. Support on defining priorities and sampling design will be given by butterfly experts involved in Madeira butterflies and BCE.

Public awareness

The actions involving biology students, nature guides, mountain guides and other volunteering groups are awareness raising initiatives, as this participation is often spread through their contact groups and families.

Additionally, the inclusion on the IFCN environmental education programme and on the DRAAC eco-schools programme will extend the awareness raising initiatives throughout all the different age-group student communities across the island. Madeira Fauna & Flora has made ppt and pdf presentations for these stakeholder programmes.

Madeira Fauna & Flora will organize annually a Butterfly Regional Week during the summer holidays to attract as many children and families as possible to watch and count butterflies. This initiative will be based on the successful "Big Butterfly Count" established in the UK by Butterfly Conservation.

To keep volunteers motivated, Madeira Fauna & Flora will also create a maBMS website which will include all supporting documents produced for volunteers by the project, awareness raising initiatives, the annual reports, the maBMS volunteers, their counts results, and all other relevant information. In 2023, MF&F will also contact large companies to help the local volunteer work with in kind and financial donations to support training and for the annual maBMS volunteers meeting. MF&F social media will be used to disseminate all maBMS activities to new volunteers.

The MF&F butterfly watching tours will be resumed in 2023 and 10% of the income will be used to support the several maBMS actions but mostly for training new volunteers, printing new hardcopies of the Madeira butterfly field guide and the flyers for tourists.

Yearly, the annual butterfly monitoring report and the Madeira Butterfly Week will be made public using all available MF&F media, IFCN media, local newspapers and television. The local news alone has a daily audience of almost 18,000 people and any coverage will increase awareness of the maBMS and the importance of butterfly conservation locally.

Plan implementation

Whilst BCE will be able to offer advice if required, implementation of this recovery plan can only be overseen and delivered by organisations based in Madeira.

MF&F are best placed for the coordinating role, as they are either the lead or the partner in all the actions in the table below. MF&F propose to annually gather together a panel of representatives of stakeholder groups and government agencies for biodiversity conservation, protected area management, forestry and agriculture. The purpose of the group will be to review actions undertaken to conserve Madeira's butterflies, with a specific focus on the maBMS and on the actions highlighted in this and other Recovery Plans for threatened endemics (Madeiran Brimstone *Pararge maderensis* and Madeiran Large White *Pieris wollastoni*).

Suggested panel participants are:

NAME	ROLE	ORGANISATION
Sérgio Teixeira	maBMS Regional Coordinator	MFF
Cristina Sevilleja	eBMS representative	BCE
Dora Pombo	Head of Entomology	University of Madeira
Miguel Ângelo Carvalho	Organic Farming Course Director	University of Madeira
Manuel Filipe or representative	President of IFCN	IFCN
Paulo Santos or representative	Regional Director	DRADR
Manuel Ara or representatitive	Regional Director	DRAAC
Vitor Castro	President	Young Farmer's Association AJAMPS

João Ferreira	President	Association of Farmers AAM
Amilcar Gonçalves or representative	President	Madeira Water and Waste ARM
Martin Wiemers	Butterfly expert: Macaronesia	IUCN MAIISG Group
António Franquinho Aguiar	Butterfly expert: Madeira	IUCN MAIISG Group

Species Action Plan summary

ACTION	PRIORITY (High, Medium. Low)	PARTNERS (Lead partner in bold)	TIMESCALE
Legal protection			
Maintain the current license system for wild species captures for research used by the IFCN, to control and monitor captures of the endemic butterfly species.	High	**SRAAC** IFCN MF&F	2025
Protected areas			
Restore degraded suitable areas into natural habitat and thus favour *P. xiphia* instead of *P. aegeria*.	Medium	**IFCN** MF&F	2023 onwards
Conservation measures			
Establish IAS elimination and LFPs seeding programme with farmers and landowners on suitable habitats	High	**IFCN** DRADR MF&F	2023 onwards
Survey and monitoring			
Increase local networks of volunteers	High	**MF&F** volunteer recorders	2023-2025
Annually undertake regular 3-week transect counts on fixed routes established through the Madeiran Butterfly Monitoring Scheme	High	**MF&F** maBMS volunteer recorders	2023 onwards
Research			
Encourage autecological research by Madeira University biology and Nature guides students	Medium	**University of Madeira** DRADR	2023
Public awareness			

Disseminate public events and training of new volunteers able to contribute to the conservation actions identified in this recovery plan	Medium	**MF&F** IFCN	ongoing
Produce a *P. xiphia* factsheet to advise land managers and owners on appropriate habitat management measures and important LFPs	Medium	**MF&F** SRAAC	2023 -2025
Produce and erect an information panel on maBMS transect start and end on each of the maBMS transects sites	Medium	**MF&F** IFCN	2023 -2025
Start the Regional Butterfly Week	Medium	**MF&F**	2023 onwards
Create the maBMS webpage	High	**MF&F**	2023 onwards

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Meetings to develop conservation actions: Sam Ellis, Chris van Swaay, Irma Wynhoff, Martin Wiemers (BCE Board members), Sergio Teixeira (Madeira Fauna & Flora; maBMS Coordinator), Duarte Barreto, Nadia Gonçalves (IFCN Senior Conservation Technicians), Manuel Filipe (IFCN President), Paulo Freitas (IFCN Council president), Dora Pombo (University of Madeira Associate professor, Senior Entomologist), José Jesus (University of Madeira Associate Professor, Ecology & systematics) and João Nunes (CMF - Parque Ecológico do Funchal),

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