Weather and landscape factors associated with adult mosquito abundance in southwestern Georgia, U.S.A.

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ABSTRACT: Mosquito community composition and population dynamics were compared to weather variables and land use/cover data during 2008 to determine which variables affected population dynamics at the J.W. Jones Ecological Research Center in southwestern Georgia. Models relating adult mosquito distributions to weather variables and time of year were compared using Akaike's Information Criterion (AIC) model selection. Precipitation, temperature, humidity, and Keetch-Byram Drought Index were important factors correlated with mosquito abundance or presence/absence for the species considered. A cluster analysis, which grouped eight sites based on the percentages of land use/cover and hydric soils located in a 1-km radius surrounding collection sites, and an indicator species analysis were used to investigate the associations among 11 mosquito species and sites with similar land use/cover. *Aedes albopictus* (Skuse), *Culex coronator* Dyar & Knab, *Culex quinquefasciatus* Say, and *Culex salinarius* Coquillett were associated with sites that had the most anthropogenic influence, while *Coquillettidia perturbans* (Walker) and *Psorophora ferox* (von Humboldt) were associated with natural land cover such as wetlands and forested land. This study demonstrates that regional climate and land use/cover data can be predictive of the population dynamics of certain mosquito populations and is the first to examine how the distribution of *Cx. coronator* adults relate to land use/cover in the southeastern United States. ***Journal of Vector Ecology* 36 (2): 269-278. 2011.**

Keyword Index: Mosquito community, weather, land use/cover.

INTRODUCTION

Understanding the spatial and temporal dynamics of mosquito communities is important for implementing control measures as well as assessing vector-borne disease prevalence within an area (Godsey et al. 2005, DeGroote et al. 2007). Several mosquito-borne viruses that cause disease in humans and other animals circulate in Georgia each year, including St. Louis encephalitis virus (SLEV), LaCrosse encephalitis virus (LACV), Eastern Equine encephalitis virus (EEEV), and West Nile virus (WNV) (Lance-Parker et al. 2002). Epizootics of these viruses occur sporadically but within relatively well-defined seasonal periods (GDCH 2010).

The occurrence and distribution of specific mosquito species in Georgia have been documented in a number of studies (eg., King et al. 1960, Smith and Floore 2001, Gray et al. 2005, Kelly et al. 2008). Other investigations have examined the relationship between land use/land cover data, human demographic data, climate ecological correlates, and WNV infection in birds (Gibbs et al. 2006, Bradley et al. 2008). However, none of these studies examined the relationship between potential disease vectors and ecological factors affecting mosquito populations in the Gulf Coastal Plain of southwestern Georgia. We compared mosquito community composition data to selected weather variables and land use/land cover data during the 2008 mosquito season to determine whether mosquito population dynamics are related to weather patterns or landscape variation.

MATERIALS AND METHODS

Study area

The study was conducted at Ichauway, the property of the J.W. Jones Ecological Research Center in southwestern Georgia. Ichauway is a remnant 11,736 hectare longleaf pine-wiregrass ecosystem embedded within an agricultural landscape dominated by center-pivot irrigated row crops (Michener et al. 1998, Smith et al. 2006). Relative humidity, precipitation, temperature, and Keetch-Byram Drought Index data for the study were obtained from the Georgia Automated Environmental Monitoring Network weather station on Ichauway property (listed as the Newton station at www.georgiaweather.net).

Sampling methods

Seven locations for collection sites were selected by creating two intersecting transects across Ichauway property and choosing points along those transects. To sample the mosquito population at a location that receives agricultural runoff, we chose an additional site that was not on the transects (Hall Pond) (Figure 1). Adult female mosquitoes were collected through weekly trapping at each site from mid-May through early November, 2008, using Centers for Disease Control and Prevention (CDC) miniature light traps and gravid traps (John W. Hock,

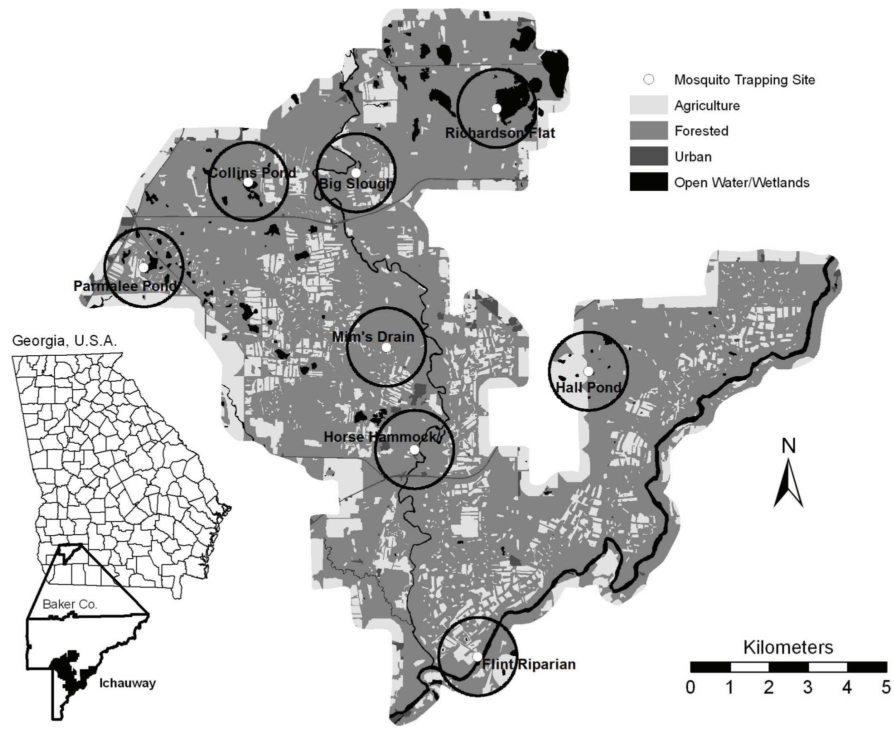

Figure 1. The eight study sites at Ichauway in southwestern Georgia, USA, where adult mosquitoes were collected from May to November 2008. The 1-km radius surrounding each site used in spatial analysis is outlined in black.

Gainesville, FL) (Silver 2008). Light traps were baited with dry ice, powered with 6-V batteries, and suspended 1.5 m above the ground. Gravid traps were baited with hay-infused water and powered with 6-V batteries. Traps were operated from approximately 17:00 until 07:00 the next morning. Collected mosquitoes were transported alive to the laboratory and anaesthetized using triethylamine (Kramer et al. 1990). Adults were identified to species using standard keys (Darsie and Morris (2003) and Darsie and Ward (2005)). For collections that resulted in large quantities of mosquitoes after Tropical Storm Fay in August, the total number of individuals collected and species composition were estimated using the mean of three sets of 100 randomly chosen individuals of mixed species that were weighed and identified (Schäfer et al. 2008).

Spatial analysis

To quantify land use/cover around sites, a map was created from 1:12,000 m scale 1992 color infrared aerial photography that is updated frequently to reflect changes in land cover from more recent photographs. Using ArcGIS (ESRI, Redlands, CA, v. 9.1), the percent area of nine land use/cover categories (Table 1) were determined within a 1-km radius of each collection site (total area = 3.14 km^2). In order to quantify the percentage of hydric and non-hydric soil within the 1-km radius of each site, a data layer was created from the Natural Resources Conservation Service Baker County Soil Survey.

Data analysis

Eleven mosquito species collected from both light and gravid traps were selected for use in statistical analyses based upon their abundance in sampling collection and/or their status as a potential arbovirus vector (Table 2) (Turell et al. 2005, Cupp et al. 2007, Kelly et al. 2008). Given that the weather data fluctuated over the study, while the spatial data remained constant, the relationships between these factors and total mosquito abundance were analyzed independently. As part of the weather data analysis, 52 *a priori* models were developed to explain daily abundance or presence/absence of selected mosquito species using combinations of 11 predictor variables (Table 2) based on the importance of these variables in the literature and field observation. Though the possible combinations of the 11 predictor variables are endless, the number of *a priori* models used in this analysis was limited to 50 along with the null and global models (Conner et al. 2010).

The second-order Akaike's Information Criteria (AIC_c) analysis for small sample sizes was used to identify the best model for each mosquito species and to predict variable importance (Burnham and Anderson 2002). As part of the AIC analysis, daily log-transformed abundance of *Aedes vexans* (Meigen) was analyzed as a function of all 52 *a priori* models using PROC GENMOD (SAS Institute Inc., Cary, NC). Due to the presence of multiple zero values in abundance data for all other mosquito species considered, the daily presence/absence of those species was analyzed as a function of all 52 *a priori* models using PROC LOGISTIC (SAS Institute Inc., Cary, NC). For each mosquito species, the model with the lowest AIC_c value was considered to be the best model (Burnham and Anderson 2002, Conner et al. 2010). Model averaging was used to calculate parameter estimates and unconditional standard errors for all predictor variables (Burnham and Anderson 2002, Conner et al. 2010). Predictor variables were considered useful in explaining mosquito abundance or presence/absence if the 95% confidence interval surrounding the parameter estimate did not contain zero and the variable weight was

Table 1. The percent area of nine land use/cover categories and hydric soils within a 1-km radius of eight study sites (total area = 3.14 km^2) at Ichauway assessed using ArcGIS (ESRI, Redlands, CA, v. 9.1).

Land use/cover category and soil	Percent area within 1-km radius of sites							
	Big Slough	Collins Pond	Horse Hammock	Mim's Drain	Richardson Flat	Flint Riparian	Parmalee Pond	Hall Pond
Coniferous forest	76.9	79.2	70.8	86.6	64.4	43.0	59.8	54.4
Deciduous forest	1.6	5.1	2.4	3.6	11.8	3.9	1.8	1.8
Bottomland deciduous	3.6	0.0	12.9	2.6	0.0	13.1	0.0	0.5
Forested wetland	0.6	5.1	1.5	0.0	0.1	0.0	5.6	0.2
Non-forested wetland	0.0	0.2	0.0	0.0	22.6	1.3	2.3	3.6
Scrub	4.8	1.2	0.9	0.8	0.0	5.9	1.0	0.0
Agriculture	8.8	8.3	3.4	5.9	1.0	25.8	26.3	39.5
Residential	0.1	0.9	5.2	0.2	0.0	0.1	3.2	0.1
Open water	3.5	0.0	2.9	0.5	0.0	6.9	0.0	0.0
Hydric soils	10.5	19.3	9.5	0.0	24.8	10.3	13.1	8.8

Table 2. Best fitting models explaining the effects of weather variables and time on mosquito abundance or presence/absence for all species considered. Models with lowest second order Akaike's information criterion difference (Δ AIC$_c$) and greatest Akaike weight (w_i) were more supported by data and are presented here. The number of predictor variables (*K*) in each model included the intercept term.

Model	K	Δ AIC$_c$	w_i
Ae. albopictus			
wk_2_rh wk_1_rh wk_2_temp	4	0.00	0.44
Ae. triseriatus			
wk_4_precip wk_6_precip	3	0.00	0.23
Ae. vexans			
wk_2_precip wk_4_precip wk_6_precip d_1_rh d1_temp wk_1_temp wk_2_temp time	9	0.00	0.46
Cq. perturbans			
wk_1_temp d1_temp wk_1_rh	4	0.00	0.13
Cx. coronator			
wk_2_precip wk_4_precip wk_6_precip d_1_rh d1_temp wk_1_temp wk_2_temp time	9	0.00	0.30
Cx. erraticus			
wk_2_precip wk_4_precip wk_6_precip d_1_rh wk_1_rh time	7	0.00	0.48
Cx. nigripalpus			
wk_4_precip wk_6_precip wk_2_rh d1_temp wk_2_temp DI	7	0.00	0.19
Cx. quinquefasciatus			
wk_6_precip d1_temp wk_1_temp wk_1_rh	5	0.00	0.21
Cx. restuans			
wk_2_precip wk_6_precip wk_2_rh d1_temp wk_1_temp	6	0.00	0.28
Cx. salinarius			
wk_4_precip	2	0.00	0.08
Ps. ferox			
wk_6_precip wk_1_temp DI time	5	0.00	0.17

Table 3. Number of mosquitoes per species collected during May-November, 2008 at eight sites in Ichauway, the property of the J. W. Jones Ecological Research Center in southwestern Georgia. Locations of sites can be found in Figure 1.

Species	Big Slough	Collins Pond	Flint Riparian	Hall Pond	Horse Hammock	Mim's Drain	Parmalee Pond	Richardson Flat
Ae. albopictus (Skuse)	2	1	11	7	3	29	30	5
Ae. atlanticus (Dyar & Knab)	0	3	0	0	0	0	1	2
Ae. canadensis canadensis (Theobald)	71	209	0	0	8	61	531	34
Ae. fulvus pallens Ross	66	9	6	3	137	6	7	5
Ae. infirmatus (Dyar & Knab)	188	297	2	21	202	79	86	15
Ae. mitchellae (Dyar)	3	50	0	8	28	5	418	21
Ae. sticticus (Meigen)	1,364	136	6	10	641	239	40	34
Ae. thibaulti Dyar & Knab	10	9	0	0	6	0	6	0
Ae. triseriatus (Say)	23	27	13	5	36	104	55	4
Ae. vexans (Meigen)	2,730	5,887	3,679	3,384	3,007	3,080	5,008	2,428
An. crucians Weidemann	105	870	14	654	39	14	102	82
An. punctipennis (Say)	75	25	25	9	56	51	1	5
An. quadrimaculatus Say	14	51	38	94	7	8	18	8
Cq. perturbans (Walker)	0	2	1	1	3	2	7	12
Cs. melanura (Coquillett)	0	1	0	0	0	1	0	0
Cx. coronator Dyar & Knab	3	3	10	85	7	22	58	69
Cx. erraticus (Dyar & Knab)	71	6	24	88	22	25	5	48
Cx. nigripalpus Theobald	83	45	42	150	28	39	9	112
Cx. quinquefasciatus Say	59	28	169	359	51	146	169	279
Cx. restuans Theobald	13	18	80	68	31	11	3	31
Cx. salinarius Coquillett	40	5	21	1,544	9	3	0	9
Cx. territans Walker	35	37	12	7	40	9	10	4
Or. signifera (Coquillett)	4	2	2	2	1	5	3	0
Ps. ciliata (Fabricius)	1	292	2	307	34	0	135	27
Ps. columbiae (Dyar & Knab)	1	32	37	75	2	1	45	97
Ps. cyanescens (Coquillett)	9	10	170	384	1	5	160	20
Ps. ferox (von Humboldt)	7,203	426	17	76	6,094	271	341	5
Ps. howardii Coquillett	17	36	13	41	34	0	64	0
Ps. mathesoni Belkin & Heinemann	4	8	0	0	0	0	0	0
Ur. sapphirina (Osten Sacken)	11	18	0	7	12	2	2	1
Total	12,205	8,543	4,394	7,389	10,539	4,218	7,314	3,357

Table 4. Model-averaged parameter estimates, their unconditional standard errors (SE), 95% confidence intervals (CI), and variable weights for parameters used to predict daily abundance or presence/absence of selected mosquito species during the 2008 mosquito season in southwestern Georgia, U.S.A. Data are only presented for those parameters with 95% confidence intervals that did not contain zero and with a high variable weight.

Variable	Coefficient	SE	95% CI	Variable Weight
Ae. albopictus				
wk_1_rh	0.24	0.09	0.06-0.42	0.9698
wk_2_rh	-0.35	0.11	-0.58- -0.13	0.9862
Ae. triseriatus				
week6precip	-0.01	0.003	-0.02- -0.001	0.9999
Ae. vexans				
week2precip	-0.01	0.003	-0.015- -0.002	0.9999
week6precip	0.004	0.002	-0.17- -0.03	0.9999
d1_temp	0.18	0.08	0.03-0.34	0.9887
wk_2_temp	-0.65	0.27	-1.17- -0.13	0.9987
d_1_rh	-0.06	0.02	-0.11- -0.02	0.9900
Cx. coronator				
week4precip	0.09	0.04	0.01-0.16	0.9774
time	2.97	1.51	0.01-5.93	0.9996
Cx. erraticus				
week4precip	0.07	0.03	0.01-0.14	0.9968
d_1_rh	-0.11	0.05	-0.20- -0.01	0.9994
wk_1_rh	-0.31	0.13	-0.57- -0.06	0.9489
time	1.59	0.75	0.1162-3.0597	0.8666
Cx. nigripalpus				
week6precip	-0.08	0.04	-0.15- -0.004	0.9999
d1_temp	-0.97	0.38	-1.72- -0.23	0.9900
DI	-0.03	0.01	-0.0434- -0.0077	0.9724
Cx. restuans				
d1_temp	-0.45	0.23	-0.89- -0.002	0.9929

Table 5. Indicator species analysis after Dufrene and Legendre (1997) computing indicator value (IV) coefficient of selected mosquito species across sites grouped by landscape features in southwestern Georgia, U.S.A.

Species	Group	IV	Mean	S. Dev	P*
Ae. albopictus	II	17.7	12.0	2.36	0.027*
Ae. triseriatus	II	15.7	13.6	2.54	0.176
Ae. vexans	I	35.8	34.2	1.44	0.127
Cx. coronator	III	17.1	12.2	2.45	0.048*
Cx. erraticus	III	20.1	16.9	2.67	0.121
Cx. nigripalpus	II	12.5	12.4	2.43	0.396
Cx. quinquefasciatus	III	34.7	26.0	2.51	0.006*
Cx. restuans	II	8.8	10.9	2.47	0.822
Cx. salinarius	III	28.8	11.4	2.46	0.002*
Cq. perturbans	II	12.8	5.9	1.88	0.006*
Ps. ferox	I	27.5	12.5	2.59	0.002*

Group = identifier for group with maximum observed IV.
* Indicates P is significant at 95% level.

high (i.e., > 0.80) (Miles et al. 2006, Miller and Conner 2007, Conner et al. 2010).

To study landscape effects, we used a cluster analysis to group sites based on percentages of land use/cover and hydric soils in the 1-km radius surrounding collection sites using PC-ORD (MjM Software Design, v.5.10). Associations between groups of sites and the subset of mosquito species selected for analysis were assessed using the indicator species analysis (ISA) in PC-ORD (Dufrene and Legendre 1997). ISA was performed on log-transformed weekly mosquito abundance data collected from each site grouped according to the cluster analysis results. The indicator species analysis produces indicator values (IV) for each species based on the combination of species abundance and faithfulness of occurrence for a particular group (McCune et al. 2002). If the *P*-value for the indicator value is statistically significant, then the species is considered to be an indicator of that group (McCune et al. 2002). An IV closer to 100 indicates a stronger species association with that group (McCune et al. 2002).

RESULTS

Mosquito species

Approximately 58,000 mosquitoes were collected over 355 trap nights on 78 dates. The mosquitoes belonged to 30 species within the genera *Aedes, Anopheles, Coquillettidia, Culiseta, Culex, Orthopodomyia, Psorophora*, and *Uranotaenia* (Table 3). Four species (*Ae. vexans* (50 %), *Ps. ferox* (25%), *Aedes sticticus* (Meigen) (4%), and *Anopheles crucians* Weidemann (3%)) comprised over 80% of the total mosquitoes collected.

Weather patterns

Over the sampling period, temperatures ranged from -0.4° C to 37.4° C. Average daily humidity ranged from 45.1% to 98.2%. The total rainfall during the study was 50.62 cm. Weather patterns had a strong influence on the mosquito species modeled, but predictive variables varied by species. The model for predicting daily abundance of *Ae. vexans* that yielded the lowest second order Akaike's information criterion difference (Δ AIC_c) and greatest Akaike weight (w_i = 0.46) contained all precipitation variables considered, one day average relative humidity and temperature, one and two week average temperature, and time (Table 2). The best model for predicting the presence/absence of all other mosquitoes varied by species (Table 2).

Focusing on the importance of individual variables through the use of model averaged parameter estimates suggested that abundance of *Ae. vexans* was best predicted by the following variables: total precipitation for two and six weeks, average temperature for one day and two weeks, and average relative humidity for one day (Table 4). Of the variables examined, the daily presence/absence of *Ae. albopictus* was best predicted by average relative humidity for one and two weeks. Six-week total precipitation best described daily presence/absence of *Aedes triseriatus* (Say). *Cx. coronator* daily presence/absence was best described by total precipitation for four weeks and time of year, while *Culex erraticus* (Dyar & Knab) daily presence/absence was best described by these variables as well as average relative humidity for one day and one week. Six-week total precipitation, one-day average temperature, and drought index were most useful in describing *Culex nigripalpus* Theobald daily presence/absence. The pattern of *Culex restuans* Theobald daily presence/absence was best described by the one-day average temperature.

Spatial distribution

The cluster analysis grouped sites based on percentages of land use/cover and hydric soils into the following three assemblages: Group I: Big Slough, Collins Pond, and Horse

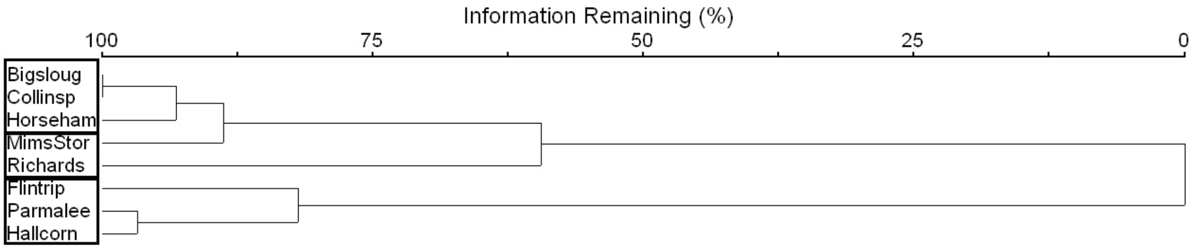

Figure 2. A cluster analysis dendrogram of the percent area of the nine land use/ cover categories listed in Table 1 and hydric soils within a 1-km radius of eight study sites created using PC-ORD. Site groupings interpreted from the dendrogram are outlined in black.

Hammock, Group II: Mim's Drain and Richardson Flat, Group III: Flint Riparian, Hall Pond, and Parmalee Pond (Figure 2). Of the 11 species considered, ISA identified seven with significant indicator values ($P \leq 0.05$) (Table 5). *Ps. ferox* (IV = 27.5, P = 0.002) was the only species associated with the sites in Group I. *Ae. albopictus* (IV = 17.7, P = 0.027) and *Cq. perturbans* (IV = 12.8, P = 0.006) were both associated with the sites in Group II. *Cx. coronator* (IV = 17.1, P = 0.048), *Cx. quinquefasciatus* (IV = 34.7, P = 0.006), and *Cx. salinarius* (IV = 28.8, P = 0.002) were all associated with the sites in Group III.

DISCUSSION

AIC analysis suggested that total precipitation over two and six weeks, average temperature over one day and two weeks, and daily average relative humidity were the most influential weather variables affecting the daily abundance of *Ae. vexans*. The correlation with abundance and precipitation is likely because this mosquito is a floodwater species, and immature stages are often found in temporary rain-filled pools (Carpenter and LaCasse 1955). The positive correlation between *Ae. vexans* daily abundance and average temperature on collection day is potentially a reflection of warm temperatures encouraging host-seeking (Shone et al. 2006). The Asian tiger mosquito, *Ae. albopictus,* is susceptible to body fluid loss at low relative humidity (Hylton 1967), which may explain the importance of average relative humidity in modeling the daily presence/absence of this species.

In the southeastern United States, *Cx. coronator* and *Cx. erraticus* lay their eggs on the surface of standing water and usually exhibit a peak in population density in mid- to late summer (Bolling et al. 2005, Goddard et al. 2006). These life-history characteristics potentially explain the importance of four-week total precipitation and time of year in modeling their presence/absence. Negative correlations between daily presence/absence of *Cx. nigripalpus*, six-week total precipitation, and Keetch-Byram Drought Index we observed are consistent with those of Shaman et al. (2003), who found that antecedent drought, coincident wetting, and the emergence of *Cx. nigripalpus* were all associated with increased prevalence of SLEV in wild birds in southern Florida. *Ae. triseriatus* is a tree hole/container breeder and its negative correlation with six-week total precipitation may reflect the effect of rainfall on the volume and persistence of water within tree holes and other potential breeding sites. In a survey of tree holes in Pennsylvania, Paradise (2004) reported that higher densities of *Ae. triseriatus* larvae were always found in tree holes that maintained high water volumes.

Cq. perturbans, *Cx. quinquefasciatus*, *Cx. salinarius*, and *Ps. ferox* presence/absence were not successfully predicted using weather variables in our study. However, the results of the ISA suggested that land use/cover could be useful in predicting the presence/absence of these species. The sites delegated into Group I by the cluster analysis are all forested wetlands with surrounding land use/cover comprised of primarily coniferous forest with little cultivated land (Table 1). *Ps. ferox*'s ISA-based association with these sites reflects its preference for breeding in woodland pools (King 1960).

The ISA-based association between *Cq. perturbans* and Group II sites is likely because it was collected in greatest abundance from Richardson Flat, the site with the largest percentage of wetland within its 1-km radius (Table 1). Rochlin et al. (2008b) found that abundance of *Cq. perturbans* in Suffolk County, NY increased with wetland area surrounding a site. *Ae. albopictus* is associated with Group II due to its abundance at Mim's Drain (Table 3). Although natural breeding sites for *Ae. albopictus* (i.e., tree holes) could be found at all sites, the abundance of this species collected from Mim's Drain may be because it is located near a residential area where artificial containers are present, which could allow for increased breeding. In a recent north-central Florida study, Obenauer et al. (2009) found the greatest abundance of *Ae. albopictus* near residential areas.

Cx. coronator's association with Group III sites (approximately 25-40% of their 1-km radius in cultivated land) is potentially important, because this mosquito species, common to the American tropics, has recently expanded its range in the southeastern United States (Gray et al. 2008). Although observations on the occurrence and distribution of *Cx. coronator* larvae and adults in the southeastern United States exist (Goddard et al. 2006, Gray et al. 2008, Kelly et al. 2008, Moulis et al. 2008), our study is the first that examines *Cx. coronator* adult distribution in relation to land use/cover. WNV and SLEV have been detected in *Cx. coronator* mosquitoes (Hammon and Reaves 1943, Mackay et al. 2008), but the effect of this species on arbovirus transmission in areas where it has been recently found is unknown (Kelly et al. 2008). Studying the link between the distribution of this species, its life history, and land use/cover in the southeastern United States is important to understanding its potential as a disease vector.

Cx. salinarius' relatively high IV coefficient of 28.8 with Group III is most likely due to 95% of its total abundance trapped at Hall Pond (Table 3). *Cx. salinarius* breeds in fresh and saltwater marshes, lakes, and ponds but can also be found in water polluted with organic matter (Rochlin et al. 2008a). Hall Pond receives runoff from an adjacent agricultural area and has higher nutrient and suspended solids concentrations compared to undisturbed wetlands (S. Golladay, J.W. Jones Research Center, unpublished data), which makes it a suitable breeding site for *Cx. salinarius*. *Cx. quinquefasciatus*, the primary vector of WNV in Georgia, also breeds in water rich in organic matter (Calhoun et al. 2007). Its IV coefficient of 34.7 was the highest of all species examined for the group of sites with the least natural land cover. Our observations are similar to those reported on the spatial distribution and abundance of *Cx. quinquefasciatus* in Hawaii by Reiter and Lapointe (2007), who found agricultural lands and forest fragmentation significantly increased the abundance of this species.

Although our study represents an initial, exploratory analysis, it demonstrated that regional climate and land use/cover data can be predictive of the population dynamics of certain mosquito populations. It is important to note that the seasonal distribution and abundance of mosquitoes documented here reflect a year that had extreme drought conditions followed by a tropical storm. Therefore, our findings may not apply to years when different climatic conditions prevail. Sampling of larval as well as adult mosquitoes at replicated sites encompassing a wider range of conditions would enable us to improve predictive models and better understand this component of mosquito ecology and arbovirus transmission in southwestern Georgia. In combination with similar analyses of vertebrate host population ecology, these methods could provide a much clearer picture of mosquito interactions that affect human and veterinary health in this region.

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