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ABSTRACT: The common vampire bat apparently is expanding its range northwards in Mexico and seems poised to enter the southern United States. Climate models predict suitable habitat in the U.S. in south Texas and parts of southern Arizona. While vampire bats' northward range expansion is not unexpected, the fact that this species brings a strain of rabies that impacts livestock and people warrants a strategic response. Annual economic damages from bats are estimated between $7M and $9M, largely associated with deaths of livestock from rabies. To prepare for the emerging rabies issue, USDA Wildlife Services programs in Texas and Arizona have begun training employees to recognize symptoms and respond to bat presence. Surveillance of livestock at sale barns and on ranches is designed to maximize the opportunity to detect bat bites in livestock. Outreach on the issue, via one-on-one training and a DVD handout to landowners along both sides of the border, has been initiated. This paper details the extent of preparations for an emerging disease; quantifies expenditures necessary for a responsive program; and discusses some issues associated with the proximity of vampire bats to the U.S.-Mexico border.

KEY WORDS: *Desmodus rotundus*, emerging disease, livestock, rabies, rabies management, United States, vampire bat

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INTRODUCTION

Hematophagous (i.e., blood-eating) bats are endemic to Latin America and are represented by three species, *Desmodus rotundus*, *Diaemus youngi*, *and Diphylla ecaudata*. Of these, the common vampire bat (*Desmodus rotundus*, hereinafter vampire bat), has the widest distribution (Barquez et al. 2015). Although translocation experiments show that vampire bats are capable of long-distance movements, home range sizes are normally <10 km^2 (Ruschi 1951, Trajano 1996, Streiker et al. 2012). Currently, the range of the vampire bat in Mexico extends northward into the states of Chihuahua, Nuevo Leon, Sonora, and Tamaulipas (Zarza et al. 2017) and evidence suggests the range could naturally extend into the United States in Texas and Arizona (Mistry and Moreno-Valdez 2009, Hayes and Piaggio 2018). Suitable climate and habitat also extend into Florida (Lee et al. 2012, Hayes and Piaggio 2018), but natural connectivity is uncertain. Fossilized remains of a variety of species of vampire bat have been found in Arizona, California, New Mexico, Texas, Florida, and West Virginia (Ray et al. 1988). In recent times, vampire bats have been documented within about 50 km of the U.S. state of Texas (Hayes and Piaggio 2018).

Vampire bats have a preference for feeding on livestock, especially cattle, and vampire bat populations are larger in areas with livestock (Mayen 2003, Voigt and Kelm 2006, Johnson et al. 2014). Rabies exposure can occur directly from vampire bat bites as well via human exposure to rabid livestock. Livestock exposure to vampire bats can cause bovine paralytic rabies, with both public health and economic consequences. Beyond rabies, vampire bats can cause direct damage to livestock value through reduced milk production, weight loss, and damaged skins. (Thompson et al. 1977, Schmidt and Badger 1979, Anderson et al. 2014a). Additional economic expenses are incurred due to the need for increased use of livestock rabies vaccines, increased husbandry costs, and the need for governmental response.

Estimates on the livestock industry in Mexico indicate losses of more than $46.7M per year from vampire bat rabies, through mortality, damaged meat, decreased milk production, devaluation of hides caused by bites, restrictions on commercialization of suspect or sick animals, and decreased consumption of meat due to consumer fear of contamination by rabies (PAHO 1995, Jimenez 2004, Shwiff et al. 2006, Jimenez 2007). Anderson et al. (2014b) estimated annual economic impact of the potential spread of vampire bats into South Texas between $7M and $9M.

The number of cases and the advancement rate of rabies in the U.S.-Mexico area is unknown. One study in Argentina described an infected bat population advancing a linear distance averaging 40 km per year for several years (Fornes et al. 1974, Benavides et al. 2016). Anecdotal evidence indicates cases of bovine paralytic rabies cases have occurred within 25 km of the U.S.-Mexico border south of Reynosa, Tamaulipas, and southwest of Falcon Reservoir in Nuevo Leon, in recent years. A single case occurred in Texas in a cow of Mexican origin, causing officials to believe that the cow became infected in Mexico (Blanton et al. 2011). Three additional cases have appeared near the California-Mexico border in Mexicali in 2013 (Rodriguez Castillo et al. 2015). While no confirmed cases of infection have occurred in the U.S., the proximity of cases within Mexico indicate that vampire bats and bat mediated rabies may appear in the U.S. at any time. As vampire bats expand their range northward, knowledge about vampire bats and recognition of rabies symptoms and rabid livestock is likely to be lacking in rural communities.

METHODS AND RESULTS

An extensive scientific, management, and regulatory interface exists among agriculture, public health, and wildlife management agencies responsible for rabies control and prevention activities within the United States. Individual state and federal agencies have statutory authorities and a public trust requirement to meet agency missions (Slate et al. 2009). As a consequence, planning, implementing, and coordinating effective rabies control and prevention strategies necessitates collaboration among diverse disciplines and authorities. The signing of the North American Rabies Management Plan (NARMP) in October 2008 by representatives from Canada, Mexico, the Navajo Nation, and the United States has extended collaboration across international boundaries and multiple disciplines in four focus areas: communications, control, research, and surveillance (Slate et al. 2008). Signatories to the NARMP include the U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) Wildlife Services (WS).

The mission of the WS program is to provide Federal leadership in managing conflicts with wildlife (USDA 2009). WS uses an integrated wildlife damage management (IWDM) approach to resolving conflicts with wildlife; that approach includes integration and application of all practical methods of prevention and control to minimize wildlife damage (USDA 2009). To prevent rabies transmission to livestock or humans by vampire bats, specific strategies adapted to local situations are required (Slate et al 2008); however, a basic rabies-response program incorporates:

1) Campaign promotion;
2) Training at multiple levels and jurisdictions;
3) Vaccination of susceptible livestock populations;
4) Control of vampire bat populations;
5) Updating diagnostic laboratories, implementing new diagnostic techniques
6) Epidemiological surveillance in endemic areas and regions where rabies cases are reported in animals of economic importance at risk for vampire bat-transmitted rabies and other variants; and
7) Organization of specific interagency committees for collaboration and dissemination of information.

As the United States does not have vampire bat rabies at this time, WS' strategy focuses on number 1, 2, 6, and 7. Wildlife Services initiated training for biologists associated with rabies management campaigns in conjunction with APHIS International Services (IS) in Mexico. Biologists traveled to locations in Mexico to learn from Mexican biologists on biology and ecology of vampire bats and the agricultural impacts and practices used for management. A total of 10 workshops have been held in Mexico and 70 biologists have been trained. One additional workshop was held in Texas in 2018 with 8 people receiving the training.

Because bovine paralytic rabies' symptoms are not well-recognized in either the U.S. or Mexico, WS collaborated with IS, SAGARPA, and Mexican colleagues to produce a bilingual (English/Spanish) DVD describing vampire bats, bat bites, and the symptoms of rabies. The intended audience includes rural landowners along both sides of the border, veterinarians, agricultural workers, and employees of land and wildlife managing agencies. Production of the DVD was done in-house within WS and involved two one-week trips for a two-person crew plus in-country support from IS and cooperating Mexican agencies. DVD's were duplicated from the WS Master locally in San Antonio Texas and packaged by WS for a combined cost of $3.83 per copy. The DVD was debuted at the 2015 Rabies in The Americas Conference in Colorado, and since that time 1,173 DVDs have been distributed.

Beginning in 2016, WS Operations in Texas, Arizona, and Florida began systematic surveillance of livestock at point of sale facilities ("sale barns") and confined livestock operations (e.g., dairies and feedlots). In Texas, additional surveys were conducted on ranches directly on the border when livestock were encountered closely enough to confirm the presence or absence of bites. The intention of these surveys is to detect freshly bitten cattle through observations of fresh or dried blood or wounds similar to vampire bat bites (Greenhall et al. 1971, Greenhall 1972). Annually, between 149 and 357 individual surveys have been conducted since 2016. A total of 887 surveys examining 312,138 head of livestock were conducted through FY 2019.

Training may effectively prevent rabies by bats in local communities (Kikuti et al. 2011, Benavides et al. 2016). Since FY 2013, the authors estimate a minimum of $54,000 spent on training, $14,706 on DVD-based education, and $117,295 on livestock surveys for a total of $186,001 or an annual average of $26,571. Additional expenditures include one-on-one technical assistance, educational booths at public events, non-DVD outreach to the public and wildlife professionals, and administrative costs associated with rabies management in general.

DISCUSSION

WS uses a systematic approach to decision making, called the WS Decision Model (Slate et al. 1992, USDA 2014) (Figure 1). The model prescribes a stepwise process to be followed for selection of wildlife damage management "services" and evaluating the results. In the case of vampire bat range expansion, what is usually the initial step in the Decision Model ("Receive Request for Assistance") is lacking from an external source. Instead, all actions to date have been selected *proactively* by WS leadership in anticipation of conflicts associated with bats and bat mediated rabies.

Expenditures in preparation of conflict is not unprecedented: states adjacent to occupied wolf range often spend considerable resources, even in the absence of wolves. Surveillance expenses are common in disease management. Training is a necessary expenditure in all wildlife damage management scenarios but is especially important for novel conflicts where local knowledge is lacking.

If predictions are accurate and trends in distribution in Mexico continue, vampire bats will arrive in extreme south Texas and perhaps in Arizona in the near future. Assisting in the potential expansion is the vampire bats ability to feed

on other common species such as feral swine (McCarthy 1989, de Macedo Pessoa 2011, Estefano et al. 2015, Galetti et al. 2016, Hernandez-Perez et al. 2019) whose numbers readily outnumber the number of cattle along the Texas/ Mexico border. To help guide a coordinated science-based response among agencies and organizations, WS Leadership will convene a "Blue Ribbon Panel" of rabies and wildlife experts to examine the science behind range expansion, the risks to human and livestock and the options (and expenses) associated with a variety of potential management strategies. The panel will convene in late 2020. It is unlikely that expenses associated with management will decrease and, in the absence of new sources of funding, resource reallocation will continue.

Once vampire bats arrive in the U.S., public opinion, along with political interest, will likely be polarized, with regional interests most affected. State and federal wildlife, agricultural, and public health interests and agencies will also become engaged. WS-led management options may be more or less prescribed by other agencies should the issue become polarized. It is rare that WS becomes involved in mitigation of wildlife damage before it occurs, but the vampire bat response, to date, is a demonstration of proactive management and Federal leadership in managing conflicts with wildlife.

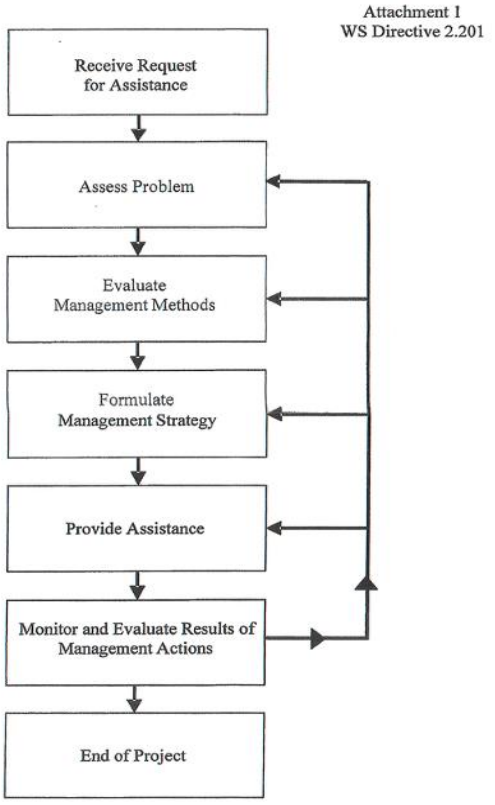

Figure 1. Schematic of the USDA APHIS WS Decision Model (Slate et al. 1992 and USDA 2014).

LITERATURE CITED

Anderson, A. M., S. S. Shwiff, K. Gebhardt, A. J. Ramírez, S. Shwiff, D. Kohler, and L. Lecuona. 2014a. Economic evaluation of vampire bat (*Desmodus rotundus*) rabies prevention in Mexico. Transboundary and Emerging Diseases 61:140-146.

Anderson, A. M., S. S. Shwiff, and S. A. Shwiff. 2014b. Economic impact of the potential spread of vampire bats into South Texas. Proceedings of Vertebrate Pest Conference 26:305-309.

Barquez, R., S. Perez, B. Miller, and M. Diaz. 2015. *Desmodus rotundus*. The IUCN Red List of Threatened Species 2015:e.T6510A21979045.

Benavides, J. A., W. Valderrama, and D. G. Streicker. 2016. Spatial expansions and travelling waves of rabies in vampire bats. Proceedings of the Royal Society B 283:20160328.

Blanton, J. D., D. Palmer, J. Dyer, and C. E. Rupprecht. 2011. Rabies surveillance in the United States during 2010. Journal of the American Veterinary Medical Association 239:773-783.

de Macedo Pessoa, C. R., M. L. Cristiny Rodrigues Silva, A. A. de Barros Gomes, A. I. Estévez Garcia, F. Honma Ito, P. E. Brandão, and F. Riet-Correa. 2011. Paralytic rabies in swine. Brazilian Journal of Microbiology 42:298-302

Estefano, P., D. Bobrowiec, M. R. Lemes, and R. Gribel. 2015. Prey preference of the common vampire bat (*Desmodus rotundus*, Chiroptera) using molecular analysis. Journal of Mammalogy 96:54-63.

Fornes, A., R. D. Lord, M. L. Kuns, O. P. Larghi, E. Fuenzalida and L. Lazara. 1974. Control of bovine rabies through vampire bat control. Journal of Wildlife Diseases 10:310-316.

Galetti, M., F. Pedrosa, A. Keuroghlian, and I. Sazima. 2016. Liquid lunch: vampire bats feed on invasive feral pigs and other ungulates. Frontiers in Ecology 14(9):505-506.

Greenhall, A. M. 1972. The biting and feeding habits of the vampire bat *Desmodus rotundus*. Journal of Zoology, London 168:451-461.

Greenhall, A. M., U. Schmidt, and W. Lopez-Forment. 1971. Attacking behavior of the vampire bat, *Desmodus rotundus*, under field conditions in Mexico. Biotropica 3:136-141.

Hayes, M. A., and A. J. Piaggio. 2018. Assessing the potential impacts of a changing climate on the distribution of a rabies virus vector. PLoS ONE 13 (2):e0192887.

Hernández-Pérez, E. L., G. Castillo-Vela, G. García-Marmolejo, M. Sanvicente López, and R. Reyna-Hurtado. 2019. Wild pig (*Sus scrofa*) as prey of the common vampire bat (*Desmodus rotundus*). THERYA 10:195-199.

Jimenez, R. A. 2004. La rabia bovina en Mexico y el fortalecimiento institucional para su control. Memorias Rabies in the Americas (RITA). Santo Domingo, Republica Domicana.

Jimenez, R. A. 2007. Implementacion de un calculo matermatico para estimar el impacto sanitario y economico de la rabia transmitida por vampiros (*Desmodus rotundus*). Rabies in the Americas Conference Proceedings. Guanajuato, Mexico.

Johnson, N., N. Aréchiga-Ceballos, and A. Aguilar-Setien. 2014. Vampire bat rabies: ecology, epidemiology and control. Viruses 6:1911-1928.

Kikuti, M., I. A. D. Paploski, M. d. C. P. Silva, E. A. de Oliveira, A. W. C. da Silva, and A. W. Biondo. 2011. Prevention educational program of human rabies transmitted by bats in rainforest preserved area of southern Brazilian coast. Zoonoses and Public Health 58:529-532.

Lee, D. N., M. Papeş, and R. A. Van Den Bussche. 2012. Present and potential future distribution of common vampire bats in the Americas and the associated risk to cattle. PLoS ONE 7(8):e42466.

Mayen, F. 2003. Haematophagous bats in Brazil, their role in rabies transmission, impact on public health, livestock industry and alternatives to an indiscriminate reduction of bat population. Journal of Veterinary Medicine, B. Infectious Diseases and Veterinary Public Health 50:469-472.

McCarthy, T. J. 1989. Human depredation by vampire bats (*Desmodus rotundus*) following a hog cholera campaign. The American Journal of Tropical Medicine and Hygiene 40:320-322.

Mistry, S., and A. Moreno-Valdez. 2009. COS 85-2: Climate change, vampire bats, and rabies: modeling range shifts on the US-Mexico border. Conference Proceedings of the 94th Ecological Society of America.

PAHO (Pan American Health Organization). 1995. Human rabies in the Americas. Epidemiological Bulletin. 16(1).

Ray, C. E., O. J. Linares, and G. S. Morgan. 1988. Paleontology. Pages 19-30 *in* A. M. Greenhall and U. Schmidt, editors. Natural history of vampire bats. CRC Press, Inc., Boca Raton, FL.

Rodriguez Castillo, J. L., A. de la Mora Valle, and G. E. Medina Basulto. 2015. Report of rabies in feedlot cattle introduced to Baja California from the state of Guerrero, Mexico. Turkish Journal of Veterinary Animal Sciences 39:241-244.

Ruschi, A. 1951. Morcegos do estado do Espı´rito Santo: introduc¸a˜o e considerac¸o˜es gerais. Boletim do Museu de Biologia Professor Mello Leita˜o. 1:1-16.

Schmidt, K. M., and D. D. Badger. 1979. Some social and economic aspects in controlling vampire bats. Proceedings of the Oklahoma Academy of Sciences 59:112-114.

Shwiff, S., R. A. Jimenez, O. L. Lecuona, K. Kirkpatrick, and D. Kohler. 2006. Vaccinating cattle to protect against rabies transmission from rabid bat populations in Mexico's endemic zones: an analysis using economic models of the benefits and costs. Rabies in the Americas (RITA) Conference Proceedings. Brasilia, Brazil.

Slate, D., T. P. Algeo, K. M. Nelson, R. B. Chipman, D. Donovan, J. D. Blanton, M. Niezgoda, and C. E. Rupprecht. 2009. Oral rabies vaccination in North America: opportunities, complexities, and challenges. PLoS Neglected Tropical Diseases 3(12):e549.

Slate, D., W. Anderson, L. Lecuona, R. Chipman, M. Mendoza, C. Rupprecht, D. Donovan, S. Oertli, C. Trimarchi, S. Bender, R. McLean, C. Alvarez Lucas, F. Vargas Pino, D. Batalla Campero, J. A. Jimenez Ramirez, I. Lopez Martinez, A. Melendez Felix, L. A. Gomez Mendieta, Y. Toxqui, J. Badcock, M. Dunbar, D. Lein, D. Bergman, and K. Nelson. 2008. North American rabies management plan. U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, Concord, NH.

Slate, D., R. Owens, G. Connolly, and G. Simmons. 1992. Decision making for wildlife damage management. Transactions of the North American Wildlife and Natural Resources Conference 57:51-62.

Streicker, D. G., S. Recuenco, W. Valderrama, J. G. Benavides, I. Vargas, V. Pacheco, R. E. Condori, J. Montgomery, C. E. Rupprecht, P. Rohani, and S. Altizer. 2012 Ecological and anthropogenic drivers of rabies exposure in vampire bats: implications for transmission and control. Proceedings of the Royal Society B 279:3384-3392.

Thompson, R. D., D. J. Elias, and G. C. Mitchell. 1977. Effects of vampire bat control on bovine milk production. Journal of Wildlife Management 41:736-739.

Trajano, E. 1996 Movements of cave bats in southeastern Brazil, with emphasis on the population ecology of the common vampire bat, *Desmodus rotundus* (Chiroptera). Biotropica 28:121-129.

USDA (U.S. Department of Agriculture), 2009. Mission and philosophy of the WS program. Directive 1.201. Wildlife Services Policy Manual, Washington, D.C.

USDA. 2014. WS Decision Model. Directive 2.201. Wildlife Services Policy Manual, Washington, D.C.

Voigt, C. C., and D. H. Kelm. 2006. Host preference of the common vampire bat (*Desmodus rotundus*; Chiroptera) assessed by stable isotopes. Journal of Mammalogy 87:1-6.

Zarza H, E. Martínez-Meyer, G. Suzán, and G. Ceballos. 2017. Geographic distribution of *Desmodus rotundus* in Mexico under current and future climate change scenarios: implications for bovine paralytic rabies infection. Veterinaria México OA. 2017:4(3).