

Benefits of Golf Course Roughs for Pollinator Conservation and Protocols for Safeguarding Bees when Using Insecticides

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Objectives:

1. *Initiate the first Operation Pollinator for Golf Courses project in North America.*
2. *Evaluate if, by harboring natural enemies, golf course naturalized areas can augment biological control of pests in adjacent mowed turf.*
3. *Evaluate potential adverse impacts of turfgrass insecticides on bees and natural enemies under real-world scenarios and how turf managers can mitigate them.*

Reconciliation ecology seeks ways to modify human-impacted habitats to improve their capacity to sustain wild species and protect the environment. The Golf Industry has been a leader in that initiative through the USGA Wildlife Links program, the Audubon Cooperative Sanctuary Program, and various projects supported by the USGA Turfgrass and Environmental Research Program. The present project focused on 1) developing protocols for establishing pollinator sanctuaries in naturalized roughs and documenting their value as habitat for native pollinators, 2) evaluating naturalized roughs as sources of natural enemies that provide biological control of pests in mowed turf, and 3) developing best management practices (BMPs) by which professional turf managers can avoid harming bees and other pollinators when applying insecticides. Progress related to Objectives 1 and 2 was summarized in TERO (<http://usgatero.msu.edu/v13/n2-44.pdf>), a GCSAA webinar “Positive Environmental Actions for your Golf Course” (22 July 2014), trade journals <http://gcmdigital.gcsaa.org/i/118283/111>, and forthcoming scientific papers. This report summarizes new work related mainly to Objective 3.

About 50 species of native bees, including several rare and declining bumble bee species, were documented visiting Operation Pollinator wildflower plantings



Photo 1: Diversity of pollinators visiting wildflower plantings established in out-of-play areas was documented.

established on five central Kentucky golf courses (TERO: March-April 2014). Also, white clover, which is common in golf course secondary roughs and out-of-play areas, was visited by about 40 species of native bees including declining species (<http://link.springer.com/article/10.1007/s10841-014-9694-9>). We showed that besides providing food for monarch butterfly larvae, natural stands of common milkweed on golf courses provide floral resources (nectar and pollen) for dozens of bee species.



Photo 2: Wildflower plantings were established on golf courses and evaluated as sanctuaries for native pollinators. More than 50 species of native pollinators were documented visiting the stands.

An article addressing how conservation biologists can work with the golf industry to promote environmental education is in preparation for the national journal. Our project documents the benefits of naturalized golf courses as pollinator sanctuaries, and as corridors and stepping stones for movement of charismatic migratory species (e.g., monarch butterflies) between remnants of natural habitat in urbanized areas.

Systemic insecticides are used on golf courses to control of destructive pests such as white grubs, cutworms, and annual bluegrass weevil. Neonicotinoids, in particular, are under intense public and regulatory scrutiny for their alleged role as a factor in bee decline. Although the scientific consensus is that bee diseases and parasites, habitat loss, and changes in beekeeping practices are the primary drivers of bee decline, with insecticide exposure a potential aggravating factor, the latter is an easy target for blame. We have been evaluating insecticide hazards to pollinators under realistic use scenarios to help develop BMPs that will enable the Green Industry to better use insecticides in a manner that does not harm pollinators. We tested their transference into nectar of flowering weeds or grass guttation droplets which, if high enough, could be hazardous to bees or other insects that feed on such exudates. We applied imidacloprid or clothianidin to turf with white clover, followed by irrigation, and used LC-MS/MS to analyze residues in clover blooms that were directly sprayed during application or that formed after the first mowing. Imidacloprid residues in guttation fluid from field-grown creeping bentgrass were assessed similarly. We also fed the nectar and guttation to *Orius*, a small bug that is sensitive to dietary neonicotinoids, as a bioindicator of the exudates' toxicity. Nectar from directly sprayed clover blooms contained 5493–6588 ng/g imidacloprid or 2882–2992 ng/g clothianidin and was acutely toxic to *Orius*.



Figure 3. Wildflower mixes suitable for planting on golf courses were evaluated. This stand of spring-blooming lance leaf coreopsis gave way to other types of wildflowers, including black-eyed Susan and purple-blooming bergamot (bee balm) as the growing season progressed.

Importantly, residues in nectar of blooms formed after mowing were reduced 99.4–99.8% compared to those in nectar of directly sprayed blooms, and non-toxic to *Orius*. The very low levels of imidacloprid present in turfgrass guttation are unlikely to pose a hazard to bees. Systemic transference of neonicotinoids into white clover nectar and creeping bentgrass guttation appears relatively low and transitory. Hazard to non-target insects via nectar of flowering weeds in treated turf can be mitigated by adhering to label precautions and mowing to remove weed blooms if they are inadvertently sprayed.

Neonicotinoid insecticides, if misused, do have the potential to harm pollinators. In another experiment, we intentionally oversprayed blooming white clover present in turf, a violation of label restrictions not to apply such insecticides to flowering plants where bees may visit. Bumble bee colonies exposed to the directly sprayed weedy turf showed reduced foraging, delayed weight gain, and failed to reproduce; i.e., produce new queens. Notably, colonies exposed to the turf after it was mowed and new blooms had formed showed no adverse effects (<http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0066375>). Chlorantraniliprole (Acelepryn), a relatively new insecticidal chemistry, did not harm the bees even when they foraged on directly sprayed blooms.

Summary Points:

- The potential value of golf course roughs in pollinator conservation was documented by cataloging dozens of species of native bees, including rare and declining species, visiting wildflower plantings and white clover. Protocols for establishing Operation Pollinator plots, including suitable seed mixes, were developed.
- Hazard to bees from neonicotinoid insecticides can be mitigated by adherence to label precautions and mowing to remove any directly sprayed weed blooms. Hazard from systemic transference into weed nectar and turf guttation fluid is low and transitory.



Figure 4. Evaluating health of a bumble bee colony some weeks after its workers had foraged on flowering clover in insecticide-treated turf.



Photo 5. Bumble bee colonies were exposed to white clover in insecticide-sprayed turf, or to the same plots with new blooms that formed after the first mowing. The results, showing negligible systemic transference into nectar, indicate that mowing mitigates the hazard to bees if flowering weeds are oversprayed inadvertently.