

Proceedings of the



***SYMPOSIUM ON THE CONSERVATION OF
THE HOMERUS SWALLOWTAIL AND
COCKPIT COUNTRY, JAMAICA***

Kingston, Jamaica, April 19th, 2010

With the financial support of



1. ACKNOWLEDGEMENTS

Funding for this symposium was provided by the Dutch Zoo Conservation Fund (DZCF), the International Association of Butterfly Exhibitors and Suppliers (IABES) and the International Tropical Conservation Foundation (ITCF). We also wish to thank the contributors, participants and their respective organizations for their on-going dedication to the conservation of the Jamaican Giant Swallowtail butterfly (*Papilio [Pterourus] homerus*) and protection of its remaining habitats.

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(cover photograph courtesy of Brandon Hay)

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3. OPENING ADDRESS

Invited Speaker: Ms. Marilyn Headley
CEO and Conservator of Forests
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Salutations!

Thank you for inviting me to participate in today's activities.

To Mr. Caspar Bijleveld, Director of the Papiliorama Foundation (Switzerland) and chairman of the Conservation Committee of the International Association of Butterfly Exhibitors and Suppliers (IABES) and his team, let me, on behalf of the entire Forestry Department team, extend a warm Jamaican welcome to you. We look forward to working with you as there is much to be done and as we say in Jamaican parlance 'every liddle mek a mukkile'. We welcome your intervention as it takes us one step closer to preserving the integrity of the forest environment.

Today's symposium, which is a collaborative effort with the Windsor Research Centre, brings together persons of like mind, interested in the preservation of the Homerus Swallowtail Butterfly and its natural habitat the Cockpit Country.

As the largest species of the genus Papilio in the world and the largest butterfly in the Western Hemisphere, this rare butterfly once inhabited most of Jamaica but has now dwindled into two tiny populations: an eastern population, found where the Blue Mountains and John Crow Mountains merge, and a western population in the Cockpit Country.

As a child, every year particularly during the summer holidays, it was one of the childhood pleasures to chase after and attempt to catch butterflies. They all seemed so resplendent and tactical. I might have sought after a swallowtail or two, but back then one did not actually differentiate between the species. Unfortunately, over the years there has been a drastic reduction in their numbers, so rare that to see a swallowtail butterfly today is almost akin to a 'sighting'.

A few months ago we were in Bowden Pen walking on the trail with the members of the Bowden Pen community group, when we saw some early stage larvae on the leaf of the water mahoe; it was major excitement ... since we had not seen a swallowtail for years. Over the many decades, something in the ecosystem changed! And that is a truly disturbing fact.

Ladies and Gentlemen, both the swallowtail butterfly and the Cockpit Country are endangered, both as a result of human intervention!

Any activity that will bring to the fore the perils to the Swallowtail butterfly and the Cockpit Country will be supported by the Forestry Department.

The Cockpit Country, which is Jamaica's largest forest reserve, has been receiving much attention both locally and internationally. It is known the world over for its vast endemism. The Department has been working with the Fairchild Tropical Gardens to explore the 'secrets' of the Cockpit Country. With regular visits to the Cockpit Country, the group, including representatives from the University of the West Indies (UWI), FD, Institute of Jamaica (IOJ) among others are still discovering and rediscovering flora that was thought dead for a century. The area is a natural heritage and deserves preservation at the highest level.

The area is truly a national treasure. Something of which to be proud: Something worth preserving.

Over the last several years the Forestry Department has been working with a number of NGO's and international agencies including the Canadian International Development Agency (CIDA) under its "Trees for Tomorrow" project, The Nature Conservancy (TNC) and USAID through its Parks in Peril Programme. Over the period of collaboration awareness of the Cockpit country and its resources has grown.

An important outcome of the years of collaboration has been the heightened awareness among community members. The Forestry Department, as one of key strategies for forest preservation, engaged community members from in and around the forest reserve. Today there are three Local Forest Management Committees operating in the area. These groups engage in income generating activities that are sustainable and contribute to maintaining the integrity of the reserve.

Without the Cockpit country we will surely lose one of the last of two natural habitats for the swallowtail butterfly. This cannot be allowed to happen and with interests such as being expressed today the area will be preserved.

I wish you all the success in today's symposium and expect great outcomes from today's activity in particular the forging of new partnership including that with the Forestry Department, as well as the strengthening of existing collaborations. After all, we all stand to benefit from any effort geared towards the preservation of the natural environment as it is quite apparent that the occurrences in one country are having an impact across the globe.

At the end of the symposium we expect to receive great insights into some of the issues pertinent to both the swallowtail butterfly as well as the Cockpit Country. We also expect a plan of action as to the possible way forward to meet our desired end. We expect to have a productive day.

Before I close, let me extend thanks to the Windsor Research Centre for undertaking the partnership necessary to make today's event a reality. The Forestry Department and WRC have had a long and fruitful working relationship, one that we cherish and expect to deepen in years to come. Thank you again.

To all participants, sit back, listen, participate and then let's get busy in seeing to the business of preservation.

I thank you.

4. Symposium Objectives

- Reconcile all scientific facts, including the distribution of the Jamaican Giant Swallowtail butterfly (*Papilio homerus*), to guide the development of a conservation plan for the Jamaican Giant Swallowtail butterfly;
- Identify gaps in knowledge, particularly in relation to genetic diversity, factors that potentially limit dispersal, demography, and the viability of Western populations;
- Facilitate the acquaintance of persons active in the research, monitoring, and conservation of the Jamaican Giant Swallowtail.

5. Presentation Synopses

5.1. *Early descriptions of Giant Swallowtails in Jamaica and background to the symposium (Caspar Bijleveld).*

The Jamaican Giant Swallowtail butterfly was first described by Fabricius in 1793 and given the scientific name *Papilio homerus*. Following its description, several early naturalists painted scientific plates to augment museum specimens and to provide the wider public with an image of this magnificent butterfly. Paintings from the earliest artists include:

- William Jones (prepared 1783-1785; see Vane-Wright and Hugues 2004)
- Henry Seymer and Henry Seymer, Jr. (1768)
- Henry Seymer (1773)
- W.C. Hewiston (ca. 1845)

In a comparison of these and other early plates, speculation is growing that the extant *P. homerus* swallowtail is not THE Giant Swallowtail of Jamaica, but the

last of SEVERAL giant swallowtails that evolved on the island (Vane-Wright, pers. comm. to Bijleveld). If this is, indeed, the case – and molecular analyses of museums specimens and the extant populations will elucidate – there may be important management consequences for the extant populations in the Blue and John Crow Mountains and Cockpit Country.

Currently listed as Endangered in the IUCN Red Data Book, *P. homerus* has attracted attention both nationally and internationally. In 2004 Windsor Research Centre received funding from the Dutch Zoo Conservation Fund (DZCF) to conduct a butterfly training workshop for local research assistants and to assess the possibility as to whether *P. homerus* still existed in the Mt. Diablo region of Central Jamaica, as reported by Kaye (1926) and one Mr. Massey to Dr. Andre Avinoff (Carnegie Museum, Pittsburgh, Pennsylvania, USA) and Nicholas Shoumatoff between 1931 and 1940 (see Brown and Heineman 1972, pp 334-338). Similar to Avinoff and Shoumatoff, WRC was unable to document the existence of *P. homerus* in Mt. Diablo.

It was through DZCF that Caspar Bijleveld was introduced to WRC's conservation interests. Mr. Bijleveld serves as Chairman to the Conservation Committee of the International Association of Butterfly Exhibitors and Suppliers (IABES). At Mr. Bijleveld's urging, the Committee was created to challenge the approximately 130 IABES members to assist in project coordination and fundraising for in-situ conservation: 13 IABES member institutions are now actively fundraising for conservation of *Papilio homerus*.

The International Tropical Conservation Fund (ITCF) also provides financial support and project coordination. ITCF has been engaged for more than 20 years in fundraising and Protected Area management in Belize. Through ITCF's efforts, the 8,000 ha Shipstern Nature Reserve was established in 1989, with peripheral lands added in 1994 (Xo-Pol, 650 ha). The Shipstern Nature Reserve serves as a model for integrated conservation, combining an education centre, watch tower, and butterfly display house with habitat protection.

Through a collaboration with WRC and its partners, IABES is working to support Phase I of a global conservation strategy for *P. homerus*, which includes:

- Defining landscape and habitat boundaries, with particular attention to ensure Cockpit Country is correctly delineated;
- Organizing a conservation symposium;
- Meeting with local communities;
- Exploring the possibility of land acquisition in Western Cockpit Country, an area of great importance for *P. homerus* and which is extremely vulnerable to destruction by bauxite mining.

5.2. History of *Papilio homerus* research (Eric Garraway).

Since its description by Fabricius in 1793, *Papilio homerus* has been a highly-prized butterfly. Although studied opportunistically since its discovery (including studies and filming by Andre Avinoff (Carnegie Museum) in the 1920s and surveys by Charles Bernard Lewis (Institute of Jamaica) from the 1940s-60s and Thomas Turner in the 1960s-70s), the first long-term monitoring project of *P. homerus* was established by John R. Parnell (Dept. of Zoology, University of the West Indies), in the Rio Grande Valley in the 1980s. What began as field surveys in the 1970s by intrepid researchers living out of a van, evolved into a site-based field station that enabled Eric Garraway, Audette Bailey, and a cadre of UWI students to study in great detail the life history and factors limiting reproductive performance and survival of *P. homerus*. The field station, along with their regular research presence, promoted information sharing and the development of a sense of pride by community members in their unique location in the World, with this unique endemic butterfly. Dr. Garraway was almost too successful in his education outreach: during follow-up surveys, two local children asked their parents to contact the police, to report on the “strangers carrying nets to capture ‘their’ Giant Swallowtail.” A true measure of conservation success! Research by Dr. Garraway continued in the 1990s, in collaboration with Thomas Emmel (University of Florida) and contributors Audette Bailey, Jaret Daniels, Matthew Lehnert, and Errol Francis.

Grounded in the improved scientific knowledge and conservation threats, *Papilio homerus* became a flagship species for the establishment of the Blue and John Crow Mountain National Park (BJCMNP) and serves as the logo for the Park. In a break from its name, RARE Center for Tropical Bird Conservation, undertook a community-based conservation programme for *P. homerus* in the mid-1990s. On-going community outreach is maintained through the Rio Grande Field Station and through BJCMNP rangers. As another measure of conservation success, community members continue to plant larval food plants and nectar sources.



Entrance sign of the Blue and John Crow NP



Millbank Ranger station



Homerus celebrated as a natural heritage by school children in Jamaica

Local and national affinity for *P. homerus* is seen through the adoption of its image in a wide range of emblems and products. In addition to being the logo for the Natural History Society of Jamaica, it appears on the \$1000 bank note, phone cards, t-shirts, and school book cover. It is a focal topic in the

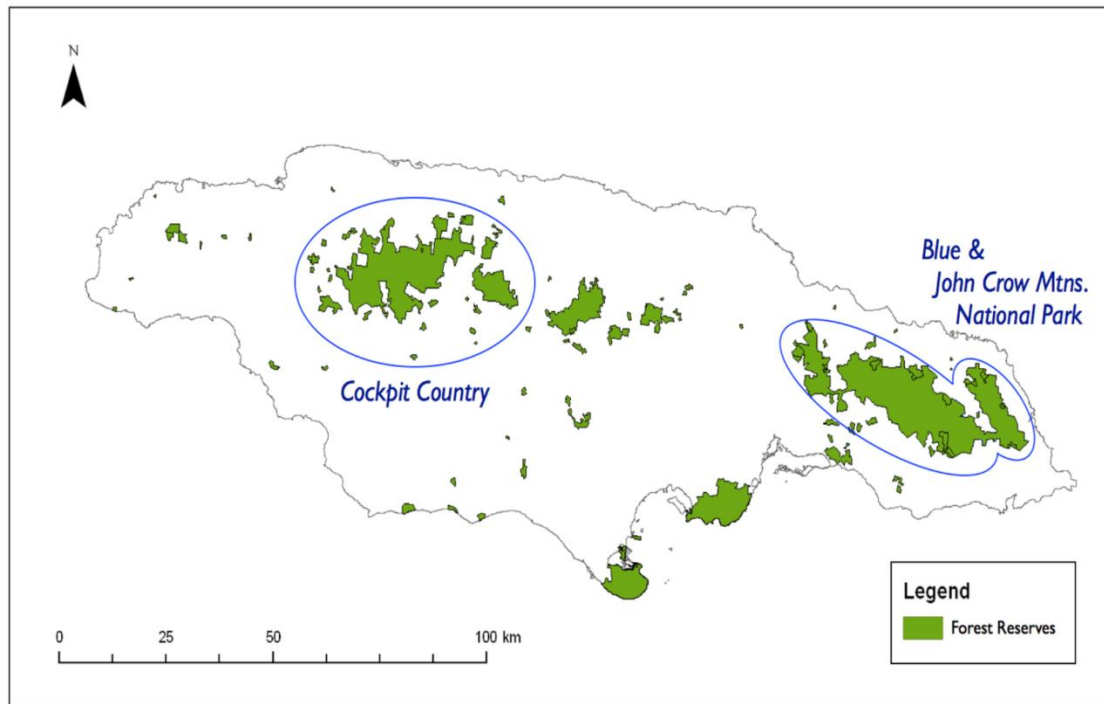
national environmental education programme and is celebrated as part of Jamaica's natural heritage by school children. It also serves as an umbrella species for all butterflies, for increasing awareness of the economic value of the sustainable use of butterflies. This "unofficial" national butterfly merits full designation as Jamaica's official National Butterfly.

5.3. Biology and ecology: Fact sheet on the Jamaican Giant Swallowtail butterfly (Thomas C. Emmel, in collaboration with Jaret C. Daniels)

The Jamaican Giant Swallowtail butterfly (Scientific name: *Papilio homerus*) was listed as one of the four endangered swallowtail species in the IUCN Red Data Book (Morris and Collins, 1985). Subsequently, all collection and trade of the species was banned under CITES Appendix 1, 1987, and Jamaican Wild Life Protection Act (1945; amended 1988). It is the largest of the true swallowtail species in the Americas and arguably one of the most spectacular butterflies in all of the world. The Jamaican Giant Swallowtail is a colourful butterfly, with bold and distinctive broad yellow bands on a black background, large tails, and hindwings trimmed with iridescent blue scaling.

The Jamaican Giant Swallowtail butterfly is endemic to the island of Jamaica. Historically, it has been recorded from seven of Jamaica's thirteen parishes. Currently, the butterfly is found only in two isolated and decreasing population strongholds: a western population in Cockpit Country and an eastern population at the crossroads of the John Crow and Blue Mountains in St. Thomas and Portland parishes. The majority of available scientific knowledge on the biology and ecology of the butterfly to date has come from work conducted on the eastern population. Relatively little definitive information is available on the size and condition of the western population, owing to its remoteness and the

excessively difficult terrain of Cockpit Country. In August 1986, Emmel and Garraway visited the western population and verified the continued survival and presence of the species there.



Today's distribution of *Homerus* swallowtail in Jamaica.
On the left, Cockpit Country. On the right, the Blue & John Crow Mountains.

The Jamaican Giant Swallowtail butterfly typically inhabits two major vegetative zones: the Wet Limestone Forest at elevations of 300-780m and the Lower Montane Rain Forest at higher elevations up to 1,070m. A third zone, the Montane Mist Forest, occurs above the Lower Montane Rain Forest and consists of the upper reaches and peaks of the Blue Mountains. Although not considered a habitat of the Giant Swallowtail, the integrity of the Montane Mist Forest serves as a critical structural component for the supply of water and atmospheric moisture to the lower elevation plant communities.

The caterpillar stage of the butterfly feeds on two endemic species of *Hernandia* (Hernandiaceae): Water Mahoe (*Hernandia catalpifolia*) in the eastern population and Pumpkinwood (*Hernandia jamaicensis*) in the western population, while adults utilize the nectar of a number of different flowering plants.

The eggs are laid singly on the leaves of *Hernandia* spp. The developing larvae pass through five distinctly different instars, molting their outer skin between each stage and assuming a different coloration and pattern. Upon maturity, an individual larva may attain a length of well over five centimetres, a width greater than a man's thumb, and weigh as much as a large mouse (5 ounces). At this stage it is one of the largest caterpillars in the world. The pupae formed after the last larval stage display several colour forms, with the most common colour being brown. The duration of the life cycle from egg to adult varies from 63 to 78 days under ambient conditions in the upper Rio Grande Valley. At least one life history stage has been recorded from all months of the year, indicating the presence of adults breeding throughout the year. The height of the adult flight season typically occurs from March to August, although the actual number of adult butterflies present at any one time fluctuates considerably.

Outline of nectar sources used by *Papilio homerus*
(Lehnert, 2008)

Mimosaceae:	<i>Entada gigas</i> (L.)
Zingiberaceae:	<i>Hedychium coronarium</i> Koenig
Hernandiaceae:	<i>Hernandia catalaefolia</i> Britton and Harris
Malvaceae:	<i>Hibiscus rosa-sinensis</i> L., <i>Urena lobata</i> L.
Verbenaceae:	<i>Lantana camara</i> L.
Acanthaceae:	<i>Pachystachys coccinea</i> (Aubl.)
Papilionaceae:	<i>Psophocarpus palustris</i> Desv.
Apocynaceae:	<i>Tabernaemontana ochroleuca</i> Urb

All nectar sources except for the family Apocynaceae were recorded from the eastern population (Garraway et al. 1993). The nectar sources recorded from the western population are Malvaceae and Apocynaceae. Vaughan Turland mentions also *Bauhinia divaricata* (Caesalpiniceae) as a most preferred nectar source (see 5.9)

The major identified threats to the continued survival and recovery of the existing Giant Swallowtail butterfly populations include habitat loss and fragmentation due to continued agricultural expansion, a high incidence of mortality during the immature stages, and, to a lesser extent, continued illegal poaching.

The ultimate survival of the Giant Swallowtail butterfly in Jamaica depends on:

- 1) Continued and effective habitat protection and restoration.
- 2) Additional research on the conservation biology of the butterfly, including long-term surveys of butterfly numbers in eastern and western populations, habitat requirements, and the factors limiting population density and mobility.
- 3) The development and implementation of a vigorous, sustained educational campaign on the value of this species and the continued preservation of its unique Jamaican habitats.

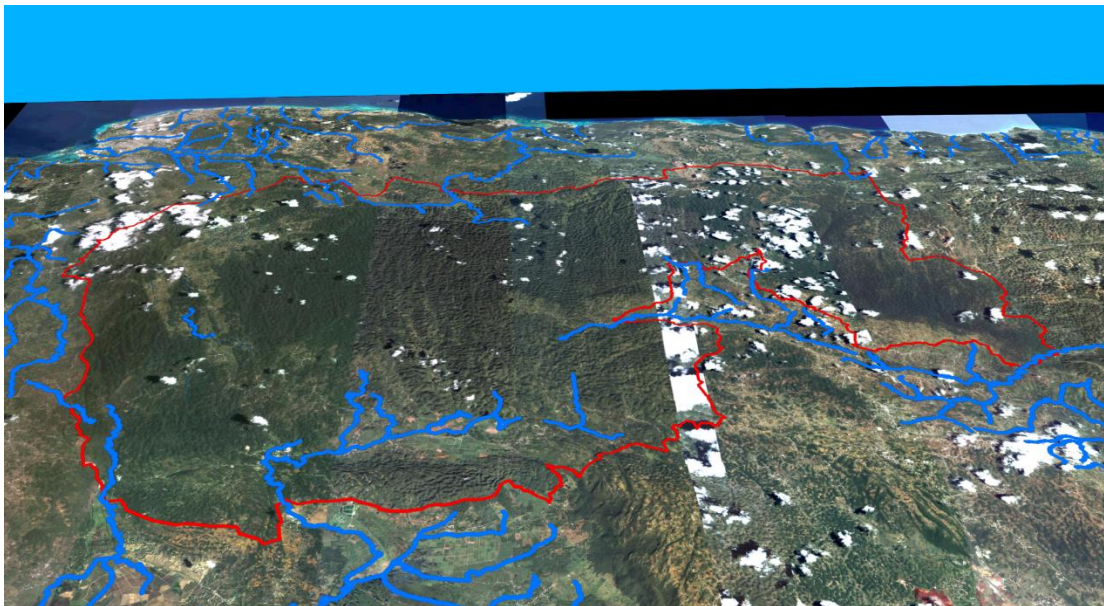
And may have to include, eventually:

- 4) The development of a captive propagation program to increase existing wild population numbers and reduce inbreeding depression in the present two isolated small populations.

Why this butterfly is important

- **An indicator for the preservation and continued health of Jamaica's critical watershed:**

The Giant Swallowtail butterfly occurs within Wet Limestone Forest, Lower Montane Rain Forest and the boundary of the Montane Mist Forest habitat. It frequents the natural sunlit flyways of streams and rivers prevalent in the first two plant communities mentioned above. Maintaining the functional dynamics of all species in these habitats is critical for maintaining the watershed. The seeds of the *Hernandia* food plant regenerate quickly following natural disturbances such as tropical storms and hurricanes, thus not only ensuring the persistence of the Giant Swallowtail but also providing early succession stabilization of exposed soils on hill slopes. Habitat clearing for agricultural use in these sensitive environmental areas is not only detrimental to the continued survival of the butterfly but presents a clear and present danger to the quality and supply of Jamaica's fresh water for over 50% of its human population.



A satellite view of Cockpit Country enhancing its importance as a the source of many watersheds (IKONOS Satellite image courtesy of GEOEYE and Forestry Department)

- **A colourful tropical species unique to the island of Jamaica:**

The Giant Swallowtail is representative of a unique tropical group of swallowtail butterflies and is found nowhere else in the world except Jamaica. A large, colourful, and highly sought-after species, it represents a potentially important draw for ecotourism.

- **The role of the Giant Swallowtail in nature:**

Like virtually all butterflies, the Giant Swallowtail helps to pollinate flowers in the adult stage, helps recycle minerals in vegetation in the larval stage, and provides a food source to numerous insectivorous birds and mammals as well as many other rain forest inhabitants. Aesthetically, its majestic beauty and majestic flight is virtually unmatched by any other New World butterfly species. It adds a source of richness to the human observer's experience in Jamaica, and can serve as a powerful symbol of Jamaica's autonomy, the Jamaican lover of nature and the environment, and the extensive protected area system in Jamaica.

The McGuire Center, Florida Museum of Natural History (University of Florida, Gainesville, Florida, USA): A living exhibit to celebrate butterflies and support research and conservation:

A US-\$4.2 million gift was received from William and Nadine McGuire of Wayzata, Minnesota in 2000 to establish the *William W. and Nadine M. McGuire Center for Lepidoptera and Biodiversity*. This gift was one of the largest private gifts ever given to foster research on insects and was matched from the State of Florida Alec Courtelis Facilities Enhancement Challenge Grant Program. The McGuires later gave another US-\$3 million to fund final construction of the center. This US-\$12 million facility for Lepidoptera research and public exhibits opened in August 2004.

The McGuire Center for Lepidoptera and Biodiversity serves both research and public education functions. The center includes the 6,400 square feet (595 m²), 60 feet (18m) tall living Butterfly Rainforest and exhibit space that features information about Lepidoptera and rainforests worldwide, as well as 39,000 square feet (3,600 m²) of research laboratories and collection space.

The research space includes laboratories focusing on molecular genetics, scanning electron microscopy, image analysis, conservation and captive propagation of endangered species, optical microscopy and specimen preparation, as well as classrooms and offices for 12 faculty curators, collection managers and other staff.

Some of the research laboratories and collection can be viewed through glass panels at the back of the museum. Because the public display is grounded in

research, butterflies are selected for display such that animal welfare is given highest priority. For example males in species which need large spaces for courtship dances are not suitable for display, but females can be shown.

Drs. Thomas C. Emmel and Jaret C. Daniels of the McGuire Center have been involved in *in-situ* conservation of *Papilio homerus* since the 1980s.

5.4. Population dynamics (Eric Garraway)

Based on historic records, *Papilio homerus* likely has always existed at low densities. Surveys over the past three decades of the eastern Blue and John Crow Mountain populations, conducted by John Parnell, Eric Garraway, Audette Bailey and colleagues, reveal that densities remain stable, although populations do appear to shift around in the environment, including along the elevation gradient. What has changed through time, however, is the availability of suitable habitat, with deforestation and conversion to agriculture decreasing the area and range of occupancy. Although *P. homerus* does not require mature forest and, indeed, likely benefits from small-scale disturbance (e.g., gaps in the canopy created when mature trees blow-over during tropical storms) because of the rapid regeneration of the larval food plant following disturbance, the species' propensity to occur at low densities dictates that it needs a large area to support adequate numbers of individuals for a viable population.



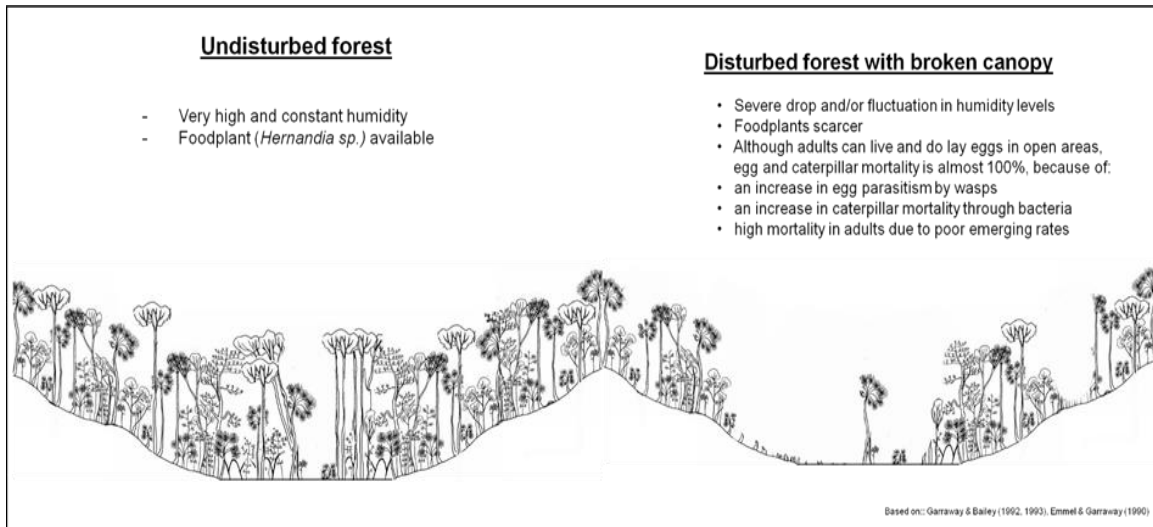
***Hernandia catalpifolia* growing at the Butterfly House of the Amsterdam Zoo, in the Netherlands.**

Although historic site records include Long Mountain (reported by Seavey in 1940, the Spanish River (Portland), and one record from Mount Diablo (St. Ann), current breeding populations are restricted to the Blue and John Crow Mountains and Cockpit Country. It is noted that the larval food plant, *Hernandia catalpifolia* is present in Spanish River, but no evidence of adults or larvae feeding has ever been detected. Similarly, *Hernandia jamaicensis* occurs in Dolphin Head, in western Jamaica, but *P. homerus* had never been reported for this region.

Although the Dolphin Head habitat appears suitable based on availability of larval food plant and high annual rainfall (2500 mm), the area has a distinct and prolonged dry season which may have prevented the establishment of this species historically. Moisture and relative humidity may be significant limiting factors for *P. homerus* as all stages of the life cycle require moisture: larvae drink water and dehydrated pupae yield adults with crinkled wings. In the Blue and John Crow Mountains, significantly higher levels of oviposition have been recorded on trees near to streams, again suggesting that reliably high humidity, and not necessarily total rainfall, is important for successful reproduction.

In both the Blue and John Crow Mountains and Cockpit Country, the larval *Hernandia* food plant is widely available and does not appear to be a limiting factor. As noted previously, *Hernandia* spp. regenerate quickly following localized disturbance. In the Rio Grande Valley, for example, *H. catalpifolia* occurs at higher densities in disturbed patches (e.g., 80 plants / km²) compared to undisturbed patches (55 plants / km²). Similarly, there is much higher usage of food plants, both egg deposition and larvae feeding, in disturbed sites (60% of plants) versus undisturbed sites (31%). But as these figures reveal, 40% of potential food resources are not utilized by *P. homerus*: food does not appear to be a limiting factor.

Although disturbed habitats support higher densities of reproductive effort (e.g. cumulative density of eggs in disturbed habitat = 8542 / km² vs. undisturbed = 3218 / km²), disturbed habitats also experience higher rates of mortality. For example, 75% of eggs failed to survive in disturbed habitats, compared to 47% mortality in undisturbed habitats. Parasitic wasps accounted for 66% of egg mortality, while the remaining 9% was ascribed to ants and fungal attacks. Causes of larvae mortality include bacteria and ants and 13% of pupae succumb to bacteria-related events. Predators of adults include birds and lizards. The consequence is that, although disturbed habitats have initially higher reproductive output (potential source habitat), the significantly higher rates of mortality may render them as potential sink habitats for the *Homerus* population in the Blue and John Crow Mountains.

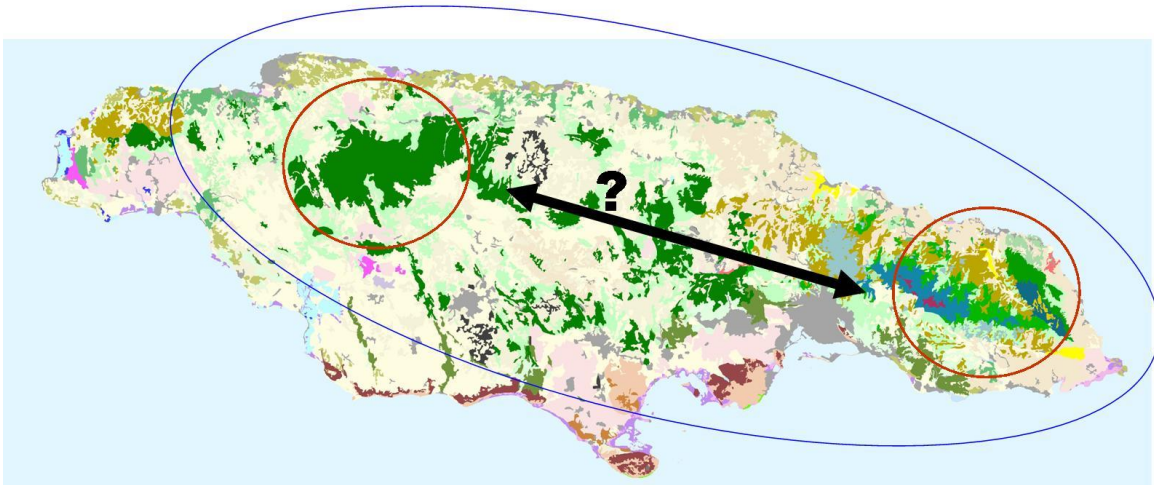


A schematic view of the problems affecting the Homerus Swallowtail when forest fragmentation occurs.

Key questions remain unanswered concerning the distribution and dispersal capabilities of *P. homerus* both within and between population centres. Populations sometimes disappear for months, even years, only to re-appear. What factors cause these shifts remain unknown. Turner speculated on seasonal (summer-winter / dry-wet) altitudinal migration in the John Crow Mountains but Garraway and Bailey recorded only daily, not seasonal, movements up and down the hillside. It is not known whether individuals remain within a single drainage channel while undertaking these daily movements or whether they cross-over, perhaps at the upper reaches along the ridge, to move to an adjacent drainage channel on the mountainside.

Historic and current movements across the landscape: Should *Papilio homerus* be managed as a single metapopulation? Or are there two genetically unique species of giant swallowtails?

Although *P. homerus* exists in systems of subpopulations, changing in time and space, it is not clear whether these subpopulations interact as a metapopulation. Although forest conversion over the past 5 centuries has dramatically fragmented the Jamaican landscape, it is not clear to what extent this fragmentation has prevented gene flow between the eastern and western subpopulations. It is possible that abiotic conditions in pre-Columbian Jamaica (e.g., patterns of seasonal drought observed in present-day Mount Diablo) had limited the persistence of a permanent population in central Jamaica, thus presenting a “moisture barrier” that restricted dispersal and gene flow, perhaps with the exception of occasional, but extremely wet, climatic cycles. Alternatively, the presence of the Mount Diablo forest may have represented a stepping-stone for



movement from east-to-west, serving as a “bridging corridor” that was critical for gene flow, but only during extreme events such as during tropical storms or excessive rains associated with El Niño Southern Oscillation cycles. Understanding the genetic patterns of historic and current *P. homerus* population is critically needed for species management: if humans have disrupted the Mt. Diablo corridor through forest conversion, then human intervention may be needed to restore gene flow; if Mt. Diablo served as a natural barrier and *Homerus* is, perhaps, two genetically unique subspecies or species, artificial movement of genes between the eastern and western populations would be an irreversible disaster for each population.

5.5. Cockpit Country survey results (Herlitz Davis)

Opportunistic observations of *P. homerus* in Cockpit Country were carried out during field work for The Jamaican Parrot Project from 1995 to 1998. Observations were continued during systematic efforts to census parrots in Cockpit Country from 1998 to 2000 and again during avian surveys for the Important Bird Areas programme in 2003.

These opportunistic records were supplemented by systematic surveys from October 2005 to December 2006 under the Cockpit Country Parks-in-Peril Project (funded by USAID and administered by The Nature Conservancy-Jamaica). Nine individuals observed during these months displayed the complete range of wing condition, from new and fresh to extensive damage. Similar to reports of the Blue and John Crow Mountain population, adult *P. homerus* in Cockpit Country were more frequently associated in areas of slight disturbance – regenerating cockpit bottomlands surrounded by forested hillsides.

A report of survey results was prepared for The Nature Conservancy-Jamaica. Survey transects and *P. homerus* sightings were geo-referenced but remain unpublished to protect the population from poaching.

5.6. Ecology and population biology of the Cockpit Country population (Mathew Lehnert)

Fieldwork was conducted from 11 July – 14 August 2004 and 19 December 2004 – 8 January 2005 to study the behavioural ecology of *Papilio homerus* in the south-western portion of the species' Cockpit Country range. Eighteen adults (13 males and 5 females) were captured and uniquely marked with a Sharpie® permanent ink marker on the discal cell on the ventral side of the hindwing. Morphometric data on wing length were collected (males average 73mm; females average 77mm), and degree-of-wing-damage qualitatively described on a scale of 1-5, ranging from heavily battered to perfect. Photographs also were taken of wings to quantitatively assess %-change in wing damage of recaptured individuals. Butterflies were released within three minutes of capture, to minimize stress, and subsequently monitored in the wild to collect new data on activity budgets, site fidelity, territorial behaviour, and survival rates in the Cockpit Country population. No adults were encountered during the December-January session, which corresponds to the winter dry season.

Typical adult daily activity corresponded to patterns of sunlight:

- 08hr00: still inactive; butterflies tended not to move when ambient temperature was below 26°C.
- 09hr00: as the sun crested the hilltops, butterfly activity increased.
- 11hr00: activity levels peaked, most territorial battles occurred during these late morning hours.
- 12hr00: activity levels decreased, individuals appeared to leave the study area, possibly to mate or to find cooler ambient conditions for resting.
- 12hr00-15hr00: adults remained scarce, particularly when afternoon thunderstorms occurred.

Males were highly territorial and spent their morning hours patrolling defined areas, flying circles around a perimeter and displaying curiosity towards almost every flying object (e.g., one male chased after a hummingbird). They displayed all three territorial behavioural patterns described by Wickman and Wicklund (1983): (1) horizontal flight pursuit; (2) spinning wheel pursuit; and (3) horizontal-spiralling flight pursuit. During territorial defence encounters, males smacked hard against each other, with a consequence that they sustained heavy wing damage. For example, by the end of a two-week monitoring period of one male, recaptured 12 times, 40% of his total wing area was missing, including the entire rear wing on one side. During the morning hours, males were rarely observed to feed on nectar.

Females, in marked contrast to males, were nomadic: of the five females monitored, only one was recaptured and her recapture event was on the morning (08hr15) following her initial capture event (13hr37).

During the intensive mid-July to mid-August monitoring effort, no courtship was observed nor were any eggs or larvae found.

Potential conservation activities for the Cockpit Country population might include:

- Rearing of disease-free individuals to supplement existing population;
- Mating between the two existing population areas of Cockpit Country and the Blue and John Crow Mountains;
- Determine which plants are capable of serving as a host plant for F1 hybrids;
- Determine if F1 hybrids are fertile and viable;
- Possibly transport healthy pupae from the eastern population
- Develop a comprehensive recovery plan.

See, however, *7. Round-Table Discussion and Recommendations*: before any interbreeding is contemplated, the molecular genetics and historic and current levels of diversity must be evaluated for of the eastern and western populations. This will determine whether they must be managed as one species, two distinct subspecies, or two distinct species.

5.7. Conservation status of Cockpit Country (Michael Schwartz)

Cockpit Country is the western part of an uplifted white limestone plateau where the mechanical and chemical action of rain has sculpted the topography of rounded peaks, steep-sided hills and star-shaped, closed depressions which form a unique type of polygonal karst known as “cockpit karst.” Although rainfall in Cockpit Country is high (1500-3125 mm per annum), the closed karst valleys drain surface water rapidly because of the fissured limestone substrate. However, the hills and their accompanying vegetation protect the valleys from drying winds; consequently, there exists the paradoxical situation of a high rainfall, very humid tropical forest which has no surface water. This has important consequences for the biota, which had to adapt to this landscape.

The rainfall and associated relative humidity regimes are critical for the survival of *Papilio homerus*, which requires 100% relative humidity for all stages of the life cycle. Even during the months of lowest rainfall (both in terms of total precipitation and number of continuous days without precipitation: December – March), the air is saturated for all but the middle hours of the day. A “dry” day in Windsor, in northern Cockpit Country, is when relative humidity drops to 75% !



An aerial view of Cockpit Country, showing the numerous karstic pits at the source of its name (IKONOS Satellite image courtesy of GEOEYE and Forestry Department)

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The major threat to Cockpit Country and its *P. homerus* population is bauxite mining. Bauxite (consisting mostly of aluminium and ferrous oxides) in Jamaica accumulated in valleys after soluble components leached out. To extract these deposits, networks of roads are carved through the “saddle corridors” of the limestone hills and the bauxite deposits, which are up to 30 metres deep, are removed by “open-pit mining”. To reclaim the landscape, “fill” is obtained from the periphery of the pit and is covered with compacted marl and a thin (15-20cm) layer of soil. Mining irreversibly alters geo-morphology and hydrology. Moisture and relative humidity also are altered: with the re-shaping and widening of corridors between hills, valleys may experience more-direct, drying winds; with the loss of forest-cover and no natural regeneration of forest after post-mining rehabilitation efforts, exposed soils desiccate in direct sunlight and there is no

source material to re-build the thick layer of organic material (e.g., leaves and decaying wood, which can absorb up to seven times their weight in water) which existed prior to mining. Were bauxite mining to occur in Cockpit Country, it is very likely that a drier landscape would be left behind and *P. homerus* would go locally extinct.

In 2004, Government of Jamaica issued to Alcoa Minerals of Jamaica LLC and Clarendon Alumina Producers two licenses to prospect for bauxite in Cockpit Country. The licenses were renewed in 2005 and 2006. Following intense public outcry, the Government suspended one license and one was surrendered back to Government by the licensees. A third prospecting license, which includes the western side of Cockpit Country has also been “left to expire”. If mining were to proceed in these three license areas, more than 80% of Cockpit Country would be irreversibly damaged. In a “Jamaica Magazine” radio interview on 22 November 2006, the managing director of the Jamaica Bauxite Institute, Mr. Parris Lyew-Ayee, Sr., assured the public that there are no plans for “mining the Cockpit Country *per se*, the critical core of Cockpit Country will not be touched.” Shortly after assuming office in August 2007, the current Prime Minister, Bruce Golding, issued a letter stating:

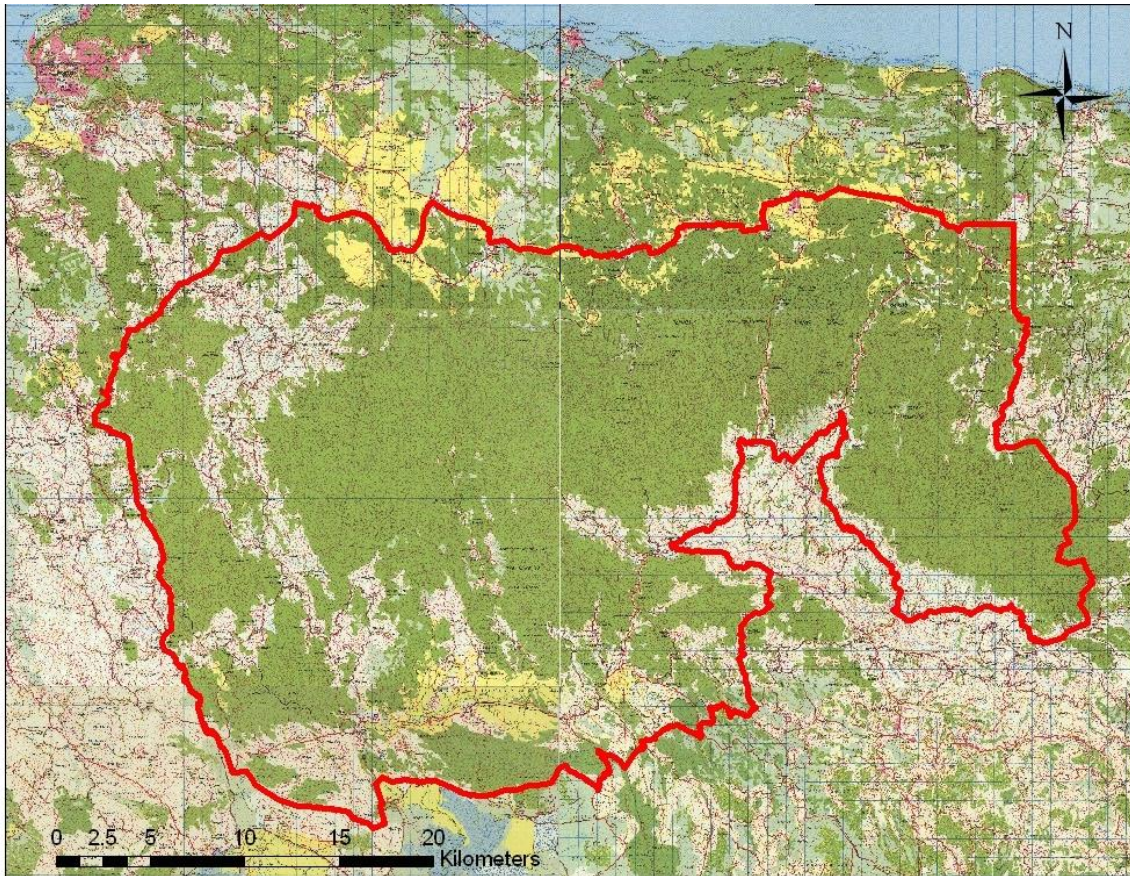
“...that the government will not allow any mining activity in what has generally become known as the Cockpit Country. I am anxious for us to establish geographically “what has generally become known as the Cockpit Country”.

The question remains: where is Cockpit Country?

In 2007, the former Government commissioned a survey to determine the boundary of Cockpit Country; as of June 2010, the current Government has yet to release the results of this survey for public discussion.

If one defines Cockpit Country with all relevant layers – geology, morphology, hydrology and the landscape where the British soldiers and Leeward Maroons engaged in warfare, the population of *P. homerus* will be protected. If one uses a restrictive definition which excludes any of these critical layers, such as the Western forested areas, the robust *P. homerus* population in western Cockpit Country will very probably not survive.

To protect *P. homerus*, all of Cockpit Country must be declared “closed to bauxite mining.”



Holistic definition of Cockpit Country's boundaries, including many critical *Homerus* habitats

5.8. Potential role of ecotourism for *Homerus* conservation (Court Whelan)

Ecotourism is grounded in responsible, educational-based activities directed towards conservation of the environment and the promotion of local community welfare. Large and predictable aggregations of animals, such as the overwintering roosts of millions of Monarch butterflies (*Danaus plexippus*) in Mexico, can serve to attract visitors, who, by their presence and willingness to pay to witness this natural spectacle, bring value of the existing forest to members of the community. Problems can arise, however, when natural phenomena are highly seasonal and community members feel a need to unsustainably exploit the forest resources outside of the “tourist season” or when external markets continue to place a higher extractive value on the ecosystem.

The success of an ecotourism endeavour depends on identifying the types of visitors who will be interested in that which the focal ecosystem or species have to offer: visitor expectation must be matched to reality, which can be a challenge when wildlife is involved. Potential visitors who would be interested in nature, in general, and *P. homerus*, specifically, include:

1. Bird-watchers;
2. Volunteer tourists (e.g., EarthWatch);
3. Museum members, who are interested in natural history and love to travel;
4. Family tourism (but this typically requires a high level of infrastructure)

Examples of successful ecotourism activities often highlight the multiple functions of a centre. For example, the Asa Wright Nature Center (AWNC) in Trinidad evolved out of the adjacent Simla Field Station (owned and operated by William Beebe of the New York Zoological Society) and the associated well-known "Oilbird Cave". As infrastructure improved and local assistants became highly-knowledgeable about the flora and fauna of the site, bird-watchers and nature-lovers experienced increasingly greater value-for-money. In targeting multiple users (e.g. researchers who tend to stay for longer periods of time, particularly during the summer months of bird breeding seasons; bird-watchers from North America and northern Europe / UK, who tend to travel to the Caribbean during the winter months; an increasing number of resident Trinidadians with an interest in their natural heritage), AWNC has developed a viable business model which depends on an intact forest ecosystem.

5.9. Contributed Notes: Photographing *Papilio homerus* (Vaughan Turland)

My pursuit of *P. homerus* is confined to the southern Cockpit Country. Since March 2007, I have spent around 60 man-days at *P. homerus* habitats in the southern Cockpit Country. I have visited in all months, though mostly in late spring and mid-summer. I have had more than 80 sightings of *P. homerus*. Most of these were in 2008 and 2009.

In the 41 visits when I observed *P. homerus*, I have only seen it nectaring on *Bauhinia divaricata* (Caesalpiniaceae), *Psychotria pedunculata* (Rubiaceae) and on just one occasion, on *Ocotea leucoxydon* (Lauraceae). *Bauhinia divaricata* is definitely a preferred nectar source and I have seen four *P. homerus* foraging at one time on a single tree when it was in full flower. Concurrently, there was only

one individual nectaring on an adjacent *Psychotria pedunculata*. It may of course be that the nectar flow on these flowers is at a slightly different hour of the day.

October sightings were especially interesting, as all specimens were immaculate – no obvious wing wear. This is usually a rainy month. Most specimens with substantial wing wear were observed in June and July. This may be just an artefact. For me, the earliest sighting date in any single year was 8 March and latest was 18 November. They seem to fly between around 9.30 a.m. to perhaps 4 p.m. In the drier months, December to February, I have yet to observe *Homerus* in the Southern Cockpit Country. Humidity levels are much lower in this period, the ground can be very dry underfoot and there are even less nectar sources available than at other times of the year.

6. Round-Table Discussion and Recommendations

The conservation of *Papilio homerus* requires actions to eliminate the major threats to the populations in the Blue and John Crow Mountains and Cockpit Country, including reducing or eliminating:

- Habitat loss (reduced range of occupancy and, consequently maximum population size)
- Habitat fragmentation (and associated isolation of small, potentially non-viable subpopulations)
- Illegal collection

In the Blue and John Crow Mountains, habitat loss is primarily associated with conversion of forest for agriculture and the expansion in range of non-native plant species following disturbances, such as tropical storms and hurricanes. In Cockpit Country, the threat of bauxite mining overrides the current rates of conversion of forest to agriculture. Because the sources of habitat loss and fragmentation are different for the two populations, actions must be developed that are region-specific. However, all actions must be grounded in good science to ensure that new management interventions cause no harm, and communities that co-exist with *P. homerus* must be fully engaged, as they will be the frontline stewards for protecting the species.

6.1. Science-based Conservation

Several key questions must be answered to ensure proper management of populations and their habitats:

- What is the genetic relationship between the eastern Blue and John Crow Mountain population and the western Cockpit Country population: Are they a single species which has had gene flow interrupted because of habitat conversion over the past five centuries? Are they two distinct subspecies? Are they two distinct species?
- Within populations, what are barriers to dispersal? This will include natural (e.g. possibly ridge-tops, which isolate stream channels) as well as anthropogenic barriers.
- What is occurring within the populations during the driest months of December-February, when no stages in the life cycle are detected? Do they undergo diapause? Is there migration to as-yet-identified areas? (This question is important, as a survey which fails to detect the presence of *Homerus*, will reach the conclusion that the area is unimportant and can be destroyed for e.g., bauxite mining or limestone quarrying.)
- What is the demography of the Cockpit Country population and what factors limit reproductive success and survival in each stage in the life cycle? Are there potential source:sink dynamics in degraded edge habitat, as reported for the Blue and John Crow Mountain population?

Recommendation 1

DNA sampling (molecular genetics) is a critical first step to determine the current level of diversity between the two populations, to determine whether they should be managed as a single species, two distinct subspecies, or two distinct species. In addition to non-destructive sampling (e.g., a 1 x 1 mm wing clip is sufficient for analyses, an amount which will have no effect on flight efficiency, particularly when compared to the total natural damage adults experience during the lifespan), museum specimens should be analyzed for historic reference.

Molecular attention also should be given in the Cockpit Country population to assess whether road and associated rural development presents a major barrier to movement between core and peripheral forest blocks.

The MacGuire Center has the capacity to conduct the DNA analyses but because *P. homerus* is CITES I, exportation of biological samples from Jamaica will be heavily controlled by permit requirements. Capacity of the BioChemistry Department at UWI to conduct the molecular analyses needs to be explored, with the possibility that collaboration with the MacGuire Center will help to build local capacity.

Recommendation 2

Establish a scientifically led “Captive Life-Cycle Research Project” to fill knowledge gaps in ecology and demography, including ovipositing rates, duration of egg-lying cycles, total egg production, and patterns (if any) of diapause. A complete set of life history questions should be generated to guide the development of this project and it is strongly recommended that animals be released into the wild to demonstrate clearly to local communities the direct relationship between science and species and habitat conservation. As a pre-requisite, rigorous protocols must be developed to prevent introduction of pathogens and parasites from captivity into wild populations.

Recommendation 3

In relation to Recommendation 2 and if releasing captive-reared animals is determined to be safe for wild populations, controlled releases under variable conditions should be conducted to identify the factors that limit dispersal, with a goal of understanding corridor requirements in order to maintain gene flow among subpopulations.

Recommendation 4

Continue field surveys to improve distribution maps, particularly to document seasonal and annual variation, which may be correlated to rainfall patterns. Survey results, including climate parameters, should be integrated into a model to predict the potential effects of climate change on *P. homerus* populations, with particular attention to the configuration of habitat reserves within the landscape (e.g., single large to minimize edge effects, including drier microclimate at the edge, vs. several small, connected by corridors).

Recommendation 5

Protocols should be developed to enable standardized surveying of all *P. homerus* life-history stages within permanent monitoring plots already established by Forestry Department's BioPhysical Inventory Programme. Results of new *P. homerus* field surveys may help guide the placement of additional permanent monitoring plots.

6.2. Stakeholder and Community-based Support

Dr. Eric Garraway's anecdote that two children in his Rio Grande Valley study area asked their parents to telephone the police when they saw Dr. Garraway and his students arrive with collecting nets, several years after he concluded his intensive field research, highlights the critical role that communities will play in *P. homerus* conservation: the children were not protecting the butterflies because of any financial interest, they were protecting the globally unique natural heritage of their community from intruders whom they believed to be illegal poachers.

In the national arena, decision-makers who have land-use desires which conflict with the protection and conservation of Jamaica's natural heritage and the associated life-sustaining ecosystem services might benefit from spending a day with the children of the Rio Grande Valley, looking at the butterflies they hopefully can remember from their youth.

To facilitate positive and informative encounters with butterflies in their natural, wild habitats, community-based eco-tourism opportunities exist for the Blue and John Crow Mountain National Park and around Cockpit Country. With the recently-established Cockpit Country Local Forest Management Committees (CC-LFMCs), mechanisms are in-place to connect Jamaican and overseas visitors who are interested in natural and cultural heritage to communities that are interested in hosting low-intensity tourism activities. This might include volunteer research tourism and focused efforts to promote Cockpit Country to members of international natural history museums.

Recommendation 6

To confirm *P. homerus*' unique and beloved status in Jamaica, workshop participants endorse its formal nomination as the "National Butterfly". Education and outreach would accompany official recognition. Mechanisms for dissemination include NEPA's Education Branch, the CC-LFMCs, and "SmartPhone" technology offered by mobile telephone service providers. Dr. Garraway's 1984 video of *P. homerus* life history and more-

recent video by Court Whelan could offer glimpses of this unique butterfly to the majority of Jamaicans who have never seen this species. All material used should be endorsed by NEPA to make sure no sensitive materials potentially endangering P. homerus enters the public domain.

Recommendation 7

To facilitate development of educational materials, along with pursuing conservation recommendations, a “Homerus Working Group” was established during the workshop and a ListServe will be created for maintaining communication.

Recommendation 8

With any increased attention given to P. homerus, either locally or nationally, there will be an increased risk of poaching and smuggling to supply an illicit international market. National enforcement agencies, including NEPA and the Island Special Constabulary Force must be networked effectively with CITES, to ensure adequate vigilance to increased smuggling, particularly of pupae. Although “flooding the market” with legal animals, licensed out of Jamaica, may be one option to defeat demand, the “joy of circumventing government control” by some members of the Jamaican public will make legal control of a market extremely difficult. Until adequate safeguards are in place, the CITES ban on trade must be enforced.

Recommendation 9

The feasibility of eco-tourism must be assessed for the “High Priority” western region of Cockpit Country, which is a recognized hotspot for P. homerus and is under major threat from bauxite mining as some agencies do not acknowledge that the area is part of “Cockpit Country.” The natural and cultural assets need to be identified and mapped, to enable proper spatial planning. From this, a proposal can be developed to support alternative income strategies, such as an “Cockpit Country Heritage Centre,” which should not have an exclusive focus on P. homerus but, rather, should focus visitor attention to a healthy, integrated ecosystem.

6.3. Habitat Conservation

The protection of the western population of *P. homerus* demands that Cockpit Country be declared “Closed to Mining”. The Forest Reserves within the Cockpit Country landscape offer primary protection under Forestry Department’s policy of “no net forest loss”; however, it must be recognized that, because the Mining Act (1947) has precedence over all other environmental protection acts, including the Natural Resources Conservation Authority (NRCA) Act (1991) and the Forest Act (1996), a ministerial decree affords the only legal protection against the irreversible destruction of bauxite mining and limestone quarrying. The Homerus Working Group endorses efforts to have Cockpit Country declared “Closed to Mining.”

The NRCA Act incorporates regulations for the establishment of National Parks. While it is acknowledged that a re-designation of the landscape’s Forest Reserves to “National Park” status may be perceived by the international community as an improvement in conservation status, as noted above, because the Mining Act has precedence over the NRCA Act, a change in designation affords no greater legal protection. Further, re-designation to National Park would result in parallel management responsibilities as Government of Jamaica might delegate management of the park to a Non-Governmental Organization (NGO), but Forestry Department would retain its responsibilities for the Forest Reserves (which include IUCN Management Categories I-Strict Nature Reserve/Wilderness Area, II-National Park; and IV-Habitat/Species Management Area). Finally, social surveys of the communities around Cockpit Country reveal little support for a single NGO managing Cockpit Country; instead, they support a paradigm of Local Forest Management Committees, where Forestry Department collaborates with organized communities. It is important to understand the differences between Jamaican perceptions of what constitutes a “National Park” (and what activities are allowed within park zones) and international understandings: in Jamaica, the designation of “Forest Reserve” is generally perceived to place greater emphasis on forest-cover and watershed protection than “National Park”.

Recommendation 10

With the recognition that the western region of Cockpit Country is a “hotspot” for *P. homerus* and that the region remains vulnerable to bauxite mining, continuing efforts should be directed towards expanding community support for maintaining buffer zones around existing Forest Reserves. One leverage point for conservation is the potential availability of a 38-hectare privately owned forested block, which is adjacent to the Fyffe and Rankin Forest Reserves and which could be purchased or leased in order to develop an “Cockpit Country Heritage Centre”.

As scientific research improves our understanding of the factors that limit *P. homerus* populations in Cockpit Country, it will be possible to spatially identify and prioritize additional conservation corridors in western Cockpit Country.

It should also be noted that during initial efforts to identify private landholdings that could be purchased to protect the buffer zone around the Fyffe and Ranking Forest Reserves, Forestry Department discovered that the two large parcels of most interest were already owned by Government of Jamaica, including one which had been declared a Forest Reserve but had not been gazetted. Forestry Department is working to have both parcels gazetted as soon as possible. This can by all means be described as an initial conservation success.

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