Guidelines for Minimizing the Negative Impact to Bats and Other Cave Organisms from Guano Harvesting

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Guidelines for Minimizing the Negative Impact to Bats and Other Cave Organisms from Guano Harvesting

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These guidelines have been prepared by the Emerging Wildlife Conservation Leaders Bat Group (EWCLBG), in collaboration with Bat Conservation International and the EWCLBG Advisory Committee, in response to the increasing occurrence of unsustainable bat guano mining practices and, consequently, the loss of millions of bats worldwide. They were developed as a first step towards addressing the need for standards for guano harvesting that can guide a wide variety of stakeholders, including cave managers, government agencies, and harvesting companies, towards the use of practices that minimize harm to bat colonies and related cave fauna due to guano harvesting.

Emerging Wildlife Conservation Leaders Bat Group members

Ryan Richards, Danielle Brigida, Crystal DiMiceli, Kate Gersh, Allison Sribarra, Mathilde Iweins

EWCLBG Advisory Committee members

Dave Waldien, Neil Furey, Iain Mackie, Marlynn Mendoza, Paul Racey

Guidelines reviewers

Abel Pérez González, Louis Deharveng, Melvin Gumal, Axel Hochkirch, Mike Hoffmann, Rachel Roberts, Tony Whitten

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INTRODUCTION

Highly diverse and ecologically valuable, bats provide billions of dollars in ecosystem services.[1] These include seed dispersal and pollination, which help maintain plant communities, and insect control, which limits the distribution and abundance of many pests responsible for spreading human diseases and causing significant economic damages to crops and livestock.

In addition, cave bats play an important role in nutrient cycling through the production of guano. This guano forms the basis of cave ecosystems in many regions of the world, as the main source of energy input from the outside world. Guano deposits support a wide range of fragile and unique species, many of which are limited to specific caves. It is also important to agricultural enterprise as a source of phosphorous for fertilizers, either as guano or rock phosphate (a rock with high percentage of phosphorus as a result of leaching from guano deposits).

Unfortunately, poor understanding of cave ecology and bat biology, along with ill-defined mining/property rights for many caves, have often resulted in unsustainable guano harvesting practices, the loss of millions of bats and their associated biota, and extirpation of many local colonies. This is especially evident in cases where extraction techniques have destroyed geological features of caves that have taken thousands of years to form, damaging roosting habitats for bats and altering energy flows in cave ecosystems. These harvesting practices also increase exposure to risk factors such as zoonotic diseases, as bats serve as a reservoir for many dangerous diseases.

Conservation scientists have recognized the need for cave management guidelines, producing documents on cave and karst protection.[2] However, there is little guidance on planning, implementing, and monitoring guano harvesting operations with consideration for the overall well-being of caves, bats, and cave invertebrates, and to support continued guano harvests. These guidelines have been developed to address this gap.

GEOGRAPHIC SCOPE OF GUIDELINES

Due to the vast differences in social, political, and economic situations of harvesters throughout the world, these guidelines are meant to act as a general guide to procedures that may help to minimize disturbance to bat colonies and cave ecosystems. They are not an inflexible code of conduct and should be updated as new information comes to light and “best management practices” are developed. Implementation manuals that are specific to countries, regions, or locales can be derived from the information outlined below. Any guano harvesting must follow applicable international, national and local laws and regulations.

It should also be noted that there are limited organized data on the scale and impact of guano harvesting around the world. Historical records exist from some regions (e.g., the southeastern United States), and in isolated locations (see footnote 7 on Ratchaburi Province, Thailand), but efforts to aggregate knowledge on this subject are recent. It is possible that this will lead to geographically specialized management approaches (for instance, the management of ‘hot caves’ in the tropics) at some point in the future, and these guidelines should be modified accordingly.

1 Boyles, J.G., Cryan, P.M., McCracken, G.F., and Kunz, T.H. (2011). Economic importance of bats in agriculture. Science, 332: 41-42.

2 Watson, J., Hamilton-Smith, E., Gillieson, D., and Kiernan, K. (1997). Guidelines for cave and karst protection. IUCN, Gland, Switzerland, and Cambridge, UK. 63 pp.

Compliance with these guidelines does not guarantee bats or other cave organisms will tolerate guano harvesting and monitoring of the reactions of bats and cave invertebrates to the harvest should be undertaken. It should be noted that there are some situations that may make harvesting unsustainable at any scale. For instance, the conservation status of an ecosystem or species in the cave may preclude a site from being considered appropriate for harvesting. In addition, exposure to zoonotic diseases, or the probability of transmission of disease, such as white-nose syndrome, into a cave should restrict any harvesting activity. It should be noted that caves are utilized for a variety of other purposes, such as recreation, tourism and religious worship, but those uses are beyond the scope of these guidelines. Every situation is unique and not all guidelines will be applicable universally.

GUIDELINES

Definitions

Sustainable – For the purposes of this document, the sustainability of bat guano harvesting is defined by its ecological impact (its conservation outcome), which in turn affects the social and economic aspects of the activity. Guano harvesting, in this instance, is considered sustainable when it does not result in the decline or extinction of the resident bat colony responsible for the production of the guano (either through direct disturbance caused by extraction, or associated disturbance such as changes in temperature within the cave or the spread of disease, such as white-nose syndrome), the loss of guano-dependent cave organisms, or the loss of cave-associated species (e.g., cave swiftlets).

Guano – the excrement produced by cave-dwelling bats. This excludes rock phosphate, which develops after long periods of time (often after extended periods of deposition) and is not necessarily found in conjunction with bat colonies.

Cave Selection

1. Wherever possible, caves should be comprehensively assessed for their biological, ecological, geological, hydrological, and cultural values prior to any consideration of guano harvesting or other uses. These assessments should be conducted in accordance with government regulations, as applicable.

2. Given the potential risks to the persistence of bat colonies and cave invertebrates that human activity presents, guano harvesting should be avoided in high vulnerability areas, such as small, isolated caves.

3. Diseases, such as white-nose syndrome, have been observed to have devastating effects on bat colonies across regions. Prior to the endorsement of any harvesting, the risk of introducing diseases to novel cave environments should be examined, and harvesting should be avoided in instances where infection is likely.

Baseline assessments of cave bats and other organisms

1. Cave bat populations in the cave that is targeted for guano extraction, and other caves in the vicinity, should be assessed. This assessment should include consideration of species present, populations, roosting locations and the length of their occupation of the site, reproductive seasonality, and foraging areas.[3]

2. Inventories of cave invertebrates should be undertaken and priority species should be identified using endemism, rareness and threats as indicators. For these priority species, the spatial distribution within the cave should be documented.

3. Cave uses (whether legal or not) should be documented, including the use of caves for recreation, harvest of bats, existing guano harvesting, and spiritual or religious uses.

4. Legal or customary ownership and management of the cave should be identified and acknowledged.

3 Methodology for these assessments can be found in: Kunz T.H., Parsons, S. (eds.) (2009). Ecological and behavioral methods for the study of bats. Baltimore, USA: Johns Hopkins University Press.

Monitoring and Reporting

1. As part of partnerships for sustainable guano harvesting, harvesters and their government or non-government counterparts need to agree on regular monitoring and reporting protocols, and assign staff (preferably teams from at least two of these partners, with training on monitoring protocols) to conduct monitoring activities.

2. Establishing a baseline population estimate for each species of cave bat and, if possible, macroinvertebrate species is critical to determine whether their numbers are affected by guano harvesting.

    a. Indicators for monitoring bats include exit counts, assessing area of space occupied by roosting bats, and echolocation calls.

    b. Indicators for invertebrates include population density and species richness. Species identifications generally require taxonomical expertise. Methods for determining this can be found in Schneider, et al. (2010). For priority species, the spatial distribution, number, and size of populations should be documented.

3. Sustainable harvesting will also require protocols for regular monitoring of

    a. Populations of bats and invertebrates[4,5]

    b. Populations of priority invertebrate species (for large cave systems the spatial distribution of priority species and number of populations should be monitored, for smaller systems the population size should be monitored).

    c. Cave temperature and microclimate[6]

    d. Size and frequency of guano harvests[7]

    e. Photographs of the cave (especially where bats are roosting and where the guano is being harvested) should be taken at regular intervals to track population trends and other changes within the cave.

Temporal Segregation – separate the timing of guano harvest from the use of the cave or mine by bats

1. *Migratory Bats*: For bats that are migratory and leave their caves during certain seasons, guano harvesting should be limited to the season(s) in which bats are not present in the cave.[8] This will only work for migratory species and will not be a suitable management tool in areas where bat species spend the entire year in the same cave.

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4 Kunz, T.H., Parsons, S. (eds.) (2009). Ecological and behavioral methods for the study of bats. Baltimore, USA: Johns Hopkins University Press.

5 Flaquer C., Torre, I., and Arrizabalaga, A. (2007). Comparison of sampling methods for inventory of bat communities. Journal of Mammalogy 88: 526–533.

6 Along with guano deposition, cave temperature and microclimates play critical roles in the composition and function of cave ecosystems (Refer to: Ladle, R.J., Firmino, J.V.L., and Malhado, A.C.M. (2012). Unexplored Diversity and Conservation Potential of Neotropical Hot Caves. Conservation Biology 26 (6): 978-982 and the IUCN Guidelines for Cave and Karst Protection)

7 An example of harvest records exists at Khao Chon Pran cave in Ratchaburi Province, Thailand. Monks have collected weekly data on guano harvests for the past 10 years. During the first few years in which records were kept, guano harvests showed a steady decline. This is reported to be a result of declining bat numbers, which emphasizes the importance of population surveys. Please contact Paul Racey for more information.

8 Refer to: Cryan, P.M., and Diehl, R. (2009). Analyzing bat migration. In: Kunz T.H., and Parsons, S. (eds.) Ecological and behavioral methods for the study of bats, 2nd edn., pp. 476–478. Baltimore, USA: Johns Hopkins University Press.

2. *Non-Migratory Bats*: For bats that are not migratory, the feeding and roosting behavior of bats must be considered to develop appropriate schedules for potential harvesting regimes. The following points provide guidance on determining appropriate activities.

    a. To minimize disturbance, which can cause pup loss and other stresses, guano is best collected when the bats are not in the cave. Given the crepuscular and nocturnal behavior exhibited by most species, harvesting activity is less likely to interfere with bat colonies at night when the bats have left the cave to forage. This, as well as local work schedules and culture, need to be considered by stakeholders as part of harvest planning.

    b. In caves where harvesting has been determined to be possible while bats are present in the cave, guano should only be harvested from high-ceiling areas where the bats are roosting furthest from the cave floor. This minimizes disturbance, bat-human contact and risk of disease transmission.

        i. Health risks to workers can be reduced by providing respirators capable of filtering dust particles down to one micron in diameter and changing filters daily.[9]

    c. The timing of reproductive cycles of bat species should be established and considered in harvest planning. Guano should not be harvested when females are about to give birth or when babies (pups) are born and being raised; it can be harvested after the young are able to fly and feed independently.

3. The extraction period (or "harvesting season") for a cave must take into account the seasonality of the site, suitable opportunities for low-impact activities within the cave and extraction quotas agreed upon by companies and the agencies or other organizations involved in the sustainable management of the cave.

Spatial Segregation – separate the location of guano harvest from the use of the cave or mine by bats

In some situations the bats may segregate themselves within a larger cave/mine roost that would allow guano harvesting even while the bats are in the cave/mine. In these instances, when potential disturbance is unlikely and can be documented, harvesting may occur while bats are present.

Habitat inside and outside of the cave

1. Limit extreme modifications to the habitat (e.g., excessive clearing of vegetation) surrounding the cave/mine entrance, as well as the underground system to which the cave belongs, as this may change the internal cave/mine temperature and water content, negatively impacting bat use and altering habitat properties for invertebrates.[10,11,12]

9 Tuttle, M.D., and Moreno, A. (2005). Cave-dwelling Bats of Northern Mexico. Bat Conservation International.

10 Racey, P. (2011), pers. comm.

11 Glover, A.M., and Altringham, J.D. (2008). Cave selection and use by swarming bat species. Biological Conservation 141(6): 1493-1504.

12 Raesly, R.L., and Gates, J.E. (1987). Winter Habitat Selection by North Temperate Cave Bats. American Midland Naturalist 118(1): 15-31.

2. Avoid obstructing cave entrances or digging shafts to access guano deposits. Obstructions can limit access for bats and increase risks from predators[13], while new shafts or changes in entrance size can change roost temperatures.[14] Either activity can force bats to abandon the cave and invertebrate populations to collapse.

3. Disturbances inside the cave may also negatively affect other fauna in the cave ecosystem.[15] Guano is an integral component of cave ecosystems, and this must be considered while determining the appropriate amounts of guano to extract.[16]

   a. Inventories of cave invertebrate communities suggest that humidity gradients within caves influence diversity. This suggests that the spatial arrangement of guano should be maintained during harvesting, with some guano left behind in different sections of the cave to support resident biodiversity.

   b. Surveys of cave biota (see Assessment and Monitoring and Reporting sections at beginning of this document) will help identify target species and unique cave sections.

4. Do not enlarge or reduce cave entrances or create new openings without first consulting experts familiar with the ecology and geology of the cave system and with its resident bat and cave invertebrate species.

   a. Monitor vegetation in and around cave entrances, to maintain the original characteristics of flyways and circulations. Invasive plants, such as vines, have been observed to block caves entrances in some regions.[17]

5. Minimize use of pesticides at times and places where they are most likely to harm bats, especially in areas where bats feed. Spraying crops at dawn is least likely to contaminate insects that are eaten by bats. Organochlorine, organophosphate and carbamate insecticides can pose serious threats to bats.[18, 19] Studies suggest that some synthetic pyrethroids (e.g., permethrin) do not result in obvious harm, but other forms may.[20,21]

13 See Tuttle, M.D., and Moreno, A. (2005). Cave-dwelling Bats of Northern Mexico. Bat Conservation International. Although this suggestion is not based on published data, it does get at the larger point – if caves are to be managed for guano harvest, steps should also be taken to minimize other possible losses and to maintain the highest quality habitat for bat colonies as possible.

14 Note that both high and low temperature fluctuations may be detrimental to bat survival, although there has been little monitoring in this regard.

15 Deharveng, L., and Bedos, A. (2012). Diversity Patterns in the Tropics. In: William B. White and David C. Culver (eds.) Encyclopedia of Caves, pp. 238-250. Chennai: Academic Press.

16 Much of the literature on the ecosystem effects of guano has involved complete removal of organic matter from cave floors and experimental treatments of new material (See Schneider, et al., 2011). This does not provide insight on an 'appropriate' extraction quantity, and therefore these guidelines adopt the position that removal of all organic matter in a cave is to be avoided, and that research on the response of cave invertebrates to varied amounts of allochthonous material is made a priority.

17 See Gerlach, J., and Taylor, M. (2006). Habitat use, roost characteristics and diet of the Seychelles sheath-tailed bat Coleura seychellensis. Acta Chiropterologica, 8(1): 129 - 139.

18 Tuttle, M.D., and Moreno, A. (2005). Cave-dwelling Bats of Northern Mexico. Bat Conservation International.

19 Clark, Jr., D.R., Kunz, T.H., and Kaiser, T. (1978) Insecticides applied to a nursery colony of little brown bats (Myotis lucifugus): lethal concentrations in brain tissues. Journal of Mammalogy 59(1): 84-91.

20 Racey, P.A., and Swift, S.M. (1986) The residual effects of remedial timber treatments on bats. Biological Conservation, 35(3): 205-214.

21 Clark, Jr., D.R., and Shore, R.F. (2001) Chiroptera. In: Shore RF, Rattner BA (eds) Ecotoxicology of wild mammals, p. 159–214. New York: John Wiley & Sons.

Harvesting/Extraction Operations

1. Route heavily used tracks away from cave entrances.[22]
2. Entrance gates can help protect bats from human disturbance, but different species require different gate dimensions. For guidance contact professionals with technical expertise in cave management.
    a. Posted fences may be useful in some instances if they do not obstruct the bats' flight path.
3. Fire should not be permitted in caves or near cave entrances. Smoke can enter and suffocate bats and the guano can catch fire and may burn for months.
    a. This also includes internal-combustion engines and kerosene torches. In addition to oxygen depletion, fumes can kill bats and humans in the enclosed space.
4. Because bats and many cave invertebrates are sensitive to light and disturbance by light can cause distress, this should be minimized within the cave. Do not shine directly on the bats or into the cave entrance when the bats exit at night or return in the morning. Lights that produce any kind of fumes or smoke should be avoided, as should high-candlepower spotlights.
    a. Headlamps and heavy-duty flashlights are potential alternatives.
5. A certain amount of noise is inevitable, but all practical measures should be taken to minimize this within the cave (e.g., machinery not being used should be shut down, no radios or music players, reduce shouting).

Harvesting operations should not include the harvest of individual bats for food, or for sale as food.

Policy and Management

1. Permits can be effective at controlling the amount of guano collected, the number of harvesters allowed to harvest at a given time, and/or the times when harvesting occurs. Permits should be issued by the appropriate natural resource management authority, and should initially be short-term (1-2 years with the prospect of renewal if sustainability criteria are met) to ensure that additional research and observations can be incorporated through adaptive management.
2. Enforcement through random checks or regularly scheduled audits and site visits should be undertaken to ensure the permission process achieves the desired control.
3. Where possible, and for very large harvesting campaigns, accredited observers should be used during mining operations to ensure these adhere to sustainable management guidelines.
4. Depending on the operation and the management scheme that is being utilized, observers may come from several different backgrounds:
    a. Government officials can represent the interests of the public as observers (similar to the role of a park ranger/enforcement officer) in areas where government regulation and financial resources permit.

22 Tuttle, M.D., and Moreno, A. (2005) Cave-dwelling Bats of Northern Mexico. Bat Conservation International

b. Industry or community representatives can serve as observers, given proper training. This is fea sible in areas where property rights for the cave and guano resources are clearly established.[23]

c. An observer can be present on behalf of a third-party auditor in instances where a certification scheme has been established. The Forest Stewardship Council is the highest profile example of this type of auditing in the natural resources sector.[24]

5. Consideration should be given to the legal status of the cave system and its relationship to local communities. Sustainability is difficult to maintain where there is no clear social and legal recognition of responsibility for cave resources. Customary or legal landowners, those who use the cave, and local residents are all very important stakeholders, and support from those who will enforce cave management is necessary for successful management.

6. Working with a variety of stakeholders, local land managers or community members should be done to ensure appropriate collection limits are understood and followed.[25]

7. Local communities living near the cave should be informed of the guano harvesting activity as well as the terms and conditions of the permit, and consulted to learn about possible infractions.

23 There are several examples of this practice being successfully implemented in community forestry or marine fishery contexts. Rare Conservation (http://www.rareconservation.org) specializes in this type of project, and several case studies are available through their website.

24 Forest Stewardship Council (http://www.fsc.org). Note also that third party certification is most successful in particular market settings, where there is a 'social license to operate' that includes sufficient public demand for certified products (see Cashore, B., Gale, F., and Meidinger, E. (2006). Confronting Sustainability: Forest Certification in Developing and Transitioning Countries. New Haven, Connecticut: Yale School of Forestry & Environmental Studies.)

25 Within conservation, examples of this type of community engagement are often found in marine protected areas, or in community-based natural resource management (CBNRM) projects, such as those in southern Africa (see Child, B., and Barnes, G. (2010). The conceptual evolution and practice of community-based natural resource management in southern Africa: past, present and future. Environmental Conservation 37: 283-295). In addition to these case studies, tools for planning, such as the Open Standards for the Practice of Conservation (http://www.conservationmeasures.org/initiatives/standards-for-project-management), or for communication, are informative.

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