PETITION TO LIST
15 BAT SPECIES
UNDER THE ENDANGERED SPECIES ACT
(16 U.S.C. §§ 1531 *et seq*.)

Bonin Flying Fox Eating Pandanus Fruit
Photograph by Masafumi Yanase
Available from http://www.metro.tokyo.jp/ENGLISH/TOPICS/2007/IMG/fth8h100_06.jpg

Petition Submitted to the U.S. Secretary of Interior
Acting through the U.S. Fish and Wildlife Service

Petitioner:
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WILDEARTH GUARDIANS
A FORCE FOR NATURE

I. INTRODUCTION

WildEarth Guardians hereby petitions the Secretary of the Interior (Secretary), acting through the U.S. Fish and Wildlife Service (FWS), to list the following species as Threatened or Endangered under the Endangered Species Act (ESA):

Armenian Myotis (*Myotis hajastanicus*)
Aru Flying Fox (*Pteropus aruensis*)
Bonin Flying Fox (*Pteropus pselaphon*)
Christmas Island Pipistrelle (*Pipistrellus murrayi*)
Cuban Greater Funnel-Eared Bat (*Natalus primus*)
Greater Monkey-Faced Bat (*Pteralopex flanneryi*)
Hill's Horseshoe Bat (*Rhinoiophus hilli*)
Jamaican Greater Funnel-Eared Bat (*Natalus jamaicensis*)
Montane Monkey-Faced Bat (*Pteralopex pulchra*)
Lamotte's Roundleaf Bat (*Hipposideros lamottei*)
Lord Howe Long-Eared Bat (*Nyctophilus howensis*)
Negros Naked-Backed Fruit Bat (*Dobsonia chapmani*)
New Caledonia Long-Eared Bat (*Nyctophilus nebulosus*)
New Zealand Greater Short-Tailed Bat (*Mystacina robusta*)
Paraguana Mustached Bat (*Pteronotus paraguanensis)*

The IUCN classifies each of these bat species as Critically Endangered. Bats, order Chiroptera, are among the "most diverse and geographically dispersed" of any living mammal.[1] As of 2002, 1,001 species of bats are known to exist[2] and they inhabit all continents expect Antarctica.[3] The diversity of bats' diets is "unparalleled among living mammals," and their roosting habitats are also highly varied, as are their reproductive and behavioral characteristics.[4] Bats also play beneficial roles in ecosystems around the world,[5] including pollination, seed dispersal, and insect reduction[6] and are often keystone species in their habitats.[7,8]

Yet despite their adaptiveness, broad range, and great ecological importance, bats are "highly susceptible to environmental disruption, and many species have declined

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[1] Nowak, Ronald and Ernest Walker. 1994. *Walker's Bats of the World*. John Hopkins University Press. 6th ed. page 1.
[2] Mickleburgh, Simon, Anthony Hutson, and Paul Racey. 2002. "A Review of the Global Conservation Status of Bats." *Oryx*. 36(1): 18-34, 18.
[3] Nowak, Ronald and Ernest Walker. 1994. *Walker's Bats of the World*. John Hopkins University Press. 6th ed. page 1.
[4] *Id.*
[5] Pennisi, Lisa, Stephen Holland, and Taylor Stein. 2004. "Achieving Bat Conservation Through Tourism." *Journal of Ecotourism*. 3(3): 195-207, 195.
[6] *Id.* at 25.
[7] Nowak, Ronald and Ernest Walker. 1994. *Walker's Bats of the World*. John Hopkins University Press. 6th ed. page 25.
[8] Pennisi, Lisa, Stephen Holland, and Taylor Stein. 2004. "Achieving Bat Conservation Through Tourism." *Journal of Ecotourism*. 3(3): 195-207, 195.

drastically due to human activity."[9] As a result, nearly a quarter of all bats species are globally threatened.[10] The bats discussed in this Petition have had their populations decimated and their ranges greatly circumscribed. Numerous ongoing threats place the continued survival of these 15 species at risk. These threats include habitat degradation and destruction that impact roosting and foraging, invasive species that predate upon the bats and alter their habitat, hunting, and a lack of adequate protective regulatory mechanisms. Therefore, multifaceted conservation efforts are needed to save these species from extinction. Listing these bats as either Endangered or Threatened will provide a critical step in such conservation efforts.

This Petition will explain the ESA listing process, provide relevant information about each of the petitioned species, and explain, based on the five listing factors, why each species should be listed as endangered or threatened under the ESA. Due to the variety of threats that each species in this petition faces, each bat, including full species information and the relevant listing factor(s) will be discussed individually.

II. THE ESA LISTING PROCESS

The ESA is the "most comprehensive legislation for the preservation of endangered species ever enacted by any nation."[11] In passing this landmark legislation, Congress intended to halt and reverse the trend of species extinction, no matter what the cost.[12] The Supreme Court has confirmed this intention by stating that the ESA's structure indicates "beyond doubt" that Congress intended to place the highest priority on protecting endangered species.[13] However, before a species can receive protection under the ESA, that species must first be "listed," or placed on the ESA's official list of threatened and endangered species.[14] Section 4 of the ESA[15] provides for this listing process,[16] which is the critical first step in the ESA's system for protecting species from extinction.[17]

A. ESA's Listing Requirements

According to Section 4 of the ESA, the Secretary must determine whether a species is threatened or endangered based on *any* of the following five factors:

(A) The present or threatened destruction, modification, or curtailment of its habitat or range;

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[9] Nowak, Ronald and Ernest Walker. 1994. *Walker's Bats of the World*. John Hopkins University Press. 6th ed. page 1.
[10] Mickleburgh, Simon, Anthony Hutson, and Paul Racey. 2002. "A Review of the Global Conservation Status of Bats." *Oryx*. 36(1): 18-34, 18.
[11] *Tennessee Valley Authority v. Hill*, 437 U.S. 153, 180 (1978).
[12] *Id.*
[13] *Id.* at 174.
[14] 16 U.S.C. §1531(a) (2003).
[15] 16 U.S.C. § 1533.
[16] *Tennessee Valley Authority* at 180.
[17] 16 U.S.C. §1531(a) (2003).

(B) Over-utilization for commercial, recreational, scientific, or educational purposes;
(C) Disease or predation;
(D) The inadequacy of existing regulatory mechanisms; or
(E) Other natural or manmade factors affecting its continued existence[18]

If any of these factors are present, the Secretary must list a species as "endangered" or "threatened." The ESA defines an endangered species as a species that "is in danger of extinction throughout all or a significant portion of its range."[19] A threatened species is a species that is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range."[20]

In making listing decisions, the Secretary shall also give consideration to species that are (1) "designated as requiring protection from unrestricted commerce by any foreign nation, or pursuant to any international agreement"[21] or (2) "identified as in danger of extinction, or likely to become so within the foreseeable future, by any State agency or by any agency of a foreign nation that is responsible for the conservation of fish or wildlife or plants."[22]

B. Standards that Guide Listing Decisions

In evaluating the listing factors, the Secretary must reach his or her decision "solely on the basis of the best scientific and commercial data available."[23] The ESA does not state that any specific amount of data is required to list a species. Therefore, incomplete scientific evidence is not a bar to listing under the ESA, and it is not an excuse for a lack of action. In cases of incomplete data, such as for some of the species in this petition, the Secretary must still rely on the best data available to make listing decisions. This petition provides that data.

[18] 16 U.S.C. §1533(a)(1)(A-E) (2003).
[19] 16 U.S.C. §1532(6) (2003).
[20] 16 U.S.C. §1532 (20) (2003).
[21] 16 U.S.C. § 1533(b)(1)(B)(i) (2003).
[22] 16 U.S.C. § 1533(b)(1)(B)(ii) (2003).
[23] 16 U.S.C. §1533(b)(1)(A) (2003).

III. SPECIES DISCUSSIONS

A. Armenian Myotis/Armenian Whiskered Bat (*Myotis hajastanicus*)

1. Taxonomy

Although this species was originally included in *Myotis mystacinus*, two studies[24,25] have differentiated this bat on the basis of morphologic comparison.[26]

2. Physical Description

Myotis hajastanicus has a brown hair base, a yellowish-brown back, light yellow to white abdominal coloring, and light brown wing membranes.[27] Its combined head and body measures 45 mm, its forearm measures 34.5 to 37.3 mm, and its wingspan measures 200 mm. It weighs between 4.5 and 9 g.[28]

3. Distribution and Range

This bat is native to Armenia.[29] It is endemic[30] to the eastern bank of Sevan Lake, Sordza (Nadezdino)[31] and is known only from five sites.[32] Lake Sevan is located to the northeast of Armenia's capital city of Yerevan, and is one of the largest alpine lakes in the world.[33]

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[24] Benda, P. and Tsytsulina K. A. 2000. Taxonomic revision of *Myotis mystacinus* group (Mammalia: Chiroptera) in the western Palearctic. *Acta Societatis Zoologicae Bohemicae* 64: 331-398.
[25] Tsytsulina, E. A. 2000. Geographic variation of the whiskered bat *Myotis mystacinus* (Kuhl, 1817) in the Caucasus. 3: 35-42.
[26] Tsytsulina, K., Benda, P., Aulagnier, S. & Hutson, A.M. 2008. Myotis hajastanicus. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[27] Argyropulo 1939. Zool. Sbornick, 1 (Trudy Biol. Inst. 3): 27.
[28] *Id.*
[29] Tsytsulina, K., Benda, P., Aulagnier, S. & Hutson, A.M. 2008. Myotis hajastanicus. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[30] *Id.*
[31] Wilson, Don E. & DeeAnn M. Reeder (editors). 2005. "Myotis hajastanicus." *Mammal Species of the World. A Taxonomic and Geographic Reference*. (3rd ed). online, page 508.
[32] Tsytsulina, K., Benda, P., Aulagnier, S. & Hutson, A.M. 2008. Myotis hajastanicus. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[33] Wang, Hua, Benoit Laplante, Xun Wu, and Craig Meisner. 2004. "Estimating Willingness-to-Pay with Random Valuation Models: an application to Lake Sevan, Armenia. World Bank Policy Research Working Paper 3367. August. Page 1-41, 11.

Figure A.1 *M. hajastanicus* is endemic to Armenia (in red).

Source: http://www.eurogeographics.org/country/armenia

Figure A.2 Location of Lake Sevan, the only known location of *M. hajastanicus,* in Armenia (Lake Sevan is the blue water body depicted in the map)

Source: http://www.nature-ic.am/biodiv/eng/maps/index-6.html

4. Habitat and Ecology

The exact habitat of this species is unknown.[34] However, it may be similar to the habitat of *Myotis aurascens*, which includes forest and scrub vegetation. *M. aurascens* roosts in underground sites, and it is believed that *M. hajastanicus* may as well.[35]

5. Population and Trend

The population size of this species, as well as the population trend, is not known, and based on recent surveys conducted in 2003 this species may be extinct.[36] Although the survey targeted this bat specifically, no evidence of the species was found. There have been no proven accounts of this species since the 1980s.[37]

6. Major Threats

The destruction of habitat and roost sites may be a threat to this species.[38]

7. Conservation Actions

This bat is one of 45 bat species listed as protected in Europe under the Agreement on the Conservation of Populations of European Bats, more commonly known as EUROBATS.[39] The goals of EUROBATS are the "identification of important sites for bat conservation, surveys of bat population status and trends and studies of their migratory patterns."[40] Based on the information gathered by these activities, the Agreement aims to develop guidelines that the parties then implement on national levels.[41] These guidelines involve topics that include (1) important underground and overground sites and foraging habitats, (2) sustainable forest management for bats, (3) remedial timber treatment and anti-parasitic drugs for livestock, (4) capture and study of captured wild bats, (5) the impact of wind turbines on bat populations, and (6) international co-operation between governments and non-governmental organizations. In addition to developing these guidelines, the member states to this agreement prohibit "the deliberate capture, keeping or killing of bats except for research purposes, for which a special permit is required."[42]

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[34] Tsytsulina, K., Benda, P., Aulagnier, S. & Hutson, A.M. 2008. Myotis hajastanicus. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[35] *Id.*
[36] *Id.*
[37] *Id.*
[38] *Id.*
[39] UNEP/EUROBATS. "Protected Species." Available at: http://www.eurobats.org/about/protected_species.htm. Accessed on 6/24/2010.
[40] UNEP/EUROBATS. "The Agreement of the Conservation of Populations of European Bats." Available from: http://www.eurobats.org/publications/leaflet/EUROBATS_leaflet_English.pdf. Accessed on 6/20/2010.
[41] *Id.*
[42] *Id.*

8. ESA Listing Factors

A. The present or threatened destruction, modification, or curtailment of its habitat or range

Since the 1920s, Armenia has undergone drastic human population growth and growth of urban centers.[43] This change, and the resulting pressures on the region's ecosystems, have greatly degraded and destroyed these ecosystems.[44] During the 70-year period between 1920 and 1990, Armenia's population increased 5-fold, and the urban population expanded 26-fold.[45] As a result of this urban population explosion, urban areas have spread 14-fold during this 70-year period.[46] Associated industrial centers have grown 30-fold, and constructed areas, such as buildings, roads, etc., have grown 20-fold.[47] These serious ecological impacts are due in part to the very small size of Armenia, which has a total land area of only 29,740 km^2.[48] Across this area there are approximately 980 settlements that are connected by road networks spanning 14,000 km.[49] This increase in human population and urban areas is one of the most important threats to biodiversity in Armenia.[50]

Human population and infrastructure pressure have resulted in marked changes in Armenian ecosystems.[51] Human activities have had an especially heavy impact on forest habitat, which *M. hajastanicus* is believed to rely on. Today, forests cover only 10% of the land in Armenia, which represents a 75% decrease over the past 70 years. Several regions have been entirely deforested, and others have only very restricted forest cover remaining.[52]

Several factors have contributed to deforestation in the country. First, mass migrations of rural populations into city centers spurred the growth of industry in Armenia, and demand for wood greatly increased in order to fuel this increased industrial activity.[53] There were two major periods of timber extraction in the country's history.

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[43] Biodiversity Strategy for the Republic of Armenia. 1999. "Threats to, and Impacts on, Biodiversity in Armenia." Armenia National Report, Biodiversity Strategy and Action Plan to CBD Project. Available from http://www.nature-ic.am/biodiv/eng/national_report/first/6/index-1.html. Accessed on 7/27/2010.
[44] *Id.*
[45] *Id.*
[46] *Id.*
[47] *Id.* at Table 6.1.
[48] Wang, Hua, Benoit Laplante, Xun Wu, and Craig Meisner. 2004. "Estimating Willingness-to-Pay with Random Valuation Models: an application to Lake Sevan, Armenia. World Bank Policy Research Working Paper 3367. August. Page 1-41, 11.
[49] Biodiversity Strategy for the Republic of Armenia. 1999. "Threats to, and Impacts on, Biodiversity in Armenia." Armenia National Report, Biodiversity Strategy and Action Plan to CBD Project. Available from http://www.nature-ic.am/biodiv/eng/national_report/first/6/index-1.html. Accessed on 7/27/2010.
[50] *Id.*
[51] *Id.*
[52] *Id.*
[53] *Id.*

The first occurred between the 1930s and 1950s. During this period, 450,000 m^3 of wood was removed every year from Armenia's forests. While this extraction was supposed to be based on selective logging, it was not, and most of the mature trees in the country were destroyed. As a result, there is a current lack of mature and post-mature forest stands in Armenia. The second period of extensive deforestation occurred between 1992 and 1995, which was a period of economic blockade and energy crisis in the country. During this time, more than 8% of the total forest area, representing approximately 27,000 ha, was damaged and around 7,000 ha were totally denuded. This resulted from a combination of poor forest management and illegal timber cutting. The effects of the energy crisis were particularly severe around urban areas, where extensive deforestation in surrounding areas resulted from the need to supply fuelwood.[54]

In addition to logging, a second source of deforestation in Armenia is grazing and agriculture.[55] As of 2005, approximately 47% of Armenia's total land area was used for agriculture or grazing.[56] The majority of agricultural development is occurring in the Ararat Valley, where the capital city, Yerevan, is located.[57] Extensive grazing by cattle and pigs in forest habitats has also contributed to the degradation of forests and has also had a strong negative influence on forest regeneration.[58]

C. Disease or predation

Bat species worldwide may be at risk from white-nose syndrome, caused by a cold-loving fungus of the Geomyces genus.[59] The syndrome has been known to cause 80-97% mortality rates in some large hibernation colonies.[60] Until recently, the disease was restricted to the northeastern United States. However, in 2009 it was detected in France.[61] It is not known how quickly this disease may spread to other areas of the world, but it poses a severe threat to all bat species, especially those with small ranges of those restricted to one or two caves. If infected, these species may lose nearly their entire

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[54] *Id.*
[55] *Id.*
[56] Wang, Hua, Benoit Laplante, Xun Wu, and Craig Meisner. 2004. "Estimating Willingness-to-Pay with Random Valuation Models: an application to Lake Sevan, Armenia. World Bank Policy Research Working Paper 3367. August. Page 1-41, 11.
[57] Laplante, Benoit, Craig Meisner, and Hua Wang. 2005. "Environment as Cultural Heritage: the Armenian Diaspora's Willingness to Pay to Protect Armenia's Lake Sevan." World Bank Policy Research Working Paper 3520. February. Page 1-35, 5.
[58] Biodiversity Strategy for the Republic of Armenia. 1999. "Threats to, and Impacts on, Biodiversity in Armenia." Armenia National Report, Biodiversity Strategy and Action Plan to CBD Project. Available from http://www.nature-ic.am/biodiv/eng/national_report/first/6/index-1.html. Accessed on 7/27/2010.
[59] Handwerk, Brian. 2008.: "Deadly Bat Disease Linked to Cold-Loving Fungus." National Geographic News. http://news.nationalgeographic.com/news/2008/10/081031-bat-fungus.html [Accessed October 2010].
[60] *Id.*
[61] Puechmaille SJ, Verdeyroux P, Fuller H, Ar Gouilh M, Bekaert M, Teeling EC. 2010 "White-nose syndrome fungus (*Geomyces destructans*) in bat, France." Emerg Infect Dis. e-pub. Available online at http://www.cdc.gov/eid/content/16/2/pdfs/09-1391.pdf [Accessed October 2010].

population in one fell swoop. Since white-nose syndrome was recently discovered in Europe, it may be of particular concern for this Armenian species.

D. The inadequacy of existing regulatory mechanisms

While the listing of this species under the EUROBATS agreement is a useful step towards the conservation of this species, it is insufficient to fully protect *M. hajastanicus*. Armenia, the only country in which this bat is located, has not signed the EUROBATS agreement and thus is not a party to it.[62] Although Armenia has submitted update reports nearly every year since 2001 that discuss how the country is implementing EUROBATS,[63] there does not appear to be a plan that addresses the recovery of *M. hajastanicus*. Furthermore, the EUROBATS website only indicates that parties to the Agreement prohibit "the deliberate capture, keeping or killing of bats" that are listed.[64] There is nothing to suggest that non-member parties also must take this action, and since Armenia is not a member to this Agreement, an important component of the Agreement may potentially not extend to *M. hajastanicus*. For these reasons, the EUROBATS agreement standing alone is not sufficient to protect this bat species.

The IUCN reflects this concern. This organization states that *M. hajastanicus* requires additional legal protection and a conservation management plan.[65] The IUCN also recommends that additional research be conducted on the status, ecology, threats, and conservation measures that are needed for this species and states that a public awareness campaign would also be valuable.[66]

Lastly, after extensive research no documents could be found that indicate that law protects the habitat of this species. This clearly indicates the inadequacy of regulatory mechanisms. Even if the bats' habitat was protected by law, the numerous threats that it faces, including population pressures, expansive urban growth, logging, agriculture, and grazing,[67] indicate that legal habitat protections alone likely would not be adequate to ensure this species' survival.

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[62] UNEP/EUROBATS. "National Reports." Available at: http://www.eurobats.org/documents/national_reports.htm. Accessed on 6/24/2010.

[63] *Id.*

[64] Agreement on the Conservation of Bats in Europe. 1991. Treaty Series No. 9. Article III, Section 1. Available from: http://www.eurobats.org/documents/pdf/Agreementtexts/FCO_Agreement_Text_engl.pdf

[65] Tsytsulina, K., Benda, P., Aulagnier, S. & Hutson, A.M. 2008. Myotis hajastanicus. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[66] *Id.*

[67] Biodiversity Strategy for the Republic of Armenia. 1999. "Threats to, and Impacts on, Biodiversity in Armenia." Armenia National Report, Biodiversity Strategy and Action Plan to CBD Project. Available from http://www.nature-ic.am/biodiv/eng/national_report/first/6/index-1.html. Accessed on 7/27/2010.

E. Other natural or manmade factors affecting its continued existence

M. hajastanicus has a very restricted range.[68] The most threatened species are often those that exist in very few places.[69] Species occupying small habitat ranges, known as 'narrow-range endemicity,'[70] are more likely to become extinct than species that occupy large habitat ranges, and this fact is "inescapable."[71] Additionally, many species with naturally small ranges are being further isolated in habitats that are shrinking, largely due to habitat destruction.[72] This applies to *M. hajastanicus*. This species has a very limited range, as it is known to occur only on the eastern bank of one lake in one country.[73] Due to the deforestation that has occurred and continues to occur in *M. hajastanicus*' small range,[74] the likelihood of further decrease in this species' already very limited habitat is high. This increases the likelihood that *M. hajastanicus* will become extinct if appropriate action is not taken. FWS has routinely recognized that small population size and restricted range increase the likelihood of extinction.[75]

The second factor that makes this species particularly vulnerable to extinction is its low fecundity. Across all bats species generally, fetal development occurs slowly, with pregnancies lasting between three to six months.[76] In temperate regions, which include Albania and thus *M. hajastanicus*, female bats generally produce one young per year. This is believed to be due to the very large size of bat pups at birth. Young bats comprise from between 12-15% of the mother's body mass up to 25% of the mother's body mass during pregnancy. Scientists believe that the weight of the pup during pregnancy limits

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[68] Tsytsulina, K., Benda, P., Aulagnier, S. & Hutson, A.M. 2008. Myotis hajastanicus. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[69] Bibby, Colin J. 1994. "Recent Past and Future Extinctions in Birds." *Philosophical Transaction of the Royal Society of London B: Biological Sciences.* 344: 35-40, 35.

[70] New, T.R. and D.P.A Sands. "Narrow-range Endemicity and Conservation Status: interpretations for Australian Butterflies." *Invertebrate Systematics*. 16(4): 665-670, 665.

[71] Gaston, Kevin. 1998. "Species-range Size Distributions: products of speciation, extinction, and transformation." *Philosophical Transaction of the Royal Society of London B: Biological Sciences.* 353: 219-230, 226.

[72] Bibby, Colin J. 1994. "Recent Past and Future Extinctions in Birds." *Philosophical Transaction of the Royal Society of London B: Biological Sciences.* 344: 35-40, 35.

[73] Tsytsulina, K., Benda, P., Aulagnier, S. & Hutson, A.M. 2008. Myotis hajastanicus. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[74] Biodiversity Strategy for the Republic of Armenia. 1999. "Threats to, and Impacts on, Biodiversity in Armenia." Armenia National Report, Biodiversity Strategy and Action Plan to CBD Project. Available from http://www.nature-ic.am/biodiv/eng/national_report/first/6/index-1.html. Accessed on 7/27/2010.

[75] See, for example, FWS candidate assessment forms for *Doryopteris takeuchii, Huperzia stemmermanniae, Megalagrion nesiotes, Melicope degeneri, Melicope hiiakae, Myrsine mezii, Ostodes strigatus, Partula langfordi, Peperomia subpetiolata, Phyllostegia bracteata*, and *Tryonia circumstriata*. Accessible via FWS website at http://www.fws.gov/endangered/wildlife.html [Accessed November 2009].

[76] Nowak, Ronald and Ernest Walker. 1994. *Walker's Bats of the World*. John Hopkins University Press. Page 20.

the mother's litter size due to her need to fly while pregnant.[77]

Litter size is also likely limited due to nursing characteristics that are unique to bat species.[78] Most mammals wean their young when the young reach 40%, or less, of their adult size. Bats, however, nurse their young until they are nearly adult size. This is because bats cannot feed on their own until their wings are near adult dimensions. This may contribute to the low fecundity of bats.[79] Species with low fecundity are "particularly predisposed to anthropogenic threats given their low replacement rate."[80] Thus, low fecundity is another reason that *M. hajastanicus* faces serious risk of extinction unless further action is taken.

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[77] *Id.*
[78] *Id.*
[79] *Id.*
[80] Brook, Barry, Navjot Sodhi, and Corey Bradshaw. 2008. "Synergies Among Extinction Drivers Under Global Change." *Trends in Ecology and Evolution*. 23(8): 453-460, 455.

B. Aru Flying Fox (*Pteropus aruensis*)

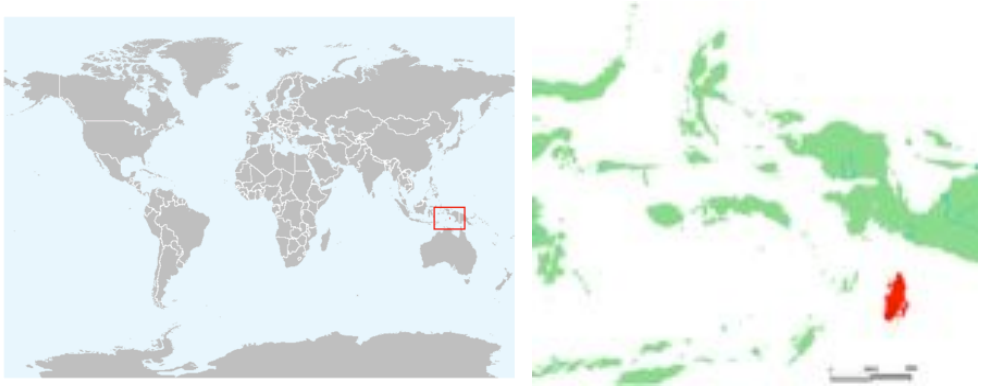
1. Taxonomy

Uncertainty exists as to whether *Pteropus aruensis* is a distinct species or a subspecies of *Pteropus parnelllii*.[81]

2. Distribution and Range

This species is endemic to the Aru Islands of Indonesia.[82] This group of islands is located west of Irian Jaya in the Arafura Sea.[83]

Figure B.1 *P. aruensis* is endemic to the Aru Islands of Indonesia (in red).



Source (left): Helgen, K. 2008. *Pteropus aruensis*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 26 June 2010
Source (right): *http://www.demis.nl/home/pages/Gallery/examples.htm*

3. Habitat and Ecology

Although there is no specific study of this species' ecology,[84] all *Pteropus* species feed on plant resources consisting primarily of nectar and pollen, fruit, leaves, bark, and seeds.[85] Regarding life history, *Pteropus* species have "slow life cycles characterized by low fecundity and a long life-span.[86]

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[81] Helgen, K. 2008. *Pteropus aruensis*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 26 June 2010.
[82] *Id.*
[83] Grotting, Bjorn. "The Aru Islands." 19 January 2010. Available online at http://www.indonesiaphoto.com/destinations/maluku/item/146-the-aru-islands. Accessed on 7/2/2010.
[84] Helgen, K. 2008. *Pteropus aruensis*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 26 June 2010.
[85] Marshall, A.G. 1985. "Old world phytophagus bats (Megachiroptera) and their food plants: a survey." *Zoological Journal of the Linnean Society*. 83: 351-369.
[86] McIlwee, A.P. & Martin, L. 2002. "On the intrinsic capacity for increase of Australian flying-

4. Population and Trend

This species is potentially extinct because it has not been recorded with certainty since the nineteenth century.[87] Surveys conducted in the early 1990s by the Western Australian Museum failed to locate the species.[88] "However, a single toothless jaw from a kitchen midden collected at Namara on Kobroor Island by P.A. Woolley in October/November of 1992 probably represents this species" (field number NA/36, unregistered lot at CSIRO). The population trend is unknown.[89]

5. Major Threats

Hunting,[90] habitat destruction, and culling programs implemented by farmers may have led to the decline of this species.[91]

6. Conservation Actions

P. aruensis was listed as an Appendix II species under CITES on October 22, 1987.[92,93] A proposed protected area, Pulau Kobroor Game Reserve, is within the general location where this species has been found.[94]

7. ESA Listing Factors

A. The present or threatened destruction, modification, or curtailment of its habitat or range

Although 90% of the Aru Islands remain forested, new developments threaten the forest and may jeopardize this species' survival.[95] Logging occurs in the various islands

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foxes (*Pteropus* spp., Megachiroptera)." *Australian Zoologist*. 32: 76-100.
[87] Helgen, K. 2008. *Pteropus aruensis*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 26 June 2010.
[88] *Id.*
[89] *Id.*
[90] *Id.*
[91] Wilson, D.E. & Graham, G.L. 1992. "Pacific Island Flying-Foxes." *In* Proceedings of an International Conservation Conference (eds D.E. Wilson & G.L. Graham). US Department of the Interior Biological report No 90.
[92] UNEP-WCMC. 2010. *UNEP-WCMC Species Database: CITES-Listed Species* Available from: http://www.unep-wcmc.org/isdb/CITES/Taxonomy/tax-species-result.cfm/isdb/CITES/Taxonomy/tax-species-result.cfm?Genus=Pteropus&Species=aruensis&source=animals&tabname=status.
[93] CITES Checklist. Page 1-503, 236. Available from: http://www.cites.org/eng/resources/pub/checklist08/Checklist.pdf
[94] Helgen, K. 2008. *Pteropus aruensis*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 26 June 2010.
[95] Morrison, John. 2001. "Vogelkop-Aru Lowland Rain Forests." *World Wildlife Fund*. Available from: http://www.worldwildlife.org/wildworld/profiles/terrestrial/aa/aa0128_full.html.

that form the Aru Island chain. On the island of Irian Jaya, this logging has coincided with urban development and infrastructure construction that is part of a transmigration program. This island also contains petroleum development operations. Government-sponsored resettlement initiatives occur in the Sorong region of Irian Jaya. On Misool Island, increasing population has exerted pressures on the island's forests. Development has occurred near these forests, and they are being destroyed by agriculture, logging, and fire.[96] This habitat destruction, which appears to be accelerating with the island chain's increasing population,[97] threatens *P. aruensis*.[98]

B. Over-utilization for commercial, recreational, scientific, or educational purposes

This bat is likely susceptible to targeted hunting efforts because it is very large and colorful.[99] The IUCN recognizes hunting as a factor that likely has led to this species' decline.[100] Hunting is a particularly grave threat to other *Pteropus* species as well. Culling programs are often implemented to decrease *Pteropus* populations. Since fruit comprises part of their diet, they are viewed as crop pests.[101]

C. Disease or predation

Bat species worldwide may be at risk from white-nose syndrome, caused by a cold-loving fungus of the Geomyces genus.[102] The syndrome has been known to cause 80% to 97% mortality rates in some large hibernation colonies.[103] Until recently, the disease was restricted to the northeastern United States. However, in 2009 it was detected in France.[104] It is not known how quickly this disease may spread to other areas of the world, but it poses a severe threat to all bat species, especially those with small ranges of those restricted to one or two caves. If infected, these species may lose nearly their entire population in one fell swoop.

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[96] *Id.*
[97] *Id.*
[98] Wilson, D.E. & Graham, G.L. 1992. "Pacific Island Flying-Foxes." *In* Proceedings of an International Conservation Conference (eds D.E. Wilson & G.L. Graham). US Department of the Interior Biological Report No. 90.
[99] Helgen, K. 2008. *Pteropus aruensis*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 26 June 2010.
[100] *Id.*
[101] Wilson, D.E. & Graham, G.L. (1992) Pacific Island Flying-Foxes. In Proceedings of an International Conservation Conference (eds D.E. Wilson & G.L. Graham). US Department of the Interior Biological report No 90.
[102] Handwerk, Brian. 2008.: "Deadly Bat Disease Linked to Cold-Loving Fungus." National Geographic News. http://news.nationalgeographic.com/news/2008/10/081031-bat-fungus.html [Accessed October 2010].
[103] *Id.*
[104] Puechmaille SJ, Verdeyroux P, Fuller H, Ar Gouilh M, Bekaert M, Teeling EC. 2010 "White-nose syndrome fungus (*Geomyces destructans*) in bat, France." Emerg Infect Dis. e-pub. Available online at http://www.cdc.gov/eid/content/16/2/pdfs/09-1391.pdf [Accessed October 2010].

D. The inadequacy of existing regulatory mechanisms

While the CITES listing of this species[105] is certainly a positive step, it does not appear that this listing has had any positive impact on this species. Every single *Pteropus* species has been listed as an Appendix I or Appendix II species.[106] Although this action recognizes that *Pteropus* species worldwide are in jeopardy, it does not appear that any measures have been implemented under CITES to protect *P. aruenisis* in particular. This conclusion is based upon a review of the material contained on the CITES website and searches conducted for this species on the CITES website. And there is no evidence, based on the IUCN evaluation of *P. aruensis*,[107] that the population has increased or otherwise become more viable since this species was listed under CITES. Therefore, the fact that this species is listed as a CITES Appendix II species is not sufficient to ensure the survival of this species.

Additionally, the location of a proposed protected area, Pulau Kobroor Game Reserve, within the range of this species[108] is not adequate protection. First, this Reserve is still in the proposal phase, and thus no conservation measures have actually been taken.[109] Second, illegal hunting of endangered species, as well as a "considerable" amount of wildlife trade already occurs in this proposed reserve. The situation is exacerbated by lack of effective management of illegal hunting or wildlife trade.[110] Furthermore, even legally protected reserves on the Aru Islands are not safe from forest destruction because logging is permitted to occur within protected areas.[111] Therefore, the concern with the proposed protected area is three-fold; (1) it has not been established, (2) hunting and wildlife harvesting occurs in the proposed area, and (3) based upon logging data, it appears that the borders of legally protected areas may not be strictly enforced. This means hunting and other activities that are harmful to *P. aruensis* may continue to occur even if the area is listed as a reserve. As such, this proposed protected area is not sufficient to protect *P. aruensis*.

E. Other natural or manmade factors affecting its continued existence

i. Climate change

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[105] UNEP-WCMC. 2010. *UNEP-WCMC Species Database: CITES-Listed Species* Available from: http://www.unep-wcmc.org/isdb/CITES/Taxonomy/tax-species-result.cfm/isdb/CITES/Taxonomy/tax-species-result.cfm?Genus=Pteropus&Species=aruensis&source=animals&tabname=status.

[106] Hutson, Anthony, Simon Mickleburgh, and Paul Racey. 2001. *Microchiropteran Bats: global status survey and conservation action plan*. IUCN/SSC Chiroptera Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. 1-246, 52.

[107] Helgen, K. 2008. *Pteropus aruensis*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 26 June 2010.

[108] *Id.*

[109] Silvius, Marcel and Agustinus W. Taufik. "Pulau Kobroor." Available at: http://www.arcbc.org.ph/wetlands/indonesia/idn_pul_kobroor.htm. Accessed 6/26/2010.

[110] *Id.*

[111] Morrison, John. 2001. "Vogelkop-Aru Lowland Rain Forests." *World Wildlife Fund*. Available from: http://www.worldwildlife.org/wildworld/profiles/terrestrial/aa/aa0128_full.html.

The IPCC states that human activities are likely contributing to global climate change. "Most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic GHG concentrations… It is *likely* that there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica)."[112] Due to climate change, "there are projected to be major changes in ecosystem structure and function, species' ecological interactions and shifts in species' geographical ranges, with predominantly negative consequences for biodiversity."[113] Threats from global climate change are relevant to this bat species.

As an archipelago, Indonesia is particularly vulnerable to the impacts of climate change.[114] "Global average sea level is rising predominantly as a consequence of three factors—thermal expansion of warming ocean water, addition of new water from the ice sheets of Greenland and Antarctica and from glaciers and ice caps, and the addition of water from land hydrology. All three potential sources are undergoing changes of anthropogenic origin."[115] The IPCC projects that on small islands, "sea level rise is expected to exacerbate inundation, storm surge, erosion and other coastal hazards… [and] with higher temperatures, increased invasion by non-native species is expected to occur, particularly on mid- and high-latitude islands."[116] Indonesia may experience a moderate rise in temperature, prolonged droughts, and increases in extreme weather events including heavy rainfall and flooding. Sea level rise may inundate coastal areas and decrease viable farmland,[117] causing human migration into the interior. All of these changes may have negative impacts on populations and habitats of *P. aruensis.*

ii. Biological vulnerability

As this species has not been recorded with certainty since the nineteenth century, it likely has a very small population size. FWS has routinely recognized that small population size and restricted range increase the likelihood of extinction.[118] Island

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[112] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009]

[113] *Id.*

[114] Sari, Agus P., Martha Maulidya, Ria N. Butarbutar, Rizka E. Sari, and Wisnu Rusmantoro. 2007. Executive Summary: Indonesia and Climate Change. Working Paper on Current Status and Policies. Report from Department for International Development and the World Bank. Available at http://www.conflictrecovery.org/bin/PEACEClimateChange-ExecSum.pdf [Accessed October 2010].

[115] McMullen, C.P. and Jabbour, J. 2009. Climate Change Science Compendium 2009. United Nations Environment Programme, Nairobi, EarthPrint. Online at http://www.unep.org/compendium2009/ [Accessed November 2009].

[116] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009]

[117] *Id.*

[118] *See* FWS candidate assessment forms for *Doryopteris takeuchii, Huperzia stemmermanniae, Megalagrion nesiotes, Melicope degeneri, Melicope hiiakae, Myrsine mezii, Ostodes strigatus, Partula langfordi, Peperomia subpetiolata, Phyllostegia bracteata*, and *Tryonia circumstriata*.

species are particularly susceptible to extinction.[119,120] An additional factor that qualifies this species for ESA protection is its low fecundity, a characteristic of all *Pteropus* species.[121] Across all bats species generally, fetal development occurs slowly, with pregnancies lasting between three to six months.[122] Female bats generally produce one young per year. This is believed to be due to the very large size of bat pups at birth. Young bats comprise from between 12-15% of the mother's body mass up to 25% of the mother's body mass during pregnancy. Scientists believe that the weight of the pup during pregnancy limits the mother's litter size due to her need to fly while pregnant.[123]

Litter size is also likely limited due to nursing characteristics that are unique to bat species.[124] Most mammals wean their young when the young reach 40%, or less, of their adult size. Bats, however, nurse their young until they are nearly adult size. This is because bats cannot feed on their own until their wings are near adult dimensions. This may contribute to the low fecundity of bats.[125] Species with low fecundity are "particularly predisposed to anthropogenic threats given their low replacement rate."[126] Thus, low fecundity is another reason that *P. aruensis* faces serious risk of extinction unless further action is taken.

Accessible via FWS website at http://www.fws.gov/endangered/wildlife.html [Accessed November 2009].

[119] *See* Groombridge, B. 1992. Global Biodiversity - Status of the Earth's Living Resources: A Report Compiled by the World Conservation Monitoring Centre. Chapman and Hall, London, New York. Available at http://www.archive.org/details/globalbiodiversi92wcmc [Accessed 10/19/10].

[120] Frankham, Richard. 2008. "Inbreeding and Extinction: Island Populations." Conservation Biology. 12: 665–675. Available at http://onlinelibrary.wiley.com/doi/10.1111/j.1523-1739.1998.96456.x/abstract [Accessed 10/19/10].

[121] McIlwee, A.P. & Martin, L. 2002. "On the intrinsic capacity for increase of Australian flying-foxes (*Pteropus* spp., Megachiroptera)." *Australian Zoologist*. 32: 76-100.

[122] Nowak, Ronald and Ernest Walker. 1994. *Walker's Bats of the World*. John Hopkins University Press. Page 20.

[123] *Id.*

[124] *Id.*

[125] *Id.*

[126] Brook, Barry, Navjot Sodhi, and Corey Bradshaw. 2008. "Synergies Among Extinction Drivers Under Global Change." *Trends in Ecology and Evolution*. 23(8): 453-460, 455.

C. Bonin Flying Fox (*Pteropus pselaphon*)

1. Taxonomy

Pteropus pselaphon belongs to the order Chiroptera, family Pteropodidae.[127]

Figure C.1 *P. pselaphon* feeding

Source: http://www.metro.tokyo.jp/ENGLISH/TOPICS/2007/IMG/fth8h100_06.jpg

2. Distribution and Range

This species is known to occur only in the Ogasawara Islands in Japan, with evidence of existence on Chichi-Jima, Haha-Jima, Kita-Iwo-Jima, Minami-Iwo-Jima, and Iwo Jima.[128] These islands are part of an archipelago located in the western Pacific Ocean 1,000 km south of Tokyo.[129]

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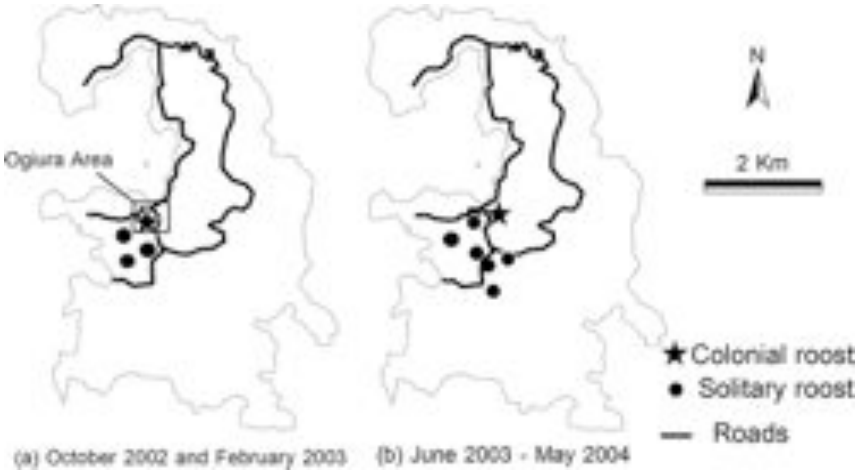
[127] Ishii, N. & Maeda, K. 2008. Pteropus pselaphon. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[128] *Id.*
[129] Mukai, Takahiko, Shozo Nakamura, Toshiyuki Suzuki, and Mutsumi Nishida. 2005. "Mitochondrial DNA Divergence in Yoshinobori gobies (Rhinogobius species complex) Between the Bonin Islands and the Japan-Ryukyu Archipelago." *Ichthyological Research*. 52(4): 410-413, 410.

Figure C.2 *P. pselaphon* is endemic to the Ogasawara Islands in Japan

Source: *http://www.demis.nl/home/pages/Gallery/examples.htm*

Figure C.3 Bonin flying fox roosting sites on Chichi-Jima Island, Japan. The solid circles indicate the locations of solitary roosts and stars indicate the locations of winter colonial roosts.



Source: Sugita, Norimasa, Makoto Inaba and Keisuke Ueda. 2009. *Journal of Mammalogy*. 90(1): 195–202, figure 1.

3. Habitat and Ecology

This species occupies forest habitats.[130] The small northern islands of the Ogasawara chain are now covered mostly in grasses, a secondary vegetation that resulted

[130] Ishii, N. & Maeda, K. 2008. Pteropus pselaphon. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

from grazing by introduced goats.[131] Only fragments of forest remain on the smaller islands of the Ogasawara chain. Broadleaf evergreen forests still cover extensive areas of the larger island of Haha-jima, as well as parts of Chichi-jima, though much of Chichi-jima is secondary forest. The primary native forests are restricted to more the remote and inaccessible parts of Chichi-jima.[132]

Similar to all *Pteropus* species, *P. pselaphon* feeds on nectar, pollen, fruit, leaves, bark, and seeds.[133] Surveys conducted on the bats' feces on Minami-Iwo-To Island and Chichi-jima Island indicated a diet based mainly on flower pollen and fern spores.[134] On Minami-Iwo-To Island, one type of pollen was found in the feces, that of *Pandanus* sp. Fern spores were also commonly found, and are a major resource for the bats on this island. On Chichi-jima, however, pollen from seven different plant species was found in the feces. These species are *Syzygium* sp., *Pandanus* sp., and introduced plant species including *Agave Americana*, *Ficus microcarpa*, and *Syzygium jambos*, which constitute major components of the bat's diet on Chichi-jima. Fern spores were also frequently found, suggesting that "ferns also provide a major food resource."[135] There is evidence that this bat also feeds on cultivated bananas on Chichi-Jima.[136] In the two northern-most islands *P. pselaphon* feeds in orchards and is known to cause fruit damage.[137]

A study conducted on Chichi-jima provided insight into the roosting pattern and reproductive cycle of this species. This study indicated that during the winter, *P. pselaphon* formed a colonial roost that contained approximately 100 individuals in "ball-shaped, dense clusters."[138] In summer, their roosts were more widely dispersed and consisted of either solitary individuals or nursing females.[139] Copulation and fertilization likely occurs only in winter colonial roosts, which are therefore important mating sites.[140]

4. Population and Trend

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[131] Mueller-Dombois, D. and F.R. Fosberg. 1998. *Vegetation of the tropical Pacific Islands.* Springer-Verlag, New York.
[132] *Id.*
[133] Marshall, A.G. 1985. "Old world phytophagus bats (Megachiroptera) and their food plants: a survey." *Zoological Journal of the Linnean Society*. 83: 351-369.
[134] Takuma, Nakamura, Huzita Takashi, Suzuki Hajime, and Sugita Norimasa. 2008. "Pollen analysis of feces, food study of endangered species in Chichi Ogasawaraookoumori Minami-Iwo Island: pollen recovered from the feces of the Bonin flying fox (Pteropus pselaphon Layard, 1829) on Minami-Iwo-To and Chichi-jima Islands." *Journal of Japan Society of Pollen.* 54(2): 53-60.
[135] *Id.*
[136] Bureau of Environment, Tokyo Metropolitan University. 2007. "First natural environment survey in a quarter century on world natural heritage site candidate, Minami-Iouto Island." July 27. Available at: http://www.metro.tokyo.jp/ENGLISH/TOPICS/2007/fth8h100.htm. Accessed 7/4/2010.
[137] Ishii, N. & Maeda, K. 2008. Pteropus pselaphon. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[138] Sugita, Norimasa, Makoto Inaba, and Keisuke Ueda. 2009. "Roosting pattern and reproductive cycle of Bonin flying foxes (Pteropus pselaphon)." *Journal of Mammology*. 90(1): 195-202, 195.
[139] *Id.*
[140] *Id.*

Less than 650 individuals of *P. pselaphon* survive across its five-island range.[141] No subpopulation is expected to have more than 50 mature individuals.[142] It is estimated that 100-150 individuals live on Chichi-jima and less than 50 individuals live on Haha-Jima, according to data collected in March 2006.[143] A survey conducted in 2001 directly observed 25 individuals on Kita-Iwo-Jimo, and estimated that no more than 50 individuals lived on the island.[144] The most recent survey on Minami-Iwo-To (Minami-Iwo-Jima), conducted in 2007, estimated the population to be between 100 and 300 individuals.[145] On Iwo-Jima, the population size is estimated to be 300 individuals or less, though survey conduction is difficult due to topography and because the island is a military base.[146] The overall population trend is decreasing.[147]

5. Major Threats

A primary threat to this species is deforestation and habitat degradation, which destroy both roost sites and food sources.[148] Nets hung around fruit trees to prevent damage to fruits cause fatalities and feral cats and dogs may also be a threat.[149] The black rat (*Rattus rattus*) may indirectly affect this species as well.[150]

6. Conservation Actions

This species is listed as Critically Endangered (CR) on the Japanese Red List (2007).[151] It was also designated as a Natural Monument in 1969 under the Law for the Protection of Cultural Properties, and capturing or hunting this bat without permission is prohibited. Minami-Iwo and Kita-Iwo are protected islands that have no human

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[141] Ishii, N. & Maeda, K. 2008. Pteropus pselaphon. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010; Suzuki, Hajime, Kazuto Kawakami, Taku Fujita. 2008. "Flying fox of Minami-Iwo-To Island, Volcano Isls, the Bonin Islands." *Ogasawara Research*. (33): 89-104.
[142] Ishii, N. & Maeda, K. 2008. Pteropus pselaphon. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[143] *Id.*
[144] *Id.*
[145] Suzuki, Hajime, Kazuto Kawakami, Taku Fujita. 2008. "Flying fox of Minami-Iwo-To Island, Volcano Isls, the Bonin Islands." *Ogasawara Research*. (33): 89-104.
[146] Ishii, N. & Maeda, K. 2008. Pteropus pselaphon. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[147] *Id.*
[148] *Id.*
[149] *Id.*
[150] Kawakami, Kazuto, Kazuo Horikoshi, Hajime Suzuki, and Tetsuro Sasaki. 2010. Chapter: Impacts of predation by the invasive black rat Rattus rattus on the Bulwer's Petrel Bulweria bulweril in the Bonin Islands, Japan." *Restoring the Oceanic Island Ecosystem: Impact and Management of invasive alien species in the Bonin Islands*" Kazuto Kawakami and Isamu Okochi (eds). Springer Japan.
[151] Ishii, N. & Maeda, K. 2008. Pteropus pselaphon. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

inhabitants. Although Iwo-Jima hosts a military base, a National Wildlife Protection Area that includes the species' habitat was established in 1980.[152] Additionally, CITES listed this species under Appendix II on January 18, 1990.[153]

Rat eradication programs began on some of the Ogasawara Islands in 2007,[154] though it appears no program has been implemented on the islands where the Bonin flying fox is found.[155]

7. ESA Listing Factors

A. The present or threatened destruction, modification, or curtailment of its habitat or range

Destruction of *P. pselaphon's* forest habitat is the most serious threat to its continued survival.[156] A variety of factors have contributed to habitat destruction. First, the forests that *P. pselaphon* depends on have recently been deteriorating due to an introduced pine wood nematode, *Bungaphalenchus zylophelus*, and its vector, the beetle *Monochamus alternatus*.[157]

Second, these forests are threatened by human disturbance, goat grazing, and the introduction of alien plant species.[158] This bat is particularly threatened by disturbance from tourists and construction at its roost sites on the two northernmost islands.[159] Tourism is a major industry for the Islands.[160] Approximately 28,000 tourists visit the Islands each year.[161] Boats make weekly trips from Tokyo to the Islands bringing travelers.[162] There have been discussions in recent years about introducing an express ship that could cut travel time to the Islands significantly, increasing the number of visiting tourists.[163] Tourism is also expected to increase because the Ogasawara Islands

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[152] *Id.*
[153] UNEP-WCMC. 2010. *UNEP-WCMC Species Database: CITES-Listed Species*. Available from: http://www.unep-wcmc.org/isdb/CITES/Taxonomy/tax-species-result.cfm/isdb/CITES/Taxonomy/tax-species-result.cfm?Genus=Pteropus&Species=pselaphon&source=animals.
[154] Hashimoto, Takuma. 2010. "Eradication and ecosystem impacts of rats in the Ogasawara Islands." *In Restoring the Oceanic Island Ecosystem: Impact and Management of invasive alien species in the Bonin Islands*" Kazuto Kawakami and Isamu Okochi (eds). Springer Japan.
[155] *See Id.*
[156] *See* Ishii, N. & Maeda, K. 2008. *Pteropus pselaphon*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[157] *Id.*
[158] *Id.*
[159] *Id.*
[160] *Daily Yomiuri (Japan)*. 2001. "Tokyo Government to Protect Ogasawara Isles." July 1. Page 2.
[161] *U.S. State News*. 2006. "Colorado State Researchers Partner with Japanese Islands to Protect Nesting Green Sea Turtles, Promote Ecotourism." Dec. 20.
[162] Noel, Pamela. 2001. "Q & A: Tokyo's Remote Islands." *N.Y. Times*. March 11, at 520.
[163] Ichiki, Shigeo. 2003. Ecotourism in Ogasawara Islands. Ogasawara Whale-watching Association and Bonin Ecotourism Commission Report 15.

were recently nominated for consideration by UNESCO as a World Heritage Site.[164,165] In recent years, tourists have caused an increasing amount of environmental destruction,[166] which makes the potential increase in the number of tourists a concern. There are no effective guidelines to regulate tourists visiting the bat[167] and IUCN identifies disturbance at roost sites by tourists as one of the main threats to this species.[168] Construction also threatens this species' habitat. Road construction occurred in 2003 near a forest in the Oogiura district, where Bonin flying foxes roost and forage.[169]

Third, tropical typhoons also disturb these islands. In May 2007, a typhoon directly hit Minami-Iwo-To Island, causing "a large scale of disturbances on the forest environment."[170] The bats appeared to suffer a food shortage at this time.[171] These three factors make *P. pselaphon* particularly susceptible to habitat loss.

C. Disease or predation

According to the IUCN, feral cats and dogs may threaten this species,[172] presumably through predation. Due to the agile nature of cats, it may be possible for feral cats to climb these bat's roost trees and predate upon *P. pselaphon*, although this has not been confirmed.[173]

Bat species worldwide may also be at risk from white-nose syndrome, caused by a cold-loving fungus of the Geomyces genus.[174] The syndrome has been known to cause 80- 97% mortality rates in some large hibernation colonies.[175] Until recently, the disease was restricted to the northeastern United States. However, in 2009 it was detected in France.[176] It is not known how quickly this disease may spread to other areas of the

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[164] *UNESCO*. "Unesco World Heritage Center Tentative List." Available from: http://whc.unesco.org/en/tentativelists/5095/.
[165] *U.S. State News*. 2006. "Colorado State Researchers Partner with Japanese Islands to Protect Nesting Green Sea Turtles, Promote Ecotourism." Dec. 20.
[166] *Daily Yomiuri (Japan)*. 2001. "Tokyo Government to Protect Ogasawara Isles." July 1. Page 2.
[167] Ichiki, Shigeo. 2003. Ecotourism in Ogasawara Islands. Ogasawara Whale-watching Association and Bonin Ecotourism Commission Report 15 at 19.
[168] Ishii, N. & Maeda, K. 2008. Pteropus pselaphon. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[169] Scholars at work to protect endangered Bonin flying fox. Asia Africa Intelligence Wire | January 18, 2003. Available online at http://www.accessmylibrary.com/coms2/summary_0286-22429853_ITM Accessed 7/2/2010).
[170] Suzuki, Hajime, Kazuto Kawakami, Taku Fujita. 2008. "Flying fox of Minami-Iwo-To Island, Volcano Isls, the Bonin Islands." *Ogasawara Research*. (33): 89-104.
[171] *Id.*
[172] Ishii, N. & Maeda, K. 2008. Pteropus pselaphon. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.)
[173] *See Id.*
[174] Handwerk, Brian. 2008.: "Deadly Bat Disease Linked to Cold-Loving Fungus." National Geographic News. http://news.nationalgeographic.com/news/2008/10/081031-bat-fungus.html [Accessed October 2010].
[175] *Id.*
[176] Puechmaille SJ, Verdeyroux P, Fuller H, Ar Gouilh M, Bekaert M, Teeling EC. 2010 "White-nose syndrome fungus (*Geomyces destructans*) in bat, France." Emerg Infect Dis. e-pub. Available online at http://www.cdc.gov/eid/content/16/2/pdfs/09-1391.pdf [Accessed October

world, but it poses a severe threat to all bat species, especially those with small ranges or those restricted to one or two caves. If infected, these species may lose nearly their entire population in one fell swoop.

D. The inadequacy of existing regulatory mechanisms

Although this species is listed as Critically Endangered on the Japanese Red List, and was designated as a Natural Monument in 1969,[177] neither of these measures appears adequate to ensure the species' long-term survival. The Japanese Environment Agency does not have a comprehensive conservation-oriented wildlife policy, which leaves domestic endangered species, like the Bonin Flying Fox, largely unprotected.[178] The population of *P. pselaphon* is still dangerously low, at fewer than 650 individuals, and the population trend is declining despite the regulatory measures in place.[179] And while capturing and hunting this bat is illegal without permission, it does not appear that capture or hunting is the primary threat to this species. Rather, the primary threat is habitat destruction, and it is unclear how habitat destruction is being mitigated under the legal protections currently afforded to this species.

Additionally, while the CITES listing of this species is certainly a positive step, it does not appear that this listing has had any positive impact on this species. Every *Pteropus* species has been listed as an Appendix I or Appendix II species. Although this does indicate that *Pteropus* species worldwide are in jeopardy, it does not appear that any specific measures have been implemented under CITES to protect *P. pselaphon* in particular. Furthermore, in the two decades since this species was listed under CITES, the population has continued to decline and remains at a very low number, which indicates that a CITES listing is not adequate to protect this species.

E. Other natural or manmade factors affecting its continued existence

i. Climate change

The Intergovernmental Panel on Climate Change (IPCC) states that human activities are likely contributing to global climate change. "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic [greenhouse gas] concentrations… It is likely that there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica)."[180] Due to climate change, "there are projected to be major changes in ecosystem structure and function, species' ecological interactions and

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2010].

[177] *Id.*

[178] Dupree, Margaret. 1995. "Passing through enemy waters: marine turtles in Japan." 14 UCLA Pac. Basin L.J. 75, 77.

[179] *Id.*

[180] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Available from: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009].

shifts in species' geographical ranges, with predominantly negative consequences for biodiversity."[181] Threats from global climate change are relevant to this bat species.

P. pselaphon is endemic to an island, which face particularly urgent threats from rising sea levels and increasingly severe and frequent tropical storms caused by human-induced climate change. "Global average sea level is rising predominantly as a consequence of three factors—thermal expansion of warming ocean water, addition of new water from the ice sheets of Greenland and Antarctica and from glaciers and ice caps, and the addition of water from land hydrology. All three potential sources are undergoing changes of anthropogenic origin."[182] The IPCC projects that on small islands, " sea level rise is expected to exacerbate inundation, storm surge, erosion and other coastal hazards… [and] with higher temperatures, increased invasion by non-native species is expected to occur, particularly on mid- and high-latitude islands."[183]

ii. Biological vulnerability

Three additional factors make ESA listing appropriate. First, this species has a small population size (~650 individuals) and a range restricted to five islands in the Japanese archipelago. FWS has routinely recognized that small population size and restricted range increase the likelihood of extinction.[184] Island species are particularly susceptible to extinction.[185,186]

Second, this species may be indirectly impacted by the black rat (*Rattus rattus*). This rat is one of the most invasive alien species on the Bonin Islands and has been recorded on at least 16 of the islands.[187] It is not known if these rats directly impact P. *pselaphon*, but they do have a negative impact on other fauna,[188] which could have an

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[181] *Id.*

[182] McMullen, C.P. and Jabbour, J. 2009. Climate Change Science Compendium 2009. United Nations Environment Programme, Nairobi, EarthPrint. Online at http://www.unep.org/compendium2009/ [Accessed November 2009].

[183] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009]

[184] See, for example, FWS candidate assessment forms for *Doryopteris takeuchii, Huperzia stemmermanniae, Megalagrion nesiotes, Melicope degeneri, Melicope hiiakae, Myrsine mezii, Ostodes strigatus, Partula langfordi, Peperomia subpetiolata, Phyllostegia bracteata*, and *Tryonia circumstriata*. Accessible via FWS website at http://www.fws.gov/endangered/wildlife.html [Accessed November 2009].

[185] Groombridge, B. 1992. Global Biodiversity - Status of the Earth's Living Resources: A Report Compiled by the World Conservation Monitoring Centre. Chapman and Hall, London, New York. Available at http://www.archive.org/details/globalbiodiversi92wcmc [Accessed 10/19/10].

[186] Frankham, Richard. 2008. "Inbreeding and Extinction: Island Populations." Conservation Biology. 12: 665–675. Available at http://onlinelibrary.wiley.com/doi/10.1111/j.1523-1739.1998.96456.x/abstract [Accessed 10/19/10].

[187] Kawakami, Kazuto, Kazuo Horikoshi, Hajime Suzuki, and Tetsuro Sasaki. 2010. "Impacts of predation by the invasive black rat Rattus rattus on the Bulwer's Petrel Bulweria bulweril in the Bonin Islands, Japan." *Restoring the Oceanic Island Ecosystem: Impact and Management of invasive alien species in the Bonin Islands*" Kazuto Kawakami and Isamu Okochi (eds). Springer Japan.

[188] *Id.*

indirect impact on the bat through changes in the ecosystems of these islands.

The third factor that affects the continued viability of this species is low fecundity, which characterizes all *Pteropus* species.[189] Across all bats species generally, fetal development occurs slowly, with pregnancies lasting between three to six months.[190] Female bats generally produce one young per year. This is believed to be due to the very large size of bat pups at birth. Young bats comprise from between 12-15% of the mother's body mass up to 25% of the mother's body mass during pregnancy. Scientists believe that the weight of the pup during pregnancy limits the mother's litter size due to her need to fly while pregnant.[191]

Litter size is also likely limited due to nursing characteristics that are unique to bat species.[192] Most mammals wean their young when the young reach 40%, or less, of their adult size. Bats, however, nurse their young until they are nearly adult size. This is because bats cannot feed on their own until their wings are near adult dimensions. This may contribute to the low fecundity of bats.[193] Species with low fecundity are "particularly predisposed to anthropogenic threats given their low replacement rate."[194] Thus, low fecundity is another reason that *P. pselaphon* faces a high likelihood of extinction unless action is taken.

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[189] McIlwee, A.P. & Martin, L. (2002) "On the intrinsic capacity for increase of Australian flying-foxes (*Pteropus* spp., Megachiroptera)." *Australian Zoologist*, 32, 76-100.
[190] Nowak, Ronald and Ernest Walker. 1994. *Walker's Bats of the World*. John Hopkins University Press. Page 20.
[191] *Id.*
[192] *Id.*
[193] *Id.*
[194] Brook, Barry, Navjot Sodhi, and Corey Bradshaw. 2008. "Synergies Among Extinction Drivers Under Global Change." *Trends in Ecology and Evolution*. 23(8): 453-460, 455.

D. Christmas Island Pipistrelle (*Pipistrellus murrayi*)

1. Taxonomy

The two most recent taxonomic studies on *Pipistrellus murrayi*, both conducted in 2008 by leading specialists (P. Racey, L. Lumsden, and Tidemann), recognize *P. murrayi* as a distinct species.[195] An earlier study in 1987 listed *P. murrayi* as a separate species based on baculum, and a 1986 study by Kitchener *et al.* considered *P. murrayi* distinct.[196] Prior to this, there were differing opinions about the status of *P. murrayi*, with one researcher, Koopman, suggesting that *P. murrayi* was conspecific with *Pipistrellus tenuis*, though no presentation of data was given.[197] Overall, the evidence points to *P. murrayi* being a distinct species.[198]

2. Species Description

This species is a microbat, with a weight of about 3-4.5 grams[199] and a forearm length of 30-32 mm.[200] The fur on the pipistrelle's back is "brown with yellowish tips, and is slightly lighter on the belly."[201]

Figure D.1 *P. murrayi*

Source: Lumsden, L (2009). The Christmas Island Pipistrelle *(Pipistrellus murrayi)* at risk of extinction within six months!. *Australasian Bat Society Website*. [Online]. Available from: http://batcall.csu.edu.au/abs/ChristmasIsland/PipistrellusmurrayiJan_09.htm

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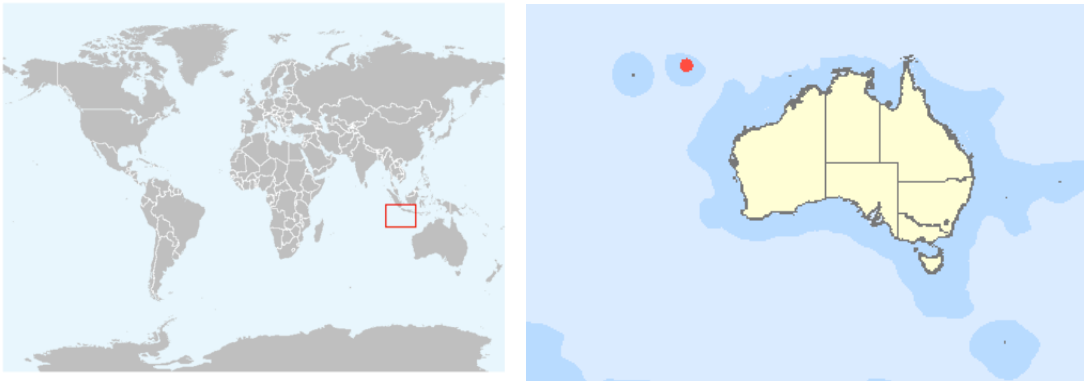
[195] Lumsden, L., Racey, P.A. & Hutson, A.M. 2008. Pipistrellus murrayi. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[196] *Id.*
[197] *Id.*
[198] *Id.*
[199] Schulz, M. and L.F. Lumsden. 2004. National Recovery Plan for the Christmas Island Pipistrelle *Pipistrellus murrayi*. Commonwealth of Australia, Canberra, page 4.
[200] Advice to the Minister for the Environment and Heritage from the Threatened Species Scientific Committee on Amendments to the list of Threatened Species under the Environment Protection and Biodiversity Conservation Act of 1999 (EPBC Act), page 1.
[201] *Id.*

3. Distribution and Range

This bat is endemic to Christmas Island (Australia).[202] The Island is approximately 135 km^2 in size, and located in the eastern Indian Ocean. While this bat used to have a widespread range on Christmas Island, it is now largely limited to western areas of the island.[203] In the 1990s, this westward contraction was documented when targeted surveys demonstrated a "marked reduction in abundance" and range relative to results of initial surveys conducted in 1984.[204] This bat no longer occurs across more than 90 percent of its former range.[205] Since 2006, this bat has continued to disappear from "many of the few remaining sites where it was present in 2006."[206] As of 2005, it was estimated that 95 percent of the remaining population occurred within an area of 1.25km^2.[207] The population has plummeted in the years since 2005,[208] so it is likely that its current range is even smaller than the 2005 estimate.

Figure D.2 *P. murrayi* is endemic to Christmas Island, off the coast of Australia (in red).



Source (left): Lumsden, L., Racey, P.A. & Hutson, A.M. 2008. Pipistrellus murrayi. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
Source (right): *Australian Government: Department of the Environment, Water, Heritage and the Arts.* "Pipistrellus murrayi—Christmas Island Pipistrelle." Species Profile and Threats Database. Available at: http://www.environment.gov.au/cgibin/sprat/public/publicspecies.pl?taxon_id=64383

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[202] Lumsden, L., Racey, P.A. & Hutson, A.M. 2008. *Pipistrellus murrayi*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 27 June 2010.
[203] *Id.*
[204] Schulz, M. and Lumsden, L.F. 2004. National Recovery Plan for the Christmas Island Pipistrelle *Pipistrellus murrayi.* Commonwealth of Australia, Canberra. Page 1.
[205] Lumsden, L., Racey, P.A. & Hutson, A.M. 2008. *Pipistrellus murrayi*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 27 June 2010.
[206] *Id.*
[207] Advice to the Minister for the Environment and Heritage from the Threatened Species Scientific Committee on Amendments to the list of Threatened Species under the Environment Protection and Biodiversity Conservation Act of 1999 (EPBC Act). Page 1.
[208] Lumsden, L (2009). The Christmas Island Pipistrelle *(Pipistrellus murrayi)* at risk of extinction within six months!. *Australasian Bat Society Website*. [Online]. Available from: http://batcall.csu.edu.au/abs/ChristmasIsland/PipistrellusmurrayiJan_09.htm.

4. Habitat and Ecology

P. murrayi roosts in "mature, tropical, evergreen, closed canopy rainforests and mature, tropical, semi-deciduous rainforests."[209] Of the few documented roosts of this species, all are located in primary rainforest.[210] Roosts have been found under tree trunk bark, in dead foliage, and in a tree hollow.[211,212] Females are believed to form colonies of up to approximately 50 individuals, while males often roost alone.[213] No maternity roosts have ever been found.[214] In tree-roosting bats, maternity roost often occur in specific types of trees that are present in low numbers in the landscape.[215] This may apply to this bat species.[216]

P. murrayi, which is insectivorous and preys on a variety of flying insects, prefers feeding in the primary forests where it roosts, and is known to favor traveling along tracks and other small gaps in primary rainforest.[217] This bat also travels to other habitat to forage, including "secondary forests and thickets of woody weeds,"[218] as well as minefield rehabilitation sites.[219]

The generation length of this species is likely 4-5 years.[220] Births probably occur in late December, and lactation is believed to last for approximately four weeks.[221]

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[209] Lumsden, L., Racey, P.A. & Hutson, A.M. 2008. *Pipistrellus murrayi*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 27 June 2010.
[210] Schulz, M. and Lumsden, L.F. 2004. National Recovery Plan for the Christmas Island Pipistrelle *Pipistrellus murrayi.* Commonwealth of Australia, Canberra. Page 1.
[211] Lumsden, L., Racey, P.A. & Hutson, A.M. 2008. *Pipistrellus murrayi*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 27 June 2010.
[212] Schulz, M. and Lumsden, L.F. 2004. National Recovery Plan for the Christmas Island Pipistrelle *Pipistrellus murrayi.* Commonwealth of Australia, Canberra. Page 19.
[213] Lumsden, L., Racey, P.A. & Hutson, A.M. 2008. *Pipistrellus murrayi*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 27 June 2010.
[214] Schulz, M. and Lumsden, L.F. 2004. National Recovery Plan for the Christmas Island Pipistrelle *Pipistrellus murrayi.* Commonwealth of Australia, Canberra. Page 1.
[215] *Id.* at 19.
[216] *Id.*
[217] *Id.* at 1.
[218] Lumsden, L., Racey, P.A. & Hutson, A.M. 2008. *Pipistrellus murrayi*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 27 June 2010.
[219] Schulz, M. and Lumsden, L.F. 2004. National Recovery Plan for the Christmas Island Pipistrelle *Pipistrellus murrayi.* Commonwealth of Australia, Canberra. Page 1.
[220] Lumsden, L., Racey, P.A. & Hutson, A.M. 2008. *Pipistrellus murrayi*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 27 June 2010.
[221] Schulz, M. and Lumsden, L.F. 2004. National Recovery Plan for the Christmas Island Pipistrelle *Pipistrellus murrayi.* Commonwealth of Australia, Canberra. Page 19.

5. Population and Trend

This species' population has plummeted at an extremely alarming rate over the last several years. Between 1994 and 2006, the abundance declined by 99 percent, as indicated by long-term monitoring using ultrasonic bat detectors.[222] In 2006, Dr. Lindy Lumsden (one of the foremost experts on the Christmas Island Pipistrelle) estimated the pipistrelle population to be between 500 and 1000 individuals.[223] Since that time, however, four of the seven known roost trees have fallen over.[224] Based on a population reassessment in January 2009, Dr. Lumsden estimated that there "*could be as few as 20 individuals left*, [and] [t]he only known communal roost contains only four individuals."[225] This same roost contained 54 individuals as recently as 2006, and "there were several other known, similar-sized colonies" that no longer existed by 2009.[226] Dr. Lumsden predicted that if the population decline continued at this rate, then the Christmas Island Pipistrelle would likely be extinct within the next six months, which set an extinction date of around July 2009.[227] More recent articles support this prediction. An article in Scientific American published in late May of 2009 indicated the possibility that at that time only four individual bats remained at that time.[228] By September of 2009, there was speculation that the species was extinct.[229]

6. Major Threats

Multiple factors are contributing to this species' drastic decline and possible extinction. Predation and disturbance to bats within their roosts by introduced species is a major threat.[230] The introduced species that likely pose a threat to this bat are the common wolf snake (*Lycodon aulicus capucinus*), feral cats, black rats (*Rattus rattus*),

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[222] Lumsden, L (2009). The Christmas Island Pipistrelle *(Pipistrellus murrayi)* at risk of extinction within six months!. *Australasian Bat Society Website*. [Online]. Available from: http://batcall.csu.edu.au/abs/ChristmasIsland/PipistrellusmurrayiJan_09.htm.

[223] Advice to the Minister for the Environment and Heritage from the Threatened Species Scientific Committee on Amendments to the list of Threatened Species under the Environment Protection and Biodiversity Conservation Act of 1999 (EPBC Act). Page 2.

[224] *Id.*

[225] *Id.* [emphasis added].

[226] *Id.*

[227] Lumsden, L (2009). The Christmas Island Pipistrelle *(Pipistrellus murrayi)* at risk of extinction within six months!. *Australasian Bat Society Website*. [Online]. Available from: http://batcall.csu.edu.au/abs/ChristmasIsland/PipistrellusmurrayiJan_09.htm.

[228] Platt, John. "Conservation setback may doom Christmas Island pipistrelle bat to extinction." *Scientific American*. May 29.

[229] Platt, John. "Last chance to save the Christmas Island bat fails; species doomed to extinction?" *Scientific American*. Sept. 8. Available online at: http://www.scientificamerican.com/blog/post.cfm?id=last-chance-to-save-the-christmas-i-2009-09-08.

[230] Lumsden, L., Racey, P.A. & Hutson, A.M. 2008. *Pipistrellus murrayi*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 27 June 2010.

giant centipedes (*Scolapendra morsitans*),[231] the Nankeen kestrel (*Falco cenchroides*),[232] and the yellow crazy ant (*Anoplolepis gracilipes*).[233] These species are likely to have both direct and indirect negative effects on this bat.[234] Some form of disease may also be contributing to the decline.[235] However, individuals appear to be in good health, despite low white blood cell counts.[236] Additional threats to this species include habitat alteration and destruction, altered prey availability, vehicle-related mortality, cyclones, and wildfires.[237]

7. Conservation Actions

In 2006, the Australian Government listed the Christmas Island Pipistrelle as Critically Endangered under Australia's Environmental Protection and Biodiversity Conservation Act of 1999.[238,239] Additionally, a 2004 Christmas Island Pipistrelle Recovery Plan outlines recovery objectives, timelines, and performance criteria,[240] and much of the pipistrelle's remaining range is protected by the Christmas Island National Park, which covers part of the island.[241] Active conservation actions also include installing protective barriers around the bases of the last remaining roost trees and setting up bat boxes to provide supplementary roosting locations.[242] As a final measure, in July 2009 an attempt at a captive breeding program, led by Dr. Lumsden, was made.[243]

Regarding invasive species, some progress has been made in controlling yellow crazy ant supercolonies on Christmas Island. A Yellow Crazy Ant Steering Committee was established, and with Parks Australia North, the Committee authorized an aerial ant-

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[231] *Id.*
[232] Schulz, M. and Lumsden, L.F. 2004. National Recovery Plan for the Christmas Island Pipistrelle *Pipistrellus murrayi*. Commonwealth of Australia, Canberra. Page 1.
[233] *Id.*
[234] *Id.*
[235] Lumsden, L., Racey, P.A. & Hutson, A.M. 2008. *Pipistrellus murrayi*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 27 June 2010.
[236] *Id.*
[237] Schulz, M. and Lumsden, L.F. 2004. National Recovery Plan for the Christmas Island Pipistrelle *Pipistrellus murrayi*. Commonwealth of Australia, Canberra. Page 1.
[238] Lumsden, L., Racey, P.A. & Hutson, A.M. 2008. *Pipistrellus murrayi*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 27 June 2010.
[239] Lumsden, L. 2009. "The Christmas Island Pipistrelle *(Pipistrellus murrayi)* at risk of extinction within six months!" *Australasian Bat Society Website*. [Online]. Available from: http://batcall.csu.edu.au/abs/ChristmasIsland/PipistrellusmurrayiJan_09.htm.
[240] Schulz, M. and Lumsden, L.F. 2004. National Recovery Plan for the Christmas Island Pipistrelle *Pipistrellus murrayi*. Commonwealth of Australia, Canberra. Page 32-33.
[241] Lumsden, L., Racey, P.A. & Hutson, A.M. 2008. *Pipistrellus murrayi*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 27 June 2010.
[242] *Id.*
[243] Arup, Tom. 2009. "Extinction of bat highlights critical ecosystem failure." The Sydney Morning Herald. Sept. 8. Available online at: http://www.smh.com.au/environment/extinction-of-bat-highlights-critical-ecosystem-failure-20090907-feej.html.

baiting program that destroyed the supercolonies at all targeted sites.[244]

8. ESA Listing Factors

A. <u>The present or threatened destruction, modification, or curtailment of its habitat or range</u>

The Christmas Island Pipistrelle Recovery Plan states that one of the "most critical conservation problems" the pipistrelle faces is habitat loss.[245] Habitat alteration is also a serious threat.[246] First, proposed development could threaten the bat's habitat in the near future. Phosphate mining has been proposed on the eastern side of the island, including areas within the Christmas Island National Park. This mining would result in rainforest clearing that could harm this species' foraging, commuting, and roosting habitat.[247]

Additionally, the Australian Crown is considering several development projects that would destroy this bat's habitat.[248] These include a new cell phone tower on Limestone Hill in South Point, the Christmas Island airport upgrade, and the Linkwater Road re-alignment. In the past, small numbers of pipistrelles have been found at both the proposed cell phone tower site and airport upgrade site, so construction in these areas could stress current populations of pipistrelles and reduce their habitat, threatening their long-term survival.[249]

In addition to mining and other infrastructure developments, the pipistrelle's habitat is undergoing fundamental alteration due to yellow crazy ant supercolonies.[250] This ant was introduced to Christmas Island between 1915 and 1934, though it was not until the 1990s that "dramatic increases in supercolony formation began…at several widespread locations."[251] The effect these ants have on pipistrelle habitat is multifaceted. Yellow crazy ants may access pipistrelle roosts and predate upon the bats. Roost sites may be "usurped by ants nesting in canopy or midstrata tree hollows."[252] Following ant invasions, any pipistrelles that survive will most likely be displaced and forced to select a different roost site, if available. Alternate, less desirable roost sites may not adequately shelter bats from the elements, protect against predators, and provide an appropriate "thermal microclimate."[253]

Yellow crazy ants not only threaten pipistrelle habitat by usurping their roosts, but also actually alter the rainforests in which pipistrelles live.[254] Yellow crazy ants cause tree dieback. Some tree species are more impacted than others, which could alter the

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[244] Schulz, M. and Lumsden, L.F. 2004. National Recovery Plan for the Christmas Island Pipistrelle *Pipistrellus murrayi*. Commonwealth of Australia, Canberra. Page 26).
[245] *Id.* at 42.
[246] *Id.* at 24.
[247] *Id.*
[248] *Id.*
[249] *Id.*
[250] *Id.* at 25.
[251] *Id.*
[252] *Id.*
[253] *Id.*
[254] *Id.* at 26.

floral species composition of primary rainforests on the island. The impact of these ants on the invertebrate and bird community could also impact the vegetation composition of rainforests. These combined effects could cause long-term changes in the rainforest, making it less suitable pipistrelle habitat. For example, particular tree species form hollows and exfoliate bark more than others and these trees form ideal roost sites. If these trees are impacted by the ant, the pipistrelle would have fewer suitable roost sites, which would harm the population.[255]

In addition to directly causing tree dieback, the ant also has the potential to indirectly, yet fundamentally, alter the forest ecology of Christmas Island.[256] Since 1989, yellow crazy ant activity on the island has killed 15-20 million red crabs (*Gecarcoidea natalis*). Red crabs are a keystone species that influence "the ecology of the rainforest on Christmas Island at a landscape level."[257] The mass die-off of the red crab has resulted in "increased seedling production, increased forest leaf litter accumulation, and an increase in understory growth thereby altering the structure of the rainforest."[258] These alterations may negatively impact the pipistrelle's foraging habitat. The pipistrelle prefers foraging in breaks in the canopy, and a denser mid-canopy would "restrict within-canopy foraging."[259] Increased vegetative density in the understory may also harm the bats' ability to access potential roosts.[260]

The habitat that the pipistrelle depends on for survival is undergoing fundamental alterations in species composition and understory density. Mining and infrastructure development have the potential to negatively affect the pipistrelle's habitat in the future. Combined, these pressures endanger the already extremely small population of pipistrelles on Christmas Island, and if unchecked, could be a primary driver of the species' extinction.

C. Disease or predation

An array of different introduced and naturalized predators likely feed upon the pipistrelle and threaten its continued survival. There are five predators that are believed to impact the Christmas Island pipistrelle population. These predators are yellow crazy ants, the common wolf snake, feral cats, black rats, and the Nankeen kestrel.[261,262] Giant centipedes are also believed to predate upon pipistrelles, though little information exists on the interaction between these two species.[263]

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[255] *Id.*
[256] *Id.*
[257] *Id.*
[258] *Id.*
[259] *Id.*
[260] *Id.*
[261] Lumsden, L., Racey, P.A. & Hutson, A.M. 2008. *Pipistrellus murrayi*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 27 June 2010.
[262] Schulz, M. and Lumsden, L.F. 2004. National Recovery Plan for the Christmas Island Pipistrelle *Pipistrellus murrayi*. Commonwealth of Australia, Canberra. Page 1.
[263] Lumsden, L., Racey, P.A. & Hutson, A.M. 2008. *Pipistrellus murrayi*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 27 June 2010.

Yellow crazy ants have been witnessed attacking and killing one pipistrelle.[264] This bat was caught in a harp trap and died from a yellow crazy ant attack in 1998. Another concern is that pipistrelle roosts, which are located under bark, figs, or in tree hollows, are "directly in the path of foraging columns of ants traveling from nests on the ground to the canopy where they forage."[265] Therefore, ants are likely to have easy access to pipistrelles' roost sites. The ants may infest the roosts and predate upon the bats living there. This threat is particularly worrying considering the small size of the pipistrelle, which weighs three grams, because they would more easily succumb to attack. While no maternity roosts have been discovered, they may also be located in hollows of rainforest trees, in which case they are also vulnerable to invasion by the ants. Since pipistrelle young likely weigh only one gram and cannot fly, they are considered at risk of falling prey to the yellow crazy ant.[266]

The common wolf snake is also believed to prey upon the pipistrelle.[267] This snake, originally from Southeast Asia, was introduced to the Settlement area of Christmas Island in 1987. It has since spread west and was found in buildings at Grant Well, which is at the center of the island. In 1998, a snake population was found at the Christmas Island Research and Education Station. More recently, the snake has been found on the edges of the island's primary rainforest, and it is possible that the snake has infiltrated the primary rainforest, though this in unconfirmed. By the late 1990s, up to 500 individual snakes per hectare were recorded in some areas. The snake feeds on lizards and small mammals usually found on the ground or in lower forest strata. The pipistrelle is within the size range of the snake's prey, and is in fact smaller than some other mammals that the snake is known to prey upon. The pipistrelle is also readily accessible to the snake due to the snake's ability to climb trees. Therefore, pipistrelles, "particularly those sheltering under exfoliating bark and strangler figs on the lower trunks of rainforest trees" are susceptible to predation by the snake.[268] Pipistrelle young, which are unable to fly, are especially threatened when they are left in maternity roosts at night while adults forage. Additionally, the pipistrelle did not evolve with arboreal predators, and therefore is likely to be "naïve to the risk of climbing snakes and would not have developed strategies to avoid such predation."[269]

The common wolf snake is believed to be a "likely" contributor to the pipistrelle's "decline and westward contraction."[270] The spread of the snake closely tracks the loss of pipistrelles in particular areas.[271] The Settlement was the area where the snakes were originally introduced. While the pipistrelle was common in the Settlement in 1984, prior to the snake's introduction, no pipistrelles could be found in the Settlement by 1994. By 1998, no pipistrelles were recorded in the far-northeastern part of the island, and the snake's movement to the center of the island corresponds with bat decline in that region.

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[264] Schulz, M. and Lumsden, L.F. 2004. National Recovery Plan for the Christmas Island Pipistrelle *Pipistrellus murrayi*. Commonwealth of Australia, Canberra. Page 25.
[265] *Id.*
[266] *Id.*
[267] *Id.* at 27.
[268] *Id.*
[269] *Id.*
[270] *Id.*
[271] *Id.*

Lastly, there was a "marked decline" in bat activity near the Christmas Island Research and Education Station, another location where the snake established a population. No bats were recorded at the detector sites next to the three common wolf snake locations in the island's center.[272] According to Schulz and Lumsden, "the common wolf snake is the only species for which the timing of the introduction was immediately prior to the decline of the pipistrelle and whose distribution mirrors that of the pipistrelle."[273]

Another predator of concern is feral cats, which were introduced to the Settlement Area and are now common and widespread on Christmas Island.[274] Feral cats are a "severe threat" to the island's fauna.[275] While no studies have indicated that these cats prey on the pipistrelle specifically, it is possible that cats could capture individuals since bat roosts are relatively low to the ground and bats also forage low to the ground, making themselves potentially accessible to cats.[276]

Although it is unknown whether black rats predate upon pipistrelles, they are considered to pose a "severe threat" to the native mammals on the island.[277] Similar to feral cats, black rats were introduced to the island when it was first settled, and have now become common and widespread. The rat's distribution coincides both with areas that the pipistrelle inhabits and areas where it is no longer found. It is possible that black rats may be contributing to the pipistrelles' decline, and possible changes in the rat's distribution and abundance due to altered food resources as a result of yellow crazy ant supercolonies must be considered as well.[278]

Lastly, the Nankeen kestrel is believed to have contributed to the pipistrelles' decline.[279] The kestrel originated on mainland Australia and expanded its range to Christmas Island in the 1980s. Its abundance also increased during that time. This kestrel prefers open habitats and is abundant in secondary rainforest re-growth. It does not live in areas of dense primary rainforest, although it is present along the edges and tracks of primary rainforest, which is the same type of habitat the pipistrelle forages in. While it is unlikely that the kestrel is the primary cause of the pipistrelles' decline, it is possibly a compounding factor. This is evidenced by a change in the pipistrelles' foraging behavior once this falcon became prevalent on the island. In 1984, a study recorded the pipistrelle foraging in the late afternoon, "several hours before dusk."[280] On other islands, bat foraging during daylight has been attributed to a lack of avian predators.[281] However, by 1994 a survey indicated that pipistrelles no longer foraged during daylight hours, and instead emerged at dusk, when "predation risk is lower."[282] This behavioral change may signal that this kestrel preys upon pipistrelles.[283]

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[272] *Id.*
[273] *Id.*
[274] *Id.* at 29.
[275] *Id.*
[276] *Id.*
[277] *Id.*
[278] *Id.*
[279] *Id.*
[280] *Id.*
[281] *Id.*
[282] *Id.*
[283] *Id.*

Bat species worldwide may also be at risk from white-nose syndrome, caused by a cold-loving fungus of the Geomyces genus.[284] The syndrome has been known to cause 80- 97% mortality rates in some large hibernation colonies.[285] Until recently, the disease was restricted to the northeastern United States. However, in 2009 it was detected in France.[286] It is not known how quickly this disease may spread to other areas of the world, but it poses a severe threat to all bat species, especially those with small ranges or those restricted to one or two caves. If infected, these species may lose nearly their entire population in one fell swoop.

D. The inadequacy of existing regulatory mechanisms

While numerous conservation actions have been taken to protect the Christmas Island pipistrelle, the population has nonetheless plummeted to extremely low numbers and possibly to extinction, which indicates that these measures are not adequate to protect the pipistrelle. The 2006 listing of this species as Critically Endangered under Australia's Environmental Protection and Biodiversity Conservation Act[287] did not prevent the bat's decline from between 500-1000 individuals in 2006[288] to approximately 20 individuals in January 2009,[289] and possibly to only four by late May 2009.[290] Neither the Christmas Island Pipistrelle Conservation Plan of 2004, nor the establishment of protective barriers around known roosting sites, nor the provision of bat boxes for additional roosting prevented this decline.

The captive breeding that the Australian Government attempted as a "last ditch" conservation measure in July 2009 failed.[291] This was announced on September 8, 2009.[292] A single Christmas Island Pipistrelle was observed in August 2009 but it evaded

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[284] Handwerk, Brian. 2008.: "Deadly Bat Disease Linked to Cold-Loving Fungus." National Geographic News. http://news.nationalgeographic.com/news/2008/10/081031-bat-fungus.html [Accessed October 2010].

[285] *Id.*

[286] Puechmaille SJ, Verdeyroux P, Fuller H, Ar Gouilh M, Bekaert M, Teeling EC. 2010 "White-nose syndrome fungus (*Geomyces destructans*) in bat, France." Emerg Infect Dis. e-pub. Available online at http://www.cdc.gov/eid/content/16/2/pdfs/09-1391.pdf [Accessed October 2010].

[287] Lumsden, L., Racey, P.A. & Hutson, A.M. 2008. Pipistrellus murrayi. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[288] Advice to the Minister for the Environment and Heritage from the Threatened Species Scientific Committee on Amendments to the list of Threatened Species under the Environment Protection and Biodiversity Conservation Act of 1999 (EPBC Act). Page 2.

[289] Lumsden, L. 2009. "The Christmas Island Pipistrelle *(Pipistrellus murrayi)* at risk of extinction within six months!" *Australasian Bat Society Website*. [Online]. Available from: http://batcall.csu.edu.au/abs/ChristmasIsland/PipistrellusmurrayiJan_09.htm.

[290] Platt, John. 2009. "Conservation setback may doom Christmas Island pipistrelle bat to extinction." *Scientific American*. May 29.

[291] Arup, Tom. 2009. "Extinction of bat highlights critical ecosystem failure." The Sydney Morning Herald. Sept. 8. Available online at: http://www.smh.com.au/environment/extinction-of-bat-highlights-critical-ecosystem-failure-20090907-feej.html.

[292] *Id.*

capture.[293] This was precisely the fear that Dr. Lindy Lumsden, a leading expert on the Christmas Island pipistrelle and a participant in the capture attempts, expressed in January 2009.[294] In an article written that month, Dr. Lumsden stated that it was "critical…that a captive breeding program is established immediately."[295] Dr. Lumsden further added that it was "essential" that the captive breeding program begin by March 2009 because "leaving it any longer than this, there is a risk there will be so few animals left that it will not be possible to catch them."[296] Unfortunately, this was exactly the fate of the captive breeding program.

Regulatory mechanisms to protect the pipistrelle's habitat have failed to prevent the population from drastic decline. Although the Australian government established Christmas Island National Park, this park does not cover the pipistrelle's entire known and potential habitat. Furthermore, phosphate mining has occurred in the past both within and adjacent to the National Park.[297] This mining resulted in "extensive" habitat loss, which reduced the amount of suitable habitat available to the pipistrelle population.[298] Most concerningly, there are current proposals to mine additional phosphate stockpiles both within and next to the Park, which "may adversely affect foraging, roosting, and commuting habitat" of the pipistrelle.[299] The destruction that has been allowed to occur within this Park, both in the past and potentially in the future, combined with the fact that the Park has been unable to sustain a stable pipistrelle population, indicates that the Park's creation is an inadequate mechanism for protecting the pipistrelle.

E. Other natural or manmade factors affecting its continued existence

i. Climate change

The Intergovernmental Panel on Climate Change (IPCC) states that human activities are likely contributing to global climate change. "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic [greenhouse gas] concentrations… It is likely that there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica)."[300] Due to climate change, "there are projected to be major changes in ecosystem structure and function, species' ecological interactions and

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[293] *Id.*
[294] Lumsden, L. 2009. "The Christmas Island Pipistrelle *(Pipistrellus murrayi)* at risk of extinction within six months!" *Australasian Bat Society Website*. [Online]. Available from: http://batcall.csu.edu.au/abs/ChristmasIsland/PipistrellusmurrayiJan_09.htm.
[295] *Id.*
[296] *Id.*
[297] Schulz, M. and Lumsden, L.F. 2004. National Recovery Plan for the Christmas Island Pipistrelle *Pipistrellus murrayi*. Commonwealth of Australia, Canberra.
[298] *Id.* at 38.
[299] *Id.*
[300] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Available from: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009].

shifts in species' geographical ranges, with predominantly negative consequences for biodiversity."[301] Threats from global climate change are relevant to this bat species.

The pipistrelle is endemic to an island, which face particularly urgent threats from rising sea levels and increasingly severe and frequent tropical storms caused by human-induced climate change. "Global average sea level is rising predominantly as a consequence of three factors—thermal expansion of warming ocean water, addition of new water from the ice sheets of Greenland and Antarctica and from glaciers and ice caps, and the addition of water from land hydrology. All three potential sources are undergoing changes of anthropogenic origin."[302] The IPCC projects that on small islands, "sea level rise is expected to exacerbate inundation, storm surge, erosion and other coastal hazards… [and] with higher temperatures, increased invasion by non-native species is expected to occur, particularly on mid- and high-latitude islands."[303]

ii. Other climactic conditions

Climatic conditions, primarily cyclones and fires, also threaten the Christmas Island pipistrelle.[304] A severe storm in March 1988 damaged large areas of primary rainforest, and potentially harmed pipistrelles, though the exact effect on roosting, maternity, and foraging sites is unknown. Recent droughts on Christmas Island may also have a negative impact on pipistrelles, although the specific effects of a 1997 and 1998 drought are unknown. However, it is likely that these conditions decrease the amount of invertebrate prey available to the pipistrelle, and may "influence the thermal properties of roosts resulting in a population decline."[305] Forest fires also occurred in the pipistrelles' rainforest habitat during "extended dry periods in 1994 and 1997."[306] The fires possibly impacted the pipistrelle by destroying their roost sites and decreasing prey populations. Additionally, "falling debris from wayward or failed launches."[307] at the proposed Asia Pacific Space Center may increase the risk of fire if the Center is built.[308]

iii. Changes in prey composition

The pipistrelle's prey has undergone changes as a result of yellow crazy ant supercolonies. These ants have become the numerically dominant consumer both on the island's forest floor and in the canopy.[309] At the height of the infestation, these ants had spread to 25% of the island's total rainforest area. Their diet includes a "variety of leaf litter and arboreal invertebrates" that they forage for day and night. As a result of the

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[301] *Id.*
[302] McMullen, C.P. and Jabbour, J. 2009. Climate Change Science Compendium 2009. United Nations Environment Programme, Nairobi, EarthPrint. Online at http://www.unep.org/compendium2009/ [Accessed November 2009].
[303] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009]
[304] Schulz, M. and Lumsden, L.F. 2004. National Recovery Plan for the Christmas Island Pipistrelle *Pipistrellus murrayi*. Commonwealth of Australia, Canberra.
[305] *Id.*
[306] *Id.*
[307] *Id.*
[308] *Id.*
[309] *Id.*

ants' massive numbers, wide range, and feeding habits, "intense localized predation pressures [have] altered the invertebrate diversity and abundance throughout all strata of the rainforest."[310] These predation pressures on invertebrates are likely to influence the availability of the pipistrelle's prey. The "reduction in flying insect numbers may result in reduced breeding success and a reduction in bat population size."[311]

Pipistrelles have also been negatively impacted by the chemical methods used to control yellow crazy ants.[312] Formic acid has been sprayed on Christmas Island to kill these ants. Pipistrelles exposed to formic acid have been blinded and suffered physiological stress, both of which reduce fitness[313] and therefore harm the Island's pipistrelle population.

iv. Vehicle-related mortality

Vehicle-related mortality is also a concern for this species.[314] At least some level of vehicle-related mortality is "likely to occur on main thoroughfares between the Settlement and phosphate mining site or developments in the south and west of the island."[315] The development of the Immigration, Reception, and Processing Center may cause higher mortality rates because the road that connects this Center and the Settlement "pass[es] through areas of high bat foraging activity."[316] This road, as well as others on the Island, presents a concern because the pipistrelle "commonly forages along roads from close to ground level to above canopy height within and along the ecotone of primary rainforest and secondary rainforest regrowth."[317] Furthermore, there has been an increased level of nighttime traffic on the island, which may increase pipistrelle deaths. Although traffic is not considered a major cause of mortality, the pipistrelles' extremely low population numbers means that, "any additional deaths have a greater impact."[318]

v. Biological vulnerability

The extremely low population size of the pipistrelle and its very limited range are in themselves highly threatening. A "small population size increases the risk of extinction through inbreeding depression and stochastic events."[319] This bat's "very restricted" geographic distribution is also "precarious for the survival of the species, and evidence suggests that the numbers will continue to decline at a very high rate."[320] FWS has routinely recognized that small population size and restricted range increase the likelihood of extinction.[321] Island species are particularly susceptible to extinction.[322,323]

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[310] *Id.*
[311] *Id.* at 26.
[312] *Id.* at 25.
[313] *Id.*
[314] *Id.* at 31.
[315] *Id.*
[316] *Id.*
[317] *Id.* at 30.
[318] *Id.*
[319] *Id.* at 31.
[320] *Id.* at 39.
[321] See, for example, FWS candidate assessment forms for *Doryopteris takeuchii, Huperzia stemmermanniae, Megalagrion nesiotes, Melicope degeneri, Melicope hiiakae, Myrsine mezii, Ostodes strigatus, Partula langfordi, Peperomia subpetiolata, Phyllostegia bracteata*, and

Lastly, low fecundity affects all bat species. In general, fetal development occurs slowly, with pregnancies lasting between three to six months.[324] Female bats generally produce one young per year. This is believed to be due to the very large size of bat pups at birth. Young bats comprise from between 12-15% of the mother's body mass up to 25% of the mother's body mass during pregnancy. Scientists believe that the weight of the pup during pregnancy limits the mother's litter size due to her need to fly while pregnant.[325]

Litter size is also likely limited due to nursing characteristics that are unique to bat species.[326] Most mammals wean their young when the young reach 40%, or less, of their adult size. Bats, however, nurse their young until they are nearly adult size. This is because bats cannot feed on their own until their wings are near adult dimensions. This may contribute to the low fecundity of bats.[327] Species with low fecundity are "particularly predisposed to anthropogenic threats given their low replacement rate."[328] Thus, low fecundity is another reason that the pipistrelle faces a high likelihood of extinction unless action is taken.

The numerous threats that the Christmas Island pipistrelle faces will undoubtedly continue to plague the pipistrelle's crashing population if stronger protections are not immediately implemented. The pipistrelle urgently needs listing under the ESA to avoid extinction.

Tryonia circumstriata. Accessible via FWS website at http://www.fws.gov/endangered/wildlife.html [Accessed November 2009].

[322] Groombridge, B. 1992. Global Biodiversity - Status of the Earth's Living Resources: A Report Compiled by the World Conservation Monitoring Centre. Chapman and Hall, London, New York. Available at http://www.archive.org/details/globalbiodiversi92wcmc [Accessed 10/19/10].

[323] Frankham, Richard. 2008. "Inbreeding and Extinction: Island Populations." Conservation Biology. 12: 665–675. Available at http://onlinelibrary.wiley.com/doi/10.1111/j.1523-1739.1998.96456.x/abstract [Accessed 10/19/10].

[324] Nowak, Ronald and Ernest Walker. 1994. *Walker's Bats of the World*. John Hopkins University Press. Page 20.

[325] *Id.*

[326] *Id.*

[327] *Id.*

[328] Brook, Barry, Navjot Sodhi, and Corey Bradshaw. 2008. "Synergies Among Extinction Drivers Under Global Change." *Trends in Ecology and Evolution*. 23(8): 453-460, 455.

E. Cuban Greater Funnel-Eared Bat (*Natalus primus*)

1. Taxonomy

Natalus primus belongs to the Order Chiroptera, family Natalidae. It was formerly included in *Natalus stramineus*, but is "clearly distinct from that species."[329] Leading authors on this taxonomic classification include Morgan (1989), Morgan and Czaplewski (2003), and Simmons (2005).[330]

Figure E.1 *N. primus* in flight.

Photo Source: Digital painting. New York, USA. 2002.
http://picasaweb.google.com/AdrianTejedor/Illustrations#5302390395659157138

2. Distribution and Range

This species lives on the Isle of Pines, Cuba, and is known to occur in only one cave,[331] known as Cueva La Barca.[332] This cave is located in Pinar del Rio, Manuel Lazo, which is 20 km East of Cabo de San Antonio.[333]

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[329] Dávalos, L. & Mancina, C. 2008. Natalus primus. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[330] *Id.*
[331] *Id.*
[332] Tejedor, Adrian, Valeria Tavares, and Dialvys Rodriguez-Hernandez. 2005. "New records of hot-cave bats from Cuba and the Dominican Republic." *Bol. Soc. Venezolana Espel*. 39: 10-15.
[333] *Id.*

Figure E.2 *N. primus* is endemic to the Isle of Pines, Cuba. The approximate location of the Isle is indicated by the red box in the map below.

Source: http://wwp.greenwichmeantime.com/time-zone/caribbean/cuba/map.htm

3. Habitat and Ecology

Cueva La Barca is a large phreatic cave that opens on a rocky karst plane[334] on the Guanahacabibes peninsula.[335] Cueva La Barca is a hot cave[336] that is characterized by its warmth (between 26-40°C) and humidity (above 90%).[337] Hot caves "provide this bat with climatically stable shelter where the species can minimize the energy and water required to maintain homeostasis and reproductive function." The constant heat and humidity provide this species with "high independence of external fluctuations in climate, which also enhances alertness to predators and facilitates social interaction."[338,339,340,341]

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[334] Clements, Reuben, Navjot Sodhi, Menno Schilthuizen, and Peter K. L. Ng. 2006. "Limestone karsts of Southeast Asia: imperiled arks of biodiversity." *BioScience*. 45(9): 733-742, 733.
[335] Tejedor, Adrian, Valeria Tavares, and Dialvys Rodriguez-Hernandez. 2005. "New records of hot-cave bats from Cuba and the Dominican Republic." *Bol. Soc. Venezolana Espel*. 39: 10-15.
[336] Dávalos, L. & Mancina, C. 2008. Natalus primus. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[337] Rodríguez-Durán, A. 1998. "Nonrandom aggregations of cave-dwelling bats in Puerto Rico." *J. Mammal.* 79(1): 141-146.
[338] Bonaccorso, F. J., A. Arends, M. Genoud, D. Cantoni, and T. Morton. 1992. "Thermal ecology of moustached and ghost-faced bats (Mormoopidae) in Venezuela." *J. Mammal*. 73: 365-378.
[339] Humphrey, S. R., A. R. Richter, and J. B. Cope. 1977. "Summer Habitat and Ecology of the Endangered Indiana Bat, *Myotis sodalis*." *J. Mammal*. 58: 334-346.
[340] Kunz, T. H. 1982. "Roosting ecology of bats." In *Ecology of bats*, ed. T. H. Kunz. New York: Plenum Press. Page 155.
[341] Rodríguez-Durán, A. 1998. "Nonrandom aggregations of cave-dwelling bats in Puerto Rico." *J. Mammal.* 79(1): 141-146.

Twelve additional species of bat also inhabit Cueva La Barca along with *N. primus*.[342] The vegetation surrounding the cave is a selectively logged semideciduous forest.[343] *N. primus* "is moderately to highly gregarious."[344] Copulation occurs in April, and pregnant females have been observed in May.[345] The bat's diet consists primarily of moths, crickets, and beetles.[346]

4. Population and Trend

The single cave this species is known to inhabit contains fewer than 100 individuals.[347] The population is decreasing.[348]

5. Major Threats

This species faces three primary threats, all of which jeopardize Cueva La Barca.[349] First, human intrusion on and disturbance of the hot cave is a significant threat. Second, the roof of the cave is collapsing. Third, climatic changes could "interrupt the thermal cave balance and result in extinction."[350]

6. Conservation Actions

No protective measures exist for this species.[351]

7. ESA Listing Factors

A. <u>The present or threatened destruction, modification, or curtailment of its habitat or range</u>

Three different factors jeopardize the only known location of this species. Human intrusion and disturbance result in physical degradation of the cave. The fact that the roof of the cave is collapsing, combined with climatic changes that will only become more pronounced in the future, threatens to interrupt the cave's thermal balance.[352] As described above under the "Habitat and Ecology" section, this species depends on the cave's thermal balance to save energy and increase alertness to predators, both of which

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[342] Tejedor, Adrian, Valeria Tavares, and Dialvys Rodriguez-Hernandez. 2005. "New records of hot-cave bats from Cuba and the Dominican Republic." *Bol. Soc. Venezolana Espel*. 39: 10-15.
[343] *Id.*
[344] Dávalos, L. & Mancina, C. 2008. Natalus primus. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[345] *Id.*
[346] *Id.*
[347] *Id.*
[348] *Id.*
[349] *Id.*
[350] *Id.*
[351] *Id.*
[352] *Id.*

are critical to the species' survival.[353,354,355,356] Species such as *N. primus* that roost in hot caves are especially vulnerable to "significant populational declines associated with cave disturbance due to their high gregariousness and specialized microclimatic requirements."[357]

C. Disease or predation

Bat species worldwide may be at risk from white-nose syndrome, caused by a cold-loving fungus of the Geomyces genus.[358] The syndrome has been known to cause 80- 97% mortality rates in some large hibernation colonies.[359] Until recently, the disease was restricted to the northeastern United States. However, in 2009 it was detected in France.[360] It is not known how quickly this disease may spread to other areas of the world, but it poses a severe threat to all bat species, especially those with small ranges or those restricted to one or two caves. If infected, these species may lose nearly their entire population in one fell swoop.

D. The inadequacy of existing regulatory mechanisms

No protections exist for this species at all. This situation is clearly untenable and will not ensure the continued survival of *N. primus*. Protecting Cueva La Barca is the single most important priority[361] for preventing the extinction of this bat. Protecting this cave will also assist with the protection and preservation of the twelve other species that inhabit it: *Pteronotus parnellii*, *Brachyphylla nana*, *Phyllonycteris poeyi*, *Artibeus jamaicensis*, *Eptesicus fuscus*,[362] *Mormoops blainvillii*, *Pteronotus quadridens*, *Pteronotus macleayi*, *Erophylla sezekorni*, *Monophyllus redmani*, *Chilonatalus*

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[353] Bonaccorso, F. J., A. Arends, M. Genoud, D. Cantoni, and T. Morton. 1992. "Thermal ecology of moustached and ghost-faced bats (Mormoopidae) in Venezuela." *J. Mammal*. 73: 365-378.
[354] Humphrey, S. R., A. R. Richter, and J. B. Cope. 1977. "Summer Habitat and Ecology of the Endangered Indiana Bat, *Myotis sodalis*." *J. Mammal*. 58: 334-346.
[355] Kunz, T. H. 1982. "Roosting ecology of bats." In *Ecology of bats*, ed. T. H. Kunz. New York: Plenum Press. Page 155.
[356] Rodríguez-Durán, A. 1998. "Nonrandom aggregations of cave-dwelling bats in Puerto Rico." *J. Mammal.* 79(1): 141-146.
[357] Silva-Taboada, G. 1979. *Los Murciélagos de Cuba*. La Habana: Editorial Academia.
[358] Handwerk, Brian. 2008.: "Deadly Bat Disease Linked to Cold-Loving Fungus." National Geographic News. http://news.nationalgeographic.com/news/2008/10/081031-bat-fungus.html [Accessed October 2010].
[359] *Id.*
[360] Puechmaille SJ, Verdeyroux P, Fuller H, Ar Gouilh M, Bekaert M, Teeling EC. 2010 "White-nose syndrome fungus (*Geomyces destructans*) in bat, France." Emerg Infect Dis. e-pub. Available online at http://www.cdc.gov/eid/content/16/2/pdfs/09-1391.pdf [Accessed October 2010].
[361] Dávalos, L. & Mancina, C. 2008. Natalus primus. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.
[362] Armas, L. F. de; M. E. Palacios, R. Novo, and T. Iglesias. 1989. "Fauna de Cueva La Barca, Península de Guanahacabibes, Pinar del Río: Cuba." *Reporte de Investigación Inst. Ecol. Sist., Acad. Cien. Cuba*, ser. *Zool*. 5: 1-19.

micropus,[363] and *Macrotus waterhousii*.[364] Cueva La Barca is one of the two most bat-species-rich caves not only in Cuba but also in the entire Caribbean.[365] This cave is home to 50% of Cuba's bat fauna, and 24% of all of West Indian bat fauna.[366] Protecting this cave would therefore be hugely beneficial for the diversity of bat fauna in the Caribbean region. The fact that a cave essential to the survival of so many species faces three serious threats, yet does not have a single legal protection in place, emphasizes the urgency of placing *N. primus* under the protection of the ESA, which would preserve the critical habitat it needs to survive.

E. Other natural or manmade factors affecting its continued existence

i. Additional climate change effects

The Intergovernmental Panel on Climate Change (IPCC) states that human activities are likely contributing to global climate change. "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic [greenhouse gas] concentrations… It is likely that there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica)."[367] Due to climate change, "there are projected to be major changes in ecosystem structure and function, species' ecological interactions and shifts in species' geographical ranges, with predominantly negative consequences for biodiversity."[368] Threats from global climate change are relevant to this bat species.

N. primus is endemic to an island, which face particularly urgent threats from rising sea levels and increasingly severe and frequent tropical storms caused by human-induced climate change. "Global average sea level is rising predominantly as a consequence of three factors—thermal expansion of warming ocean water, addition of new water from the ice sheets of Greenland and Antarctica and from glaciers and ice caps, and the addition of water from land hydrology. All three potential sources are undergoing changes of anthropogenic origin."[369] The IPCC projects that on small islands, "sea level rise is expected to exacerbate inundation, storm surge, erosion and other coastal hazards… [and] with higher temperatures, increased invasion by non-native species is expected to occur, particularly on mid- and high-latitude islands."[370] *N. primus*

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[363] Tejedor, Adrian, Valeria Tavares, and Dialvys Rodriguez-Hernandez. 2005. "New records of hot-cave bats from Cuba and the Dominican Republic." *Bol. Soc. Venezolana Espel*. 39: 10-15.
[364] *Id.*
[365] *Id.*
[366] *Id.*
[367] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Available from: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009].
[368] *Id.*
[369] McMullen, C.P. and Jabbour, J. 2009. Climate Change Science Compendium 2009. United Nations Environment Programme, Nairobi, EarthPrint. Online at http://www.unep.org/compendium2009/ [Accessed November 2009].
[370] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009]

lives near Cuba's coast, and therefore climate change will have an even more serious impact on this species. On coastlines, "the impacts of sea level rise will be felt through both an increase in mean sea-level and through an increase in the frequency of extreme sea-level events such as storm surges."[371] The Intergovernmental Panel on Climate Change (IPCC) underscored the risk facing coasts worldwide from climate change: "Coasts are projected to be exposed to increasing risks, including coastal erosion, due to climate change and sea level rise. The effect will be exacerbated by increasing human-induced pressures on coastal areas (very high confidence)…"[372]

ii. Biological vulnerability

Two additional factors place *N. primus* in peril of extinction. First, the extremely low population size, which is less than 100 individuals,[373] increases the likelihood that this species will go extinct. When a species' population reaches such a low number of individuals, inbreeding depression and stochastic events increase the likelihood of extinction.[374] FWS has routinely recognized that small population size and restricted range increase the likelihood of extinction.[375] Island species are particularly susceptible to extinction.[376,377]

Lastly, low fecundity affects all bats species. In general, fetal development occurs slowly, with pregnancies lasting between three to six months.[378] Female bats generally produce one young per year. This is believed to be due to the very large size of bat pups at birth. Young bats comprise from between 12-15% of the mother's body mass up to 25% of the mother's body mass during pregnancy. Scientists believe that the weight of the pup during pregnancy limits the mother's litter size due to her need to fly while

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[371] Karl, T.R., Melillo, J. M., and T.C. Peterson (eds). 2009. Global Climate Change Impacts in the United States, Cambridge University Press, 2009. Online at http://www.globalchange.gov/whats-new/286-new-assessment-climate-impacts-us [Accessed November 2009].

[372] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009]

[373] Dávalos, L. & Mancina, C. 2008. Natalus primus. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. www.iucnredlist.org.

[374] Schulz, M. and Lumsden, L.F. 2004. National Recovery Plan for the Christmas Island Pipistrelle *Pipistrellus murrayi*. Commonwealth of Australia, Canberra. Page 31.

[375] See, for example, FWS candidate assessment forms for *Doryopteris takeuchii, Huperzia stemmermanniae, Megalagrion nesiotes, Melicope degeneri, Melicope hiiakae, Myrsine mezii, Ostodes strigatus, Partula langfordi, Peperomia subpetiolata, Phyllostegia bracteata*, and *Tryonia circumstriata*. Accessible via FWS website at http://www.fws.gov/endangered/wildlife.html [Accessed November 2009].

[376] Groombridge, B. 1992. Global Biodiversity - Status of the Earth's Living Resources: A Report Compiled by the World Conservation Monitoring Centre. Chapman and Hall, London, New York. Available at http://www.archive.org/details/globalbiodiversi92wcmc [Accessed 10/19/10].

[377] Frankham, Richard. 2008. "Inbreeding and Extinction: Island Populations." Conservation Biology. 12: 665–675. Available at http://onlinelibrary.wiley.com/doi/10.1111/j.1523-1739.1998.96456.x/abstract [Accessed 10/19/10].

[378] Nowak, Ronald and Ernest Walker. 1994. *Walker's Bats of the World*. John Hopkins University Press. Page 20.

pregnant.[379]

Litter size is also likely limited due to nursing characteristics that are unique to bat species.[380] Most mammals wean their young when the young reach 40%, or less, of their adult size. Bats, however, nurse their young until they are nearly adult size. This is because bats cannot feed on their own until their wings are near adult dimensions. This may contribute to the low fecundity of bats.[381] Species with low fecundity are "particularly predisposed to anthropogenic threats given their low replacement rate."[382] Thus, low fecundity is another reason that *N. primus* faces a high likelihood of extinction unless action is taken.

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[379] *Id.*
[380] *Id.*
[381] *Id.*
[382] Brook, Barry, Navjot Sodhi, and Corey Bradshaw. 2008. "Synergies Among Extinction Drivers Under Global Change." *Trends in Ecology and Evolution*. 23(8): 453-460, 455.

F. Greater Monkey-Faced Bat (Pteralopex flanneryi)

1. Taxonomy

Although scientists used to believe that only one species of *Pteralopex*, *Pteralopex anceps*, lived in Papua New Guinea and the Solomon Islands, two species (both *P. anceps* and *Pteralopex flanneryi*) actually occur in this area.[383] The two species are differentiated by physical characteristics and habitat preference. *P. anceps* has an extensive yellow belly and it prefers upland habitat,[384] whereas *P. flanneryi* has fur on the breast that is only tipped with yellow or white[385] and it prefers lowland habitat.[386] *P. flanneryi* also has a much larger skull and a narrower braincase than *P. anceps*.[387] Based on this evidence, these two bats have been determined to be two separate and distinct species.[388] For a detailed morphological contrast of these two species, see Helgen, 2005.[389]

2. Physical Description

P. flanneryi is the largest of the five known monkey-faced bats.[390] It has a forearm length of 159 mm or greater, and a condylobasal skull length of greater than 71 mm. Its fur is black with occasional lighter colored hair (yellow or white) on the breast in adults.[391]

3. Distribution and Range

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[383] Helgen, K., Hamilton, S. & Leary, T. 2008. Pteralopex flanneryi. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[384] *Id.*
[385] Helgen, K. M. 2005. "Systematics of the Pacific monkey-faced bats (Chiroptera: Pteropodidae), with a new species of *Pteralopex* and a new Fijian genus." *Systematics and Biodiversity* 3(4): 433-453, 437.
[386] Helgen, K., Hamilton, S. & Leary, T. 2008. Pteralopex flanneryi. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[387] Helgen, K. M. 2005. "Systematics of the Pacific monkey-faced bats (Chiroptera: Pteropodidae), with a new species of *Pteralopex* and a new Fijian genus." *Systematics and Biodiversity*. 3(4): 433-453, 437.
[388] Helgen, K., Hamilton, S. & Leary, T. 2008. Pteralopex flanneryi. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[389] Helgen, K. M. 2005. "Systematics of the Pacific monkey-faced bats (Chiroptera: Pteropodidae), with a new species of *Pteralopex* and a new Fijian genus." *Systematics and Biodiversity*. 3(4): 433-453, 439.
[390] *Id.* at 437.
[391] *Id.*

This bat is native to Papua New Guinea and the Solomon Islands.[392] Specifically, this species inhabits the islands of Bougainville, Puruata, Buka, Choiseul, Isabel, and Barora Fa. It is found from sea level up to 200m.[393]

Figure F.1 *P. flanneryi* is native to Papua New Guinea and the Solomon Islands.

Source (left): Helgen, K., Hamilton, S. & Leary, T. 2008. Pteralopex flanneryi. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
Source (right): http://www.google.com/imgres?imgurl=http://explore.wingsworldquest.org/userfiles/Mytinger%2520Map(3).jpg&imgrefurl

4. Habitat and Ecology

P. flanneryi is "entirely dependent on old-growth, lowland forest,"[394] which it probably needs both for roosting sites and for hunting its preferred foods.[395] It likely roosts solitarily in foliage, though it might also use hollows in large ficus trees."[396] Regarding reproduction, a female collected in 1968 was lactating in July, and "subadults have been collected in February, April, and September."[397] The generation length may be five years.[398] The diet of this species is largely unknown, but one individual was seen

[392] Helgen, K., Hamilton, S. & Leary, T. 2008. Pteralopex flanneryi. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[393] *Id.*
[394] *Id.*
[395] Helgen, K. M. 2005. "Systematics of the Pacific monkey-faced bats (Chiroptera: Pteropodidae), with a new species of *Pteralopex* and a new Fijian genus." *Systematics and Biodiversity* 3(4): 433-453, 450.
[396] Helgen, K., Hamilton, S. & Leary, T. 2008. Pteralopex flanneryi. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[397] Helgen, K. M. 2005. "Systematics of the Pacific monkey-faced bats (Chiroptera: Pteropodidae), with a new species of *Pteralopex* and a new Fijian genus." *Systematics and Biodiversity*. 3(4): 433-453, 442.
[398] Helgen, K., Hamilton, S. & Leary, T. 2008. Pteralopex flanneryi. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

eating green coconuts on Isabel Island.[399]

5. Population and Trend

The population has decreased by more than 80% over the last three generations, and this drastic decline is expected to continue.[400] Surveys conducted in the 1990s failed to locate *P. flanneryi* on Choiseul Island, which indicated that this bat "may have already been extirpated from Choiseul Island."[401] Local people of Choiseul also suggest that the bat has disappeared from the island. The species was last collected on Choiseul in 1964. A survey from the 1990s on Isabel Island also failed to detect this species. Another survey conducted from 2002-2005 on Bougainville was unable to find this bat. The most recent specimen found on Bougainville was collected in 1968. The most recent collection from Buka was in 1987, and from Barora Fa in 2000.[402]

6. Major Threats

Habitat destruction and disturbance through forest clearing and active hunting likely threatens this bat.[403]

7. Conservation Actions

No conservation actions are in place for this species.[404]

8. ESA Listing Factors

A. <u>The present or threatened destruction, modification, or curtailment of its habitat or range</u>

Much of the primary forest that *P. flanneryi* depends on for roosting and food has been destroyed through timber logging.[405] This is a serious threat because "relatively large areas of old-growth forest [are needed] to sustain resident populations" of this species.[406] This is a threat across the species' entire range because both countries where this species is found, the Solomon Islands and Papua New Guinea, have experienced

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[399] Helgen, K. M. 2005. Systematics of the Pacific monkey-faced bats (Chiroptera: Pteropodidae), with a new species of *Pteralopex* and a new Fijian genus. *Systematics and Biodiversity* 3(4): 433-453, 442.
[400] Helgen, K., Hamilton, S. & Leary, T. 2008. Pteralopex flanneryi. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[401] *Id.*
[402] *Id.*
[403] *Id.*
[404] *Id.*
[405] Helgen, K. M. 2005. "Systematics of the Pacific monkey-faced bats (Chiroptera: Pteropodidae), with a new species of *Pteralopex* and a new Fijian genus." *Systematics and Biodiversity*. 3(4): 433-453, 451.
[406] *Id.*

relatively high rates of primary forest loss.[407]

On the Solomon Islands, small-scale logging began in the 1920s due to Australian demand for tropical timber.[408] Until World War II, this industry was "minor."[409] The use of the Island's timber resources during World War II, however, increased foreign interest in exploiting the Island's forest. With the expectation of future timber markets, as well as burgeoning local demand, the Island's colonial government "invoked a model of forest use common to many British and other imperial powers, the establishment of sustainable plantation forestry on government land."[410] These forestry plantations were frequently planted with exotic species of hardwoods.[411] By the 1960s, new technological developments, including chain-saws, tractors, and bulldozers, allowed foreign loggers to economically harvest large areas of the Island's forests.[412] Around this same time, with the growing push for de-colonization, the Island's colonial government began to view the development of its forests as a means of financing itself and so extended government timber plantations. These plans came to a head beginning in 1978, when the Solomon Islands gained independence at the same time that timber supplies in South-east Asia began to decline. These two developments, in addition to technological developments and a government that wanted to build wealth through forest resource exploitation, led to high levels of logging in the 1980s and 1990s. The primary loggers during this time were Asian companies with Japan being the primary importer of felled logs.[413]

This development brought with it extensive habitat destruction. As timber comprised an increasing source of income to the Solomon Island government, the government's "flawed economic decisions" meant that "logging became more politicized and unsustainable, with extraction rates far exceeding forest increment."[414] This is put in sharp focus by the large increase in extraction rates that occurred in the 1990s.[415] Between 1991 and 1995, log production from forested lands "more than doubled, increasing from 381,000 cubic meters to about 826,000 cubic meters" with the production rate in 1996 remaining at approximately the same level as 1995.[416] This put production "around three times higher than sustainable levels."[417] Further estimates from that time indicate that if logging continued at the 1996 rate, the Solomon Islands would deplete its commercial timber supply in approximately 10 years, which would have been around 2007.[418] Given this, "all scenarios indicate a looming environmental… crisis for the

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[407] Wiles, Gary and Anne Brooke. "Conservation Threats to Bats in the Tropical Pacific Islands." in Fleming, Theodore and Paul Racey. 2010. *Island Bats: Evolution, Ecology, and Conservation*. University of Chicago Press: 1-549, 407.
[408] Bennett, Judith. 2000. *Pacific Forest: a history of resource control and contest in the Solomon Islands, c. 1800-1997*. White Horse Press: Cambridge. 1-517, 2.
[409] *Id.*
[410] *Id.*
[411] *Id.* at 204.
[412] *Id.* at 2.
[413] *Id.* at 1.
[414] *Id.* at 2.
[415] Dauvergne, Peter. 1997. "Globalization and Deforestation in the Asia-Pacific." Working Paper No. 1997/7. Australian National University. Page 1-31, 14.
[416] *Id.*
[417] *Id.*
[418] *Id.*

Solomon Islands."[419]

The unsustainable logging of the Solomon Islands has produced long-lasting negative environmental impacts. Timber companies used extensive networks of gravel roads to access forest stands,[420] which fragmented whatever forest patches were left standing and likely decreases the suitability of those patches for bat habitat. Additionally, a study conducted as early as 1970 indicated that the topsoil in many logged areas was so damaged that attempts to reforest the area 20 years later failed.[421] In areas that could be replanted, the use of tractors to log had "re-distributed and compacted the topsoil" to such an extent that the growth of replanted trees was reduced.[422]

Not only has the forest that *P. flanneryi* relies on been destroyed, but the fundamental soil structure has also been damaged in a way that will likely preclude re-growth of the forest. These deforested areas may never be able to support this species again, even in the distant future. Habitat restoration, if planned, might therefore not be an effective solution for reviving the habitat that this species needs.

Local subsistence farmers and squatters have also degraded, destroyed, and altered the ecology of previously forested land on the Solomon Islands.[423] Farmers have "gardened, cut wood, lit fires, built houses, kept pigs…and generally denuded the hills."[424] This has resulted not only in habitat destruction but also in fundamental habitat alteration, as land that was once covered by primary forest is now "dominated by thermida grass and the 'weed' tree *Brousonnettia papirifera*."[425]

In Papua New Guinea, *P. flanneryi*'s forest habitat has been deforested and degraded. A 2009 study based on land-cover maps indicates that deforestation and forest degradation has "occurred to a greater extent than previously recorded."[426] Between 1972 and 2002, Papua New Guinea lost a total of 15% of its primary forest, and logging degraded an additional 8.8%.[427] Much of this clearing was concentrated in accessible forest estates, which lost 36% of their primary forest to deforestation and degradation.[428] The major drivers of this deforestation are "logging in the lowland forests and subsistence agriculture, with minor contributions also being made by forest fires, plantation establishment, and mining."[429]

Logging in Papua New Guinea takes two forms.[430] First, much logging involves

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[419] *Id.*
[420] Bennett, Judith. 2000. *Pacific Forest: a history of resource control and contest in the Solomon Islands, c. 1800-1997*. White Horse Press: Cambridge. 1-517, 187.
[421] *Id.*
[422] *Id.*
[423] *Id.* at 188-189.
[424] *Id.*
[425] *Id.*
[426] Shearman, Phil, Julian Ash, Brendan Mackey, Jane Bryan, and Barbara Lokes. 2009. "Forest Conversion and Degradation in Papua New Guinea 1972-2002." *Biotropica*. 41 (3): 379-390, 379 (abstract).
[427] *Id.*
[428] *Id.*
[429] *Id.*
[430] Whitmore, Timothy, and Jeffrey Sayer. 1992. *Tropical Deforestation and Species Extinction*. IUCN Forest Conservation Programme. Chapman & Hall: London. 1-155, 144-146.

clear cutting for wood-chip production.[431] Clear cutting in Papua New Guinea has "resulted in almost complete loss of the natural species diversity of the forest" in clear-cut areas.[432] Tracts that have been clear-cut do not regenerate in a manner that reflects the species composition of the original primary rainforest.[433] After primary forest has been cleared, "aggressive secondary species, such as *Anthocephalus chinensis* and *Macaranga* spp., [become] established."[434] Most other species, including trees, shrubs, and herbs, do not re-establish in clear-cut areas.[435] A study indicated that even after four years, vegetation re-growth in clear-cut areas was comprised of only four to five woody species.[436]

Logging also occurs via "selective logging for export-grade lumber."[437] Despite selective logging, the impacts on primary forest are disruptive[438] and the subsequent degradation likely decreases or eliminates the habitat for *P. flanneryi*, which require large areas of old-growth forest.[439] Removing logs "includes damage during felling operations, damage during skidding, clearing for log dumps and the destruction of drainage systems during track construction."[440] Microclimate changes can also occur as a result of selective logging.[441]

Logging provides access into previously remote forest. Farmers often move in and clear land for agriculture subsequent to logging.[442] The primary crops include cocoa, coffee, rubber, oil palm, and copra.[443] The Government of Papua New Guinea promotes the establishment of agriculture in these areas, despite "the economic, social, or biological problems associated with deforestation."[444]

Another threat to the habitat of *P. flanneryi* in Papua New Guinea is extensive large-scale mining operations.[445] Mining "plays a prominent role in the country's development strategy."[446] In 1990, Papua New Guinea generated 12% of its GDP by mining, which "provided over 60% of the total export revenues."[447] As of 1990, there

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[431] *Id.*
[432] *Id.*
[433] *Id.* at 144.
[434] *Id.*
[435] *Id.*
[436] *Id.*
[437] *Id.* at 145.
[438] *Id.*
[439] Helgen, K. M. 2005. "Systematics of the Pacific monkey-faced bats (Chiroptera: Pteropodidae), with a new species of *Pteralopex* and a new Fijian genus." *Systematics and Biodiversity*. 3(4): 433-453, 451.
[440] Whitmore, Timothy, and Jeffrey Sayer. 1992. *Tropical Deforestation and Species Extinction*. IUCN Forest Conservation Programme. Chapman & Hall: London. 1-155, 145.
[441] *Id.*
[442] *Id.*
[443] *Id.*
[444] *Id.*
[445] Bartelmus, Peter, Ernst Lutz, and Stefan Schweinfest. 1992. "Integrated Environmental and Economic Accounting: a case study for Papua New Guinea." The World Bank. Environment Working Paper No. 54. Page 1-57, 15.
[446] *Id.*
[447] *Id.*

were five primary mines within the country that produced 95% of the nation's mineral output.[448] The first mine was the Bougainville copper and gold mine, which began operations in 1972 on the island of Bougainville,[449] which is a part of *P. flanneryi*'s range.[450] By 1988, the mine had increased production and "contributed approximately 35 percent of the country's export earnings."[451] In 1989, the mine was shut down due to conflicts with local landowners.[452] After this closure, Ok Tedi gold and copper mine, which was opened in 1984, became Papua New Guinea's main mining project. It is located in the Star Mountains of the Western Province, and has an expected lifetime of 25 years. The third mine was the Mount Victor gold mine, which began mining activities in 1987 and depleted the gold resources of the mountain within three years. The Wau gold and silver mine began open pit activities in 1986 and closed in 1990 after the removal of 3.2 tons of gold and 3.8 tons of silver. The Porgera gold mine is a very large operation that began in 1990. It is expected to produce 28 tons of gold each year for 25 to 30 years. In addition to mines that have already begun operations, there are five additional mines that as of 1990 were under development. These operations are: (1) the Lihir gold mine, which is estimated to contain 585 tons of gold and will likely run for between 26 to 38 years, (2) the Kutubu oil project, which is expected to produce 169.8 million barrels of oil and begin production in 1992, (3) the Mt. Kare gold project, which is expected to produce 15 tons of gold, (4) the Hides gas project, which has an estimated reserve of 2.9 trillion cubic feet of gas, and (5) the Hidden Valley gold project, which is expected to produce 77 tons of gold and 1140 tons of silver over 10 years.[453]

Additionally, as of 1990 there were numerous "potential mines in an advanced stage of exploration."[454] These include "the Lakeamu gold prospect, the Tabar gold prospect, the Uramit gold prospect in East New Britain, the Tolukuma gold prospect in Central Province, the Wafi and Hamata gold prospects in Morobe, [and] the Agogo and Usano oil fields in Southern Highlands Province."[455] Furthermore, the government has approved prospecting activities in approximately 200 additional locations.[456]

The extensive destruction and degradation of primary forest from unsustainable logging and numerous mining operations threatens the continued survival of *P. flanneryi*. The governmental policies of both the Solomon Islands and Papua New Guinea favor extractive industries, which form the basis of their economy.[457,458,459] There are few

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[448] *Id.*
[449] *Id.*
[450] Helgen, K., Hamilton, S. & Leary, T. 2008. Pteralopex flanneryi. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[451] Bartelmus, Peter, Ernst Lutz, and Stefan Schweinfest. 1992. "Integrated Environmental and Economic Accounting: a case study for Papua New Guinea." The World Bank. Environment Working Paper No. 54. Page 1-57, 15.
[452] *Id.*
[453] *Id.*
[454] *Id.*
[455] *Id.*
[456] *Id.*
[457] Bartelmus, Peter, Ernst Lutz, and Stefan Schweinfest. 1992. "Integrated Environmental and Economic Accounting: a case study for Papua New Guinea." The World Bank. Environment Working Paper No. 54. Page 1-57, 15, 22.

policies in place to protect forested areas[460] and the destruction and degradation of the habitat that *P. flanneryi* needs to roost and forage will likely continue.

B. Over-utilization for commercial, recreational, scientific, or educational purposes

Humans hunt *P. flanneryi* for meat.[461] The hunting rate increased in Bougainville during "civil tensions" that occurred between 1987 and 2000.[462] Of the *Pteralopex* species that occur in Papua New Guinea and the Solomon Islands, this species is the largest,[463] which likely increases its susceptibility to hunting. Hunting has been identified as a factor in this species' decline across its range.[464]

C. Disease and predation

Bat species worldwide may also be at risk from white-nose syndrome, caused by a cold-loving fungus of the Geomyces genus.[465] The syndrome has been known to cause 80- 97% mortality rates in some large hibernation colonies.[466] Until recently, the disease was restricted to the northeastern United States. However, in 2009 it was detected in France.[467] It is not known how quickly this disease may spread to other areas of the world, but it poses a severe threat to all bat species, especially those with small ranges or those restricted to one or two caves. If infected, these species may lose nearly their entire population in one fell swoop.

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[458] *See* Dauvergne, Peter. 1997. "Globalization and Deforestation in the Asia-Pacific." Working Paper No. 1997/7. Australian National University. Page 1-31, 14.
[459] *See* Bennett, Judith. 2000. *Pacific Forest: a history of resource control and contest in the Solomon Islands, c. 1800-1997*. White Horse Press: Cambridge. 1-517, 2.
[460] *See* Dauvergne, Peter. 1997. "Globalization and Deforestation in the Asia-Pacific." Working Paper No. 1997/7. Australian National University. Page 1-31, 14.
[461] Helgen, K., Hamilton, S. & Leary, T. 2008. Pteralopex flanneryi. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[462] *Id.*
[463] Helgen, K. M. 2005. "Systematics of the Pacific monkey-faced bats (Chiroptera: Pteropodidae), with a new species of *Pteralopex* and a new Fijian genus." *Systematics and Biodiversity*. 3(4): 433-453, 437.
[464] Helgen, K., Hamilton, S. & Leary, T. 2008. Pteralopex flanneryi. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[465] Handwerk, Brian. 2008.: "Deadly Bat Disease Linked to Cold-Loving Fungus." National Geographic News. http://news.nationalgeographic.com/news/2008/10/081031-bat-fungus.html [Accessed October 2010].
[466] *Id.*
[467] Puechmaille SJ, Verdeyroux P, Fuller H, Ar Gouilh M, Bekaert M, Teeling EC. 2010 "White-nose syndrome fungus (*Geomyces destructans*) in bat, France." Emerg Infect Dis. e-pub. Available online at http://www.cdc.gov/eid/content/16/2/pdfs/09-1391.pdf [Accessed October 2010].

D. The inadequacy of existing regulatory mechanisms

There are currently no measures in place, either in Papua New Guinea or in the Solomon Islands, to protect *P. flanneryi*.[468] Considering that this species' population has declined by over 80% in the last three generations, and that the threats it faces are ongoing and severe,[469] the complete lack of any form of protection is clearly inadequate to protect this species from further decline and ultimately extinction.

Not only do these two governments' policies strongly favor extractive industries, which form the basis of their economies,[470,471,472] but foreign corporate pressures have strongly influenced government officials, leading to a very favorable climate for resource extraction[473] and facilitating habitat destruction. Solomon Island's "state officials have succumbed to corporate pressures and bribes, stalling environmental reforms, eroding implementation of forest management rules, and leading to generous tax breaks."[474] So many logging permits have been granted that both local communities and the Forestry Division itself, the very government agency responsible for monitoring logging negotiations, are largely unable to "monitor and control foreign loggers."[475] The logging permitting process is overlaid by "inadequate state supervision, ambiguous laws, corrupt and divided community negotiators, corporate bribes, corporate funding of Area Council [Timber Rights] meetings [where leaders determine whether private landowners are willing to sell the timber on their lands], and highly trained corporate negotiators, [which] have generally allowed multinational timber companies to negotiate favorable agreements."[476]

Timber corporations have gone to great lengths to maintain this favorable environment through pressuring and bribing politicians and bureaucrats to "reverse reforms that threaten profits."[477] Beginning in 1993, Prime Minister Billy Hilly's government started to undertake progressive reforms of the timber industry. The new policies were designed to decrease logging and increase government oversight. This period of reform was short-lived because Billy Hilly's government collapsed in 1994

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[468] Helgen, K., Hamilton, S. & Leary, T. 2008. Pteralopex flanneryi. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[469] *Id.*

[470] *See* Bartelmus, Peter, Ernst Lutz, and Stefan Schweinfest. 1992. "Integrated Environmental and Economic Accounting: a case study for Papua New Guinea." The World Bank. Environment Working Paper No. 54. Page 1-57, 15, 22.

[471] *See* Dauvergne, Peter. 1997. "Globalization and Deforestation in the Asia-Pacific." Working Paper No. 1997/7. Australian National University. Page 1-31, 14.

[472] *See* Bennett, Judith. 2000. *Pacific Forest: a history of resource control and contest in the Solomon Islands, c. 1800-1997*. White Horse Press: Cambridge. 1-517, 2.

[473] Dauvergne, Peter. 1997. "Weak states and the environment in Indonesia and the Solomon Islands." Resource Management in Asia-Pacific. Working Paper No. 10. 1-17, 9. Available from: http://dspace-prod1.anu.edu.au/bitstream/1885/40975/2/rmap_wp10.pdf.

[474] *Id.*

[475] *Id.*

[476] *Id.*

[477] *Id.*

under "a series of defections and resignations."[478] Joses Tuhanuku, the Minister of Forests, Environment, and Conservation at the time, stated that the numerous defections and ultimate government collapse was a result of foreign logging companies.[479] After this, environmental protections and control over foreign loggers afforded by subsequent governments "weakened even further" from the level of the very early 1990s.[480]

Not only is the government of the Solomon Islands ineffective at regulating and controlling foreign logging companies, but the few environmental protections that it has put in place are "largely ignor[ed]" or "blatantly disregard[ed]" by foreign companies.[481] The government's "weak state administrative capacity, limited state legal powers, remote logging sites, and few provincial and community resources allow loggers to operate with little scrutiny and almost no restraints."[482] These conditions have enabled logging company actions that have devastated the forested areas of the Solomon Islands.[483] Violations and impacts include "companies [that] log areas outside their license, damage or cut undersized or protected trees, build temporary and inappropriate roads and bridges, leave pools of stagnant water that spread malaria, pollute and disrupt food and water sources, disregard reforestation duties, and ignore obligations to consult with landowners."[484] One study found that a logging site in the Solomon Islands had "a degree of canopy removal and soil disturbance [that] was the most extensive seen by the authors in any logging operation in tropical rainforest in any country."[485] The *1995 Forestry Review*, described as an "unofficial internal government document," stated that "forest practices in many locations [in the Solomon Islands] are amongst the worst in the world."[486] The political environment, as well as the practices of the foreign logging industries that operate in the Solomon Islands, has created conditions that clearly demonstrate a complete inadequacy of existing regulatory mechanisms to protect *P. flanneryi*, which is entirely reliant upon forests that receive virtually no protection. This is a serious threat to this species' survival.

E. Other natural or manmade factors affecting its continued existence

i. Climate change

The Intergovernmental Panel on Climate Change (IPCC) states that human activities are likely contributing to global climate change. "Most of the observed increase

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[478] *Id.*
[479] *Id.*
[480] *Id.* at 9-10.
[481] *Id.* at 10.
[482] *Id.*
[483] *Id.*
[484] *Id.*
[485] Dauvergne, Peter. 1997. "Weak states and the environment in Indonesia and the Solomon Islands." Resource Management in Asia-Pacific. Working Paper No. 10. 1-17, 10. Available from: http://dspace-prod1.anu.edu.au/bitstream/1885/40975/2/rmap_wp10.pdf citing Forests Monitor, draft briefing document, "Kumpulan Emas Berhad and its Involvement in the Solomon Islands," April 1996. p. 7.
[486] Dauvergne, Peter. 1997. "Weak states and the environment in Indonesia and the Solomon Islands." Resource Management in Asia-Pacific. Working Paper No. 10. 1-17, 10. Available from: http://dspace-prod1.anu.edu.au/bitstream/1885/40975/2/rmap_wp10.pdf.

in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic [greenhouse gas] concentrations… It is likely that there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica)."[487] Due to climate change, "there are projected to be major changes in ecosystem structure and function, species' ecological interactions and shifts in species' geographical ranges, with predominantly negative consequences for biodiversity."[488] Threats from global climate change are relevant to this bat species.

P. flanneryi is endemic to an island, which face particularly urgent threats from rising sea levels and increasingly severe and frequent tropical storms caused by human-induced climate change. "Global average sea level is rising predominantly as a consequence of three factors—thermal expansion of warming ocean water, addition of new water from the ice sheets of Greenland and Antarctica and from glaciers and ice caps, and the addition of water from land hydrology. All three potential sources are undergoing changes of anthropogenic origin."[489] The IPCC projects that on small islands, "sea level rise is expected to exacerbate inundation, storm surge, erosion and other coastal hazards… [and] with higher temperatures, increased invasion by non-native species is expected to occur, particularly on mid- and high-latitude islands."[490] This species has an elevational range of 0-200 m, which may place some individuals near the coast. Therefore, climate change will have an even more serious impact on this species. On coastlines, "the impacts of sea level rise will be felt through both an increase in mean sea-level and through an increase in the frequency of extreme sea-level events such as storm surges."[491] The IPCC underscored the risk facing coasts worldwide from climate change: "coasts are projected to be exposed to increasing risks, including coastal erosion, due to climate change and sea level rise. The effect will be exacerbated by increasing human-induced pressures on coastal areas (very high confidence)…"[492]

ii. Biological vulnerability

The range of this species is restricted to six islands. FWS has routinely recognized

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[487] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Available from: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009].

[488] *Id.*

[489] McMullen, C.P. and Jabbour, J. 2009. Climate Change Science Compendium 2009. United Nations Environment Programme, Nairobi, EarthPrint. Online at http:// www.unep.org/compendium2009/ [Accessed November 2009].

[490] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009]

[491] Karl, T.R., Melillo, J. M., and T.C. Peterson (eds). 2009. Global Climate Change Impacts in the United States, Cambridge University Press, 2009. Online at http://www.globalchange.gov/whats-new/286-new-assessment-climate-impacts-us [Accessed November 2009].

[492] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009]

that small population size and restricted range increase the likelihood of extinction.[493] Island species are particularly susceptible to extinction.[494,495]

One additional factor that makes this species particularly vulnerable to extinction is low fecundity, which affects all bats species. In general, fetal development occurs slowly, with pregnancies lasting between three to six months.[496] Female bats generally produce one young per year. This is believed to be due to the very large size of bat pups at birth. Young bats comprise from between 12-15% of the mother's body mass up to 25% of the mother's body mass during pregnancy. Scientists believe that the weight of the pup during pregnancy limits the mother's litter size due to her need to fly while pregnant.[497]

Litter size is also likely limited due to nursing characteristics that are unique to bat species.[498] Most mammals wean their young when the young reach 40%, or less, of their adult size. Bats, however, nurse their young until they are nearly adult size. This is because bats cannot feed on their own until their wings are near adult dimensions. This may contribute to the low fecundity of bats.[499] Species with low fecundity are "particularly predisposed to anthropogenic threats given their low replacement rate."[500] Thus, low fecundity is another reason that this species faces a high likelihood of extinction unless further action is taken.

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[493] See, for example, FWS candidate assessment forms for *Doryopteris takeuchii, Huperzia stemmermanniae, Megalagrion nesiotes, Melicope degeneri, Melicope hiiakae, Myrsine mezii, Ostodes strigatus, Partula langfordi, Peperomia subpetiolata, Phyllostegia bracteata*, and *Tryonia circumstriata*. Accessible via FWS website at http://www.fws.gov/endangered/wildlife.html [Accessed November 2009].

[494] Groombridge, B. 1992. Global Biodiversity - Status of the Earth's Living Resources: A Report Compiled by the World Conservation Monitoring Centre. Chapman and Hall, London, New York. Available at http://www.archive.org/details/globalbiodiversi92wcmc [Accessed 10/19/10].

[495] Frankham, Richard. 2008. "Inbreeding and Extinction: Island Populations." Conservation Biology. 12: 665–675. Available at http://onlinelibrary.wiley.com/doi/10.1111/j.1523-1739.1998.96456.x/abstract [Accessed 10/19/10].

[496] Nowak, Ronald and Ernest Walker. 1994. *Walker's Bats of the World*. John Hopkins University Press. Page 20.

[497] *Id.*

[498] *Id.*

[499] *Id.*

[500] Brook, Barry, Navjot Sodhi, and Corey Bradshaw. 2008. "Synergies Among Extinction Drivers Under Global Change." *Trends in Ecology and Evolution*. 23(8): 453-460, 455.

G. Hill's Horseshoe Bat (*Rhinoiophus hilli*)

1. Taxonomy

Although *Rhinolophus hilli* was formerly included in *Rhinolophus maclaudi* or *Rhinolophus ruwenzorri*, Fahr et al. (2002) found *R. hilli* to be a distinct species.[501]

2. Distribution and Range

All known individuals are currently located in the Albertine Rift in Nyungwe National Park, Rwanda.[502] *R. hilli*'s range probably covers less than 10 km^2, and this species has been found only in two localities 8 km apart.[503] The elevational range of this species is between 1,750 and 2,512 m asl.[504] "Field surveys of surrounding areas of potentially suitable habitat have not found additional populations."[505]

Figure G.1 *R. hilli* is native to Rwanda.

Source: http://www.sciencedaily.com/images/2008/01/080115085344-large.jpg

3. Habitat and Ecology

This species is only known to inhabit the montane tropical moist forest of the Albertine Rift.[506] The Albertine Rift is "composed of a system of mountains from Lake

[501] Fahr. J. 2008. *Rhinolophus hilli*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[502] *Id.*
[503] *Id.*
[504] *Id.*
[505] *Id.*
[506] *Id.*

Albert to Lake Tanganyika"[507] that spans five African nations.[508] This bat can probably only occupy limited areas, most likely caves.[509] It is not known if this species can live in degraded forest habitat.[510]

4. Population and Trend

Although colonies of this species have not been found, "they are likely to be small."[511] The population is decreasing.[512]

5. Major Threats

This species is likely threatened by habitat destruction via logging, mining, and conversion of land to agriculture. Human subsistence hunting of bats in their day roosts is also a probable threat.[513]

6. Conservation Actions

R. hilli occurs in Nyungwe National Park,[514] located in Southwest Rwanda.[515] This is the largest remaining mountain forest in Africa, covering 895km^2.[516] However, the two *R. hilli* populations occupy less than 10 km^2 of the park. Populations of the bat have not been found even in other areas that appear to be suitable habitat.[517] The species' elevational range of 1,750-2,512 m corresponds most directly with the lower ombrophile forest, which has a horizon of 1,700-2,200 m and is found only in the western part of Nyungwe Park.[518] It does not appear that any additional conservation measures are in

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[507] Poulsen, Axel, David Hafashimana, Gerald Eilu, Innocent Liengola, Corneille Ewango, and Terese Hart. "Composition and species richness of forest plants along the Albertine Rift, Africa." *Biol. Skr*. 55: 129-143, 129.
[508] *World Wildlife Fund*. 2009. "Albertine Rift montane forests." Encyclopedia of Earth. Available online at: http://www.eoearth.org/article/WWF_Ecoregions_of_the_Albertine_Rift Accessed 9/15/2010.
[509] Fahr. J. 2008. Rhinolophus hilli. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[510] *Id.*
[511] *Id.*
[512] *Id.*
[513] *Id.*
[514] *Id.*
[515] Kanyamibwa, Samuel. 1998. "Impact of war on conservtion: Rwandan environment and wildlife in agony." *Biodiversity and Conservation*. 7: 1399-1406, 1400.
[516] Fidele, Ruzigandekwe. 2009. "Mountain forest loss in Rwanda: effects on bird diversity." XIII World Forestry Congress. 1-15, 2.
[517] Fahr. J. 2008. Rhinolophus hilli. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[518] Fidele, Ruzigandekwe. 2009. "Mountain forest loss in Rwanda: effects on bird diversity." XIII World Forestry Congress. 1-15, 3.

place for the bat aside from the location of its known habitat in a national park.[519,520,521]

7. ESA Listing Factors

A. <u>The present or threatened destruction, modification, or curtailment of its habitat or range</u>

The Nyungwe National Park (previously a forest reserve) decreased in forested area by 26.69% between 1934 and 1998.[522] More broadly, natural forests in Rwanda have been reduced from around 30% of the total land area in the early 1900s to only 7% of the total land area as of approximately 2000.[523] It is estimated that "if the current rate of montane forest loss continues… within 56 years there will be no montane forest remaining" on the Albertine Rift.[524] Much of this forest was lost during two separate time periods, the first from 1955 to 1974, and the second from 1993 to 1998.[525] The second time period corresponds to the Rwandan civil war of 1990 to 1994 and the devastating after-affects that displaced of millions of people.[526]

The "primary causes of forest loss in Rwanda are human settlements, forest conversion for subsistence and commercial farming (tea and pyrethrun for export) and political instability and war."[527] Large amounts of forest have also been lost due to Rwanda's massive population and traditional views of forest resource use. Rwanda is one of Africa's most heavily populated areas, with over 8 million inhabitants in a country the size of the state of Vermont.[528] Ninety-three percent of these inhabitants are directly dependent on subsistence agriculture, and therefore dependent on the country's land.[529] The dispersed nature of land occupation in the country means that environmental impacts from subsistence farming are widespread and pervasive as opposed to centralized. Many agricultural activities destroy and fragment habitat. Compounding this, Rwandan

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[519] *See* Kanyamibwa, Samuel. 1998. "Impact of war on conservtion: Rwandan environment and wildlife in agony." *Biodiversity and Conservation*. 7: 1399-1406.
[520] *See* Fidele, Ruzigandekwe. 2009. "Mountain forest loss in Rwanda: effects on bird diversity." XIII World Forestry Congress. 1-15.
[521] *See* Fahr. J. 2008. Rhinolophus hilli. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[522] Fidele, Ruzigandekwe. 2009. "Mountain forest loss in Rwanda: effects on bird diversity." XIII World Forestry Congress. 1-15, 6.
[523] Masozera, Michel. 2002. "Socioeconomic impact analysis of the conservation of the Nyungwe Forest Reserve, Rwanda." Master's Thesis. University of Florida. 1-103, 6.
[524] Fidele, Ruzigandekwe. 2009. "Mountain forest loss in Rwanda: effects on bird diversity." XIII World Forestry Congress. 1-15, 12.
[525] *Id.* at 7.
[526] Kanyamibwa, Samuel. 1998. "Impact of war on conservtion: Rwandan environment and wildlife in agony." *Biodiversity and Conservation*. 7: 1399-1406, 1399, 1403.
[527] Fidele, Ruzigandekwe. 2009. "Mountain forest loss in Rwanda: effects on bird diversity." XIII World Forestry Congress. 1-15, 7.
[528] Antioch University New England. 2009. "Nyungwe National Park." Available from http://www.nyungwe.org/. Accessed 7/10/2010.
[529] Fidele, Ruzigandekwe. 2009. "Mountain forest loss in Rwanda: effects on bird diversity." XIII World Forestry Congress. 1-15, 9.

tradition holds that access to forests is a right and that humans are entitled to exploit forests for hunting, cattle grazing, and wood harvesting. This mindset contributed to the high rate of forest loss observed during the period from 1993 to 1998.[530]

The Rwandan civil war had a devastating impact on the country's mountain forests and the species that inhabited them.[531] The forests often "served…as refuge for insurgent groups" and battles often occurred within them.[532] Also, "individuals profiting off the political instability and authority crises cleared parts of forest so as to gain more land."[533] This produced habitat fragmentation in Nyungwe Park.[534] Beyond this specific impact, the "main effects of the Rwanda civil war on the environment involve the destruction of wildlife (animals killed), the destruction of habitats by bombs, the pollution of rivers and aquatic ecosystems, fragmentation of parks and reserves, dispersion and death of local environmentalists and conservationists, and interruption of research and conservation activities."[535]

B. Over-utilization for commercial, recreational, scientific, or educational purposes

It is believed that hunting of *R. hilli* in its day roosts is a threat to the species.[536] Hunting and poaching are widespread in Rwanda, and occur both outside of protected areas and within them.[537] Poachers have invaded Nyungwe Park,[538] where *R. hilli* is found.[539] They set traps for smaller mammals, and actively hunt for larger mammals.[540] The poaching rate in this park is described as "incredibly high."[541]

C. Disease or predation

Bat species worldwide may be at risk from white-nose syndrome, caused by a cold-

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[530] *Id.*
[531] Kanyamibwa, Samuel. 1998. "Impact of war on conservtion: Rwandan environment and wildlife in agony." *Biodiversity and Conservation*. 7: 1399-1406.
[532] Fidele, Ruzigandekwe. 2009. "Mountain forest loss in Rwanda: effects on bird diversity." XIII World Forestry Congress. 1-15, 7.
[533] *Id.* at 7.
[534] Kanyamibwa, Samuel. 1998. "Impact of war on conservtion: Rwandan environment and wildlife in agony." *Biodiversity and Conservation*. 7: 1399-1406, 1403.
[535] *Id.* at 1404.
[536] Fahr. J. 2008. Rhinolophus hilli. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[537] *World Wildlife Fund*. 2009. "Albertine Rift montane forests." Encyclopedia of Earth. Available online at: http://www.eoearth.org/article/WWF_Ecoregions_of_the_Albertine_Rift. Accessed 9/15/2010.
[538] Antioch University New England. 2009. "Threats to the Forest." July 22. Available from http://www.nyungwe.org/threats.cfm. Accessed 7/10/2010.
[539] Fahr. J. 2008. Rhinolophus hilli. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[540] Antioch University New England. 2009. "Threats to the Forest." July 22. Available from: http://www.nyungwe.org/threats.cfm. Accessed 7/10/2010.
[541] *Id.*

loving fungus of the Geomyces genus.[542] The syndrome has been known to cause 80-97% mortality rates in some large hibernation colonies.[543] Until recently, the disease was restricted to the northeastern United States. However, in 2009 it was detected in France.[544] It is not known how quickly this disease may spread to other areas of the world, but it poses a severe threat to all bat species, especially those with small ranges or those restricted to one or two caves. If infected, these species may lose nearly their entire population in one fell swoop.

D. The inadequacy of existing regulatory mechanisms

While *R. hilli* occurs in Nyungwe National Park,[545] the Park is "under constant threat from anthropogenic and environmental stresses."[546] Human-induced stress is generated largely from the massive human population surrounding the Park.[547] Farms are encroaching onto the outer boundaries of the Park, and humans also establish farms deeper within the Park, which causes habitat destruction and fragmentation.[548] Prior to the Rwandan civil war, the Park was "regularly protected by guards from the National Parks Office and field staff from a local World Bank project."[549] The World Bank project was suspended during the war and appears never to have been restarted,[550] and the southeastern part of the Park has since been fragmented for agriculture.[551] Humans also destroy forest habitat in the Park by cutting down trees for firewood and woodwork.[552] As described above, the poaching rate in this Park is "incredibly high."[553] In addition to

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[542] Handwerk, Brian. 2008.: "Deadly Bat Disease Linked to Cold-Loving Fungus." National Geographic News. http://news.nationalgeographic.com/news/2008/10/081031-bat-fungus.html [Accessed October 2010].
[543] Id.
[544] Puechmaille SJ, Verdeyroux P, Fuller H, Ar Gouilh M, Bekaert M, Teeling EC. 2010 "White-nose syndrome fungus (*Geomyces destructans*) in bat, France." Emerg Infect Dis. e-pub. Available online at http://www.cdc.gov/eid/content/16/2/pdfs/09-1391.pdf [Accessed October 2010].
[545] Fahr. J. 2008. Rhinolophus hilli. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[546] Antioch University New England. 2009. "Nyungwe National Park." Available from: http://www.nyungwe.org/. Accessed 7/10/2010.
[547] Kanyamibwa, Samuel. 1998. "Impact of war on conservation: Rwandan environment and wildlife in agony." *Biodiversity and Conservation*. 7: 1399-1406, 1404.
[548] Antioch University New England. 2009. "Threats to the Forest." July 22. Available from: http://www.nyungwe.org/threats.cfm. Accessed 7/10/2010.
[549] *Id.*
[550] *Id.*
[551] Kanyamibwa, Samuel. 1998. "Impact of war on conservtion: Rwandan environment and wildlife in agony." *Biodiversity and Conservation*. 7: 1399-1406, 1404.
[552] Ntaganda, Charles. 2003. "Biodiversity and conservation issues in the high mountain forests in Rwanda." Status and trends of, and threats to, mountain biodiversity, marine, coastal and inland water ecosystems: abstracts of poster presentations at the eighth meeting of the subsidiary body on scientific, technical and technological advice of the convention on biological diversity. April. Available at: http://www.cbd.int/doc/publications/cbd-ts-08.pdf.
[553] *Id.*

poaching, humans intrude into the forest searching for wild beehives.[554] Honey-hunters often use fire to smoke bees from their hives.[555] These fires sometimes spread, causing the loss of large tracts of forest.[556] Furthermore, El Niño events leave Nyungwe Park particularly dry, which results in massive collateral fire damage.[557] Entire hillsides in Nyungwe Park are nearly or completely devoid of trees due to fire damage.[558] Mining within the Park is also prevalent.[559] Mining camps are found throughout Nyungwe Park and often contain up to 3,000 inhabitants.[560]

Due to the pervasive threats facing Nyungwe National Park, this protected area is inadequate to conserve this species' habitat. Additional regulatory measures are therefore critical to protect *R. hilli* from extinction.

E. Other natural or manmade factors affecting its continued existence

i. Climate change

The Intergovernmental Panel on Climate Change (IPCC) states that human activities are likely contributing to global climate change. "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic [greenhouse gas] concentrations… It is likely that there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica)."[561] Due to climate change, "there are projected to be major changes in ecosystem structure and function, species' ecological interactions and shifts in species' geographical ranges, with predominantly negative consequences for biodiversity."[562] Threats from global climate change are relevant to this bat species. *R. hilli* lives in a mountainous region, and climate change is expected to have unique impacts in mountainous areas. Due to anthropogenic climate change, there are expected to be " shifts of plant and animal ranges both poleward and up mountainsides."[563] Some high-elevation species may run out of habitat as they are driven higher upwards by changing temperature ranges.

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[554] *Id.*
[555] *Id.*
[556] *Id.*
[557] *Id.*
[558] *Id.*
[559] *Id.*
[560] *Id.*
[561] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Available from: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009].
[562] *Id.*
[563] Karl, Thomas R., Gerald A. Meehl, Christopher D. Miller, Susan J. Hassol, Anne M. Waple, and William L. Murray, eds. 2008. Weather and Climate Extremes in a Changing Climate, Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands. Synthesis and Assessment Product 3.3. Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Online at http://downloads.climatescience.gov/sap/sap3-3/sap3-3-final-all.pdf [Accessed October 2010]

ii. Biological vulnerability

This species likely has a small population size. FWS has routinely recognized that small population size and restricted range increase the likelihood of extinction.[564] One additional factor that makes this species particularly vulnerable to extinction is its low fecundity rate. In general, fetal development in bats occurs slowly, with pregnancies lasting between three to six months.[565] Female bats generally produce one young per year. This is believed to be due to the very large size of bat pups at birth. Young bats comprise from between 12-15% of the mother's body mass up to 25% of the mother's body mass during pregnancy. Scientists believe that the weight of the pup during pregnancy limits the mother's litter size due to her need to fly while pregnant.[566]

Litter size is also likely limited due to nursing characteristics that are unique to bat species.[567] Most mammals wean their young when the young reach 40%, or less, of their adult size. Bats, however, nurse their young until they are nearly adult size. This is because bats cannot feed on their own until their wings are near adult dimensions. This may contribute to the low fecundity of bats.[568] Species with low fecundity are "particularly predisposed to anthropogenic threats given their low replacement rate."[569] Thus, low fecundity is another reason that *R. hilli* faces a high likelihood of extinction unless further action is taken.

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[564] See, for example, FWS candidate assessment forms for *Doryopteris takeuchii, Huperzia stemmermanniae, Megalagrion nesiotes, Melicope degeneri, Melicope hiiakae, Myrsine mezii, Ostodes strigatus, Partula langfordi, Peperomia subpetiolata, Phyllostegia bracteata*, and *Tryonia circumstriata*. Accessible via FWS website at http://www.fws.gov/endangered/wildlife.html [Accessed November 2009].

[565] Nowak, Ronald and Ernest Walker. 1994. *Walker's Bats of the World*. John Hopkins University Press. Page 20.

[566] *Id.*

[567] *Id.*

[568] *Id.*

[569] Brook, Barry, Navjot Sodhi, and Corey Bradshaw. 2008. "Synergies Among Extinction Drivers Under Global Change." *Trends in Ecology and Evolution*. 23(8): 453-460, 455.

H. Jamaican Greater Funnel-Eared Bat (*Natalus jamaicensis*)

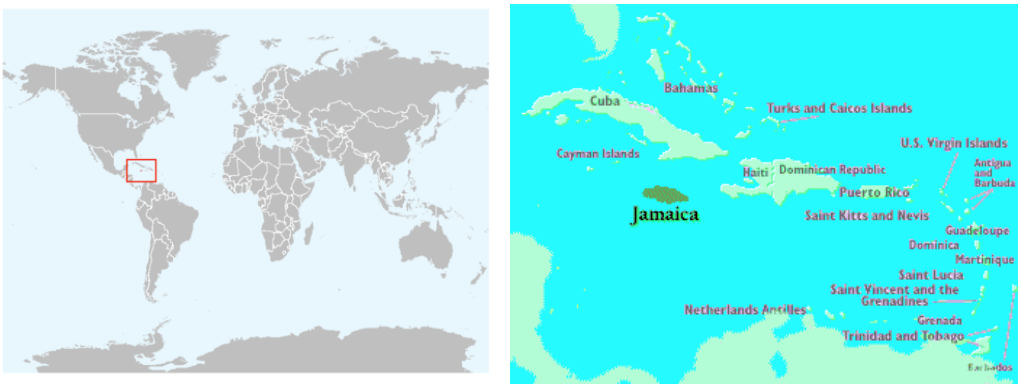
1. Taxonomy

Natalus jamaicensis belongs to the Order Chiroptera, Family Natalidae.[570] It used to be included in *Natalus stramineus*, "but is clearly distinct from that species."[571]

2. Distribution and Range

This species is known from a single cave, known as St. Clair Cave,[572] located in Point Hill, St. Catharine Parish, Jamaica.[573,574] All individuals of *N. jamaicensis* are contained in this single location.[575]

Figure H.1 *N. jamaicensis* is native to Jamaica (in green)



Source (left): Velazco, P. & Turvey, S. 2008. Natalus jamaicensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010. Source (right): http://www.jamaica-links.com/jamaica-info/images/jamaica.gif

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[570] Velazco, P. & Turvey, S. 2008. Natalus jamaicensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[571] *Id.*
[572] *Id.*
[573] Velazco, P. & Turvey, S. 2008. Natalus jamaicensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[574] Wege, David, Doug Ryan, Nigel Varty, Veronica Anadon-Irizarry, Amiro Perez-Leroux. 2009. "The Caribbean islands biodiversity hotspot." Birdlife International. December 2. Page 8.
[575] Velazco, P. & Turvey, S. 2008. Natalus jamaicensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

Figure H.2 Jamaican parishes. The parish labeled "8" is St. Catherine's Parish. *N. jamaicensis* lives in one location within this parish.

Source: "Regions in Jamaica." 2005. Available from: http://www.jamaicans.com/childsguide/regions.shtml.

3. Habitat and Ecology

N. jamaicensis appears to require large caves with high humidity in order to roost,[576] which St. Clair Cave provides.[577] The cave is approximately 2,900 m in length. Its interior is divided into several chambers and passages.[578] The temperature within these areas is elevated by the bat colonies that live there.[579] Part of the ground is covered in pools, some of which are deep enough to require swimming.[580] The solid areas of the ground and the walls are host to "a living carpet of scavenging invertebrates" and deep pits of guano.[581]

The IUCN describes the terrain surrounding the cave as "very dry and arid with xerophytic vegetation."[582] When this description is compared to the discussion of Jamaica's three vegetative categories in Genoway et al. (2005), the vegetation surrounding St. Clair Cave can likely be characterized either as a Dry Limestone Scrub Forest or an Arid Limestone Scrub Forest, depending the precise levels of precipitation.[583] Part of this ecosystem is located in the Hellshire Hills[584] of St. Catherine Parish.[585] *N. jamaicensis* eats insects captured from these dry forests, likely by "foraging

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[576] *Id.*
[577] Genoways, H. H., Baker, R. J., Bickham, J. W. and Phillips, C. J. 2005. "Bats of Jamaica." *Special Publications of the Museum of Texas Tech University* 48: 1-155, 67.
[578] *Id.*
[579] *Id.*
[580] *Id.* at 69.
[581] *Id.*
[582] Velazco, P. & Turvey, S. 2008. Natalus jamaicensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[583] Genoways, Hugh, Robert Baker, John Bickham, and Carleton Phillips. 2005. "Bats of Jamaica." *Special Publications of the Museum of Texas Tech University*. 48: 1-155, 4.
[584] Tole, Lise. 2002. "Habitat loss and anthropogenic disturbance of Jamaica's Hellshire Hills area." *Biodiversity and Conservation*. 11(4): 575-598, 598.
[585] Adams, C.D. 1969. "A Botanical description of Big Pelican Cay, a little known island off the south coast of Jamaica." Atoll Research Bulletin No. 130, The Smithsonian Institution, Washington, D.C., U.S.A. Available from: http://sipddr.si.edu/dspace/bitstream/10088/4878/1/00130.pdf.

in clustered vegetation and over relatively small home ranges."[586]

N. jamaicensis is moderately to highly gregarious, and forms cave colonies that contain less than 100 individuals.[587] Other species, including *Natalus micropus*, also roost in the St. Clair cave with *N. jamaicensis*.[588]

4. Population and Trend

The population is declining.[589]

5. Major Threats

Habitat loss is the predominant threat to this species.[590]

6. Conservation Actions

No conservation measures are in place for this species.[591] While a part of the Hellshire Hills is protected under the Forestry Act of 1937, "the act has received little enforcement."[592]

7. ESA Listing Factors

A. <u>The present or threatened destruction, modification, or curtailment of its habitat or range</u>

While it is not clear whether the vegetation surrounding St. Clair Cave is Dry Limestone Scrub Forest or Arid Limestone Scrub Forest, the uncertainty is unimportant since both of these vegetative types "have been impacted by human activities."[593] St. Catherine's Hellshire Hills, which are covered by the dry/arid limestone forest[594] that comprises *N. jamaicensis*' foraging habitat,[595] are "under increasing threat from deforestation from subsistence-driven encroachment."[596] Tole (2002) states that these

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[586] Velazco, P. & Turvey, S. 2008. Natalus jamaicensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[587] *Id.*
[588] *Id.*
[589] *Id.*
[590] *Id.*
[591] *Id.*
[592] Vogel, Peter. "Jamaican iguana *Cyclura collei*." IUCN Iguana Specialist Group. Available from: http://www.iucn-isg.org/actionplan/ch2/jamaican.php. Accessed 9/20/2010.
[593] Genoways, Hugh, Robert Baker, John Bickham, and Carleton Phillips. 2005. "Bats of Jamaica." *Special Publications of the Museum of Texas Tech University*. 48: 1-155, 4.
[594] Tole, Lise. 2002. "Habitat loss and anthropogenic disturbance of Jamaica's Hellshire Hills area." *Biodiversity and Conservation*. 11(4): 575-598, 598.
[595] Velazco, P. & Turvey, S. 2008. Natalus jamaicensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[596] Tole, Lise. 2002. "Habitat loss and anthropogenic disturbance of Jamaica's Hellshire Hills area." *Biodiversity and Conservation*. 11(4): 575-598, 598.

Hills are "intrinsically vulnerable…to outside disturbance."[597] Unfortunately, extensive disturbance has already occurred within this habitat.[598] Charcoal production, which provides income to approximately 10,000 Jamaicans, is "extensive" in the area, and as a result one third of Hellshire Hills is "badly degraded."[599] The northeastern part of Hellshire Hills has been "totally degraded" and is "virtually barren" as a result of the collection of woody plans for charcoal use.[600] Other areas of the Hellshire Hills are also being deforested.[601] Along the north-central border "charcoal burners have moved 2-3km into the forest" and charcoal burners have also cut down some of the coastal dry forest in the south.[602]

The eastern half of the Hellshire Hills is threatened by development projects that propose "large scale limestone mining and human settlements."[603] The roads that would be put in place to develop and mine limestone resources would "undoubtedly allow charcoal burners…and other forest users to migrate further into the forest."[604] Over 1 million tourists visit the island, primarily along the coast,[605] which is where the dry limestone forests that *N. jamaicensis* forages in are located.[606] To accommodate these tourists, developments are expanding "away from the coasts and into the dry forests,"[607] which threatens the area that *N. jamaicensis* requires to locate prey.

On a broader scale, Genoway et al. (2005) states that "a large portion of the vegetation of Jamaica today would fall into some stage of ruinate vegetation."[608] To support this proposition, the authors cite two studies from 1953 and 1979.[609] Considering the pressures placed on Jamaica's ecosystems, it is likely that the vegetation is in even worse condition today than what the authors described based on studies that were between 30 and 60 years old.

Jamaica's native ecosystems have been heavily impacted by agricultural activities, which "occupy nearly 50% of the island's entire land area."[610] Two types of agriculture exist on the island. One is large-scale plantation agriculture and the second is subsistence

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[597] *Id.*
[598] Vogel, Peter. "Jamaican iguana *Cyclura collei*." IUCN Iguana Specialist Group. Available from: http://www.iucn-isg.org/actionplan/ch2/jamaican.php. Accessed 9/20/2010.
[599] *Id.*
[600] *Id.*
[601] *Id.*
[602] *Id.*
[603] Gibson, R. 1996. *Cyclura collei*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3. <www.iucnredlist.org>. Downloaded on 25 September 2010.
[604] *Id.*
[605] *World Wildlife Fund*. 2008. "Jamaican dry forests." The Encyclopedia of Earth. Available from: http://www.eoearth.org/article/Jamaican_dry_forests. Accessed 9/25/2010.
[606] *See* Vogel, Peter. "Jamaican iguana *Cyclura collei*." IUCN Iguana Specialist Group. Available from: http://www.iucn-isg.org/actionplan/ch2/jamaican.php. Accessed 9/20/2010.
[607] World Wildlife Fund. 2008. "Jamaican dry forests." The Encyclopedia of Earth. Available from: http://www.eoearth.org/article/Jamaican_dry_forests. Accessed 9/25/2010.
[608] Genoways, Hugh, Robert Baker, John Bickham, and Carleton Phillips. 2005. "Bats of Jamaica." *Special Publications of the Museum of Texas Tech University*. 48: 1-155, 5.
[609] *Id.*
[610] *Id.*

farming.[611] Both forms have led to deforestation.[612] The types of crops planted as well as the system of plantations have "certainly…impacted the chiropteran fauna of the island."[613] Genoways et al. (2005) found that these broad-scale ecosystem changes have favored some bat species on the island yet harmed other species.[614] *N. jamaicensis*, due to its declining population, has clearly been negatively impacted by this mass habitat alteration due to agriculture. The bats that benefited most from the conversion of large amounts of native vegetation to agriculture have been fruit-eating bats.[615] Many of the agricultural plantations support coconut, bananas, citrus fruits, mangos, peaches, breadfruit, apples, and guava, among other types of introduced and native fruit trees.[616] Since *N. jamaicensis'* diet consists entirely of insects[617] foraged from Dry Limestone Scrub Forest or Arid Limestone Scrub Forest[618] rather than fruit, agricultural fruit production does not benefit this species.

Although the Dry Limestone and Arid Limestone Forests do not support agricultural activities,[619] agricultural development does occur in the wetter parts of St. Catherine's Parish.[620] The majority of the parish is flat and has a good water supply, and as such agriculture is the parish's "main source of employment."[621] Eighteen thousand acres are irrigated in a plain in the southern part of the parish.[622] The dry limestone forests that comprise *N. jamaicensis'* habitat[623] are also located in the southern part of St. Catherine's parish.[624] Therefore agriculture does occur near this species' habitat and should be taken into consideration when assessing *N. jamaicensis* habitat modification.

Deforestation and other habitat modification has occurred in *N. jamaicensis'* habitat

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[611] See Genoways, Hugh, Robert Baker, John Bickham, and Carleton Phillips. 2005. "Bats of Jamaica." *Special Publications of the Museum of Texas Tech University*. 48: 1-155, 5.
[612] *Id.*
[613] *Id.*
[614] *Id.*
[615] Genoways, Hugh, Robert Baker, John Bickham, and Carleton Phillips. 2005. "Bats of Jamaica." *Special Publications of the Museum of Texas Tech University*. 48: 1-155, 5.
[616] *Id.*
[617] Velazco, P. & Turvey, S. 2008. Natalus jamaicensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[618] Genoways, Hugh, Robert Baker, John Bickham, and Carleton Phillips. 2005. "Bats of Jamaica." *Special Publications of the Museum of Texas Tech University*. 48: 1-155, 4.
[619] Vogel, Peter. "Jamaican iguana *Cyclura collei*." IUCN Iguana Specialist Group. Available from: http://www.iucn-isg.org/actionplan/ch2/jamaican.php. Accessed 9/20/2010.
[620] "Saint Catherine Parish, Jamaica." http://en.academic.ru/dic.nsf/enwiki/627857. Accessed 9/20/2010.
[621] Government of Jamaica. 2006. "St. Catherine Parish Profile." St. Catherine Parish Council. Available from: http://www.stcatherinepc.gov.jm/index.php?option=com_content&task=view&id=21&Itemid=40. Accessed 9/20/2010.
[622] *Id.*
[623] Velazco, P. & Turvey, S. 2008. Natalus jamaicensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[624] Government of Jamaica. 2006. "St. Catherine Parish Profile." St. Catherine Parish Council. Available from: http://www.stcatherinepc.gov.jm/index.php?option=com_content&task=view&id=21&Itemid=40 [Accessed 9/20/2010.

due to pressures from charcoal development, mining, agriculture, and tourism development. This destruction impacts the areas that this species forages in, and presents a threat to *N. jamaicensis'* continued survival.

C. Disease or predation

Bat species worldwide may be at risk from white-nose syndrome, caused by a cold-loving fungus of the Geomyces genus.[625] The syndrome has been known to cause 80-97% mortality rates in some large hibernation colonies.[626] Until recently, the disease was restricted to the northeastern United States. However, in 2009 it was detected in France.[627] It is not known how quickly this disease may spread to other areas of the world, but it poses a severe threat to all bat species, especially those with small ranges or those restricted to one or two caves. If infected, these species may lose nearly their entire population in one fell swoop.

D. The inadequacy of existing regulatory mechanisms

Not a single legal protection is in place for either this species or the one cave where all individuals of this species are found.[628] This is clearly inadequate to ensure the continued survival of this declining species. Immediate protection of St. Clair Cave is vital to conserving *N. jamaicensis*.[629] According to Genoways et al. (2005), this cave is the single most important cave on Jamaica for the safe future of a large portion of the bat fauna on the island,[630] which is believed to comprise 21 species.[631] Thus, legal protection for the cave would provide a vital safeguard for *N. jamaicensis* and many other bat species that rely on the cave. The dry limestone forests surrounding St. Clair Cave must also be protected. While the Hellshire Hills are protected under the Forestry Act of 1937, "the act has received little enforcement."[632] "Burning of wood to produce charcoal, slash-and-burn agriculture, and other destructive uses of the forest still progress."[633] The continued destruction of this area despite its protected status demonstrates that the regulatory mechanisms in place to conserve habitat are inadequate to protect *N.*

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[625] Handwerk, Brian. 2008.: "Deadly Bat Disease Linked to Cold-Loving Fungus." National Geographic News. http://news.nationalgeographic.com/news/2008/10/081031-bat-fungus.html [Accessed October 2010].
[626] Id.
[627] Puechmaille SJ, Verdeyroux P, Fuller H, Ar Gouilh M, Bekaert M, Teeling EC. 2010 "White-nose syndrome fungus (*Geomyces destructans*) in bat, France." Emerg Infect Dis. e-pub. Available online at http://www.cdc.gov/eid/content/16/2/pdfs/09-1391.pdf [Accessed October 2010].
[628] Velazco, P. & Turvey, S. 2008. Natalus jamaicensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[629] *Id.*
[630] Genoways, Hugh, Robert Baker, John Bickham, and Carleton Phillips. 2005. "Bats of Jamaica." *Special Publications of the Museum of Texas Tech University*. 48: 1-155, 67.
[631] *Id.* at 1.
[632] Vogel, Peter. "Jamaican iguana *Cyclura collei*." IUCN Iguana Specialist Group. Available from: http://www.iucn-isg.org/actionplan/ch2/jamaican.php. Accessed 9/20/2010.
[633] *Id.*

jamaicensis.

E. Other natural or manmade factors affecting its continued existence

i. Climate change

The Intergovernmental Panel on Climate Change (IPCC) states that human activities are likely contributing to global climate change. "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic [greenhouse gas] concentrations… It is likely that there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica)."[634] Due to climate change, "there are projected to be major changes in ecosystem structure and function, species' ecological interactions and shifts in species' geographical ranges, with predominantly negative consequences for biodiversity."[635] Threats from global climate change are relevant to this bat species.

This species is endemic to an island, which face particularly urgent threats from rising sea levels and increasingly severe and frequent tropical storms caused by human-induced climate change. "Global average sea level is rising predominantly as a consequence of three factors—thermal expansion of warming ocean water, addition of new water from the ice sheets of Greenland and Antarctica and from glaciers and ice caps, and the addition of water from land hydrology. All three potential sources are undergoing changes of anthropogenic origin."[636] The IPCC projects that on small islands, "sea level rise is expected to exacerbate inundation, storm surge, erosion and other coastal hazards… [and] with higher temperatures, increased invasion by non-native species is expected to occur, particularly on mid- and high-latitude islands."[637] This species lives in coastal dry limestone forest. Therefore, climate change will have an even more serious impact on this species. On coastlines, " the impacts of sea level rise will be felt through both an increase in mean sea-level and through an increase in the frequency of extreme sea-level events such as storm surges."[638] The IPCC underscored the risk facing coasts worldwide from climate change: " Coasts are projected to be exposed to increasing risks, including coastal erosion, due to climate change and sea level rise. The effect will be exacerbated by increasing human-induced pressures on coastal areas (very high confidence)…"[639]

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[634] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Available from: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009].

[635] *Id.*

[636] McMullen, C.P. and Jabbour, J. 2009. Climate Change Science Compendium 2009. United Nations Environment Programme, Nairobi, EarthPrint. Online at http:// www.unep.org/compendium2009/ [Accessed November 2009].

[637] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009]

[638] Karl, T.R., Melillo, J. M., and T.C. Peterson (eds). 2009. Global Climate Change Impacts in the United States, Cambridge University Press, 2009. Online at http://www.globalchange.gov/whats-new/286-new-assessment-climate-impacts-us [Accessed November 2009].

[639] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis

ii. Biological vulnerability

This species has a very small population size and a range that is restricted to a single cave on the island of Jamaica. FWS has routinely recognized that small population size and restricted range increase the likelihood of extinction.[640] Island species are particularly susceptible to extinction.[641,642]

One additional factor that makes this species particularly vulnerable to extinction is its low fecundity. Across all bats species generally, fetal development occurs slowly, with pregnancies lasting between three to six months.[643] Female bats generally produce one young per year. This is believed to be due to the very large size of bat pups at birth. Young bats comprise from between 12-15% of the mother's body mass up to 25% of the mother's body mass during pregnancy. Scientists believe that the weight of the pup during pregnancy limits the mother's litter size due to her need to fly while pregnant.[644]

Litter size is also likely limited due to nursing characteristics that are unique to bat species.[645] Most mammals wean their young when the young reach 40%, or less, of their adult size. Bats, however, nurse their young until they are nearly adult size. This is because bats cannot feed on their own until their wings are near adult dimensions. This may contribute to the low fecundity of bats.[646] Species with low fecundity are "particularly predisposed to anthropogenic threats given their low replacement rate."[647] Thus, low fecundity is another reason that this species faces a high likelihood of extinction unless further action is taken.

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report. Online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009]

[640] See, for example, FWS candidate assessment forms for *Doryopteris takeuchii, Huperzia stemmermanniae, Megalagrion nesiotes, Melicope degeneri, Melicope hiiakae, Myrsine mezii, Ostodes strigatus, Partula langfordi, Peperomia subpetiolata, Phyllostegia bracteata*, and *Tryonia circumstriata*. Accessible via FWS website at http://www.fws.gov/endangered/wildlife.html [Accessed November 2009].

[641] Groombridge, B. 1992. Global Biodiversity - Status of the Earth's Living Resources: A Report Compiled by the World Conservation Monitoring Centre. Chapman and Hall, London, New York. Available at http://www.archive.org/details/globalbiodiversi92wcmc [Accessed 10/19/10].

[642] Frankham, Richard. 2008. "Inbreeding and Extinction: Island Populations." Conservation Biology. 12: 665–675. Available at http://onlinelibrary.wiley.com/doi/10.1111/j.1523-1739.1998.96456.x/abstract [Accessed 10/19/10].

[643] Nowak, Ronald and Ernest Walker. 1994. *Walker's Bats of the World*. John Hopkins University Press. Page 20.

[644] *Id.*

[645] *Id.*

[646] *Id.*

[647] Brook, Barry, Navjot Sodhi, and Corey Bradshaw. 2008. "Synergies Among Extinction Drivers Under Global Change." *Trends in Ecology and Evolution*. 23(8): 453-460, 455.

I. Lamotte's Roundleaf Bat (*Hipposideros lamottei*)

1. Taxonomy

This species is of the Order Chiroptera, Family Hipposideridae.[648] The distinction between *Hipposideros lamottei* and *Hipposideros ruber* is not entirely clear.[649]

2. Distribution and Range

This species is known to inhabit two areas on Mount Nimba,[650] which is a mountain located on the borders of Guinea, Liberia, and Côte d'Ivoire.[651]

Figure I.1 *H. lamottei* is endemic to Mt. Nimba, a mountain located on the borders of Guinea, Liberia, and Côte d'Ivoire.

Source: Mickleburgh, S., Hutson, A.M., Bergmans, W. & Fahr, J. 2008. *Hipposideros lamottei*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 28 June 2010.

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[648] Mickleburgh, S., Hutson, A.M., Bergmans, W. & Fahr, J. 2008. *Hipposideros lamottei*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 28 June 2010.

[649] *Id.*

[650] *Id.*

[651] *United Nations Educational, Scientific, and Cultural Organization (UNESCO)*. "Mount Nimba Strict Nature Reserve." World Heritage Program. Available from: http://whc.unesco.org/en/list/155 Accessed 7/5/2010.

3. Habitat and Ecology

One of the two localities where *H. lamottei* is found is a lowland tropical moist forest, and the other is an afromontane savanna.[652] Mount Nimba exists between tropical forests and the West African savanna belt.[653] The savanna covers the base of the mountain, which then rises steeply and is covered by lush tropical forest.[654] *H. lamottei* has been found in a natural cave (Grotte de Blande) and an abandoned mining tunnel (Pierre Richaud),[655] although it is not known whether the species roosts exclusively in caves and similar habitats."[656]

4. Population and Trend

Only six specimens of this species have ever been caught. The population is declining.[657]

5. Major Threats

H. lamottei faces four primary threats. Three of the threats relate to habitat destruction. First, extensive iron ore mining occurs with this species' limited range on Mount Nimba, and additional mining development is planned.[658] Mining presents a "high" threat to *H. lamottei*. Second, deforestation driven by agriculture, ranching, and logging has negatively impacted this species.[659] Third, fire has destroyed large tracts of forested area on Mount Nimba.[660] The fourth threat to this species is the "indiscriminate subsistence hunting of bats for food [that] occurs in caves on Mount Nimba and likely impacts this species."[661]

6. Conservation Actions

H. lamottei is present within the Mount Nimba Strict Nature Reserve World

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[652] Mickleburgh, S., Hutson, A.M., Bergmans, W. & Fahr, J. 2008. *Hipposideros lamottei*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 28 June 2010.
[653] *United Nations Environment Programme (UNEP).* "Mount Nimba Strict Nature Reserve Guinea and Cote D'Ivoire." World Conservation Monitoring Centre. Page 3.
[654] *Id.*
[655] Mickleburgh, S., Hutson, A.M., Bergmans, W. & Fahr, J. 2008. *Hipposideros lamottei*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 28 June 2010.
[656] *Id.*
[657] *Id.*
[658] *Id.*
[659] *Id.*
[660] Hawthorne, W.D. 1991. Fire damage forest regeneration in Ghana. Forest Inventory and Management Project. Forestry Department of Ghana, Kumasi.
[661] Mickleburgh, S., Hutson, A.M., Bergmans, W. & Fahr, J. 2008. *Hipposideros lamottei*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 28 June 2010.

Heritage Site.[662] This is a transboundary reserve between Guinea, Cote d'Ivoire, and Liberia.[663]

7. ESA Listing Factors

A. The present or threatened destruction, modification, or curtailment of its habitat or range

Mining, fire, and deforestation for farm and ranch land, timber, and fuelwood are reducing the size and habitability of the little remaining forest where this bat is found.[664,665] As a result of anthropogenic pressures, ecosystems on Mount Nimba have undergone fragmentation, degradation, and destruction.[666]

Extensive iron ore mining on Mount Nimba, *H. lamottei's* only known habitat, is extremely threatening to this bat.[667] Mount Nimba contains massive deposits of high-grade iron ore, which has made it the target of extensive mining operations.[668] The Mount Nimba range contains an estimated 600 million tons of high quality, 66% iron-ore bearing rock.[669] In the 1950s a multinational mining operation[670,671] conducted large-scale mining that did "enormous damage to East Nimba and West Nimba National Forests in the Liberian part of the range."[672] The forests and streams of this area suffered both degradation and destruction.[673,674] Since 1975, roads, wells, mineshafts, workshops,

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[662] *Id.*
[663] *United Naitons Environment Programme (UNEP*). "Mount Nimba Strict Nature Reserve Guinea and Cote D'Ivoire." World Conservation Monitoring Centre.
[664] Lebbie, Aiah. 2001. "Western Guinean Lowland Forests." *World Wildlife Fund. WWF*. Available from http://www.worldwildlife.org/wildworld/profiles/terrestrial/at/at0130_full.html. Accessed 7/1/2010.
[665] *United Naitons Environment Programme (UNEP)*. "Mount Nimba Strict Nature Reserve Guinea and Cote D'Ivoire." World Conservation Monitoring Centre. Page 7.
[666] Bourque, J.D. 1996. Inventaire preliminaire de la faune aviaire du Bassin de la riviere Kuundu et de la forest classee de Nialama, Republique de Guinée. Unpublished report.
[667] Mickleburgh, S., Hutson, A.M., Bergmans, W. & Fahr, J. 2008. *Hipposideros lamottei*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 28 June 2010.
[668] *United Naitons Environment Programme (UNEP*). "Mount Nimba Strict Nature Reserve Guinea and Cote D'Ivoire." World Conservation Monitoring Centre.
[669] *Id.*
[670] Curry-Lindahl, K. 1966. "Zoological aspects on the conservation of vegetation in tropical Africa." *Acta Phytogeographica Suecia*. 54: 25-32.
[671] Sayer, J. A., A. Green and D. Bourque. 1992b. Benin and Togo. Pages 97-101 in J. A. Sayer, C. S. Harcourt, and N. M. Collins, editors. *The Conservation Atlas of Tropical Forests: Africa*. IUCN and Simon & Schuster, Cambridge.
[672] *United Naitons Environment Programme (UNEP)*. "Mount Nimba Strict Nature Reserve Guinea and Cote D'Ivoire." World Conservation Monitoring Centre. Page 7.
[673] Curry-Lindahl, K. 1966. "Zoological aspects on the conservation of vegetation in tropical Africa." *Acta Phytogeographica Suecia*. 54: 25-32.
[674] Sayer, J. A., A. Green and D. Bourque. 1992b. Benin and Togo. Pages 97-101 in J. A. Sayer, C. S. Harcourt, and N. M. Collins, editors. *The Conservation Atlas of Tropical Forests: Africa*. IUCN and Simon & Schuster, Cambridge.

and towns have been built in the area, which was originally established as a strict nature reserve.[675] The ore deposits were exhausted in 1989.[676] Mining continued in other areas, although the Liberian civil war put a ten-year halt to mining operations.[677] Mining resumed after the war, and further mining activities are planned.[678]

One mining concession, given to the EURONIMBA consortium (now PhpBilliton) spurred the UNEP to add Mount Nimba Reserve to the List of World Heritage Sites in Danger in 1992.[679] This decision was made based on the disturbance and pollution that mining would cause as well as the possible introduction of invasive species. Despite this, PhpBilliton has restarted exploration within the concession area, and in 2003, they stated that they would begin shipping ore from the mine in the concession within 10 years, and that the concession would be worked for 30 years. In 2005, they built a 14-km approach road without consulting the authority that manages the reserve and "the Park guards were removed from the company town."[680]

The part of Mount Nimba Reserve located in Guinea may not be immune from future mining development either. It was estimated that one proposed new area of mining activity could be worth 20 million USD per annum to Guinea.[681] In light of the strong economic incentive to develop mineral resources, this proposed mine, Project Minier des Monts Nimba, might be approved, which would lead to intensified habitat destruction on Mount Nimba.[682]

The second threat facing *H. lamottei* is extensive deforestation.[683] Large tracts of the bat's forest habitat in the Mount Nimba area have been converted to farmland with slash-and-burn techniques.[684] Although large areas of moist forest remain in Liberia, the region's recent civil conflict "creates doubts about the long-term survival of the forests and their resources."[685] Most of the forest areas that lie outside of Liberia are secondary

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[675] *United Naitons Environment Programme (UNEP*). "Mount Nimba Strict Nature Reserve Guinea and Cote D'Ivoire." World Conservation Monitoring Centre. Page 7.
[676] *Id.*
[677] Allport, G. 1991. "The status and conservation of threatened birds in the Upper Guinea Forest." *Bird Conservation International*. 1: 53-74.
[678] Mickleburgh, S., Hutson, A.M., Bergmans, W. & Fahr, J. 2008. *Hipposideros lamottei*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 28 June 2010.
[679] *United Naitons Environment Programme (UNEP*). "Mount Nimba Strict Nature Reserve Guinea and Cote D'Ivoire." World Conservation Monitoring Centre. Page 7.
[680] *Id.*
[681] NIMCO. 1997. Project Minier des Monts Nimba: Environmental Impact Assessment. Man and the Biosphere, Paris.
[682] *Id.*
[683] Mickleburgh, S., Hutson, A.M., Bergmans, W. & Fahr, J. 2008. *Hipposideros lamottei*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 28 June 2010.
[684] Oates, J. F., M. Abedi-Lartey, W. S. McGraw, T. T. Struhsaker and G. H. Whitesides. 2000. "Extinction of a West African Red Colobus monkey." *Conservation Biology*. 14: 1526-1532.
[685] Lebbie, Aiah. 2001. "Western Guinean Lowland Forests." *World Wildlife Fund. WWF*. Available from: http://www.worldwildlife.org/wildworld/profiles/terrestrial/at/at0130_full.html. Accessed 7/1/2010.

stands that are isolated from each other by agricultural lands.[686] Furthermore, ranchers use slash-and-burn techniques to clear forested land and to create an environment suitable to cattle grazing.[687] In the dry season, hundreds of cattle enter Mount Nimba Reserve looking for additional food.[688]

Deforestation due to logging also presents a serious threat to *H. lamottei*. The domestic demand for timber is moderately high, as is global demand for valuable hardwoods.[689] This has spurred the development of large export markets in processed and unprocessed logs from the three countries in which Mount Nimba Reserve is located, which drives logging of the high altitude forests[690] that this bat requires.[691] The roads that loggers create to access remaining forested areas also provide access to subsistence agriculturalists and cash croppers who clear this once remote forest for cultivation.[692] Slash-and-burn techniques and the dryness that results from turning rainforest into cultivated land increase the risk of forest fires and fragment remaining forest.[693] The forest is also used for charcoal production and firewood gathering, which furthers deforestation.[694] The economic pressure to extract timber, fuelwood, and charcoal from the bat's forest habitat remains high[695] and will likely increase due to the timber export market and growing urban population centers.[696]

Intensified human population pressures have exacerbated the degradation of Mount Nimba's forests.[697] Refugees from civil wars have settled in the buffer zone around Mount Nimba as well as in the reserve itself.[698] In 2002, refugees from the Liberian civil war "flooded into Guinea around the World heritage site [Mount Nimba Reserve], which destabilized the area."[699] Rapid human population growth without planning or

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[686] *Id.*
[687] *United Naitons Environment Programme (UNEP)*. "Mount Nimba Strict Nature Reserve Guinea and Cote D'Ivoire." World Conservation Monitoring Centre. Page 7.
[688] *Id.*
[689] Lebbie, Aiah. 2001. "Eastern Guinean Forests." *World Wildlife Fund (WWF*). Available from: http://www.worldwildlife.org/wildworld/profiles/terrestrial/at/at0111_full.html. Accessed on 6/15/2010.
[690] *Id.*
[691] Mickleburgh, S., Hutson, A.M., Bergmans, W. & Fahr, J. 2008. *Hipposideros lamottei*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 28 June 2010.
[692] Sayer, J. A., A. Green and D. Bourque. 1992b. Benin and Togo. Pages 97-101 in J. A. Sayer, C. S. Harcourt, and N. M. Collins, editors. *The Conservation Atlas of Tropical Forests: Africa*. IUCN and Simon & Schuster, Cambridge.
[693] Hawthorne, W.D. 1991. Fire damage forest regeneration in Ghana. Forest Inventory and Management Project. Forestry Department of Ghana, Kumasi.
[694] Oates, J. F., M. Abedi-Lartey, W. S. McGraw, T. T. Struhsaker and G. H. Whitesides. 2000. "Extinction of a West African Red Colobus monkey." *Conservation Biology*. 14: 1526-1532.
[695] Mickleburgh, S., Hutson, A.M., Bergmans, W. & Fahr, J. 2008. *Hipposideros lamottei*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 28 June 2010.
[696] *Id.*
[697] *United Nations Environment Programme (UNEP)*. "Mount Nimba Strict Nature Reserve Guinea and Cote D'Ivoire." World Conservation Monitoring Centre. Page 7.
[698] *Id.*
[699] *Id.*

infrastructure will undoubtedly impact this already sensitive and degraded area.[700]

In summary, habitat destruction and degradation due to mining operations, slash-and-burn agriculture, ranching, logging, charcoal production, firewood collection, fires, and rapid human population growth all place *H. lamottei's* continued survival in jeopardy.

B. Over-utilization for commercial, recreational, scientific, or educational purposes

The indiscriminant subsistence hunting of bats for food in caves on Mount Nimba likely impacts this species and threatens its survival.[701]

C. Disease or predation

Bat species worldwide may be at risk from white-nose syndrome, caused by a cold-loving fungus of the Geomyces genus.[702] The syndrome has been known to cause 80- 97% mortality rates in some large hibernation colonies.[703] Until recently, the disease was restricted to the northeastern United States. However, in 2009 it was detected in France.[704] It is not known how quickly this disease may spread to other areas of the world, but it poses a severe threat to all bat species, especially those with small ranges or those restricted to one or two caves. If infected, these species may lose nearly their entire population in one fell swoop.

D. The inadequacy of existing regulatory mechanisms

There is no protection in place for *H. lamottei* specifically, and while this species' habitat on Mount Nimba has *de jure* protection, its *de facto* protection is minimal. This species is present within the Mount Nimba Strict Nature Reserve World Heritage Site.[705] Despite its designation as a protected area, the Reserve's management is poor and in some places non-existent.[706] Iron mining was allowed inside the reserve both prior to the

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[700] *See Id.*

[701] Mickleburgh, S., Hutson, A.M., Bergmans, W. & Fahr, J. 2008. *Hipposideros lamottei*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 28 June 2010.

[702] Handwerk, Brian. 2008.: "Deadly Bat Disease Linked to Cold-Loving Fungus." National Geographic News. http://news.nationalgeographic.com/news/2008/10/081031-bat-fungus.html [Accessed October 2010].

[703] Id.

[704] Puechmaille SJ, Verdeyroux P, Fuller H, Ar Gouilh M, Bekaert M, Teeling EC. 2010 "White-nose syndrome fungus (*Geomyces destructans*) in bat, France." Emerg Infect Dis. e-pub. Available online at http://www.cdc.gov/eid/content/16/2/pdfs/09-1391.pdf [Accessed October 2010].

[705] *Id.*

[706] Lebbie, Aiah. 2001. "Western Guinean Lowland Forests." *World Wildlife Fund. WWF*. Available from: http://www.worldwildlife.org/wildworld/profiles/terrestrial/at/at0130_full.html. Accessed 7/1/2010.

Liberian civil war[707] and subsequent to it.[708] As mentioned above, the UNEP was incited to add Mount Nimba Reserve to the List of World Heritage Sites in Danger in 1992, largely due to the large-scale mining concession granted to an international consortium that permitted mining on 1,550 ha within the Reserve.[709] Furthermore, the mining operations within the Reserve do not respect the Reserve's policies or personnel. In 2005, a mining consortium built a 14-km approach road without consulting the authority that manages the Reserve and the Reserve's "guards were removed from the [mining] company town."[710] The far-reaching power that mining companies exert within the Reserve—to mine, to build structures without regard to Reserve policy, and to remove Reserve employees from areas the companies don't want them to be—seriously jeopardizes the integrity of the Reserve and its usefulness in protecting the habitat that *H. lamottei* depends on.

The large number of Liberian and Ivorian war refugees displaced to areas inside the Reserve and surrounding it also contributed to the listing of Mount Nimba Reserve as a World Heritage Site in Danger.[711] Not only have refugees flooded into the Reserve, but also as of 2007 the part of the Reserve located in Cote d'Ivoire was still under the control of rebel forces.[712] The inability of Reserve officials to protect the Reserve from the ravages of civil unrest and its aftermath indicate that the regulatory mechanisms in place to protect *H. lamottei's* habitat are insufficient to ensure this species' survival.

Perhaps not surprisingly, considering the surrounding sociopolitical conditions, basic habitat management is lacking in the Reserve. For example, despite the fragmentation that characterizes the remaining forest stands in the Reserve, there are no efforts to create wildlife corridors to lessen the effects of isolation on forest species.[713] Many additional policies and protections are not being enforced within the Reserve for a variety of reasons.[714] First, the transboundary nature of the Reserve adds to the difficulty of management.[715] According to the UNEP, "until 2001, differences between the three countries [that the Reserve is located in], linguistic, cultural, administrative and economic, along with civil strife from 2000, precluded any effective transboundary action."[716] Then, in 2002 to 2003, there was civil unrest in Cote d'Ivoire, which led to

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[707] Bourque, J.D. 1996. Inventaire preliminaire de la faune aviaire du Bassin de la riviere Kuundu et de la forest classee de Nialama, Republique de Guinée. Unpublished report.
[708] *United Nations Educational, Scientific and Cultural Organization (UNESCO)*. "List of World Heritage in Danger." Available from: http://whc.unesco.org/en/danger/. Accessed 7/2/2010.
[709] *United Nations Environment Programme (UNEP*). "Mount Nimba Strict Nature Reserve Guinea and Cote D'Ivoire." World Conservation Monitoring Centre. Page 7.
[710] *Id.*
[711] *Id.*
[712] *Id.*
[713] Lebbie, Aiah. 2001. "Eastern Guinean Forests." *World Wildlife Fund (WWF*). Available from: http://www.worldwildlife.org/wildworld/profiles/terrestrial/at/at0111_full.html. Accessed on 6/15/2010.
[714] *United Nations Environment Programme (UNEP*). "Mount Nimba Strict Nature Reserve Guinea and Cote D'Ivoire." World Conservation Monitoring Centre. Page 7.
[715] *Id.*
[716] *Id.*

the suspension of operations in the part of the Reserve located in that country.[717] This civil unrest also led to the suspension of tri-national negotiations regarding the Reserve.[718] During this time NGO activity to protect the Reserve also ended due to instability in the area.[719] Cote d'Ivoire has subsequently failed to cooperate with the two other countries in protecting the Reserve.[720]

Second, the guards employed to protect the Reserve have a very difficult time actually doing so. In addition to mining companies removing guards from certain areas, mentioned above, the facilities used by Reserve guards were recently moved from a site fairly close to the park to a location 1,000 km away.[721] UNESCO has also found that the number of guards for the site is "inadequate" and that they are "poorly equipped."[722] They also suffer from a lack of funding for the Reserve.[723]

The combination of mining concessions within the Reserve, displaced war refugees settling in the Reserve, rebel control of certain areas of the Reserve, a lack of effective habitat management, the break-down of trans-national cooperation and regulation, and poorly equipped, inadequately funded, and authoritatively undermined Reserve guards, leads to the inescapable conclusion that the regulatory mechanisms intended to protect Mount Nimba are inadequate. This places the sole location of the entire *H. lamottei* population in jeopardy.

E. Other natural or manmade factors affecting its continued existence

i. Climate change

The Intergovernmental Panel on Climate Change (IPCC) states that human activities are likely contributing to global climate change. "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic [greenhouse gas] concentrations… It is likely that there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica)."[724] Due to climate change, "there are projected to be major changes in ecosystem structure and function, species' ecological interactions and shifts in species' geographical ranges, with predominantly negative consequences for biodiversity."[725] Threats from global climate change are relevant to this bat species. This species lives in a mountainous region, and climate change is expected to have unique impacts in mountainous areas. Due to anthropogenic climate change, there are expected to be "shifts of plant and animal ranges both poleward and up

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[717] *Id.*
[718] *Id.*
[719] *Id.*
[720] *Id.*
[721] *Id.* at 8.
[722] *Id.*
[723] *Id.* at 7.
[724] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Available from: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009].
[725] *Id.*

mountainsides."[726] Some high-elevation species may run out of habitat as they are driven higher upwards by changing temperature ranges.

ii. Biological vulnerability

As only six specimens of this species have ever been caught, it likely has an extremely small population size. FWS has routinely recognized that small population size and restricted range increase the likelihood of extinction.[727]

One additional factor that makes this species particularly vulnerable to extinction is its low fecundity. Across all bats species generally, fetal development occurs slowly, with pregnancies lasting between three to six months.[728] Female bats generally produce one young per year. This is believed to be due to the very large size of bat pups at birth. Young bats comprise from between 12-15% of the mother's body mass up to 25% of the mother's body mass during pregnancy. Scientists believe that the weight of the pup during pregnancy limits the mother's litter size due to her need to fly while pregnant.[729]

Litter size is also likely limited due to nursing characteristics that are unique to bat species.[730] Most mammals wean their young when the young reach 40%, or less, of their adult size. Bats, however, nurse their young until they are nearly adult size. This is because bats cannot feed on their own until their wings are near adult dimensions. This may contribute to the low fecundity of bats.[731] Species with low fecundity are "particularly predisposed to anthropogenic threats given their low replacement rate."[732] Thus, low fecundity is another reason that *H. lamottei* faces a high likelihood of extinction unless further action is taken.

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[726] Karl, Thomas R., Gerald A. Meehl, Christopher D. Miller, Susan J. Hassol, Anne M. Waple, and William L. Murray, eds. 2008. Weather and Climate Extremes in a Changing Climate, Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands. Synthesis and Assessment Product 3.3. Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Online at http://downloads.climatescience.gov/sap/sap3-3/sap3-3-final-all.pdf [Accessed October 2010]

[727] See, for example, FWS candidate assessment forms for *Doryopteris takeuchii, Huperzia stemmermanniae, Megalagrion nesiotes, Melicope degeneri, Melicope hiiakae, Myrsine mezii, Ostodes strigatus, Partula langfordi, Peperomia subpetiolata, Phyllostegia bracteata*, and *Tryonia circumstriata*. Accessible via FWS website at http://www.fws.gov/endangered/wildlife.html [Accessed November 2009].

[728] Nowak, Ronald and Ernest Walker. 1994. *Walker's Bats of the World*. John Hopkins University Press. Page 20.

[729] *Id.*

[730] *Id.*

[731] *Id.*

[732] Brook, Barry, Navjot Sodhi, and Corey Bradshaw. 2008. "Synergies Among Extinction Drivers Under Global Change." *Trends in Ecology and Evolution*. 23(8): 453-460, 455.

J. Lord Howe Long-Eared Bat (*Nyctophilus howensis*)

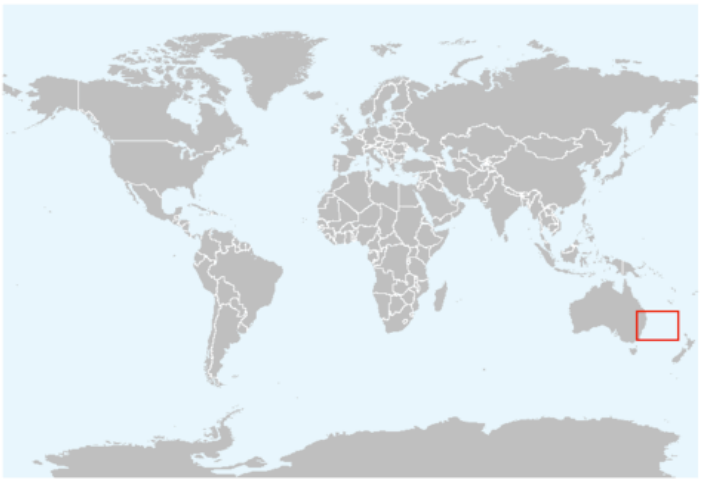
1. Taxonomy

Nyctophilus howensis is a member of the Order Chiroptera, Family Vespertilionidae.[733] While this species was placed provisionally in *Nyctophilus*, the "generic status of the species requires re-evaluation because it might not belong with *Nyctophilus*."[734]

2. Distribution and Range

"This species is endemic to Lord Howe Island, New South Wales, Australia."[735] The Island is "located in the southwest Pacific Ocean, 800 km northeast of Sydney and 630km off the New South Wales Coast."[736] The Island is 1,176 ha.[737]

Figure J.1 *N. howensis* is endemic to Lord Howe Island, New South Wales, Australia.



Source: Hall, L., Lumsden, L. & Parnaby, H. 2008. *Nyctophilus howensis*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

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[733] Hall, L., Lumsden, L. & Parnaby, H. 2008. Nyctophilus howensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[734] *Id.*
[735] Id.
[736] *United Nations Environment Programme—World Conservation Monitoring Centre*. 2008. "Lord Howe Island Group New South Wales, Australia." World Heritage Sites. 1-8, 1.
[737] *Id.*

Figure J.2 Lord Howe Island.

Source: Thompson, D., Bliss, P., and Priest, J. 1987. Lord Howe Island Geology, Geological Survey of New South Wales, Sydney.

3. Habitat and Ecology

The only known specimen of this species (an incomplete skull) was collected from a mezzanine ledge in Gooseberry Cave, which is located in a palm forest on North Head.[738] This cave is small, at approximately 3 m x 3 m, and it may have been an owl roost.[739,740] The skull seems to be 50 to 100 years old, and was most likely regurgitated by an owl.[741]

The Island's climate is humid subtropical, and is largely covered in rainforest or palm forest.[742] Ninety percent of the original forest still remains on the island, although 10 percent of the land area has been degraded through grazing.[743]

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[738] Hall, L., Lumsden, L. & Parnaby, H. 2008. Nyctophilus howensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[739] Hall, L., Lumsden, L. & Parnaby, H. 2008. Nyctophilus howensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010

[740] Richards, Greg and Les Hall. 1999. "The Action Plan for Australian Bats: Recovery outlines and taxon summaries." *Environment Australia*. Australian Department of the Environment, Water, Heritage, and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/action/bats/7.html.

[741] *Id.*

[742] *United Nations Environment Programme—World Conservation Monitoring Centre*. 2008. "Lord Howe Island Group New South Wales, Australia." World Heritage Sites. 1-8, 2.

[743] *Id.*

3. Population and Trend

IUCN believes that the population size of *N. howensis* is "almost certainly less than 50 individuals."[744] While this species was designated as extinct by the IUCN in 1996,[745] and the Australian government listed the species as extinct in 1999 in its Action Plan for Australian Bats,[746] new evidence suggests that this species is not, in fact, extinct.[747] Islanders report that they continue to see two different-sized bats on the island.[748] There is only one other bat species on Lord Howe Island,[749] *Eptesicus sagittula*,[750] so these sightings of different sizes of bats suggest that *N. howensis* is not extinct.[751] As such, IUCN's re-designated this species as critically endangered (possibly extinct) in 2008.[752] The Australian Government's designation of this species as extinct was based on two searches of Lord Howe Islands that did not yield any results.[753] In one, Les Hall conducted a search of all caves on North Head.[754] No live individuals, nor any skeletal remains, were found.[755] The other study, conducted by Glenn Hoye, used bat traps and mist nets, but failed to locate any *N. howensis* individuals.[756] Considering that the IUCN believes the *N. howensis* population to be "almost certainly be less than 50 individuals,[757] it is unsurprising that two searches in only two locations on the Island would fail to detect

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[744] Hall, L., Lumsden, L. & Parnaby, H. 2008. Nyctophilus howensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[745] *Id.*
[746] Richards, Greg and Les Hall. 1999. "The Action Plan for Australian Bats: Recovery outlines and taxon summaries." *Environment Australia*. Australian Department of the Environment, Water, Heritage, and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/action/bats/7.html.
[747] Hall, L., Lumsden, L. & Parnaby, H. 2008. Nyctophilus howensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[748] *Id.*
[749] *Id.*
[750] *United Nations Environment Programme—World Conservation Monitoring Centre*. 2008. "Lord Howe Island Group New South Wales, Australia." World Heritage Sites. 1-8, 3.
[751] Hall, L., Lumsden, L. & Parnaby, H. 2008. Nyctophilus howensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[752] *Id.*
[753] Richards, Greg and Les Hall. 1999. "The Action Plan for Australian Bats: Recovery outlines and taxon summaries." *Environment Australia*. Australian Department of the Environment, Water, Heritage, and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/action/bats/7.html.
[754] *Id.*
[755] *Id.*
[756] *Id.*
[757] Hall, L., Lumsden, L. & Parnaby, H. 2008. Nyctophilus howensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

it. Therefore, IUCN's re-designation of this species as critically endangered[758] is warranted.

5. Major Threats

It is suspected that predation of this species by introduced masked owls *Tyto novaehollandiae*[759] and black rats *Rattus rattus*[760] have contributed to its decline.[761,762]

6. Conservation Actions

The only specimen of this species was found within the boundaries of Lord Howe Island National Park, which is operated and maintained by the New South Wales national Parks and Wildlife Service.[763] Additionally, the Lord Howe Islands were designated as a World Heritage Site in 1982.[764] The preserve covers approximately 76% of the land area of Lord Howe Island.[765]

7. ESA Listing Factors

C. Disease or predation

As mentioned previously, it is suspected that predation of this species by introduced masked owls *Tyto novaehollandiae*[766] and black rats *Rattus rattus*[767] have contributed to its decline.[768,769]

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[758] *Id.*
[759] *United Nations Environment Programme—World Conservation Monitoring Centre*. 2008. "Lord Howe Island Group New South Wales, Australia." World Heritage Sites. 1-8, 5.
[760] *Id.* at 3.
[761] Hall, L., Lumsden, L. & Parnaby, H. 2008. Nyctophilus howensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[762] Richards, Greg and Les Hall. 1999. "The Action Plan for Australian Bats: Recovery outlines and taxon summaries." *Environment Australia*. Australian Department of the Environment, Water, Heritage, and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/action/bats/7.html.
[763] *Id.*
[764] McGinley, Mark. 2008. "Lord Howe Island Group, Australia." United Nations Environment Programme-World Conservation Monitoring Centre. In: *Encyclopedia of Earth*. Eds. Cutler J. Cleveland Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment. Available from: http://www.eoearth.org/article/Lord_Howe_Island_Group,_Australia.
[765] *United Nations Environment Programme—World Conservation Monitoring Centre*. 2008. "Lord Howe Island Group New South Wales, Australia." World Heritage Sites. 1-8, 1.
[766] *Id.* at 5.
[767] *Id.* at 3.
[768] Hall, L., Lumsden, L. & Parnaby, H. 2008. Nyctophilus howensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

Bat species worldwide may be at risk from white-nose syndrome, caused by a cold-loving fungus of the Geomyces genus.[770] The syndrome has been known to cause 80- 97% mortality rates in some large hibernation colonies.[771] Until recently, the disease was restricted to the northeastern United States. However, in 2009 it was detected in France.[772] It is not known how quickly this disease may spread to other areas of the world, but it poses a severe threat to all bat species, especially those with small ranges or those restricted to one or two caves. If infected, these species may lose nearly their entire population in one fell swoop.

D. The inadequacy of existing regulatory mechanisms

While most of the Island has some level of protected status,[773] there is concern over the inability to completely eradicate black rats from the Island. Commendably, introduced masked owls have been eradicated from Lord Howe Island.[774] Rat management programs are also underway as part of the management of the Park.[775,776] Nonetheless, rats have not been eradicated from the Island, and a lack of funding for the Lord Howe Park[777] indicates that eradication will be difficult. The UNEP finds that "funding and labor constraints have so far permitted only the control and not the elimination of introduced flora and fauna"[778] outside of the elimination of owls,[779] feral

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[769] Richards, Greg and Les Hall. 1999. "The Action Plan for Australian Bats: Recovery outlines and taxon summaries." *Environment Australia*. Australian Department of the Environment, Water, Heritage, and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/action/bats/7.html.

[770] Handwerk, Brian. 2008.: "Deadly Bat Disease Linked to Cold-Loving Fungus." National Geographic News. http://news.nationalgeographic.com/news/2008/10/081031-bat-fungus.html [Accessed October 2010].

[771] *Id.*

[772] Puechmaille SJ, Verdeyroux P, Fuller H, Ar Gouilh M, Bekaert M, Teeling EC. 2010 "White-nose syndrome fungus (*Geomyces destructans*) in bat, France." Emerg Infect Dis. e-pub. Available online at http://www.cdc.gov/eid/content/16/2/pdfs/09-1391.pdf [Accessed October 2010].

[773] *See* Hall, L., Lumsden, L. & Parnaby, H. 2008. Nyctophilus howensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[774] *Id.*

[775] Hall, L., Lumsden, L. & Parnaby, H. 2008. Nyctophilus howensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[776] Richards, Greg and Les Hall. 1999. "The Action Plan for Australian Bats: Recovery outlines and taxon summaries." *Environment Australia*. Australian Department of the Environment, Water, Heritage, and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/action/bats/7.html.

[777] *United Nations Environment Programme—World Conservation Monitoring Centre*. 2008. "Lord Howe Island Group New South Wales, Australia." World Heritage Sites. 1-8, 5.

[778] *Id.*

[779] Hall, L., Lumsden, L. & Parnaby, H. 2008. Nyctophilus howensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

pigs, and feral goats.[780] While owls were eliminated in 2000, *N. howensis*' population has failed to recover.[781] This may be evidence that the continued presence of black rats on the Island is now the primary factor in the inability of this species to increase its population. Therefore, the Park's inability to eliminate the black rat,[782] and the difficulty experienced in controlling it, likely jeopardizes the survival of *N. howensis*. Though programs combating invasive species in the Park have had some success, these existing regulatory measures are still inadequate to protect this elusive bat.

E. Other natural or manmade factors affecting its continued existence

i. Climate change

The Intergovernmental Panel on Climate Change (IPCC) states that human activities are likely contributing to global climate change. "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic [greenhouse gas] concentrations… It is likely that there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica)."[783] Due to climate change, "there are projected to be major changes in ecosystem structure and function, species' ecological interactions and shifts in species' geographical ranges, with predominantly negative consequences for biodiversity."[784] Threats from global climate change are relevant to this bat species.

This species is endemic to an island, which face particularly urgent threats from rising sea levels and increasingly severe and frequent tropical storms caused by human-induced climate change. "Global average sea level is rising predominantly as a consequence of three factors—thermal expansion of warming ocean water, addition of new water from the ice sheets of Greenland and Antarctica and from glaciers and ice caps, and the addition of water from land hydrology. All three potential sources are undergoing changes of anthropogenic origin."[785] The IPCC projects that on small islands, " sea level rise is expected to exacerbate inundation, storm surge, erosion and other coastal hazards… [and] with higher temperatures, increased invasion by non-native species is expected to occur, particularly on mid- and high-latitude islands."[786]

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[780] *United Nations Environment Programme—World Conservation Monitoring Centre*. 2008. "Lord Howe Island Group New South Wales, Australia." World Heritage Sites. 1-8, 5.

[781] *See* Hall, L., Lumsden, L. & Parnaby, H. 2008. Nyctophilus howensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[782] *United Nations Environment Programme—World Conservation Monitoring Centre*. 2008. "Lord Howe Island Group New South Wales, Australia." World Heritage Sites. 1-8, 5.

[783] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Available from: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009].

[784] *Id.*

[785] McMullen, C.P. and Jabbour, J. 2009. Climate Change Science Compendium 2009. United Nations Environment Programme, Nairobi, EarthPrint. Online at http:// www.unep.org/compendium2009/ [Accessed November 2009].

[786] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009]

ii. Biological vulnerability

Two additional factors threaten the continued survival of this species. First, the extremely low population size of this species, estimated to be less than 50 surviving individuals,[787] is a threat to its existence. A "small population size increases the risk of extinction through inbreeding depression and stochastic events."[788] Additionally, studies have indicated that the population of a species declines more quickly closer to the time of extinction than "earlier in the time series."[789] This indicates that this species' population of less than 50 individuals could quickly and easily plummet even lower, making this species' extinction risk very high.[790] FWS has routinely recognized that small population size and restricted range increase the likelihood of extinction.[791] Island species are particularly susceptible to extinction.[792,793]

Second, this species is particularly vulnerable to extinction due to its low fecundity. Across all bats species generally, fetal development occurs slowly, with pregnancies lasting between three to six months.[794] Female bats generally produce one young per year. This is believed to be due to the very large size of bat pups at birth. Young bats comprise from between 12-15% of the mother's body mass up to 25% of the mother's body mass during pregnancy. Scientists believe that the weight of the pup during pregnancy limits the mother's litter size due to her need to fly while pregnant.[795]

Litter size is also likely limited due to nursing characteristics that are unique to bat species.[796] Most mammals wean their young when the young reach 40%, or less, of their adult size. Bats, however, nurse their young until they are nearly adult size. This is because bats cannot feed on their own until their wings are near adult dimensions. This

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[787] Hall, L., Lumsden, L. & Parnaby, H. 2008. Nyctophilus howensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[788] Schulz, M. and Lumsden, L.F. 2004. National Recovery Plan for the Christmas Island Pipistrelle *Pipistrellus murrayi*. Commonwealth of Australia, Canberra. Page 31.

[789] Brook, Barry, Navjot Sodhi, and Corey Bradshaw. 2008. "Synergies among extinction drivers under global change." *Trends in Ecology and Evolution*. 23(8): 453-460, 456.

[790] *See Id.*

[791] See, for example, FWS candidate assessment forms for *Doryopteris takeuchii, Huperzia stemmermanniae, Megalagrion nesiotes, Melicope degeneri, Melicope hiiakae, Myrsine mezii, Ostodes strigatus, Partula langfordi, Peperomia subpetiolata, Phyllostegia bracteata*, and *Tryonia circumstriata*. Accessible via FWS website at http://www.fws.gov/endangered/wildlife.html [Accessed November 2009].

[792] Groombridge, B. 1992. Global Biodiversity - Status of the Earth's Living Resources: A Report Compiled by the World Conservation Monitoring Centre. Chapman and Hall, London, New York. Available at http://www.archive.org/details/globalbiodiversi92wcmc [Accessed 10/19/10].

[793] Frankham, Richard. 2008. "Inbreeding and Extinction: Island Populations." Conservation Biology. 12: 665–675. Available at http://onlinelibrary.wiley.com/doi/10.1111/j.1523-1739.1998.96456.x/abstract [Accessed 10/19/10].

[794] Nowak, Ronald and Ernest Walker. 1994. *Walker's Bats of the World*. John Hopkins University Press. Page 20.

[795] *Id.*

[796] *Id.*

may contribute to the low fecundity of bats.[797] Species with low fecundity are "particularly predisposed to anthropogenic threats given their low replacement rate."[798] Thus, low fecundity is another reason that *N. howensis* faces a high likelihood of extinction unless further action is taken.

[797] *Id.*

[798] Brook, Barry, Navjot Sodhi, and Corey Bradshaw. 2008. "Synergies Among Extinction Drivers Under Global Change." *Trends in Ecology and Evolution*. 23(8): 453-460, 455.

K. Montane Monkey-Faced Bat (*Pteralopex pulchra*)

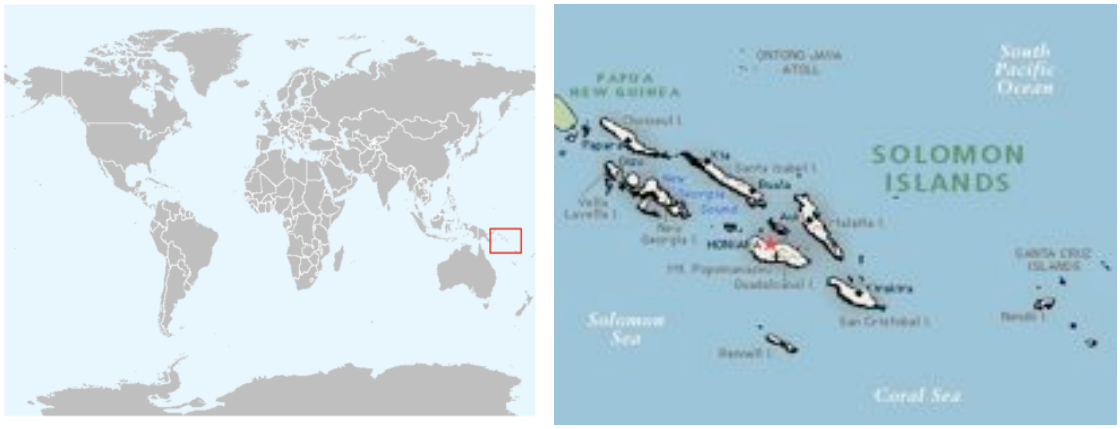
1. Taxonomy

This species belongs to the Order Chiroptera, Family Pteropodidae.[799] It was described by Flannery (1991) as a distinct new species.[800]

2. Distribution and Range

Pteralopex pulchra occurs on one island in the Solomon Island chain.[801] The single specimen by which this species is known was collected on the southern slopes of Mount Makarakonburu, which is located on the island of Guandalcanal.[802] The estimated elevational range of this species is between 1,200 and 2,448m.[803]

Figure K.1 *Pteralopex pulchra* occurs only on the island of Guandalcanal in the Solomon Island chain.



Source (left): Leary, T., Helgen, K. & Hamilton, S. 2008. *Pteralopex pulchra*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
Source (right): http://wwp.greenwichmeantime.com/time-zone/pacific/solomon-islands/map.htm

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[799] Leary, T., Helgen, K. & Hamilton, S. 2008. Pteralopex pulchra. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[800] Helgen, Kristofer. 2005. "Systematics of the Pacific monkey-faced bat (Chiroptera: Pteropodidae), with a new species of Pteralopex and a new Fijian genus." *Systematics and Biodiversity*. 3(4): 433-453, 434.
[801] Leary, T., Helgen, K. & Hamilton, S. 2008. Pteralopex pulchra. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[802] *Id.*
[803] *Id.*

3. Habitat and Ecology

Researchers found the single known *P. pulchra* specimen in a "primarily mossy montane forest with emergent *Metrosideros* and palms, and an abundant understory of ferns and climbing bamboo."[804] The species is likely endemic to upland areas[805] of cloud forest at 1200m and higher.[806]

4. Population and Trend

This species is possibly extinct.[807] If it does still survive, its population is likely less than 250 mature individuals.[808] All individuals are contained in a single subpopulation, and it is likely declining continuously.[809]

5. Major Threats

Other members of the *Pteralopex* genus are "highly susceptible to deforestation and hunting, and these threats could also be operating on this species."[810] *P. pulchra* also likely has specific habitat requirements and its restricted range could make it susceptible to a single threat event.[811]

6. Conservation Actions

This species is not found in any protected area.[812]

7. ESA Listing Factors

A. <u>The present or threatened destruction, modification, or curtailment of its habitat or range</u>

The Solomon Islands have experienced relatively high rates of primary forest

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[804] *Id.*
[805] *Id.*
[806] Helgen, Kristofer. 2005. "Systematics of the Pacific monkey-faced bat (Chiroptera: Pteropodidae), with a new species of Pteralopex and a new Fijian genus." *Systematics and Biodiversity*. 3(4): 433-453, 444.
[807] Leary, T., Helgen, K. & Hamilton, S. 2008. Pteralopex pulchra. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[808] *Id.*
[809] *Id.*
[810] *Id.*
[811] *Id.*
[812] *Id.*

loss.[813] Small-scale logging began in the 1920s due to Australian demand for tropical timber.[814] Until World War II, this industry was "minor."[815] The use of the Island's timber resources during World War II, however, increased foreign interest in exploiting the Island's forest. With the expectation of future timber markets, as well as burgeoning local demand, the Island's colonial government "invoked a model of forest use common to many British and other imperial powers, the establishment of sustainable plantation forestry on government land."[816] These forestry plantations were frequently planted with exotic species of hardwoods.[817] By the 1960s, new technological developments, including chain-saws, tractors, and bulldozers, allowed foreign loggers to economically harvest large areas of the Island's forests.[818] Around this same time, with the growing push for de-colonization, the Island's colonial government began to view the development of its forests as a means of financing itself and so extended government timber plantations. These plans came to a head beginning in 1978, when the Solomon Islands gained independence at the same time that timber supplies in South-east Asia began to decline. These two developments, in addition to technological developments and a government that wanted to build wealth through forest resource exploitation, led to high levels of logging in the 1980s and 1990s.

In the early 1980s under the first Mamaloni government, "the number of [logging] licenses quadrupled and foreign firms moved into Guadalcanal…"[819] The primary loggers consisted of Asian companies,[820] with Japan being the primary importer of felled logs. [821] This development brought with it extensive habitat destruction. As timber comprised an increasing source of income to the Solomon Island government, the government's "flawed economic decisions" meant that "logging became more politicized and unsustainable, with extraction rates far exceeding forest increment."[822] From 1981 to 1986, the log production on Guadalcanal exceeded sustainable rates.[823] Although rates fell briefly, a sharp increase in logging pressure resumed in 1991.[824]

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[813] Wiles, Gary and Anne Brooke. "Conservation Threats to Bats in the Tropical Pacific Islands." in Fleming, Theodore and Paul Racey. 2010. *Island Bats: Evolution, Ecology, and Conservation*. University of Chicago Press: 1-549, 407.

[814] Bennett, Judith. 2000. *Pacific Forest: a history of resource control and contest in the Solomon Islands, c. 1800-1997*. White Horse Press: Cambridge. 1-517, 2.

[815] *Id.*

[816] *Id.*

[817] *Id.* at 204.

[818] *Id.* at 2.

[819] Dauvergne, Peter. 1997. "Weak states and the environment in Indonesia and the Solomon Islands." Resource Management in Asia-Pacific. Working Paper No. 10. 1-17, 9. Available from: http://dspace-prod1.anu.edu.au/bitstream/1885/40975/2/rmap_wp10.pdf.

[820] *Id.*

[821] *Id.* at 1.

[822] *Id.* at 2.

[823] Dauvergne, Peter. 1997. "Weak states and the environment in Indonesia and the Solomon Islands." Resource Management in Asia-Pacific. Working Paper No. 10. 1-17, 9. Available from: http://dspace-prod1.anu.edu.au/bitstream/1885/40975/2/rmap_wp10.pdf.

[824] Dauvergne, Peter. 1997. "Weak states and the environment in Indonesia and the Solomon Islands." Resource Management in Asia-Pacific. Working Paper No. 10. 1-17, 9. Available from: http://dspace-prod1.anu.edu.au/bitstream/1885/40975/2/rmap_wp10.pdf.

Between 1991 and 1995, log production from forested lands "more than doubled, increasing from 381,000 cubic meters to about 826,000 cubic meters" with the production rate in 1996 remaining at approximately the same level as 1995.[825] This put production "around three times higher than sustainable levels."[826] Further estimates indicate that if logging continues at this rate, the Solomon Islands will deplete its commercial timber supply in approximately 10 years, which would have been around 2007.[827] Given this, "all scenarios indicate a looming environmental…crisis for the Solomon Islands."[828] The unsustainable logging of the Solomon Islands has produced long-lasting negative environmental impacts. Timber companies used extensive networks of gravel roads to access forest stands,[829] which fragmented whatever forest patches were left standing and likely decreases the suitability of those patches for bat habitat. Additionally, a study conducted as early as 1970 indicated that the topsoil in many logged areas was so damaged that attempts to reforest the area 20 years later failed.[830] In areas that could be replanted, the use of tractors to log had "re-distributed and compacted the topsoil" to such an extent that the growth of replanted trees was reduced.[831] Not only has the forest that *P. pulchra* relies on been destroyed, but the fundamental soil structure has also been damaged in a way that will likely preclude re-growth of the forest. These deforested areas may never be able to support this species again, even in the distant future. Habitat restoration, if planned, might therefore not be an effective solution for reviving the habitat that this species needs.

Local subsistence farmers and squatters have also degraded, destroyed, and altered the ecology of previously forested land on the Solomon Islands.[832] Farmers have "gardened, cut wood, lit fires, built houses, kept pigs…and generally denuded the hills."[833] This has resulted not only in habitat destruction but also in fundamental habitat alteration, as land that was once covered by primary forest is now "dominated by thermida grass and the 'weed' tree *Brousonnettia papirifera*."[834]

B. Over-utilization for commercial, recreational, scientific, or educational purposes

Similar to other members of its genus, *P. pulchra*, which is a fruit bat, may be susceptible to hunting pressures that threaten its already very low population.[835]

C. Disease or predation

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[825] *Id.*
[826] *Id.*
[827] *Id.*
[828] *Id.*
[829] Bennett, Judith. 2000. *Pacific Forest: a history of resource control and contest in the Solomon Islands, c. 1800-1997*. White Horse Press: Cambridge. 1-517, 187.
[830] *Id.*
[831] *Id.*
[832] *Id.* at 188-189.
[833] *Id.*
[834] *Id.*
[835] *Id.*

Bat species worldwide may be at risk from white-nose syndrome, caused by a cold-loving fungus of the Geomyces genus.[836] The syndrome has been known to cause 80-97% mortality rates in some large hibernation colonies.[837] Until recently, the disease was restricted to the northeastern United States. However, in 2009 it was detected in France.[838] It is not known how quickly this disease may spread to other areas of the world, but it poses a severe threat to all bat species, especially those with small ranges or those restricted to one or two caves. If infected, these species may lose nearly their entire population in one fell swoop.

D. The inadequacy of existing regulatory mechanisms

There are currently no measures in place to protect this species.[839] Considering that this species' population is estimated at less than 250 mature individuals,[840] and that the threats it faces are ongoing and severe,[841] the complete lack of any form of protection is clearly inadequate to prevent this species from further decline.

Not only do the Solomon Island's governmental policies strongly favor extractive industries, which form the basis of their economy,[842],[843],[844] but foreign corporate pressures have strongly influenced government officials, leading to a very favorable climate for resource extraction.[845] Solomon Island's "state officials have succumbed to corporate pressures and bribes, stalling environmental reforms, eroding implementation of forest management rules, and leading to generous tax breaks."[846] So many logging permits have been granted that both local communities and the Forestry Division itself, the very government agency responsible for monitoring logging negotiations, are largely

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[836] Handwerk, Brian. 2008.: "Deadly Bat Disease Linked to Cold-Loving Fungus." National Geographic News. http://news.nationalgeographic.com/news/2008/10/081031-bat-fungus.html [Accessed October 2010].
[837] Id.
[838] Puechmaille SJ, Verdeyroux P, Fuller H, Ar Gouilh M, Bekaert M, Teeling EC. 2010 "White-nose syndrome fungus (*Geomyces destructans*) in bat, France." Emerg Infect Dis. e-pub. Available online at http://www.cdc.gov/eid/content/16/2/pdfs/09-1391.pdf [Accessed October 2010].
[839] *Id.*
[840] *Id.*
[841] *See Id.*
[842] *See* Bartelmus, Peter, Ernst Lutz, and Stefan Schweinfest. 1992. "Integrated Environmental and Economic Accounting: a case study for Papua New Guinea." The World Bank. Environment Working Paper No. 54. Page 1-57, 15, 22.
[843] Dauvergne, Peter. 1997. "Globalization and Deforestation in the Asia-Pacific." Working Paper No. 1997/7. Australian National University. Page 1-31, 14.
[844] Bennett, Judith. 2000. *Pacific Forest: a history of resource control and contest in the Solomon Islands, c. 1800-1997*. White Horse Press: Cambridge. 1-517, 2.
[845] Dauvergne, Peter. 1997. "Weak states and the environment in Indonesia and the Solomon Islands." Resource Management in Asia-Pacific. Working Paper No. 10. 1-17, 9. Available from: http://dspace-prod1.anu.edu.au/bitstream/1885/40975/2/rmap_wp10.pdf.
[846] *Id.*

unable to "monitor and control foreign loggers."[847] The logging permitting process is overlaid by "inadequate state supervision, ambiguous laws, corrupt and divided community negotiators, corporate bribes, corporate funding of Area Council [Timber Rights] meetings [where leaders determine whether private landowners are willing to sell the timber on their lands], and highly trained corporate negotiators, [which] have generally allowed multinational timber companies to negotiate favorable agreements."[848]

Timber corporations have gone to great lengths to maintain this favorable environment through pressuring and bribing politicians and bureaucrats to "reverse reforms that threaten profits."[849] Beginning in 1993, Prime Minister Billy Hilly's government started to undertake progressive reforms of the timber industry. The new policies were designed to decrease logging and increase government oversight. This period of reform was short-lived because Billy Hilly's government collapsed in 1994 under "a series of defections and resignations."[850] Joses Tuhanuku, the Minister of Forests, Environment, and Conservation at the time, stated that the numerous defections and ultimate government collapse was a result of foreign logging companies.[851] After this, environmental protections and control over foreign loggers afforded by subsequent governments "weakened even further" from the level of the very early 1990s.[852]

Not only is the government of the Solomon Islands ineffective at regulating and controlling foreign logging companies, but the few environmental protections that it has put in place are "largely ignor[ed]" or "blatantly disregard[ed]" by foreign companies.[853] The government's "weak state administrative capacity, limited state legal powers, remote logging sites, and few provincial and community resources allow loggers to operate with little scrutiny and almost no restraints."[854] These conditions have enabled logging company actions that have devastated the forested areas of the Solomon Islands.[855] Violations and impacts include "companies [that] log areas outside their license, damage or cut undersized or protected trees, build temporary and inappropriate roads and bridges, leave pools of stagnant water that spread malaria, pollute and disrupt food and water sources, disregard reforestation duties, and ignore obligations to consult with landowners."[856] One study found that a logging site in the Solomon Islands had "a degree of canopy removal and soil disturbance [that] was the most extensive seen by the authors in any logging operation in tropical rainforest in any country."[857] The *1995 Forestry Review*, described as an "unofficial internal government document," stated that

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[847] *Id.*
[848] *Id.*
[849] *Id.*
[850] *Id.*
[851] *Id.*
[852] *Id.* at 9-10.
[853] *Id.* at 10.
[854] *Id.*
[855] *Id.*
[856] *Id.*
[857] Dauvergne, Peter. 1997. "Weak states and the environment in Indonesia and the Solomon Islands." Resource Management in Asia-Pacific. Working Paper No. 10. 1-17, 10. Available from: http://dspace-prod1.anu.edu.au/bitstream/1885/40975/2/rmap_wp10.pdf citing Forests Monitor, draft briefing document, "Kumpulan Emas Berhad and its Involvement in the Solomon Islands," April 1996. p. 7.

"forest practices in many locations [in the Solomon Islands] are amongst the worst in the world."[858] The political environment, as well as the practices of the foreign logging industries that operate in the Solomon Islands, has created conditions that clearly demonstrate a complete inadequacy of existing regulatory mechanisms to protect *P. flanneryi*, which is entirely reliant upon forests that receive virtually no protection. This is a serious threat to this species' survival.

E. Other natural or manmade factors affecting its continued existence

i. Climate change

The Intergovernmental Panel on Climate Change (IPCC) states that human activities are likely contributing to global climate change. "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic [greenhouse gas] concentrations… It is likely that there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica)."[859] Due to climate change, "there are projected to be major changes in ecosystem structure and function, species' ecological interactions and shifts in species' geographical ranges, with predominantly negative consequences for biodiversity."[860] Threats from global climate change are relevant to this bat species.

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ii. Biological vulnerability

Three additional factors threaten this species. First, this species only occurs on one small island, Guandalcanal. This highly restricted range could make the bat susceptible

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[858] Dauvergne, Peter. 1997. "Weak states and the environment in Indonesia and the Solomon Islands." Resource Management in Asia-Pacific. Working Paper No. 10. 1-17, 10. Available from: http://dspace-prod1.anu.edu.au/bitstream/1885/40975/2/rmap_wp10.pdf.

[859] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Available from: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009].

[860] *Id.*

[861] McMullen, C.P. and Jabbour, J. 2009. Climate Change Science Compendium 2009. United Nations Environment Programme, Nairobi, EarthPrint. Online at http://www.unep.org/compendium2009/ [Accessed November 2009].

[862] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009]

to a single threat event, such as a cyclone or fire[863] that could destroy a large part of the population. Second, the extremely low population size of this species, estimated to be less than 250 mature surviving individuals,[864] is a threat to its existence. A "small population size increases the risk of extinction through inbreeding depression and stochastic events."[865] FWS has routinely recognized that small population size and restricted range increase the likelihood of extinction.[866] Island species are particularly susceptible to extinction.[867,868] Additionally, studies have indicated that the population of a species declines more quickly closer to the time of extinction than "earlier in the time series."[869] This indicates that this species' population of less than 250 mature individuals could easily plummet to an even lower number with great rapidity, making its extinction risk very high.[870]

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[863] Leary, T., Helgen, K. & Hamilton, S. 2008. Pteralopex pulchra. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[864] Leary, T., Helgen, K. & Hamilton, S. 2008. Pteralopex pulchra. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[865] Schulz, M. and Lumsden, L.F. 2004. National Recovery Plan for the Christmas Island Pipistrelle *Pipistrellus murrayi*. Commonwealth of Australia, Canberra. Page 31.

[866] See, for example, FWS candidate assessment forms for *Doryopteris takeuchii, Huperzia stemmermanniae, Megalagrion nesiotes, Melicope degeneri, Melicope hiiakae, Myrsine mezii, Ostodes strigatus, Partula langfordi, Peperomia subpetiolata, Phyllostegia bracteata*, and *Tryonia circumstriata*. Accessible via FWS website at http://www.fws.gov/endangered/wildlife.html [Accessed November 2009].

[867] Groombridge, B. 1992. Global Biodiversity - Status of the Earth's Living Resources: A Report Compiled by the World Conservation Monitoring Centre. Chapman and Hall, London, New York. Available at http://www.archive.org/details/globalbiodiversi92wcmc [Accessed 10/19/10].

[868] Frankham, Richard. 2008. "Inbreeding and Extinction: Island Populations." Conservation Biology. 12: 665–675. Available at http://onlinelibrary.wiley.com/doi/10.1111/j.1523-1739.1998.96456.x/abstract [Accessed 10/19/10].

[869] Brook, Barry, Navjot Sodhi, and Corey Bradshaw. 2008. "Synergies among extinction drivers under global change." *Trends in Ecology and Evolution*. 23(8): 453-460, 456.

[870] *See Id.*

[871] Nowak, Ronald and Ernest Walker. 1994. *Walker's Bats of the World*. John Hopkins University Press. Page 20.

[872] *Id.*

[873] *Id.*

may contribute to the low fecundity of bats.[874] Species with low fecundity are "particularly predisposed to anthropogenic threats given their low replacement rate."[875] Thus, low fecundity is another reason that this species faces a high likelihood of extinction unless further action is taken.

[874] *Id.*

[875] Brook, Barry, Navjot Sodhi, and Corey Bradshaw. 2008. "Synergies Among Extinction Drivers Under Global Change." *Trends in Ecology and Evolution*. 23(8): 453-460, 455.

L. Negros Naked-Backed Fruit Bat/Philippine Bare-backed fruit bat (*Dobsonia chapmani*)

1. Taxonomy

Dobsonia chapmani belongs to the Order Chiroptera, Family Pteropodidae.[876]

2. Physical Description

This species has a body weight of 135 to 145g.[877]

Figure L.1 Two views of *D. chapmani*.

Source (left): http://planet-mammiferes.org/drupal/en/node/70?menace=13
Source (right): http://cebubiodiversity.org/bat1.html

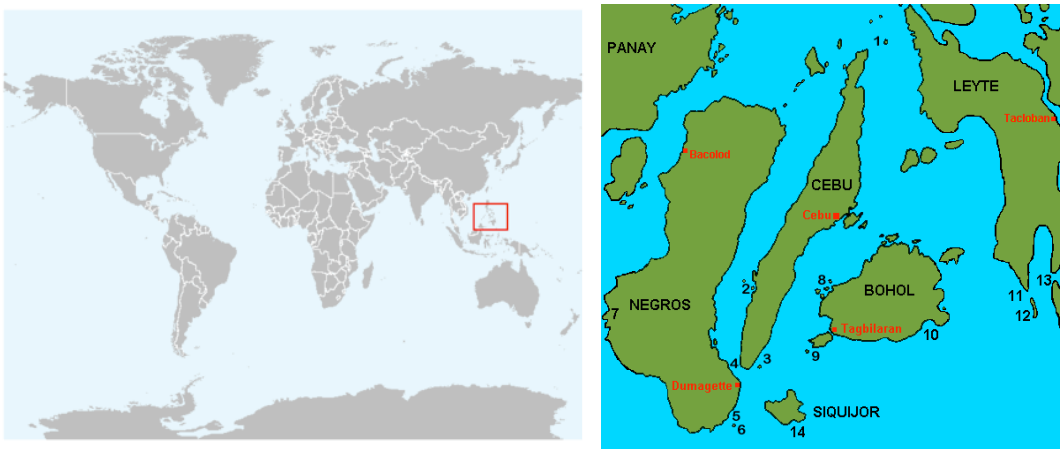
4. Distribution and Range

This bat is endemic to the Philippines.[878] It is known to occur only on Cebu and

[876] Heaney, L., Ong, P., Tabaranza, B., Rosell-Ambal, G., Balete, D., Alcala, E., Paguntulan, L.M., Pedregosa, S. & Cariño, A.B. 2008. Dobsonia chapmani. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[877] Fleming, Theodore and Paul Racey. 2010. *Island Bats: Evolution, Ecology, and Conservation*. University of Chicago Press. Page 18.
[878] Heaney, L., Ong, P., Tabaranza, B., Rosell-Ambal, G., Balete, D., Alcala, E., Paguntulan, L.M., Pedregosa, S. & Cariño, A.B. 2008. Dobsonia chapmani. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

Negros Islands from sea level to 860 m.[879,880] On Cebu Island, it was found at Carmen and Catmon, and on Negros Island it was found at Calatong, near Sipalay City in the Negros Occidental province, which is in the southwest part of the island.[881]

Figure L.2 *D. chapmani* is native to the Philippines (left, outlined in red). It is found only on Negros and Cebu islands (right).



Source (left): Heaney, L., Ong, P., Tabaranza, B., Rosell-Ambal, G., Balete, D., Alcala, E., Paguntulan, L.M., Pedregosa, S. & Cariño, A.B. 2008. Dobsonia chapmani. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010. Source (right): http://www.starfish.ch/dive/Visayas.html

4. Habitat and Ecology

This "species lives in small caves or cracks in limestone occurring in patches of secondary forest on karst limestone."[882] Three specimens were also observed to be roosting in coconut fronds.[883] This indicates that "*D. chapmani* is not restricted to forest and is able, to some extent, to make use of degraded and highly disturbed habitats."[884]

This species forages in karst habitats, which are naturally open and scrubby.[885] The native vegetation is batino (*Alstonia macrophylla*), hindunganon (*Macaranga* sp.), tubug

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[879] Heaney, L., Ong, P., Tabaranza, B., Rosell-Ambal, G., Balete, D., Alcala, E., Paguntulan, L.M., Pedregosa, S. & Cariño, A.B. 2008. *Dobsonia chapmani.* In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[880] Fleming, Theodore and Paul Racey. 2010. *Island Bats: Evolution, Ecology, and Conservation*. University of Chicago Press. Page 18.

[881] Heaney, L., Ong, P., Tabaranza, B., Rosell-Ambal, G., Balete, D., Alcala, E., Paguntulan, L.M., Pedregosa, S. & Cariño, A.B. 2008. *Dobsonia chapmani*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[882] *Id.*

[883] *Id.*

[884] *Id.*

[885] Fleming, Theodore and Paul Racey. 2010. *Island Bats: Evolution, Ecology, and Conservation*. University of Chicago Press. Page 28.

(*Ficus septica*), and matamban (*Mallotus* sp.), which grow on steep slopes.[886] The surrounding agricultural clearings are planted with abacca (*Musa textiles*), gabi (*Colocasia esculenta*), and coconuts (*Cocos nucifera*).[887] The forest at Carmen and Catmon on Cebu Island is one of the "species last critically important strongholds," even though the forest only exists there as a series of small, highly disturbed secondary-growth forests.[888]

Regarding social organization, a study conducted in the 1950s found approximately 300 bats of this species in a cave in groups of four to twelve, with one group of thirty.[889] All bats in this cave were subadult males, indicating that this was a bachelor colony.[890] Another study, conducted on Negros in 1964, located adult males and females together, which is likely indicative of a breeding colony.[891] Births occur in May or June and young are able to fly by August and September.[892] A subadult collected in December 1964 was probably weaned.[893] Regarding diet, a female shot in 1948 had been feeding on betel nut, the fruit of an introduced palm (*Areca catechu*).[894] Information about other foods in this species' diet is lacking.[895]

5. Population and Trend

Over three generations (15-20 years) this species' population declined at least 80%.[896] In 1996 IUCN deemed this species extinct after 8 years of monitoring,[897] as it had not been recorded in the Philippines since the 1960s, despite systematic searches.[898] However, the species has since been rediscovered on Cebu (2001) and Negros (2003),

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[886] Heaney, L., Ong, P., Tabaranza, B., Rosell-Ambal, G., Balete, D., Alcala, E., Paguntulan, L.M., Pedregosa, S. & Cariño, A.B. 2008. Dobsonia chapmani. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[887] *Id.*

[888] Paguntalan et al. 2004. "The Philippine bare-backed fruit bat *Dobsonia chapmani* Rabor, 1952: rediscovery and conservation status on Cebu Island." *Silliman Journal*. 45 (2): 113-122, 113.

[889] International Union for Conservation of Nature (IUCN). "Dobsonia chapmani Philippine bare-backed fruit bat." Chapter 3: Species Accounts. Available from: http://data.iucn.org/dbtw-wpd/html/Old%20world%20fruit%20bats/Chapter%203.html.

[890] *Id.*

[891] *Id.*

[892] *Id.*

[893] *Id.*

[894] *Id.*

[895] *Id.*

[896] Heaney, L., Ong, P., Tabaranza, B., Rosell-Ambal, G., Balete, D., Alcala, E., Paguntulan, L.M., Pedregosa, S. & Cariño, A.B. 2008. Dobsonia chapmani. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[897] *Id.*

[898] Paguntalan et al. 2004. "The Philippine bare-backed fruit bat *Dobsonia chapmani* Rabor, 1952: rediscovery and conservation status on Cebu Island." *Silliman Journal*. 45 (2): 113-122, 113.

which marks the first new recording since 1964.[899] Two small populations[900] were found on Cebu in Mahuli, Carmen,[901] and five individuals were found on Negros.[902] The population is declining.[903]

6. Major Threats

Habitat destruction and degradation and hunting threaten this bat.[904]

5. Conservation Actions

On Cebu Island, the local government in Carmen has "adopted this bat as a flagship species."[905] This local government "has organized a group of environmental protection coordinators who patrol and report violations to the municipal mayor and council."[906] Part of the duty of these coordinators is to survey cave sanctuaries and report tree felling and hunting of bats.[907] The municipal government has declared the caves where these bats occur as Naked-backed Fruit Bat Sanctuaries.[908] A reforestation project is underway there.[909]

Many of the other remaining forest fragments are part of the Central Cebu biodiversity corridor, as identified by the Philippines Biodiversity Conversion Priority-setting Program.[910] There is also a Central Cebu National Park.[911] However, this species has only been found near Carmen and Catmon, both of which are coastal cities on the northeastern side of the Island, and not within, or even relatively close to, the National Park. One can see this by looking at a map of Cebu Island. Unfortunately, on Cebu Island, political problems in the region make data gathering difficult because researchers

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[899] Heaney, L., Ong, P., Tabaranza, B., Rosell-Ambal, G., Balete, D., Alcala, E., Paguntulan, L.M., Pedregosa, S. & Cariño, A.B. 2008. Dobsonia chapmani. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[900] *Id.*
[901] Paguntalan et al. 2004. "The Philippine bare-backed fruit bat *Dobsonia chapmani* Rabor, 1952: rediscovery and conservation status on Cebu Island." *Silliman Journal*. 45 (2): 113-12, 113.
[902] Heaney, L., Ong, P., Tabaranza, B., Rosell-Ambal, G., Balete, D., Alcala, E., Paguntulan, L.M., Pedregosa, S. & Cariño, A.B. 2008. Dobsonia chapmani. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[903] *Id.*
[904] *Id.*
[905] *Id.*
[906] *Id.*
[907] *Id.*
[908] *Id.*
[909] *Id.*
[910] Cadiz, Geofe and Inocencio Buot. 2009. "An Enumeration of the woody plants of cantipla forest fragments, cebu island, Philippines." *Philippine Journal of Systematic Biology*. 3: page 2.
[911] *Id.*

"are reluctant to participate in surveys there."[912] On Negros Island, the species has been recorded in a provincial level forest reserve.[913] Also, two towns have pending resolutions to adopt this bat as a flagship species.[914]

A law that applies to both of the Islands is the Republic Act 9147 or the Wildlife Resources Conservation and Protection Act. This Act, among other objectives, conserves and protects wildlife and their habitat.[915] It is unclear, however, whether *D. chapmani* is listed under, and thereby receives the protection of, this law.

8. ESA Listing Factors

A. The present or threatened destruction, modification, or curtailment of its habitat or range

"Nowhere in the Philippines is environmental degradation quite so acute, and the need for immediate conservation action quite so pressing, as in the West Visayas [which include Cebu and Negros]."[916]

On Negros Island, the lowland forest and karst habitat has "been heavily degraded by logging and clearing for agriculture."[917] In 1945, about 60% of Negros was forested, but a boom in logging and an expansion of sugar plantations reduced this forested area to just 12% by 1975, and almost no forest remained below 800 m, which is the *upper* elevational limit of this species.[918] As of 1993, less than 4% of Negros Island remained forested.[919] Since this data is 17 years old, it is likely that even less of the forest remains today.

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[912] Heaney, L., Ong, P., Tabaranza, B., Rosell-Ambal, G., Balete, D., Alcala, E., Paguntulan, L.M., Pedregosa, S. & Cariño, A.B. 2008. *Dobsonia chapmani.* In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[913] *Id.*

[914] *Id.*

[915] An Act Providing for the Conservation and Protection of Wildlife Resources and Their Habitats, Appropriating Funds Therefore and for Other Purposes, Rep. Act No. 9147, §2(a)–(d) (2001) (Phil.).

[916] Oliver, W.L.R. 1993. Status Survey and Conservation Action Plan: Pigs, Peccaries, and Hippos. IUCN/SSC - Pigs, Peccaries and Hippo Specialist Groups. IUCN, Gland, Switzerland. Page. 151.

[917] Heaney, L., Ong, P., Tabaranza, B., Rosell-Ambal, G., Balete, D., Alcala, E., Paguntulan, L.M., Pedregosa, S. & Cariño, A.B. 2008. *Dobsonia chapmani*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[918] International Union for Conservation of Nature (IUCN). "Dobsonia chapmani Philippine bare-backed fruit bat." Chapter 3: Species Accounts. Available from: http://data.iucn.org/dbtw-wpd/html/Old%20world%20fruit%20bats/Chapter%203.html.

[919] Heaney, L., Ong, P., Tabaranza, B., Rosell-Ambal, G., Balete, D., Alcala, E., Paguntulan, L.M., Pedregosa, S. & Cariño, A.B. 2008. Dobsonia chapmani. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

On Cebu Island, only 0.3% of the original forest cover remains,[920] and even degraded secondary habitat is scarce.[921] Extensive conversion of habitat to agriculture in addition to mining for copper and gold has continued within this bats' habitat since its rediscovery in 2001.[922] "The largest remaining fragment of forest within the range of this species on Cebu is approximately 60 ha and is threatened by cutting trees for charcoal and agricultural development."[923]

Additionally, the caves where the bats roost were "severely disturbed" for guano mining, which contributed to the decline of the species.[924] Human activity at the bats' caves is thus considered a "serious threat."[925]

B. Over-utilization for commercial, recreational, scientific, or educational purposes

Harvesting this species for meat has "caused past population declines."[926] This species is targeted for hunting due to its large size, and in the past their meat has been sold in street markets.[927] "In an ethnobiological survey, 15 out of 28 respondents reported hunting this species."[928] Most hunters of this species were subsistence farmers "who tend to be poorly educated, earn low incomes, and killed bats…for home consumption."[929] The remaining hunters were generally more highly educated professionals who hunted the bat for sport.[930] The main capture methods were nylon lines with hooks or air guns.[931] Harvesting of this bat also occurred within its caves.[932]

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[920] Cadiz, Geofe and Inocencio Buot. 2009. "An Enumeration of the woody plants of cantipla forest fragments, cebu island, Philippines." *Philippine Journal of Systematic Biology*. 3: page 1.
[921] BirdLife International. 2003. *BirdLife's online World Bird Database: the site for bird conservation.* Version 2.0. Cambridge, UK: BirdLife International. Available from: http://www.birdlife.org. Cebu island search. Accessed 23/7/2010.
[922] Heaney, L., Ong, P., Tabaranza, B., Rosell-Ambal, G., Balete, D., Alcala, E., Paguntulan, L.M., Pedregosa, S. & Cariño, A.B. 2008. Dobsonia chapmani. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[923] *Id.*
[924] Fleming, Theodore and Paul Racey. 2010. *Island Bats: Evolution, Ecology, and Conservation*. University of Chicago Press. Page 48.
[925] Wiles, Gary, and Anne Brooke. 2010. "Conservation Threats To Bats in the Tropical Pacific Islands and Insular Southeast Asia." Chapter 14 in Fleming, Theodore and Paul Racey. 2010. *Island Bats: Evolution, Ecology, and Conservation* University of Chicago Press. Page 422.
[926] Heaney, L., Ong, P., Tabaranza, B., Rosell-Ambal, G., Balete, D., Alcala, E., Paguntulan, L.M., Pedregosa, S. & Cariño, A.B. 2008. Dobsonia chapmani. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[927] *Id.*
[928] *Id.*
[929] Wiles, Gary, and Anne Brooke. 2010. "Conservation Threats To Bats in the Tropical Pacific Islands and Insular Southeast Asia." Chapter 14 in Fleming, Theodore and Paul Racey. 2010. *Island Bats: Evolution, Ecology, and Conservation* University of Chicago Press. Page 418.
[930] *Id.*
[931] *Id.*
[932] *Id.* at 422.

However, recent hunting rates appear to be declining.[933] Since 1995, this bat has "rarely been captured in caves where it has reportedly been hunted before."[934] Interviews with hunters indicated that only one or two individuals of *D. chapmani* have been harvested between 2003 and 2005.[935] This likely reflects the large population decline this species has recently undergone.[936] This species has also been "bred in captivity by collectors as a pet" although the impact on the population is unclear.[937]

C. Disease and predation

Bat species worldwide may be at risk from white-nose syndrome, caused by a cold-loving fungus of the Geomyces genus.[938] The syndrome has been known to cause 80-97% mortality rates in some large hibernation colonies.[939] Until recently, the disease was restricted to the northeastern United States. However, in 2009 it was detected in France.[940] It is not known how quickly this disease may spread to other areas of the world, but it poses a severe threat to all bat species, especially those with small ranges or those restricted to one or two caves. If infected, these species may lose nearly their entire population in one fell swoop.

D. The inadequacy of existing regulatory mechanisms

Although certain measures do exist to protect this species and its habitat, particularly on Cebu Island, these measures are inadequate to ensure that this recently rediscovered species will not become extinct in the near future. The area that this species relies on for habitat is "underrepresented in the national protected area system."[941] One glaring inadequacy is that "the largest remaining forest fragment is not within a protected area and was not included in the listing of 'Key Conservation Sites' in Cebu."[942] The

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[933] Heaney, L., Ong, P., Tabaranza, B., Rosell-Ambal, G., Balete, D., Alcala, E., Paguntulan, L.M., Pedregosa, S. & Cariño, A.B. 2008. Dobsonia chapmani. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[934] *Id.*
[935] *Id.*
[936] *Id.*
[937] *Id.*
[938] Handwerk, Brian. 2008.: "Deadly Bat Disease Linked to Cold-Loving Fungus." National Geographic News. http://news.nationalgeographic.com/news/2008/10/081031-bat-fungus.html [Accessed October 2010].
[939] Id.
[940] Puechmaille SJ, Verdeyroux P, Fuller H, Ar Gouilh M, Bekaert M, Teeling EC. 2010 "White-nose syndrome fungus (*Geomyces destructans*) in bat, France." Emerg Infect Dis. e-pub. Available online at http://www.cdc.gov/eid/content/16/2/pdfs/09-1391.pdf [Accessed October 2010].
[941] Oliver, W.L.R. 1993. Status Survey and Conservation Action Plan: Pigs, Peccaries, and Hippos. IUCN/SSC - Pigs, Peccaries and Hippo Specialist Groups. IUCN, Gland, Switzerland. Page 151.
[942] Heaney, L., Ong, P., Tabaranza, B., Rosell-Ambal, G., Balete, D., Alcala, E., Paguntulan, L.M., Pedregosa, S. & Cariño, A.B. 2008. Dobsonia chapmani. In: IUCN 2009. IUCN Red List

IUCN states that "this needs to be rectified."[943] This remaining forest fragment, which is approximately 60 hectares, is threatened by the cutting of trees for charcoal, agricultural development, and poaching.[944] Continuing and potential future destruction of this forest fragment, which is critical to the survival of *D. chapmani*, demonstrates that the conservation measures in place are not enough to ensure this species' long-term survival.

E. Other natural or manmade factors affecting its continued existence

i. Climate change

The Intergovernmental Panel on Climate Change (IPCC) states that human activities are likely contributing to global climate change. "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic [greenhouse gas] concentrations… It is likely that there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica)."[945] Due to climate change, "there are projected to be major changes in ecosystem structure and function, species' ecological interactions and shifts in species' geographical ranges, with predominantly negative consequences for biodiversity."[946] Threats from global climate change are relevant to this bat species.

This species is endemic to an island, which face particularly urgent threats from rising sea levels and increasingly severe and frequent tropical storms caused by human-induced climate change. "Global average sea level is rising predominantly as a consequence of three factors—thermal expansion of warming ocean water, addition of new water from the ice sheets of Greenland and Antarctica and from glaciers and ice caps, and the addition of water from land hydrology. All three potential sources are undergoing changes of anthropogenic origin."[947] The IPCC projects that on small islands, " sea level rise is expected to exacerbate inundation, storm surge, erosion and other coastal hazards… [and] with higher temperatures, increased invasion by non-native species is expected to occur, particularly on mid- and high-latitude islands."[948] Since this species occurs between sea level and 860 m, some individuals of this species likely occur along the coast, and therefore climate change will have an even more serious impact on this species. On coastlines, "the impacts of sea level rise will be felt through both an increase in mean sea-level and through an increase in the frequency of extreme sea-level

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of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[943] *Id.*

[944] *Id.*

[945] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Available from: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009].

[946] *Id.*

[947] McMullen, C.P. and Jabbour, J. 2009. Climate Change Science Compendium 2009. United Nations Environment Programme, Nairobi, EarthPrint. Online at http:// www.unep.org/compendium2009/ [Accessed November 2009].

[948] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009]

events such as storm surges."[949] The IPCC underscored the risk facing coasts worldwide from climate change: "coasts are projected to be exposed to increasing risks, including coastal erosion, due to climate change and sea level rise. The effect will be exacerbated by increasing human-induced pressures on coastal areas (very high confidence)…"[950]

ii. Biological vulnerability

This species has such a small population size that it was at one point declared extinct. It is currently found on only two islands in the Philippines. FWS has routinely recognized that small population size and restricted range increase the likelihood of extinction.[951] Island species are particularly susceptible to extinction.[952,953]

One additional factor that renders this species particularly vulnerable to extinction is its low fecundity. Across all bats species generally, fetal development occurs slowly, with pregnancies lasting between three to six months.[954] Female bats generally produce one young per year. This is believed to be due to the very large size of bat pups at birth. Young bats comprise from between 12-15% of the mother's body mass up to 25% of the mother's body mass during pregnancy. Scientists believe that the weight of the pup during pregnancy limits the mother's litter size due to her need to fly while pregnant.[955]

Litter size is also likely limited due to nursing characteristics that are unique to bat species.[956] Most mammals wean their young when the young reach 40%, or less, of their adult size. Bats, however, nurse their young until they are nearly adult size. This is because bats cannot feed on their own until their wings are near adult dimensions. This may contribute to the low fecundity of bats.[957] Species with low fecundity are

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[949] Karl, T.R., Melillo, J. M., and T.C. Peterson (eds). 2009. Global Climate Change Impacts in the United States, Cambridge University Press, 2009. Online at http://www.globalchange.gov/whats-new/286-new-assessment-climate-impacts-us [Accessed November 2009].

[950] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009]

[951] See, for example, FWS candidate assessment forms for *Doryopteris takeuchii, Huperzia stemmermanniae, Megalagrion nesiotes, Melicope degeneri, Melicope hiiakae, Myrsine mezii, Ostodes strigatus, Partula langfordi, Peperomia subpetiolata, Phyllostegia bracteata*, and *Tryonia circumstriata*. Accessible via FWS website at http://www.fws.gov/endangered/wildlife.html [Accessed November 2009].

[952] Groombridge, B. 1992. Global Biodiversity - Status of the Earth's Living Resources: A Report Compiled by the World Conservation Monitoring Centre. Chapman and Hall, London, New York. Available at http://www.archive.org/details/globalbiodiversi92wcmc [Accessed 10/19/10].

[953] Frankham, Richard. 2008. "Inbreeding and Extinction: Island Populations." Conservation Biology. 12: 665–675. Available at http://onlinelibrary.wiley.com/doi/10.1111/j.1523-1739.1998.96456.x/abstract [Accessed 10/19/10].

[954] Nowak, Ronald and Ernest Walker. 1994. *Walker's Bats of the World*. John Hopkins University Press. Page 20.

[955] *Id.*

[956] *Id.*

[957] *Id.*

"particularly predisposed to anthropogenic threats given their low replacement rate."[958] Thus, low fecundity is another reason that *D. chapmani* faces a high likelihood of extinction unless further action is taken.

[958] Brook, Barry, Navjot Sodhi, and Corey Bradshaw. 2008. "Synergies Among Extinction Drivers Under Global Change." *Trends in Ecology and Evolution*. 23(8): 453-460, 455.

M. New Caledonia Long-Eared Bat (*Nyctophilus nebulosus*)

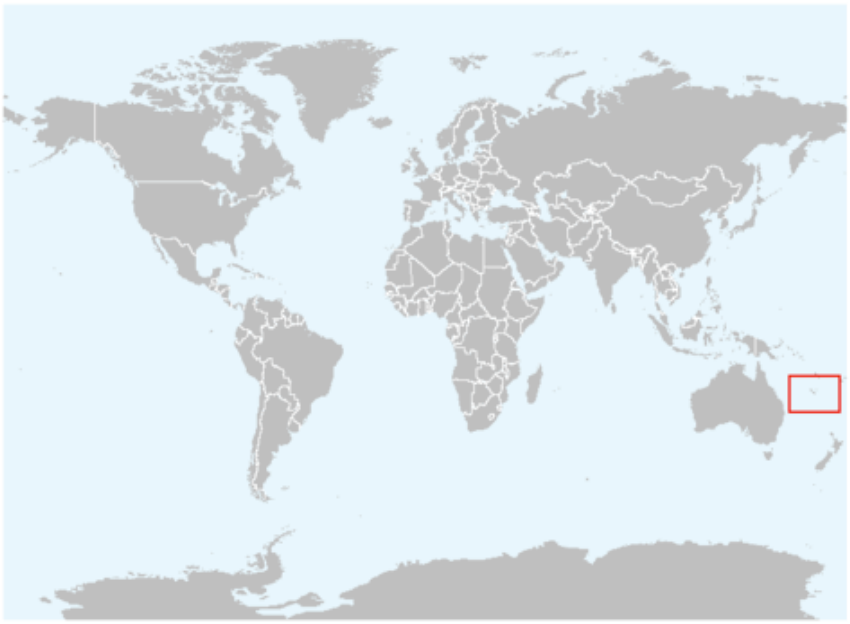
1. Taxonomy

Nyctophilus nebulosus belongs to the Order Chiroptera, Family Vespertilionidae.[959]

2. Distribution and Range

This bat is endemic to the Noumea area of the island of New Caledonia.[960] It has only been recorded in a single location on the southwestern slopes of Mount Koghis, 150 m North of Station d'Altitude car park.[961,962]

Figure M.1 *N. nebulosus* is endemic to New Caledonia (in red).



Source: Parnaby, H. 2008. Nyctophilus nebulosus. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

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[959] Parnaby, H. 2008. Nyctophilus nebulosus. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[960] *Id.*
[961] Parnaby, H. 2008. Nyctophilus nebulosus. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[962] Wilson, Don and DeeAnn M. Reeder (editors). 2005. "Nyctophilus nebulosus." *Mammal Species of the World*. A Taxonomic and Geographic Reference (3rd ed).

Figure M.2 New Caledonia.

Source: UK Net Guide. Travel. Available from http://www.uknetguide.co.uk/Holiday-Guides/Oceania/

3. Habitat and Ecology

This species has only been found in clearings in high elevation rainforests.[963]

4. Population and Trend

N. nebulosus is only known from a few individuals, and its population is declining.[964]

5. Major Threats

Habitat destruction through urban encroachment and wildfires is the primary threat to this species.[965]

6. Conservation Actions

No conservation actions appear to be in place for *N. nebulosus*.[966]

7. ESA Listing Factors

A. The present or threatened destruction, modification, or curtailment of its

[963] Parnaby, H. 2008. *Nyctophilus nebulosus*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[964] *Id.*
[965] *Id.*
[966] *See Id.*

habitat or range

Deforestation has had a significant impact on New Caledonia.[967] As of 2000, 72% of the original primary rainforest had been destroyed.[968] The sole known habitat of this species is "highly fragmented," has been "extensively cleared and modified," and is subject to "ongoing human pressures."[969] Pressures on the forest emanate from urban growth, tourism, agriculture, and mining. The urban growth rate is particularly high in the city of Noumea,[970] which is near the location where the only specimen of *N. nebulosus* was found.[971] A high level of tourism is also a continuing threat to the rainforest of Mount Koghis.[972] Searches conducted in Google for "Mount Koghis" reveal numerous articles and advertisements for excursions imploring tourists to travel to its "pristine forest."

Agricultural practices have also led to deforestation on the Island. Slash-and-burn techniques are used to clear forested land, particularly in the lowland areas of the Island, but also in the highlands as well.[973] Mining, another threat to the forests of New Caledonia, is "economically important in New Caledonia and has greatly influenced much of the countryside."[974] The Island's nickel production is the third highest in the world[975] and both chromium and cobalt are found on the Island in large quantities.[976] In New Caledonia minerals are taken by strip mining in mountainous areas.[977] The environmental harms associated with mining on the Island are "loss of vegetation and topsoil, runoffs and water pollution."[978] The more rugged the terrain, the more practical

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[967] Myers, Norman, Russell Mittermeler, Cristina Mittermeler, Gustavo Fonseca, and Jennifer Kent. "Biodiversity hotspots for conservation priorities." *Nature*. 403: 853-858, 854.
[968] *Id.*
[969] Parnaby, H. E. 2002. "A new species of long-eared bat (*Nyctophilus*: Vespertilionidae) from New Caledonia." *Australian Mammalogy*. 23: 115-124, 123.
[970] Dalto, A.G., A. Gremare, A. Dinet, D. Fichet. 2006. *Estuarine, Coastal and Shelf Science*. 67: 629-644, 644.
[971] Parnaby, H. 2008. Nyctophilus nebulosus. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[972] *Id.*
[973] Bauer, Aaron and Ross Sadlier. 1993. "Systematcis, biogeography and conservation of the lizards of New Caledonia." *Biodiversity Letters*. 1(3/4): 107-122, 116.
[974] *Id.*
[975] Hedouin, L. O. Pringault, M. Metian, P. Bustamante, and M. Warnau. 2007. "Nickel bioaccumulation in bivalves from the New Caledonia lagoon: seawater and food exposure." *Chemosphere*. 66(8): 1449-1457. (Pages renumbered 1-27, 3 in Pdf. Pdf available from: http://hal.archives-ouvertes.fr/docs/00/47/02/88/PDF/Hedouin_et_al_2007_CHEM.pdf.
[976] Bauer, Aaron and Ross Sadlier. 1993. "Systematcis, biogeography and conservation of the lizards of New Caledonia." *Biodiversity Letters*. 1(3/4): 107-122, 116.
[977] Ministerial Conference on Environment and Development in Asia and the Pacific. 2000. "Review of the State of the Environment of the Pacific Islands." Note 57. Available from: http://www.unescap.org/mced2000/pacific/SoE-pacific.htm.
[978] Bauer, Aaron and Ross Sadlier. 1993. "Systematcis, biogeography and conservation of the lizards of New Caledonia." *Biodiversity Letters*. 1(3/4): 107-122, 116.

difficulties there are in preventing massive siltation of waterways.[979] Prior to the 1980's there were few, if any, environmental precautions taken during mining activities.[980] Siltation of waterways and coastal areas was common.[981] Even after regulations were enacted, the practicalities of mine operation in rugged terrain often precluded effective environmental protection.[982]

C. Disease or predation

Bat species worldwide may be at risk from white-nose syndrome, caused by a cold-loving fungus of the Geomyces genus.[983] The syndrome has been known to cause 80- 97% mortality rates in some large hibernation colonies.[984] Until recently, the disease was restricted to the northeastern United States. However, in 2009 it was detected in France.[985] It is not known how quickly this disease may spread to other areas of the world, but it poses a severe threat to all bat species, especially those with small ranges or those restricted to one or two caves. If infected, these species may lose nearly their entire population in one fell swoop.

D. The inadequacy of existing regulatory mechanisms

It does not appear that any protections are in place for *N. nebulosus*.[986] Considering the extreme rarity of this species, and population numbers that are likely very low,[987] the lack of regulations is inadequate for protecting this species from extinction.

E. Other natural or manmade factors affecting its continued existence

i. Climate change

The Intergovernmental Panel on Climate Change (IPCC) states that human activities are likely contributing to global climate change. "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic [greenhouse gas] concentrations… It is likely that

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[979] Ministerial Conference on Environment and Development in Asia and the Pacific. 2000. "Review of the State of the Environment of the Pacific Islands." Note 57. Available from: http://www.unescap.org/mced2000/pacific/SoE-pacific.htm.
[980] *Id.*
[981] *Id.*
[982] *Id.*
[983] Handwerk, Brian. 2008.: "Deadly Bat Disease Linked to Cold-Loving Fungus." National Geographic News. http://news.nationalgeographic.com/news/2008/10/081031-bat-fungus.html [Accessed October 2010].
[984] Id.
[985] Puechmaille SJ, Verdeyroux P, Fuller H, Ar Gouilh M, Bekaert M, Teeling EC. 2010 "White-nose syndrome fungus (*Geomyces destructans*) in bat, France." Emerg Infect Dis. e-pub. Available online at http://www.cdc.gov/eid/content/16/2/pdfs/09-1391.pdf [Accessed October 2010].
[986] *See* Parnaby, H. 2008. Nyctophilus nebulosus. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[987] *See Id.*

there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica)."[988] Due to climate change, "there are projected to be major changes in ecosystem structure and function, species' ecological interactions and shifts in species' geographical ranges, with predominantly negative consequences for biodiversity."[989] Threats from global climate change are relevant to this bat species.

This species is endemic to an island, which face particularly urgent threats from rising sea levels and increasingly severe and frequent tropical storms caused by human-induced climate change. "Global average sea level is rising predominantly as a consequence of three factors—thermal expansion of warming ocean water, addition of new water from the ice sheets of Greenland and Antarctica and from glaciers and ice caps, and the addition of water from land hydrology. All three potential sources are undergoing changes of anthropogenic origin."[990] The IPCC projects that on small islands, " sea level rise is expected to exacerbate inundation, storm surge, erosion and other coastal hazards… [and] with higher temperatures, increased invasion by non-native species is expected to occur, particularly on mid- and high-latitude islands."[991]

ii. Biological vulnerability

As this species is only known from a few individuals, it likely has a very small population size. FWS has routinely recognized that small population size and restricted range increase the likelihood of extinction.[992] Island species are particularly susceptible to extinction.[993,994]

One additional factor that renders this species particularly vulnerable to extinction is its low fecundity. Across all bats species generally, fetal development occurs slowly, with pregnancies lasting between three to six months[995] Female bats generally produce

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[988] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Available from: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009].

[989] *Id.*

[990] McMullen, C.P. and Jabbour, J. 2009. Climate Change Science Compendium 2009. United Nations Environment Programme, Nairobi, EarthPrint. Online at http:// www.unep.org/compendium2009/ [Accessed November 2009].

[991] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009]

[992] See, for example, FWS candidate assessment forms for *Doryopteris takeuchii, Huperzia stemmermanniae, Megalagrion nesiotes, Melicope degeneri, Melicope hiiakae, Myrsine mezii, Ostodes strigatus, Partula langfordi, Peperomia subpetiolata, Phyllostegia bracteata*, and *Tryonia circumstriata*. Accessible via FWS website at http://www.fws.gov/endangered/wildlife.html [Accessed November 2009].

[993] Groombridge, B. 1992. Global Biodiversity - Status of the Earth's Living Resources: A Report Compiled by the World Conservation Monitoring Centre. Chapman and Hall, London, New York. Available at http://www.archive.org/details/globalbiodiversi92wcmc [Accessed 10/19/10].

[994] Frankham, Richard. 2008. "Inbreeding and Extinction: Island Populations." Conservation Biology. 12: 665–675. Available at http://onlinelibrary.wiley.com/doi/10.1111/j.1523-1739.1998.96456.x/abstract [Accessed 10/19/10].

[995] Nowak, Ronald and Ernest Walker. 1994. *Walker's Bats of the World*. John Hopkins University Press. Page 20.

one young per year. This is believed to be due to the very large size of bat pups at birth. Young bats comprise from between 12-15% of the mother's body mass up to 25% of the mother's body mass during pregnancy. Scientists believe that the weight of the pup during pregnancy limits the mother's litter size due to her need to fly while pregnant.[996]

Litter size is also likely limited due to nursing characteristics that are unique to bat species.[997] Most mammals wean their young when the young reach 40%, or less, of their adult size. Bats, however, nurse their young until they are nearly adult size. This is because bats cannot feed on their own until their wings are near adult dimensions. This may contribute to the low fecundity of bats.[998] Species with low fecundity are "particularly predisposed to anthropogenic threats given their low replacement rate."[999] Thus, low fecundity is another reason that this species faces a high likelihood of extinction unless further action is taken.

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[996] *Id.*
[997] *Id.*
[998] *Id.*
[999] Brook, Barry, Navjot Sodhi, and Corey Bradshaw. 2008. "Synergies Among Extinction Drivers Under Global Change." *Trends in Ecology and Evolution*. 23(8): 453-460, 455.

N. New Zealand Greater Short-Tailed Bat (*Mystacina robusta*)

1. Taxonomy

This species belongs to the Order Chiroptera, Family Mystacinidae.[1000]

2. Physical Description

Mystacina robusta has a total body length of approximately 90mm, and a wingspan of about 290 to 310 mm, making it one-third larger than *Mystacina tuberculata*, a close relative.[1001] Its estimated weight is 25 to 35 g[1002] with an average weight of 30 g.[1003] The fur is dark brown, the ears and nostrils are both prominent, and it has short whiskers.[1004] The hind legs and feet are robust and positioned for movement on the ground.[1005]

Figure N.1 Drawing of *Mystacina robusta*.

Source: http://planet-mammiferes.org/drupal/en/node/70?menace=13

[1000] O'Donnell, C. 2008. Mystacina robusta. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[1001] Boyes, B. and P. Myers. 2006. "Mystacina robusta." Animal Diversity Web. Available from: http://animaldiversity.ummz.umich.edu/site/accounts/information/Mystacina_robusta.htm Accessed July 24, 2010, *citing* King, C. 1990. *The Handbook of New Zealand Mammals*. Auckland, New Zealand: Oxford University Press.
[1002] Lloyd, B. D. 2001. "Advances in New Zealand Mammalogy 1990-2000: Short-tailed Bats." *Journal of the Royal Society of New Zealand* 31(1): 59-81, 76.
[1003] Daniel, M.J. and G.R. Williams. 1984. "A Survey of the distribution, seasonal activity and roost sites of New Zealand bats." *New Zealand Journal of Ecology*. 7: 9-25, 10.
[1004] Boyes, B. and P. Myers. 2006. "Mystacina robusta." Animal Diversity Web. Available from: http://animaldiversity.ummz.umich.edu/site/accounts/information/Mystacina_robusta.htm Accessed July 24, 2010, *citing* King, C. 1990. *The Handbook of New Zealand Mammals*. Auckland, New Zealand: Oxford University Press.
[1005] *Id.*

Figure N.2 The only photograph ever taken of *M. robusta*.

Source: Veronika Meduna. "Bats." Te Ara - the Encyclopedia of New Zealand. Available from: http://www.TeAra.govt.nz/en/bats/1/2.

3. Distribution and Range

This species is endemic to New Zealand.[1006] If the species is still extant it is likely restricted to islands off the coast of Stewart Island,[1007] which is located off the southern coast of New Zealand's South Island. This species was found in a cave at Puwai on Big South Cape Island.[1008,1009] It is also possible that it may still survive today on other small privately-owned islands near Stewart Island.[1010] There have been recent reports of bats on Putauhina Island, which is close to the last known location of *M. robusta*.[1011] The species' historic range was far greater.[1012] Until the 1950s, this species lived in several large caves on Solomon Island, but it is believed to have been extirpated from this location.[1013] Additionally, sub-fossil remains were found at Waitomo, Hawkes Bay and

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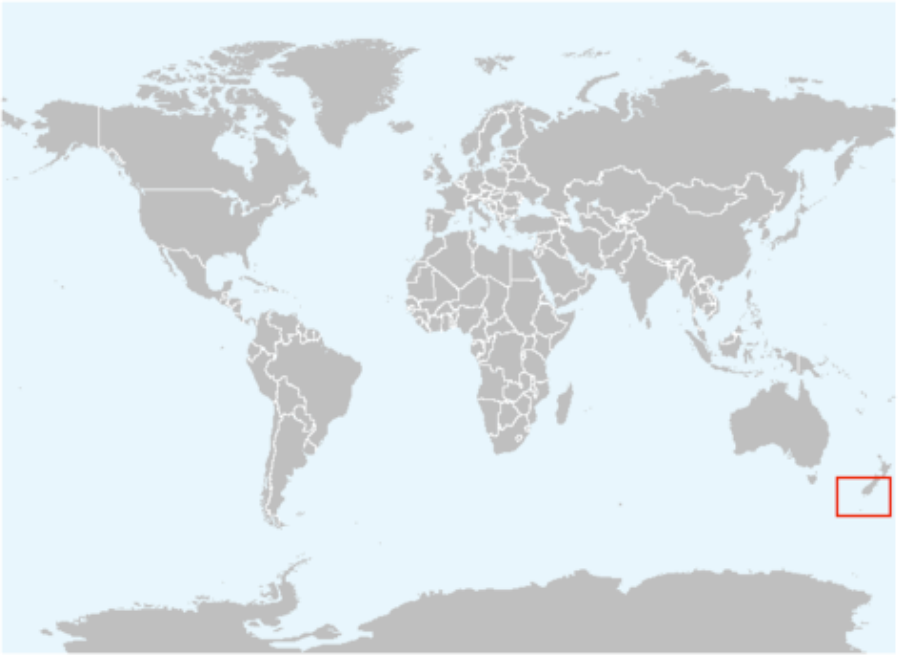
[1006] O'Donnell, C. 2008. Mystacina robusta. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[1007] Lloyd, B. D. 2001. "Advances in New Zealand Mammalogy 1990-2000: Short-tailed Bats." *Journal of the Royal Society of New Zealand* 31(1): 59-81, 76.
[1008] Boyes, B. and P. Myers. 2006. "Mystacina robusta." Animal Diversity Web. Available from: http://animaldiversity.ummz.umich.edu/site/accounts/information/Mystacina_robusta.htm Accessed July 24, 2010, *citing* Dowding, J., E. Murphy. 1994. "Ecology of Ship Rats (Rattus rattus) in A Kauri (Agathis Australis) Forest in Northland, New Zealand." *New Zealand Journal of Ecology*, 18: 19-28.
[1009] O'Donnell, C. 2008. Mystacina robusta. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[1010] *Id.*
[1011] Lloyd, B. D. 2001. "Advances in New Zealand Mammalogy 1990-2000: Short-tailed Bats." *Journal of the Royal Society of New Zealand* 31(1): 59-81, 76.
[1012] *Id.*
[1013] Boyes, B. and P. Myers. 2006. "Mystacina robusta." Animal Diversity Web. Available from: http://animaldiversity.ummz.umich.edu/site/accounts/information/Mystacina_robusta.htm Accessed July 24, 2010, *citing* Dowding, J., E. Murphy. 1994. "Ecology of Ship Rats (Rattus

Wairarapa on the North Island, and North-west Nelson, Westland, Canterbury and Central Otago on the South Island.[1014] No specimens, however, have been collected on New Zealand's three main islands since Europeans arrived around 200 years ago.[1015] The last confirmed sighting of this species was in 1967.[1016]

Figure N.3 *M. robusta* is endemic to New Zealand, and likely only remains on islands off the coast of Stewart Island.



Source: O'Donnell, C. 2008. *Mystacina robusta*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

rattus) in A Kauri (Agathis Australis) Forest in Northland, New Zealand." *New Zealand Journal of Ecology*. 18: 19-28.

[1014] Lloyd, B. D. 2001. "Advances in New Zealand Mammalogy 1990-2000: Short-tailed Bats." *Journal of the Royal Society of New Zealand*. 31(1): 59-81, 76.

[1015] *Id.*

[1016] O'Donnell, C. 2008. Mystacina robusta. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2.

Figure N.4 New Zealand. Stewart Island is located off the Southern tip of the country.

Source: http://www.xiongdudu.com/image/Detailed_Map_of_New_Zealand/4

4. Habitat and Ecology

This species is known to live in caves.[1017] This is known based on sightings of this species roosting in caves in the 1950s and 1960s.[1018] The shores South Cape Island are rugged and have many caves, the largest of which is at Puwai, which is on the south coast of the Island.[1019] Both species of *Mystacina* (both *robusta* and *tuberculata*) used to

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[1017] *Id.* at 77.

[1018] Boyes, B. and P. Myers. 2006. "Mystacina robusta." Animal Diversity Web. Available from: http://animaldiversity.ummz.umich.edu/site/accounts/information/Mystacina_robusta.htm Accessed July 24, 2010, *citing* Dowding, J., E. Murphy. 1994. "Ecology of Ship Rats (Rattus rattus) in A Kauri (Agathis Australis) Forest in Northland, New Zealand." *New Zealand Journal of Ecology*. 18: 19-28.

[1019] Boyes, B. and P. Myers. 2006. "Mystacina robusta." Animal Diversity Web. Available from: http://animaldiversity.ummz.umich.edu/site/accounts/information/Mystacina_robusta.htm Accessed July 24, 2010, *citing* Daniel and Baker 1986 Daniel, M., A. Baker. 1986. *Collins Guide to Mammals of New Zealand*. Auckland, New Zealand: William Collins Publishers Ltd.

inhabit this cave together until 1965.[1020] The shores of Solomon Island are rugged and have many cave formations,[1021] which this species may have roosted in prior to their extirpation from Solomon Island.[1022] Researchers have found remains of this bat in limestone caves, which indicates the use of these sites as roosts.[1023] Additionally, individuals of this species were known to roost in seabird burrows.[1024] It is also possible that this species roosts in tree cavities, although there is no direct evidence to support this.[1025]

This species is believed to be able to live only in areas with undisturbed old-growth forest, similar to *M. tuberculata*,[1026] commonly known as the New Zealand Lesser Short Tailed Bat, which is a smaller relative of *M. robusta* that is also endemic to New Zealand.[1027] *M. robusta* likely forages in the same habitat type as *M. tuberculata*, which consists of moist forest and muttonbird (Olearia) scrub.[1028] This species is also believed to eat the same range of food as *M. tuberculata*, which includes insects, fruit, nectar, and pollen.[1029] Part of this species' diet may further consist of meat, though this has not been definitively confirmed. This assertion stems from the behavior of seven *M. robusta* individuals held in captivity for several days. They consumed part of a diving petrel carcass the first night, but after that did not eat any more of it. It has also been suggested, without evidence, that they may eat nestlings. They may also eat meat hung out to dry, but this is also unsubstantiated.[1030]

M. robusta enters torpor, and almost certainly employs seasonal hibernation as

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[1020] *Id.*
[1021] *Id.*
[1022] Boyes, B. and P. Myers. 2006. "Mystacina robusta." Animal Diversity Web. Available from: http://animaldiversity.ummz.umich.edu/site/accounts/information/Mystacina_robusta.htm Accessed July 24, 2010, *citing* Dowding, J., E. Murphy. 1994. "Ecology of Ship Rats (Rattus rattus) in A Kauri (Agathis Australis) Forest in Northland, New Zealand." *New Zealand Journal of Ecology*, 18: 19-28.
[1023] O'Donnell, C. 2008. Mystacina robusta. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[1024] Boyes, B. and P. Myers. 2006. "Mystacina robusta." Animal Diversity Web. Available from: http://animaldiversity.ummz.umich.edu/site/accounts/information/Mystacina_robusta.htm Accessed July 24, 2010, *citing* Daniel and Baker 1986 Daniel, M., A. Baker. 1986. *Collins Guide to Mammals of New Zealand*. Auckland, New Zealand: William Collins Publishers Ltd.
[1025] O'Donnell, C. 2008. Mystacina robusta. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[1026] *Id.*
[1027] Lloyd, B. D. 2001. "Advances in New Zealand Mammalogy 1990-2000: Short-tailed Bats." *Journal of the Royal Society of New Zealand* 31(1): 59-81, 59.).
[1028] Boyes, B. and P. Myers. 2006. "Mystacina robusta." Animal Diversity Web. Available from: http://animaldiversity.ummz.umich.edu/site/accounts/information/Mystacina_robusta.htm Accessed July 24, 2010, *citing* Daniel and Baker 1986 Daniel, M., A. Baker. 1986. *Collins Guide to Mammals of New Zealand*. Auckland, New Zealand: William Collins Publishers Ltd.
[1029] Boyes, B. and P. Myers. 2006. "Mystacina robusta." Animal Diversity Web. Available from: http://animaldiversity.ummz.umich.edu/site/accounts/information/Mystacina_robusta.htm Accessed July 24, 2010, *citing* King, C. 1990. *The Handbook of New Zealand Mammals*. Auckland, New Zealand: Oxford University Press.).
[1030] Lloyd, B. D. 2001. Advances in New Zealand Mammalogy 1990-2000: Short-tailed Bats. *Journal of the Royal Society of New Zealand* 31(1): 59-81, 76.

well, though they probably make occasional flights during the winter.[1031] The primary natural predators of this species are the laughing owl (*Sceloglaux albifacies*), morepork (*Ninox novaeseelandia*) and a falcon (*Falco novaeseelandiae*). "Large numbers of remains of M. robusta were found in laughing owl middens in North-west Nelson and Canterbury, and small numbers of remains were found in falcon deposits in North Canterbury."[1032]

Regarding mating and reproduction, this species is believed to breed once a year, and observations suggest that *M. robusta* has one pup a year, which is born in April to May, with breeding occurring between February and April.[1033]

5. Population and Trend

From 1964-65, several hundred bats of this species occupied a cave on Big South Cape, and additional caves on Solomon Island.[1034] Yet the last confirmed sighting of this species was in 1967, and it may be extinct.[1035] Some evidence, however, points towards this bat's continued existence. This evidence includes several reports of bat sightings on Putauhina, an island next to Big South Cape, and Mystacina-like echolocation calls that do not belong to *M. tuberculata* or *Chalinolobus tuberculatus*, the only two other bat species known to inhabit these islands.[1036] The echolocation calls of *M. robusta* are likely 26-27 kHz, which is 1 to 2 kHz lower than *M. tuberculata*.[1037] There are also two unconfirmed reports of bats on at a location on Big South Cape. The nearest populations of *M. tuberculata* or *C. tuberculatus* are more than 50 km away from where these sightings occurred, which indicates a "real possibility" that *M. robusta* still survives.[1038] Based on this evidence, the IUCN retracted its 1996 designation of this species as extinct.[1039] It is now listed as critically endangered, and is a candidate for a "possibly extinct" listing.[1040] Nonetheless, Daniel and Williams (1984) state that "if one small colony still manages to survive… their chances of continued survival are very low

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[1031] *Id.* at 77.
[1032] *Id.*
[1033] Boyes, B. and P. Myers. 2006. "Mystacina robusta." Animal Diversity Web. Available from: http://animaldiversity.ummz.umich.edu/site/accounts/information/Mystacina_robusta.htm Accessed July 24, 2010, *citing* Daniel and Baker 1986 Daniel, M., A. Baker. 1986. *Collins Guide to Mammals of New Zealand*. Auckland, New Zealand: William Collins Publishers Ltd.
[1034] Boyes, B. and P. Myers. 2006. "Mystacina robusta." Animal Diversity Web. Available from: http://animaldiversity.ummz.umich.edu/site/accounts/information/Mystacina_robusta.htm Accessed July 24, 2010, *citing* Dowding, J., E. Murphy. 1994. "Ecology of Ship Rats (Rattus rattus) in A Kauri (Agathis Australis) Forest in Northland, New Zealand." *New Zealand Journal of Ecology*, 18: 19-28.
[1035] O'Donnell, C. 2008. Mystacina robusta. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[1036] *Id.*
[1037] Lloyd, B. D. 2001. "Advances in New Zealand Mammalogy 1990-2000: Short-tailed Bats." *Journal of the Royal Society of New Zealand* 31(1): 59-81, 77.
[1038] O'Donnell, C. 2008. Mystacina robusta. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[1039] *Id.*
[1040] *Id.*

indeed."[1041] Although the population trend is unknown, if this species is still extant the IUCN estimates that its population size would be less than 50 mature individuals.[1042]

6. Major Threats

It is likely that the introduction of the Pacific rat (*Rattus exulans*)[1043] and black rat (*Rattus rattus*) to islands that *M. robusta* inhabited contributed to its decline.[1044] Domestic and feral cats, as well as dogs, predate upon this species and have reduced its population.[1045] Secondary poisoning from cyanide bait set for possums is also a concerning threat.[1046]

7. Conservation Actions

Rats have been eradicated from both Big South Cape and Putauhina, a neighboring island. Rat eradication continues on all the islands in this chain, and more surveys for *M. robusta* have been planned.[1047]

8. ESA Listing Factors

C. Disease or predation

It is likely that the introduction of the Pacific rat (*Rattus exulans*) by early Polynesian migrants to *M. robusta's* only habitat largely contributed to its demise.[1048] This is supported by fossil evidence from laughing owl middens.[1049] There is a "close association" between the decline of *M. robusta* in owl middens and the rise of the Pacific rat in the middens instead.[1050] *M. robusta* would have been susceptible to rat predation, as the crevices they hibernated in would have been accessible to the Pacific rat.[1051]

Domestic and feral cats and dogs present a threat to this species.[1052] Daniel and

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[1041] Daniel, M.J. and G.R. Williams. 1984. "A Survey of the distribution, seasonal activity and roost sites of New Zealand bats." *New Zealand Journal of Ecology*. 7: 9-25, 22.
[1042] O'Donnell, C. 2008. Mystacina robusta. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[1043] Lloyd 2001 Lloyd, B. D. 2001. "Advances in New Zealand Mammalogy 1990-2000: Short-tailed Bats." *Journal of the Royal Society of New Zealand* 31(1): 59-81, 77.
[1044] Daniel, M.J. and G.R. Williams. 1984. "A Survey of the distribution, seasonal activity and roost sites of New Zealand bats." *New Zealand Journal of Ecology*. 7: 9-25, 9.
[1045] *Id.* at 21.
[1046] *Id.* at 22.
[1047] O'Donnell, C. 2008. Mystacina robusta. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[1048] Lloyd 2001 Lloyd, B. D. 2001. "Advances in New Zealand Mammalogy 1990-2000: Short-tailed Bats." *Journal of the Royal Society of New Zealand* 31(1): 59-81, 77.
[1049] *Id.*
[1050] *Id.*
[1051] *Id.*
[1052] Daniel, M.J. and G.R. Williams. 1984. "A Survey of the distribution, seasonal activity and roost sites of New Zealand bats." *New Zealand Journal of Ecology*. 7: 9-25, 21.

Williams (1984) surveyed the various causes of death of bats found recently dead. The survey included a sample of 23 *Mystacina*, which included both *M. robusta* and *M. tuberculata*. Generally, the authors do not distinguish whether the individual killed was *M. robusta* or *M. tuberculata*, except in one case. Therefore, while it may not have been *M. robusta* that was killed, it is probably fair to say that many of the same pressures exist for both species since they were conspecific until the precipitous decline of *M. robusta*.[1053] Six of the *Mystacina* were killed by domestic cats, which is more than twice the number caused by roosts being toppled during storms, the next most common cause of death. "The surprisingly high number…of bats killed by domestic cats in this study is cause for concern, because it suggests that feral cats, which are widely distributed on the three main islands and on many off-shore islands…may be a significant cause of mortality, particularly near accessible roosts."[1054] In the primary forests where this species is found, it would be "vulnerable to predation because of its unique terrestrial behavior."[1055] This bat often moves along the ground, as indicated by its hind legs and feet, which are robust and positioned for movement on the ground.[1056] Dogs also present a threat to this species. The death of one individual that was specifically identified to be a *M. robusta* was the result of a dog attack in 1961.[1057]

Bat species worldwide may be at risk from white-nose syndrome, caused by a cold-loving fungus of the Geomyces genus.[1058] The syndrome has been known to cause 80-97% mortality rates in some large hibernation colonies.[1059] Until recently, the disease was restricted to the northeastern United States. However, in 2009 it was detected in France.[1060] It is not known how quickly this disease may spread to other areas of the world, but it poses a severe threat to all bat species, especially those with small ranges or those restricted to one or two caves. If infected, these species may lose nearly their entire population in one fell swoop.

D. The inadequacy of existing regulatory mechanisms

Programs that have eliminated rats on Big South Cape and Putauhina, and continue

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[1053] *See Id.* at 9.
[1054] *Id.* at 21.
[1055] *Id.*
[1056] *See* Boyes, B. and P. Myers. 2006. "Mystacina robusta." Animal Diversity Web. Available from: http://animaldiversity.ummz.umich.edu/site/accounts/information/Mystacina_robusta.htm Accessed July 24, 2010, *citing* King, C. 1990. *The Handbook of New Zealand Mammals*. Auckland, New Zealand: Oxford University Press.
[1057] Daniel, M.J. and G.R. Williams. 1984. "A Survey of the distribution, seasonal activity and roost sites of New Zealand bats." *New Zealand Journal of Ecology*. 7: 9-25, 21.
[1058] Handwerk, Brian. 2008.: "Deadly Bat Disease Linked to Cold-Loving Fungus." National Geographic News. http://news.nationalgeographic.com/news/2008/10/081031-bat-fungus.html [Accessed October 2010].
[1059] Id.
[1060] Puechmaille SJ, Verdeyroux P, Fuller H, Ar Gouilh M, Bekaert M, Teeling EC. 2010 "White-nose syndrome fungus (*Geomyces destructans*) in bat, France." Emerg Infect Dis. e-pub. Available online at http://www.cdc.gov/eid/content/16/2/pdfs/09-1391.pdf [Accessed October 2010].

to eradicate rats from other islands in this chain [1061] are a very important step towards recovering this species. It must be recognized, however, that islands cleared of invasive species by eradication programs run the risk of re-invasion. Rats in particular pose this threat for three reasons. First, they are easy to accidentally reintroduce, often by ships. Second, they are capable of swimming short distances,[1062] which is of particular concern in this instance because the islands that *M. robusta* inhabits are very close to other small islands in the area (see map of New Zealand). Third, rats pose a risk of reintroduction due to their quick reproductive rate.[1063] Therefore, eradication programs alone are not sufficient to protect *M. robusta*. Programs designed to prevent reinvasion of rats must also be implemented[1064] to ensure that the islands where *M. robusta* may exist are hospitable to their survival.

Furthermore, no action appears to have been taken to protect this species from domestic and feral cats or dogs. It is unclear also whether efforts have been made to reduce the secondary cyanide poisoning that threatens this species. Considering that this species likely consists of less than 50 mature individuals,[1065] these threats must be addressed to eliminate as many threat factors as possible.

E. Other natural or manmade factors affecting its continued existence

i. Climate change

The Intergovernmental Panel on Climate Change (IPCC) states that human activities are likely contributing to global climate change. "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic [greenhouse gas] concentrations… It is likely that there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica)."[1066] Due to climate change, "there are projected to be major changes in ecosystem structure and function, species' ecological interactions and shifts in species' geographical ranges, with predominantly negative consequences for biodiversity."[1067] Threats from global climate change are relevant to this bat species.

This species is endemic to small islands, which face particularly urgent threats from rising sea levels and increasingly severe and frequent tropical storms caused by human-induced climate change. "Global average sea level is rising predominantly as a consequence of three factors—thermal expansion of warming ocean water, addition of

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[1061] O'Donnell, C. 2008. Mystacina robusta. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[1062] M.N. and J.C. Russell. 2006. "The Eradication of Mammals from New Zealand Islands." 127-141, 131. *In* Koike, F., Clout, M.N., Kawamichi, M., De Poorter, M. and Iwatsuki, K. (eds.), 2006. *Assessment and Control of Biological Invasion Risks*. Shoukadoh Book Sellers, Kyoto, Japan and IUCN, Gland, Switzerland.
[1063] *Id.*
[1064] *Id.*
[1065] O'Donnell, C. 2008. Mystacina robusta. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[1066] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Available from: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009].
[1067] *Id.*

new water from the ice sheets of Greenland and Antarctica and from glaciers and ice caps, and the addition of water from land hydrology. All three potential sources are undergoing changes of anthropogenic origin."[1068] The IPCC projects that on small islands, "sea level rise is expected to exacerbate inundation, storm surge, erosion and other coastal hazards… [and] with higher temperatures, increased invasion by non-native species is expected to occur, particularly on mid- and high-latitude islands."[1069] Since the islands that this species inhabits are small, individuals of this species are likely located near the coast of these islands. Therefore climate change will have an even more serious impact on this species. On coastlines, " the impacts of sea level rise will be felt through both an increase in mean sea-level and through an increase in the frequency of extreme sea-level events such as storm surges."[1070] The IPCC underscored the risk facing coasts worldwide from climate change: " Coasts are projected to be exposed to increasing risks, including coastal erosion, due to climate change and sea level rise. The effect will be exacerbated by increasing human-induced pressures on coastal areas (very high confidence)…"[1071]

ii. Other causes of death

Several additional factors are direct causes of deaths in *Mystacina*, yet are difficult to characterize. In their survey of the various causes of death of bats found freshly dead or recently dead, Daniel and Williams (1984) found two that were caught in barbed wire after strong winds blew them there, one hit a "television aerial" during a storm, one was shot by a duck hunter, one died after falling into a bath of hot printer's metal, one was killed by a morepork, three were killed when their "roost was blown down in a storm," and two more were found dead locked together.[1072] Secondary poisoning is also believed to present a threat.[1073] One *Mystacina* was found poisoned by cyanide bait laid for possums. Daniel and Williams (1984) postulate that there "is a strong possibility that many other of this endangered species may have been poisoned, but not reported, over the last 20 years."[1074] The authors state that *Mystacina* "is at grave risk from cyanide possum baits (many of which are fruit-lured to attract wary possums), because of its unique terrestrial feeding behavior and because it feeds on fruit and nectar as well as

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[1068] McMullen, C.P. and Jabbour, J. 2009. Climate Change Science Compendium 2009. United Nations Environment Programme, Nairobi, EarthPrint. Online at http://www.unep.org/compendium2009/ [Accessed November 2009].

[1069] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009]

[1070] Karl, T.R., Melillo, J. M., and T.C. Peterson (eds). 2009. Global Climate Change Impacts in the United States, Cambridge University Press, 2009. Online at http://www.globalchange.gov/whats-new/286-new-assessment-climate-impacts-us [Accessed November 2009].

[1071] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009]

[1072] Daniel, M.J. and G.R. Williams. 1984. "A Survey of the distribution, seasonal activity and roost sites of New Zealand bats." *New Zealand Journal of Ecology*. 7: 9-25, 21.

[1073] *Id.*

[1074] *Id.* at 21-22.

flying and ground arthropods."[1075] It should be noted that the survey included a sample of 23 *Mystacina*, which included both *M. robusta* and *M. tuberculata*. The authors did not distinguish whether the individual killed was *M. robusta* or *M. tuberculata*.[1076] Therefore, while it may not have *M. robusta* that was killed in these instances, it is probably fair to say that many of the same pressures exist for both species since they were conspecific until the decline of *M. robusta*.[1077]

iii. Biological vulnerability

Two additional factors threaten the continued survival of this species. First, the extremely low population size of this species, estimated to be less than 50 surviving mature individuals,[1078] is a threat to its existence. A "small population size increases the risk of extinction through inbreeding depression and stochastic events."[1079] FWS has routinely recognized that small population size and restricted range increase the likelihood of extinction.[1080] Island species are particularly susceptible to extinction.[1081,1082] Additionally, studies have indicated that the population of a species declines more quickly closer to the time of extinction than "earlier in the time series."[1083] This indicates that this species' population of less than 50 individuals could easily plummet to an even lower number with great rapidity, making this species' extinction risk very high.

Second, similar to other bat species, this species is particularly vulnerable to extinction due to its low fecundity. Observations suggest that *M. robusta* has only one pup each year.[1084] Across all bats species generally, fetal development occurs slowly,

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[1075] *Id.* at 22.
[1076] *Id.* at 21.
[1077] *See Id.* at 9.
[1078] O'Donnell, C. 2008. Mystacina robusta. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[1079] Schulz, M. and Lumsden, L.F. 2004. National Recovery Plan for the Christmas Island Pipistrelle *Pipistrellus murrayi*. Commonwealth of Australia, Canberra, page 31.
[1080] See, for example, FWS candidate assessment forms for *Doryopteris takeuchii, Huperzia stemmermanniae, Megalagrion nesiotes, Melicope degeneri, Melicope hiiakae, Myrsine mezii, Ostodes strigatus, Partula langfordi, Peperomia subpetiolata, Phyllostegia bracteata*, and *Tryonia circumstriata*. Accessible via FWS website at http://www.fws.gov/endangered/wildlife.html [Accessed November 2009].
[1081] Groombridge, B. 1992. Global Biodiversity - Status of the Earth's Living Resources: A Report Compiled by the World Conservation Monitoring Centre. Chapman and Hall, London, New York. Available at http://www.archive.org/details/globalbiodiversi92wcmc [Accessed 10/19/10].
[1082] Frankham, Richard. 2008. "Inbreeding and Extinction: Island Populations." Conservation Biology. 12: 665–675. Available at http://onlinelibrary.wiley.com/doi/10.1111/j.1523-1739.1998.96456.x/abstract [Accessed 10/19/10].
[1083] Brook, Barry, Navjot Sodhi, and Corey Bradshaw. 2008. "Synergies among extinction drivers under global change." *Trends in Ecology and Evolution*. 23(8): 453-460, 456.
[1084] Boyes, B. and P. Myers. 2006. "Mystacina robusta." Animal Diversity Web. Available from: http://animaldiversity.ummz.umich.edu/site/accounts/information/Mystacina_robusta.htm Accessed July 24, 2010, *citing* Daniel, M., A. Baker. 1986. *Collins Guide to Mammals of New Zealand*. Auckland, New Zealand: William Collins Publishers Ltd..Roberts 2005 Roberts, J. 2005. "Bats and Mankind." *New Zealand Journal of Mammals*, 23: 327-336.

with pregnancies lasting between three to six months.[1085] Female bats generally produce one young per year. This is believed to be due to the very large size of bat pups at birth. Young bats comprise from between 12-15% of the mother's body mass up to 25% of the mother's body mass during pregnancy. Scientists believe that the weight of the pup during pregnancy limits the mother's litter size due to her need to fly while pregnant.[1086]

Litter size is also likely limited due to nursing characteristics that are unique to bat species.[1087] Most mammals wean their young when the young reach 40%, or less, of their adult size. Bats, however, nurse their young until they are nearly adult size. This is because bats cannot feed on their own until their wings are near adult dimensions. This may contribute to the low fecundity of bats.[1088] Species with low fecundity are "particularly predisposed to anthropogenic threats given their low replacement rate."[1089] Thus, low fecundity is another reason that this species faces a high likelihood of extinction unless further action is taken.

[1085] Nowak, Ronald and Ernest Walker. 1994. *Walker's Bats of the World*. John Hopkins University Press. Page 20.
[1086] *Id.*
[1087] *Id.*
[1088] *Id.*
[1089] Brook, Barry, Navjot Sodhi, and Corey Bradshaw. 2008. "Synergies Among Extinction Drivers Under Global Change." *Trends in Ecology and Evolution*. 23(8): 453-460, 455.

O. Paraguana Mustached Bat (*Pteronotus paraguanensis)*

1. Taxonomy

Pteronotus paraguanensis belongs to the Order Chiroptera, Family Mormoopidae. "There is uncertainty if this taxon should be recognized as a distinct species or rather treated as a subspecies of *Pteronotus parnellii*."[1090]

2. Distribution and Range

This bat is endemic to the Peninsula of Paraguana in Venezuela.[1091] The total area the species occupies on the peninsula is less than 100 km^2.[1092]

Figure O.1 *P. paraguanensis* is endemic to the Peninsula of Paraguana in Venezuela.

Source (left): Molinari, J. & Guttiérrez, E.E. 2008. Pteronotus paraguanensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
Source (right): http://www.answers.com/topic/venezuela-gulf-of

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[1090] Molinari, J. & Guttiérrez, E.E. 2008. Pteronotus paraguanensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[1091] Gutierrez, Eliecer and Jesus Molinari. 2008. "Morphometrics and Taxonomy of Bats of the Genus Pteronotus (Subgenus *Phyllodia*) in Venezuela." *Journal of Mammalogy*. 89(2): 292-305, 293.
[1092] Molinari, J. & Guttiérrez, E.E. 2008. Pteronotus paraguanensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

Figure O.2 Peninsula of Paraguana in Venezuela (circled in red).

Source: http://www.soberania.org/Articulos/articulo_4664.htm

Figure O.3 Peninsula of Paraguana in Venezuela.

Source: http://www.tiwy.com/pais/venezuela/peninsula_paraguana/eng.phtml

3. Habitat and Ecology

P. paraguanensis "uses the densest forest (xerophytic shrub) on the peninsula.[1093] This bat may limit its movements to the major forested areas of the peninsula, which are Cerro Santa Ana, Fila de Monte Cano, and Cerro Colorado, and the caves where it

[1093] *Id.*

lives.[1094] Cerro Santa Ana is a mountain that rises to 850 m. It displays distinct vegetative zones based on elevation. Xerophytic thorn forest occurs up to 300m.[1095] Fila de Monte Cano is "much lower and drier" than Cerro Santa Ana, and is best described as a ridge with a maximum elevation of 250m. The vegetation is characterized as "dry to very dry tropical forest."[1096] This forest has been severely reduced.[1097]

There are only three caves where this species is known to roost. These are Cueva de Piedra Honda, Cueva del Guano, and Cueva del Balneario El Pico.[1098] Cueva del Guano is a limestone cave that is located in a nearly flat, thorn-scrub environment with an elevation of 120m.[1099] The village of Buena Vista is nearby.[1100]

Cueva del Pico is located near a beach resort, Balneario El Pico, which is 3km from the town of Los Teques. The cave, which sits at an elevation of 10m, is surrounded by dry coastal desert filled with Cereus and Prosopis (mesquite) shrubs. The Cueva de Piedra Honda is 120 m high and approximately 7 km from Pueblo Nuevo, which is also near the village of San Jose de Cocodite. The cave is surrounded by dry thorn-scrub forest.[1101] There are four shafts that serve as entrances to the caves.[1102]

P. paraguanensis' behavior includes sexual segregation that occurs by cave.[1103] Other bat species also use these caves, including *P. davyi*, *Mormoops megalophylla*, *Natalus tumidirostris*, and *Leptonycteris curasoae*.[1104]

[1094] Gutierrez, Eliecer and Jesus Molinari. 2008. "Morphometrics and Taxonomy of Bats of the Genus Pteronotus (Subgenus *Phyllodia*) in Venezuela." *Journal of Mammalogy*. 89(2): 292-305, 299.

[1095] Anderson, R. P. 2003. "Taxonomy, distribution, and Natural History of the genus *Heteromys* (Rodentia: Heteromyidae) in western Venezuela, with the description of a dwarf species from the Península de Paragauná." *American Museum Novitates* 3396: 1-43, 20.

[1096] *Id.* at 21.

[1097] Molinari, J. & Guttiérrez, E.E. 2008. Pteronotus paraguanensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[1098] Gutierrez, Eliecer and Jesus Molinari. 2008. "Morphometrics and Taxonomy of Bats of the Genus Pteronotus (Subgenus *Phyllodia*) in Venezuela." *Journal of Mammalogy*. 89(2): 292-305, 299-300.

[1099] Molinari, Jesus, and Eliecer Gutierrez. 2005. "Predation by Giant Centipedes, Scolopendra gigantean, on Three Species of Bats in a Venezuelan Cave." *Caribbean Journal of Scienc*e. 41(2): 340-346, 340.

[1100] Peck, Stewart. 1982. "A Contribution to the Knowledge of the Invertebrate Cave Faunas of Venezuela: invertebrate faunas of tropical American caves, part. 4." *International Journal of Speleology*. 12: 75-81, 76.

[1101] *Id.*

[1102] *Id.* at 77.

[1103] Molinari, J. & Guttiérrez, E.E. 2008. Pteronotus paraguanensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[1104] Gutierrez, Eliecer and Jesus Molinari. 2008. "Morphometrics and Taxonomy of Bats of the Genus Pteronotus (Subgenus *Phyllodia*) in Venezuela." *Journal of Mammalogy*. 89(2): 292-305, 300.

4. Population and Trend

P. paraguanensis' population is declining.[1105]

5. Major Threats

This species is imperiled by habitat destruction, degradation, and fragmentation as well as deliberate human disturbance and vandalism of the caves where this species roosts. The bat's behavior of sexual segregation by cave is also a threat to its continued existence.[1106] This is threat because if one cave is particularly impacted by some event, such as human vandalism, many members of one sex could be destroyed, thus impairing the species' reproductive capacity. Based on these factors, the IUCN has stated that "this species is extremely vulnerable to exploitation of the three sites where it is found and could become extinct very easily if not conserved."[1107]

6. Conservation Actions

Since 2002, a bat conservation program has been implemented at Paraguana by the Asociacion Venezolana para la Conservacion de las Areas Naturales (ACOANA), Bat Conservation International (BCI), and local communities.[1108] One of the caves where this species lives, Cueva de Piedra Honda, was fenced off in 2003.[1109] Additionally, the small distribution area that this species occurs in is protected by the Monumento Natural Cerro de Santa Ana and the Reserva Biologica Monte Cano, which is protected in a nongovernmental biological reserve managed by INFALCOSTA, a partnership between the Universidad Nacional Experimental Francisco de Miranda (in Coro) and local communities.[1110] When the Cerro de Santa Ana was declared a Natural Monument in 1972, human presence and hunting on Cerro Santa Ana decreased.[1111]

7. ESA Listing Factors

A. <u>The present or threatened destruction, modification, or curtailment of its habitat or range</u>

[1105] Molinari, J. & Guttiérrez, E.E. 2008. Pteronotus paraguanensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.
[1106] *Id.*
[1107] *Id.*
[1108] Gutierrez, Eliecer and Jesus Molinari. 2008. "Morphometrics and Taxonomy of Bats of the Genus Pteronotus (Subgenus *Phyllodia*) in Venezuela." *Journal of Mammalogy*. 89(2): 292-305, 300.
[1109] *Id.*
[1110] Anderson, R. P. 2003. Taxonomy, distribution, and Natural History of the genus *Heteromys* (Rodentia: Heteromyidae) in western Venezuela, with the description of a dwarf species from the Península de Paragauná. *American Museum Novitates* 3396: 1-43, 22.
[1111] *Id.*

This species is "narrowly restricted and confined to endangered habitats."[1112] Its habitat is "severely fragmented, and there is a continuing decline in its extent and quality.[1113] Extensive areas of dry scrubland have been destroyed, and once this happens, sand dunes move into the area. Secondary regrowth, if it occurs, is not suitable for *P. paraguanensis*.[1114]

There are several factors that contribute to the deforestation and degradation of this species' habitat. The greatest threat on Cerro Santa Ana and Monte Cano is grazing by free-ranging domestic goats, which defoliates native vegetation on the slopes. Defoliation accelerates erosion, which further degrades the habitat.[1115]

Second, unplanned urban and tourism development threaten the scrubland habitat this species relies on. Although there has been some success in limiting the establishment of tourism complexes, the threat still exists. A recent attempt to establish a new tourist area destroyed extensive areas of scrubland vegetation, which created new sand dunes.[1116] Monte Cano is particularly threatened by the construction of infrastructure for tourism.[1117]

Third, timber cutting has resulted in the destruction of large segments of dry forests. Most of this activity is "carried out furtively but intensively by the most economically deprived population." People use the timber for firewood and building furniture, shelving and fences. *Caesalpinia coriaria* is harvested for making furniture, while *Proposis juliflora* is "used intensively for firewood and for making shelving, [and] fences." This has caused drastic changes in the species composition of scrubland forests. Harvesting been so intense that in many areas the only trees that remain are hundred-year-old individuals of *Guajacum officinale*.[1118] On Monte Cano, there is also small-scale gathering of wood and ornamental plants.[1119]

Fourth, some small-scale mining projects are planned in Monte Cano, which present a threat to this species' habitat.[1120] Lastly, clearing scrubland for agricultural crops has destroyed portions of habitat. In the northern part in the state of Falcón and in

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[1112] Molinari, J. & Guttiérrez, E.E. 2008. Pteronotus paraguanensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[1113] *Id.*

[1114] *See* Alarcon, Clara. 2001. "Paraguana Xeric Scrub." *World Wildlife Fund*. Available from: http://www.worldwildlife.org/wildworld/profiles/terrestrial/nt/nt1313_full.html.

[1115] Anderson, R. P. 2003. Taxonomy, distribution, and Natural History of the genus *Heteromys* (Rodentia: Heteromyidae) in western Venezuela, with the description of a dwarf species from the Península de Paragauná. *American Museum Novitates* 3396: 1-43, 22.

[1116] Alarcon, Clara. 2001. "Paraguana Xeric Scrub." *World Wildlife Fund*. Available from: http://www.worldwildlife.org/wildworld/profiles/terrestrial/nt/nt1313_full.html.

[1117] Anderson, R. P. 2003. Taxonomy, distribution, and Natural History of the genus *Heteromys* (Rodentia: Heteromyidae) in western Venezuela, with the description of a dwarf species from the Península de Paragauná. *American Museum Novitates* 3396: 1-43, 22.

[1118] Alarcon, Clara. 2001. "Paraguana Xeric Scrub." *World Wildlife Fund*. Available from: http://www.worldwildlife.org/wildworld/profiles/terrestrial/nt/nt1313_full.html.

[1119] Anderson, R. P. 2003. Taxonomy, distribution, and Natural History of the genus *Heteromys* (Rodentia: Heteromyidae) in western Venezuela, with the description of a dwarf species from the Península de Paragauná. *American Museum Novitates* 3396: 1-43, 22.

[1120] *Id.*

the state of Lara, "wide areas of xeric scrubland have been destroyed to make way for the planting of vegetables."[1121]

B. Over-utilization for commercial, recreational, scientific, or educational purposes

Deliberate human disturbance and vandalism of the caves where this species roosts is a particularly alarming threat.[1122] Each of the three caves where this species roosts are located near towns and "are easily accessible to local inhabitants."[1123] In one of the caves, which contains one third of the entire population, vandals frequently light fires in the cave with the intention of killing the bats living there.[1124] Gutierrez and Molinari (2008) found thousands of dead bats in August 1997, including young of *P. paraguanensis*, "as a result of car tires that were set aflame at the entrance of the Cueva del Guano."[1125] Other mass killings could occur at Cueva del Pico, where burned car tires have also been found.[1126] Locals often assume that all bats consume blood, which drives their desire to eliminate this species near towns and farms.[1127] Furthermore, Cueva del Guano is periodically mined for guano by locals, which poses a threat to *P. paraguanensis* because it disturbs the bat's roosting habitat.[1128]

C. Disease or predation

Bat species worldwide may be at risk from white-nose syndrome, caused by a cold-loving fungus of the Geomyces genus.[1129] The syndrome has been known to cause 80- 97% mortality rates in some large hibernation colonies.[1130] Until recently, the disease was restricted to the northeastern United States. However, in 2009 it was detected in France.[1131] It is not known how quickly this disease may spread to other areas of the

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[1121] Alarcon, Clara. 2001. "Paraguana Xeric Scrub." *World Wildlife Fund*. Available from: http://www.worldwildlife.org/wildworld/profiles/terrestrial/nt/nt1313_full.html.

[1122] Molinari, J. & Guttiérrez, E.E. 2008. Pteronotus paraguanensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[1123] Gutierrez, Eliecer and Jesus Molinari. 2008. "Morphometrics and Taxonomy of Bats of the Genus Pteronotus (Subgenus *Phyllodia*) in Venezuela." *Journal of Mammalogy*. 89(2): 292-305, 300.

[1124] *Id.*

[1125] *Id.*

[1126] *Id.*

[1127] *Id.*

[1128] Peck, Stewart. 1982. "A Contribution to the Knowledge of the Invertebrate Cave Faunas of Venezuela: invertebrate faunas of tropical American caves, part. 4." *International Journal of Speleology*. 12: 75-81, 76.

[1129] Handwerk, Brian. 2008.: "Deadly Bat Disease Linked to Cold-Loving Fungus." National Geographic News. http://news.nationalgeographic.com/news/2008/10/081031-bat-fungus.html [Accessed October 2010].

[1130] Id.

[1131] Puechmaille SJ, Verdeyroux P, Fuller H, Ar Gouilh M, Bekaert M, Teeling EC. 2010 "White-nose syndrome fungus (*Geomyces destructans*) in bat, France." Emerg Infect Dis. e-pub.

world, but it poses a severe threat to all bat species, especially those with small ranges or those restricted to one or two caves. If infected, these species may lose nearly their entire population in one fell swoop.

D. The inadequacy of existing regulatory mechanisms

One of the caves where *P. paraguanensis* lives, Cueva de Piedra Honda, was fenced off in 2003..[1132] However, other the two other caves that this species depends on have not been fenced. All three of the caves must be fenced to prevent human disturbance.[1133,1134] Furthermore, while both Cerro de Santa Ana and Fila de Monte Cano received *de jure* protection,[1135] these areas are still being threatened. Vandalism of caves, grazing, cutting of trees, planned mining projects, and urban development threaten these areas regardless of their protected status.[1136,1137,1138] Therefore, it is clear that their designation as protected areas is not adequate to preserve them, endangering the habitat that *P. paraguanensis* depends on. It does not appear that Cerro Colorado, the third forested location this species relies on, receives any protection. Also, since a major threat is the deliberate killing of this species and others in their roosts, public education and awareness campaign will be critical to the conservation of *P. paraguanensis*, though no programs have been implemented.[1139]

E. Other natural or manmade factors affecting its continued existence

i. Climate change

Available online at http://www.cdc.gov/eid/content/16/2/pdfs/09-1391.pdf [Accessed October 2010].

[1132] Gutierrez, Eliecer and Jesus Molinari. 2008. "Morphometrics and Taxonomy of Bats of the Genus Pteronotus (Subgenus *Phyllodia*) in Venezuela." *Journal of Mammalogy*. 89(2): 292-305, 300.

[1133] Molinari, J. & Guttiérrez, E.E. 2008. Pteronotus paraguanensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

[1134] Gutierrez, Eliecer and Jesus Molinari. 2008. "Morphometrics and Taxonomy of Bats of the Genus Pteronotus (Subgenus *Phyllodia*) in Venezuela." *Journal of Mammalogy*. 89(2): 292-305, 300.

[1135] *Id.*

[1136] *See* Gutierrez, Eliecer and Jesus Molinari. 2008. "Morphometrics and Taxonomy of Bats of the Genus Pteronotus (Subgenus *Phyllodia*) in Venezuela." *Journal of Mammalogy*. 89(2): 292-305, 300

[1137] Anderson, R. P. 2003. Taxonomy, distribution, and Natural History of the genus *Heteromys* (Rodentia: Heteromyidae) in western Venezuela, with the description of a dwarf species from the Península de Paragauná. *American Museum Novitates* 3396: 1-43, 22;

[1138] Alarcon, Clara. 2001. "Paraguana Xeric Scrub." *World Wildlife Fund*. Available from: http://www.worldwildlife.org/wildworld/profiles/terrestrial/nt/nt1313_full.html.

[1139] (Molinari, J. & Guttiérrez, E.E. 2008. Pteronotus paraguanensis. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 03 January 2010.

The Intergovernmental Panel on Climate Change (IPCC) states that human activities are likely contributing to global climate change. "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic [greenhouse gas] concentrations… It is likely that there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica)."[1140] Due to climate change, "there are projected to be major changes in ecosystem structure and function, species' ecological interactions and shifts in species' geographical ranges, with predominantly negative consequences for biodiversity."[1141] Threats from global climate change are relevant to this bat species. Since this species lives on a peninsula, this bat likely occurs near coastlines. Therefore climate change will have an even more serious impact on this species. On coastlines, "the impacts of sea level rise will be felt through both an increase in mean sea-level and through an increase in the frequency of extreme sea-level events such as storm surges."[1142] The Intergovernmental Panel on Climate Change (IPCC) underscored the risk facing coasts worldwide from climate change: "coasts are projected to be exposed to increasing risks, including coastal erosion, due to climate change and sea level rise. The effect will be exacerbated by increasing human-induced pressures on coastal areas (very high confidence)…"[1143]

ii. Biological vulnerability

Three additional factors threaten the continued existence of this species. First, these bats have a small remaining population and a range restricted to three caves in Venezuela. FWS has routinely recognized that small population size and restricted range increase the likelihood of extinction.[1144]

Second, these bats sexually segregate themselves between caves. This means that the "loss of one cave could kill a majority of the members of one sex or the other,"[1145] which could have devastating effects on the reproductive population and seriously jeopardize this species' continued existence.

Third, similar to other bat species, this species is particularly vulnerable to extinction due to its low fecundity. Female bats generally produce one young per

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[1140] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Available from: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009].

[1141] *Id.*

[1142] Karl, T.R., Melillo, J. M., and T.C. Peterson (eds). 2009. Global Climate Change Impacts in the United States, Cambridge University Press, 2009. Online at http://www.globalchange.gov/whats-new/286-new-assessment-climate-impacts-us [Accessed November 2009].

[1143] Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [Accessed November 2009]

[1144] See, for example, FWS candidate assessment forms for *Doryopteris takeuchii, Huperzia stemmermanniae, Megalagrion nesiotes, Melicope degeneri, Melicope hiiakae, Myrsine mezii, Ostodes strigatus, Partula langfordi, Peperomia subpetiolata, Phyllostegia bracteata*, and *Tryonia circumstriata*. Accessible via FWS website at http://www.fws.gov/endangered/wildlife.html [Accessed November 2009].

[1145] *Id.*

year.[1146] Across all bats species generally, fetal development occurs slowly, with pregnancies lasting between three to six months.[1147] Female bats generally produce one young per year. This is believed to be due to the very large size of bat pups at birth. Young bats comprise from between 12-15% of the mother's body mass up to 25% of the mother's body mass during pregnancy. Scientists believe that the weight of the pup during pregnancy limits the mother's litter size due to her need to fly while pregnant.[1148]

Litter size is also likely limited due to nursing characteristics that are unique to bat species.[1149] Most mammals wean their young when the young reach 40%, or less, of their adult size. Bats, however, nurse their young until they are nearly adult size. This is because bats cannot feed on their own until their wings are near adult dimensions. This may contribute to the low fecundity of bats.[1150] Species with low fecundity are "particularly predisposed to anthropogenic threats given their low replacement rate."[1151] Thus, low fecundity is another reason that this species faces a high likelihood of extinction unless further action is taken.

[1146] Nowak, Ronald and Ernest Walker. 1994. Walker's Bats of the World. John Hopkins University Press, Page 19.
[1147] Nowak, Ronald and Ernest Walker. 1994. *Walker's Bats of the World*. John Hopkins University Press. Page 20.
[1148] *Id.*
[1149] *Id.*
[1150] *Id.*
[1151] Brook, Barry, Navjot Sodhi, and Corey Bradshaw. 2008. "Synergies Among Extinction Drivers Under Global Change." *Trends in Ecology and Evolution*. 23(8): 453-460, 455.

IV. CONCLUSION

The 15 bat species described in this petition merit listing as Endangered or Threatened species under the Endangered Species Act. These species are suffering from diverse threats, including habitat loss and degradation due to logging, mining, settlement of protected areas, and expansion of agriculture; threats from introduced predators; overexploitation by subsistence hunters; inadequate regulatory mechanisms; increased vulnerability to extinction due to small population sizes and restricted ranges; range shifts and greater likelihood of severe weather events due to anthropogenic climate change. Most species suffer from a combination of the above, likely making their risk of extinction greater due to the synergistic interaction of multiple threats. Without action to protect their dwindling populations, these unique creatures could easily disappear forever. This would not only be a tragedy for biodiversity, but would be hugely damaging to ecosystems and economically damaging to human farmers. "Because bats control insect populations throughout the world, a large decrease in bat populations would result in insect proliferations that would damage agricultural crops and spread many insect-borne diseases."[1152]

The ESA specifically states its intent to demonstrate "the commitment of the United States to worldwide protection of endangered species and threatened species (16 U.S.C. § 1537(a)) and makes provisions for the Secretary to list species from other countries (16 U.S.C. § 1533(b)(1)(A)). Protecting foreign species under the ESA activates a number of beneficial programs that could be utilized as powerful conservation tools, and the ESA calls for those tools to be used proactively for the conservation of listed species:

> 16 U.S.C. § 1536(a)(1) "All other Federal agencies shall, in consultation with and with the assistance of the Secretary, utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species listed pursuant to section 4 of this Act."

Through the ESA the Secretary may encourage foreign countries to preserve species through multilateral agreements, provision of staff and training, and conducting law enforcement or research investigations abroad (16 U.S.C. § (b) and (c)). In addition,

> 16 U.S.C. § 1537(a): "...the President may…use foreign currencies accruing to the United States Government under the Agricultural Trade Development and Assistance Act of 1954 or any other law to provide to any foreign county (with its consent) assistance in the development and management of programs in that country which the Secretary determines to be necessary or useful for the conservation of any endangered species or threatened species listed by the Secretary pursuant to section 4 of this Act."

[1152] Puechmaille SJ, Verdeyroux P, Fuller H, Ar Gouilh M, Bekaert M, Teeling EC. 2010 "White-nose syndrome fungus (*Geomyces destructans*) in bat, France." Emerg Infect Dis. e-pub. Available online at http://www.cdc.gov/eid/content/16/2/pdfs/09-1391.pdf [Accessed October 2010].

The National Oceanic and Atmospheric Administration has previously recognized that ESA protections for Elkhorn (*Acropora palmata*) and Staghorn Coral (*A. cervicornis*) would benefit these species even though the majority of their ranges exist in other countries: through the recovery planning process, the U.S. can encourage international conservation measures.[1153] Similar logic applies to these bat species, many of which currently have no protection at all. These species would benefit from increased resources, international support, and conservation leadership by the USFWS. This petition is submitted with the hope that federal protection will be granted and will prevent these species' extinction. We believe ESA listing is vital to preserving and recovering these species.

V. REQUESTED DESIGNATION

WildEarth Guardians hereby petitions the U.S. Fish and Wildlife Service under the Department of Interior to list the 15 bat species described in this petition as Endangered or Threatened species pursuant to the Endangered Species Act. This listing action is warranted, given the rarity of these species and the myriad threats they face. All bat species described in this petition are threatened by at least three of the five listing factors, and some are affected by more: present and threatened destruction, modification and curtailment of habitat and range; overutilization; disease and predation; the inadequacy of existing regulatory mechanisms; and other natural or manmade factors affecting their continued existence.

[1153] Clarke, A., Battista, T., Dieveney, B., Gledhill, D., Gombos, M., Jeffrey, C., Koss, J., Leberer, T., Loper, C., Liu, G., Miller, J., Moore, J., Morgan, J., Simpson, S., Waddell, J., and D. Wusinich-Mendez. 2008. National level activities to support US and FAS coral conservation. Pp. 11-28. In: J.E. Waddell and A.M. Clarke (eds.), The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2008. NOAA Technical Memorandum NOS NCCOS 73. NOAA/NCCOS Center for Coastal Monitoring and Assessment's Biogeography Team. Silver Spring, MD. 569 pp.