Declines in Butterflies and Insectivorous Birds in Areas of High Insecticide Use in California

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2016 North American Ornithological Conference in Washington, DC, August 10-12

Declines of colonial nesting populations of Western Purple Martins (Progne subis arboricola) and Tricolored Blackbirds (Agelaius tricolor) have been documented in the Central Valley of California since 2004 or later and 2008, respectively (Airola and Williams 2014, Meese 2015). These declines have been attributed to extensive habitat loss and pesticides. However, a wide range of agricultural and domestic uses; and use in surface water (Forister et al., 2015, and can persist in the absence of direct sunlight, with the potential to occur at chronic and acute levels in aquatic ecosystems (Moore et al., 2015). Pesticides play an important role in aquatic ecosystems, may increase the risk of pesticide residues in water, and may be a contributing factor to the decline of aquatic insectivores (Airola and Grantham 2013). The decline in purple martin abundance has been attributed to pesticide use, and recent declines in purple martin abundance have been linked to increased pesticide use (Lindstrand 2008, pers. comm.). The decline in purple martin abundance has been attributed to increased pesticide use, and recent declines in purple martin abundance have been linked to increased pesticide use (Lindstrand 2008, pers. comm.).

Study Sites

PUMA has been monitored over an extended time at 4 sites (Figure 1) in California and the corresponding watershed areas are shown in Figure 2. The Sacramento watershed is a part of the Sacramento River basin and is located in the Central Valley of California. Fish Rocks National Monument is located in the Gualala R. watershed and is part of the San Francisco Bay Area. The Sonoma-Mendocino Coastal is located in the California Central Coast and is part of the San Francisco Bay Area. The Shasta Lake is located in the Sacramento River basin and is part of the Sacramento River. The study sites are shown in Figure 2.

Results

• Five dominant insecticide classes that were widely used in large quantities were considered initially: organophosphates, carbamates, organochlorines, and neonicotinoids. These classes were chosen because they have been documented to affect purple martin abundance in previous studies (Airola et al. 2014). The PUMA study was designed to test the null hypothesis of no relationship between purple martin abundance and neonicotinoid insecticide use.

Conclusions

The population declines of purple martins have significant negative correlations with insecticide application in the two areas with the highest use of neonicotinoid insecticides, but have remained relatively stable in the one area where neonicotinoid use has been reduced. A recent study in the population in our fourth study area showed a collapse of the local population when the use of non-neonicotinoid insecticides has been reduced. These results suggest that there may be an association between observed PUMA population declines and insecticide use in agricultural areas of the Central Valley and the freshwater habitats that should be investigated further. Tricolored blackbirds breed in landscapes dominated by agriculture and this review shows that their highest average reproductive success occurs where insecticide use is lowest, suggesting that reproductive success may be affected by insecticide use. However, effects of recent increases in widespread insecticide use with intensive agricultural development on the valley floor is a possible additional stressor that has not yet been investigated.

Butterflies

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Figure 2. Watershed boundaries used to quantify insecticide use in the Shasta Lake watershed, 1991-1997. Note: Shasta watershed is within the Sacramento River basin and is part of the Sacramento River. Fish Rocks National Monument is located in the Gualala R. watershed and is part of the San Francisco Bay Area. The Sonoma-Mendocino Coastal is located in the California Central Coast and is part of the San Francisco Bay Area. The Shasta Lake is located in the Sacramento River basin and is part of the Sacramento River. The study sites are shown in Figure 2.

Figure 3. Total reported usage of insecticide by major classes in increasing use in California, 1997 (in thousands of units). The number of observed butterfly species at four sites. The response variable (y) is the exponent of Diversity (diversity is the number of species at the same site on a ratio of species to the site size). The relationship is significant at p < 0.05. (from Airola et al., 2014)

References


References


