ANNOTATED BIBLIOGRAPHY
BIO 862 CURRENT TOPICS OF ECOLOGY
DEFORESTATION EFFECTS ON VECTOR BIOLOGY
By Jenny Carlson

The study of deforestation effects on vector biology is an emerging field. Much research is needed to understand the complexity of vector biology. Many of the studies that have been conducted up till now provide minimal information of how deforestation factors affect vector density and disease transmission. In fact, so little is understood that it is common to find studies that either show that deforestation is good because it lowers vector density or that deforestation is bad because it enhances vector density. The main problem is that in order to predict how a vector will respond to deforestation, studies need to be designed to specifically target at a species level. Findings of deforestation effects of one mosquito species may differ completely from another species. Unfortunately, deforestation is a process that can't be controlled, thus, to prevent the emergence of infections diseases, investigation of possible impacts from future deforestation should be carried out.

Afrane, Y. A., G. Zhou, B. W. Lawson, A. K. Githeko and G. Yan. 2006. **Effects of microclimatic changes caused by deforestation on the survivorship and reproductive fitness of *Anopheles gambiae* in western Kenya highlands.** *Am. J. Trop. Med. Hyg.* **74**(5):772-778**.**

The West African highlands are experiencing higher rates of malaria epidemics due to land use changes. This study investigated the effects of deforestation-induced changes in indoor temperature on the survivorship and reproductive fitness of Anopheles gambiae. Homes located in deforested areas were higher in temperature than homes located in forested areas during the dry and the rainy season. Female Anopheles gambiae in deforested areas showed higher percents in net reproductive rate and in fecundity than those in forested areas. Vectorial capacity of An. gambiae was estimated to be 106% and 29% higher in the deforested area than in the forested area in dry and rainy seasons, respectively. Although results show that land use practices do increase mosquito vectorial capacity, none of the mosquitoes were tested for malaria, thus, it is hard to conclude that malaria epidemics are tied to increased mosquito activity.

Allan, B. F., F. Keesing and S. Ostfeld. 2003. **Effect of Forest Fragmentation on Lyme Disease Risk.** *Conservation Biology* **17**(1):267-272.

Densities of white-footed mice (Peromyscus leucopus) have increased due to forest destruction and fragmentation. These mice are the principal natural reservoir of the Lyme bacterium. Blacklegged ticks (Ixode scapularis) are vectors of the Lyme bacterium, thus, those that feed on mice have a higher probability to become infected than those who feed on other hosts. The study evaluated the density of infected blacklegged ticks in small forest patches (<2 ha) vs. those in larger patches (2-8 ha). Tick density and infection prevalence was found to be greater with decreasing patch size.

Ceballos, L. A., M. V. Cardinal, G. M. Vazquez-Prokopec, M. A. Lauricella, M. M. Orozco, R. Cortinas, A. G. Schijman, M. J. Levin, U. Kitron and R. E. Gurtler. 2006. **Long-term reduction of *Trypanosoma cruzi* infection in sylvatic mammals following deforestation and sustained vector surveillance in northwest Argentina.** *ACTA Tropica* **98**:286-296.

This study investigated the number of infected sylvatic animals around eight villages in northwest Argentina. After community-wide insecticide spraying Triatoma infestans, a vector of Trypanosoma cruzi, densities were found to have declined since 1992. High rates of deforestation have shown to also cause a decline of infected sylvatic animals, especially in opossum abundance. Although a decrease in infection rates was found, it is still unclear if it due to insecticide spraying or if it due to deforestation lowering sylvatic animal populations.

Munga, S., N. Minakawa, G. Zhou, E. Mushinzimana, O. J. Barrack, A. K. Githeko and G. Yan. 2006. **Association between land cover and habitat productivity of malaria vectors in western Kenyan highlands.** *Am. J. Trop. Med. Hyg.* **74**(1):69-75.

In this study, effects of land cover types on survivorship and productivity of Anopheles gambiae was investigated. Three land cover types were studied: farmland, forest, and natural swamp. Productivity of An. gambiae (number of emerging adult

mosquitoes/m2/week) was found to be higher in farmland sites, which have higher maximum temperature, less canopy cover, and fewer emergent plants than forested areas.

Overgaard, H. J., B. Ekbom, W. Suwonkerd and M. Takagi. 2003. **Effect of landscape structure on anopheline mosquito density and diversity in northern Thailand: Implications for malaria transmission and control.** *Landscape Ecology* **18**:605-619.

Aerial photographs were used in this study to understand the influence of landscape structure and ecology on anopheline mosquito density and diversity. Densities of Anopheles maculatus and Anopheles minimus, which are primarily found in forested areas, were compared to densities of Anopheles aconitus and Anopheles hyrcanus, which are primarily associated with paddy fields. The field component of the study was conducted in five villages in northern Thailand where human bait was used to capture mosquitoes. The results indicated that anopheline species diversity was low in agricultural locations and areas with little forest cover. The authors suggest that landscape management involving large-scale reduction and fragmentation of the forest cover could be used for malaria control. However, the study was only conducted in vicinity to human settlements resulting in data that misrepresents anopheline density in fields or in the forests.

Patz, J. A., T. K. Graczyk, N. Geller and A. Y. Vittor. 2000. **Effects of environmental change on emerging parasitic diseases.** *International Journal of Parasitology* **30**:1395-1405.

A review. The purpose of this review was to provide an overview of documented ecological disturbances that had an effect on the emergence and proliferation of parasitic diseases. As deforestation continues to take place at high rates, opportunities for exchange and transmission of parasites to uninfected humans and animals may continue to increase as well.

Pessoa, F. A. C., J. F. Medeiros and T. V. Barrett. 2007. **Effects of timber harvest on phlebotomine sand flies (Diptera: Psychodidae) in a production forest: abundance of species on tree trunks and prevalence of trypanosomatids.** *Mem. Inst. Oswaldo Cruz* **102**(5):593-599.

Phlebotomine sand flies, vectors of Leishmania, are known to rest in the base of tree-trunks. This study conducted a survey of sand fly abundance and infection rates before and after timber logging in Brazil. Sand fly populations decreased significantly after timber logging took place. In addition, the rate of females infected by trypanosomatids also decreased after timber logging took place. This study is one of few that combined both field collections and lab dissections (used to establish whether or not the fly is infected) to establish deforestation effects on both abundance and infection rates in a vector.

Pope, K., P. Masuoka, E. Rejmankova, J. Grieco, S. Johnson and D. Roberts. 2005. **Mosquito habitats, land use, and malaria risk in Belize from satellite imagery.** *Ecological Applications* **15**(4): 1223-1232.

Anopheles vestitipennis, a primary vector of malaria in Belize, are found in Typha domingensis marshes and in flooded forests, while Anopheles albimanu, a less potent vector of malaria, are found in Eleocharis spp. marshes. By using Geographical information systems (GIS), the authors were able to demonstrate that the amount of Typha domingensis present in a marsh is positively correlated with the amount of agricultural land. Along with GIS, 40 marsh sites were selected to collect data on vegetation, water, and soil composition along with mosquito larval sampling. The larval sampling indicated a strong correlation between densities of Typha domingensis and the densities of immature Anopheles vestitipennis. These findings suggest that the replacement of Eleocharis spp. marsh and other marsh types with Typha domingensis marsh can potentially increase malaria prevalence by increasing the abundance of An. vestitipennins.

Vittor, A. Y., R. H. Gilman, J. Tielsch, G. Glass, T. Shields, W. S. Lozano, V. Pinedo-Cancino and J. A. Patz. 2006. **The effect of deforestation on the human-biting rate of *Anopheles darlingi,* the primary vector of Falciparum malaria in the Peruvian Amazon.** *Am. J. Trop. Med. Hyg.* **74**(1):3-11.

The human-biting rate and distribution of the mosquito Anopheles darlingi was examined in this study. Sampling of these mosquitoes was done in 56 sites with varying degrees of deforestation. After controlling for human presence, it was found that An. darlingi in deforested areas had a biting rate that was 278 times higher than those found in forested areas.

Yanoviak, S. P., J. E. R. Paredes, L. P. Lounibos and S. C. Weaver. 2006. **Deforestation alters phytotelm habitat availability and mosquito production in the Peruvian Amazon.** *Ecological Applications* **16**(5):1854-1864.

Phytotelmata (plant-held waters) were used in this study to quantify the effects of deforestation on larval Wyeomyia and Limatus spp. mosquitoes. New clearings and cultivated lands with water-filled plant axils such as pineapple and plantain, were characterized with higher volumes of colonizable phytotelm water. Wyeomyia spp. prefer plant axils while Limatus spp. prefer fallen-plant-part phytotelmata as their habitat. As more deforestation takes place, more habitat availability is provided to these species of mosquitoes. This study, although informative, is lacking information needed to fully understand the biology of these taxa, such as predator distribution.

Yasuoka, J. and R. Levins. 2007. **Impact of deforestation and agricultural development on anopheline ecology and malaria epidemiology.** *Am. J. Trop. Med. Hyg.* **76**(3):450-460.

A review. This paper combines a literature review with statistical analyses to elucidate mechanisms linking deforestation and agriculture with anopheline ecology. A collection of 60 examples of changes in mosquito density as a consequence of deforestation where put forth to be analyzed statistically. Niche width and sun preference were tested for their associations with changes in mosquito density. Niche width was found to not be associated with mosquito density, while mosquito species that were sun loving were able

to increase in density in deforested areas due to increased sun light exposure. Many studies only focus on a couple of factors that influence mosquito density, but there is a need of more studies that look at a wider range of factors that influence mosquito density.

Ye-Ebiyo, Y., R. J. Pollack and A. Spielman. 2000. **Enhanced development in nature of larval *Anopheles arabiensis* mosquitoes feeding on maize pollen.** *Am. J. Trop. Med. Hyg.* **63**(1, 2):90-93.

Maize (Zea m. mays) has become a crop that is used in much of Africa and is a source of wind-borne pollen. Maize grains that settle on the surface of bodies of water have the potential to become an important food source in anopheline breeding sites. Larval Anopheles arabiensis were studied to determine if they would develop more rapidly, more frequently, and produce larger adults in close proximity to abundant maize pollen. The study found that maize pollen does constitute an important source of larval nutriment for An. Arabiensis. Experimental results showed that when fed only maize grains, larvae developed at an elevated rate and produced large adults.

Ye-Ebiyo, Y., R. J. Pollack, A. Kiszewski and A. Spielman. 2003. **Enhancement of development of larval *Anopheles arabiensis* by proximity to flowering maize (*Zea mays) in turbid water and when crowded..*** *Am. J. Trop. Med. Hyg.* **68**(6):748-752.

This study was conducted as a follow-up to the study published in 2000. In this study the authors determined whether larvae contained in turbid water developed more successfully in areas where food is readily available (close proximity to maize) than in areas that are crowded and that have a food shortage. Larvae that were further away from flowering maize and that were found in clear water developed in higher numbers and resulted in larger adults than those in turbid water. Larvae that were close to flowering maize were not developmentally affected by water turbidity and larval crowding.