

Baseline Research for Long-term Effects of Wind Farms on Insects in Wyoming

Report on 2012 pilot data

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Sites and sampling protocols

During the 2012 pilot field season, we visited an operating wind farm to estimate effects of turbines on local insect abundance. We sampled at Foote Creek Rim I, an established 69 turbine wind farm in operation since 1999. We collected terrestrial invertebrates upwind and downwind of an operating turbine by setting up 13 stations spaced 20 m apart, with 2 stations upwind and 11 stations downwind of the turbine. Each sampling station at Foote Creek Rim I consisted of a vane trap, 3 bee cups, and an aerial trap (Figure 1). Aerial traps (Figure 1, green square) were designed to collect perished insects. Vane traps (Figure 1, yellow base with blue top at left of aerial trap) and bee cups (Figure 1, white, blue, and yellow cups at bottom right of aerial trap) attract primarily pollinating insects, such as bees, flies, butterflies, and moths. We also walked around the site for 1 person-hour each morning and afternoon, and collected any invertebrates that we encountered.



Figure 1. A sampling station at Foote Creek Rim I. A second sampling station is visible near the base of the turbine on the far right.

In addition to the operating wind farm, we collected invertebrates at 4 potential wind farm sites. Two

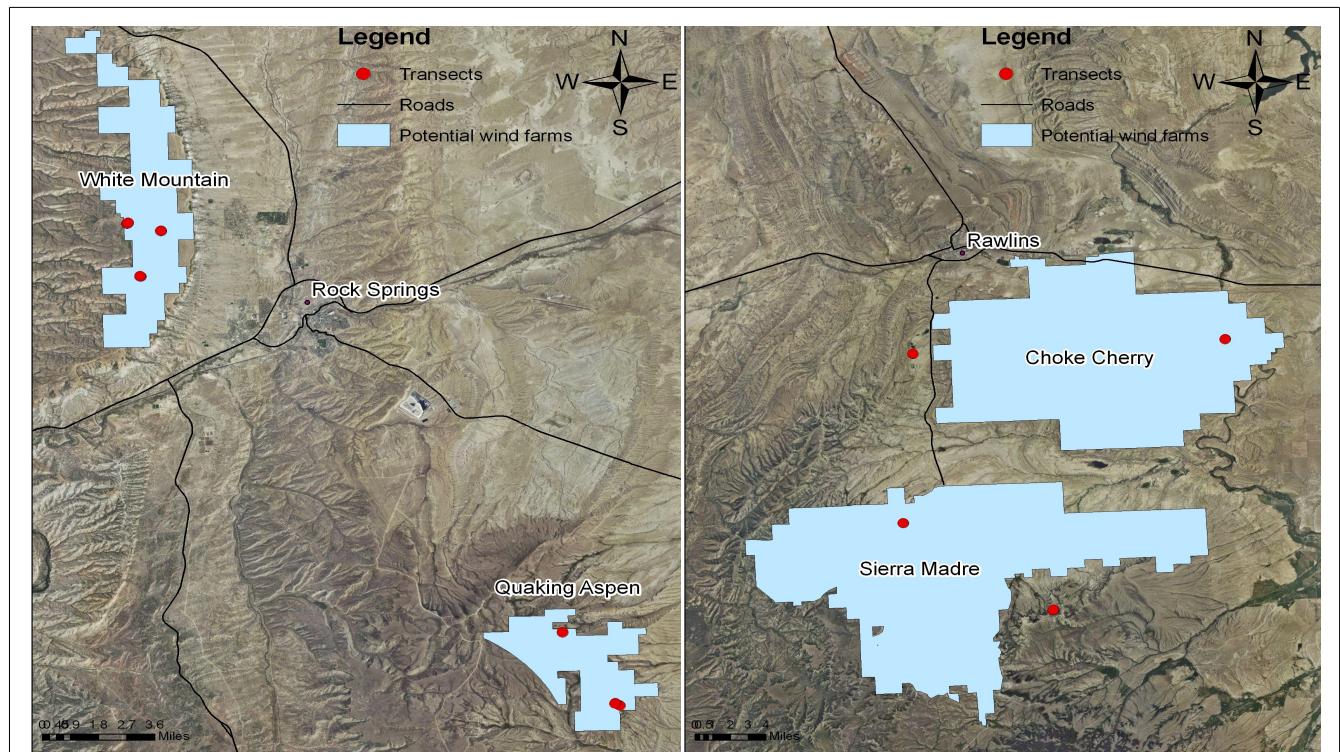


Figure 2. Sampling transects (red points) at potential wind farm sites (blue shading) within the Rock Springs (left) and Rawlins (right) Field Offices.

sites were located in the Rock Springs Field Office area (White Mountain and Quaking Aspen) and 2 sites were in the Rawlins Field Office area (Sierra Madre and Choke Cherry; Figure 2). At each site, we set up 2 to 3 transects within different zones based on vegetation, aspect, and topography. White Mountain is primarily in the inter-mountain basin big sagebrush shrubland and Quaking Aspen is mostly Wyoming basin dwarf sagebrush shrubland. Choke Cherry is primarily within the inter-mountain basin big sagebrush shrubland and Sierra Madre is a mixture of inter-mountain basin mixed salt desert scrub and sagebrush communities. For example, one transect may be placed on the ridge in a sagebrush (*Artemisia* sp.) dominated community, and another may be placed in a ravine with aspens (*Populus tremuloides*), serviceberry (*Amelanchier alnifolia*), and mixed forbs (Figure 3).



Figure 3. Sagebrush dominated ecosystem at White Mountain (left) and an aspen grove near Sierra Madre (right).

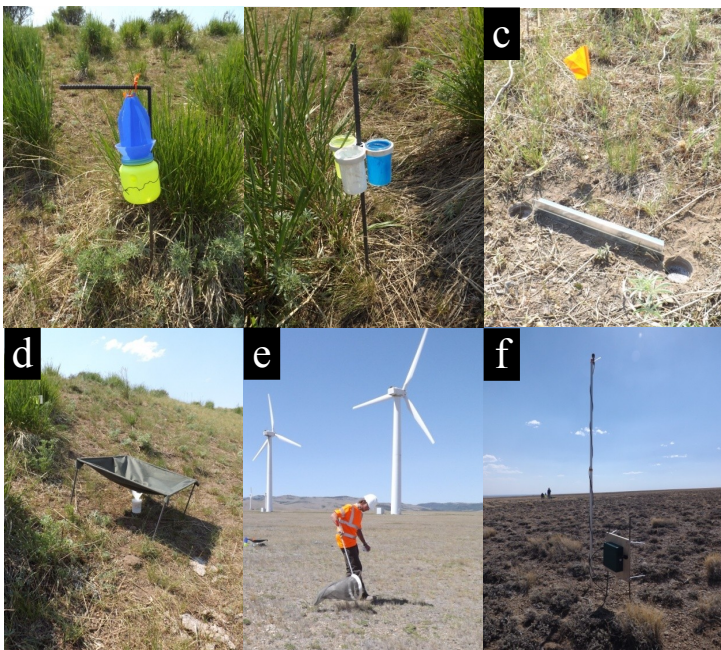


Figure 4. We sampled for invertebrates at potential wind farms using a.) vane traps, b.) bee cups, c.) pit fall traps, d.) aerial traps, and e.) visual encounter surveys. Vane traps and bee cups are designed to attract pollinating insects. Pit fall traps collect ground dwelling insects. Aerial traps were designed to collect perished insects. Visual encounter surveys detect a wide range of insects. f.) We also collected calls of songbirds and bats using Song Meters.

We sampled these transects between June 19 and July 12, 2012 using several sampling methods: vane traps, bee cups, pitfall traps, and aerial traps (Figure 4). We grouped 1 vane trap, 3 bee cups (1 blue, 1 yellow, and 1 white), 1 pit fall trap (0.3 m vane between 2 cups), and 1 aerial trap at each station. Each transect consisted of 3 stations that were at least 5 m apart. Traps were left in the field between 24 and 72 hours to collect invertebrates. In addition to invertebrate sampling, we collected calls of birds and bats using a Song Meter (Wildlife Acoustics Inc.) at each site.

Results

Sampling methods

Vane traps and bee cups yielded consistent collections of insects and, in particular, pollinators. Unfortunately, we had issues with pitfall traps, aerial traps, and visual encounter surveys in these pilot collections. Pitfall traps tended to fill with sand and mud likely due to high winds, making it very difficult to separate the few insects collected from other debris. Aerial traps were intended to capture dead insects or insect parts, but the small amount of water in the collection cup attracted live insects. The high winds made seeing and catching live insects very difficult and inconsistent. Because of these issues, we only analyzed collections from vane traps and bee cups.

We collected a total of 5620 insects in vane traps and bee cups over 3379 total sampling hours yielding on average of 2.8 insects collected per sampling hour. We collected 1.0 insects per hour on average in vane traps, with as few as zero and as many as 4.5 insects per hour collected in any given sampling event. We collected 4.1 insects per hour in bee cups, with individual collection events yielding from 0 to 37.4 insects per hour. These collection methods also attracted different types of insects. Vane traps collected proportionally more beetles, bees, and wasps than did bee cups, whereas bee cups collected more flies than did vane traps. Vane traps and bee cups collected similar numbers of butterflies and moths. Overall, the methods were complementary in characterizing the pollinating insect fauna.

Variation in insect abundance among sites

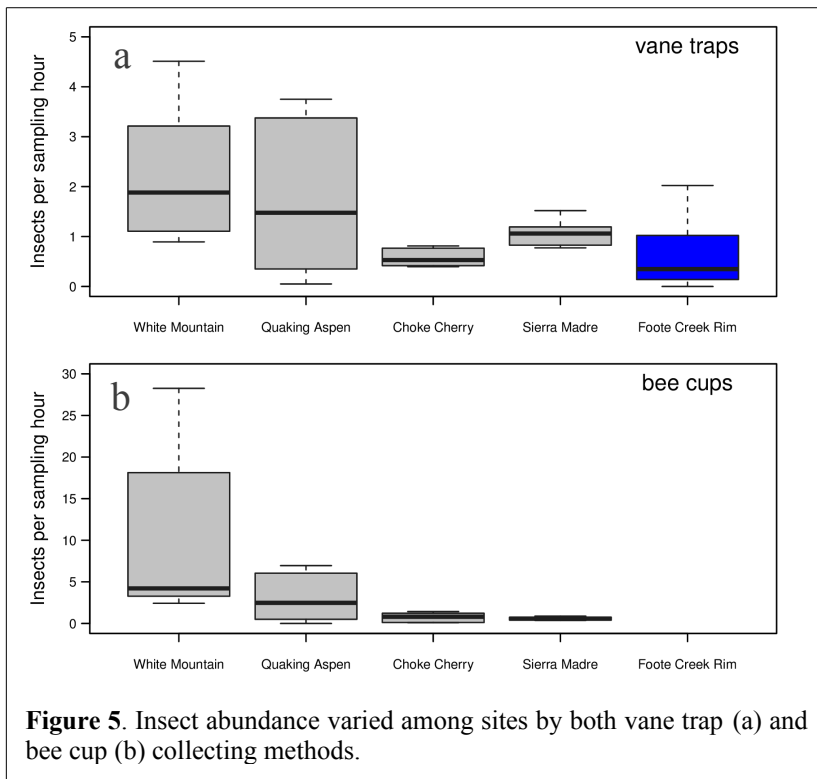


Figure 5. Insect abundance varied among sites by both vane trap (a) and bee cup (b) collecting methods.

We use the number of insects collected per sampling hour as our metric of abundance because it standardizes estimates across sites and dates for this study and facilitates future comparisons with other studies. Insect abundance in vane traps varied among planned wind farm sites (Figure 5a, gray bars), ranging from 0.57 insects per hour at Choke Cherry to 2.23 insects per hour at White Mountain. The existing wind farm site, Foote Creek Rim, had the second lowest insect abundance (0.62 insects per hour, Figure 5A, blue bar). Significant variation in insect abundance among sites (ANOVA, $F_{4,60} = 8.51$, $P < 0.001$) was driven by Choke Cherry and Foote Creek Rim having significantly fewer insects than White Mountain and Quaking Aspen

(Tukey HSD, all $P < 0.05$). Insect abundance in bee cups ranged from a mean of 0.59 insects per hour at Sierra Madre to 10.1 insects per hour at White Mountain (Fig 5b). Significant variation among sites (ANOVA, $F_{3,27} = 5.37$, $P < 0.001$) was driven by White Mountain having significantly more insects than all other sites (Tukey HSD, all $P < 0.05$).

Effects of an existing wind farm on insect abundance

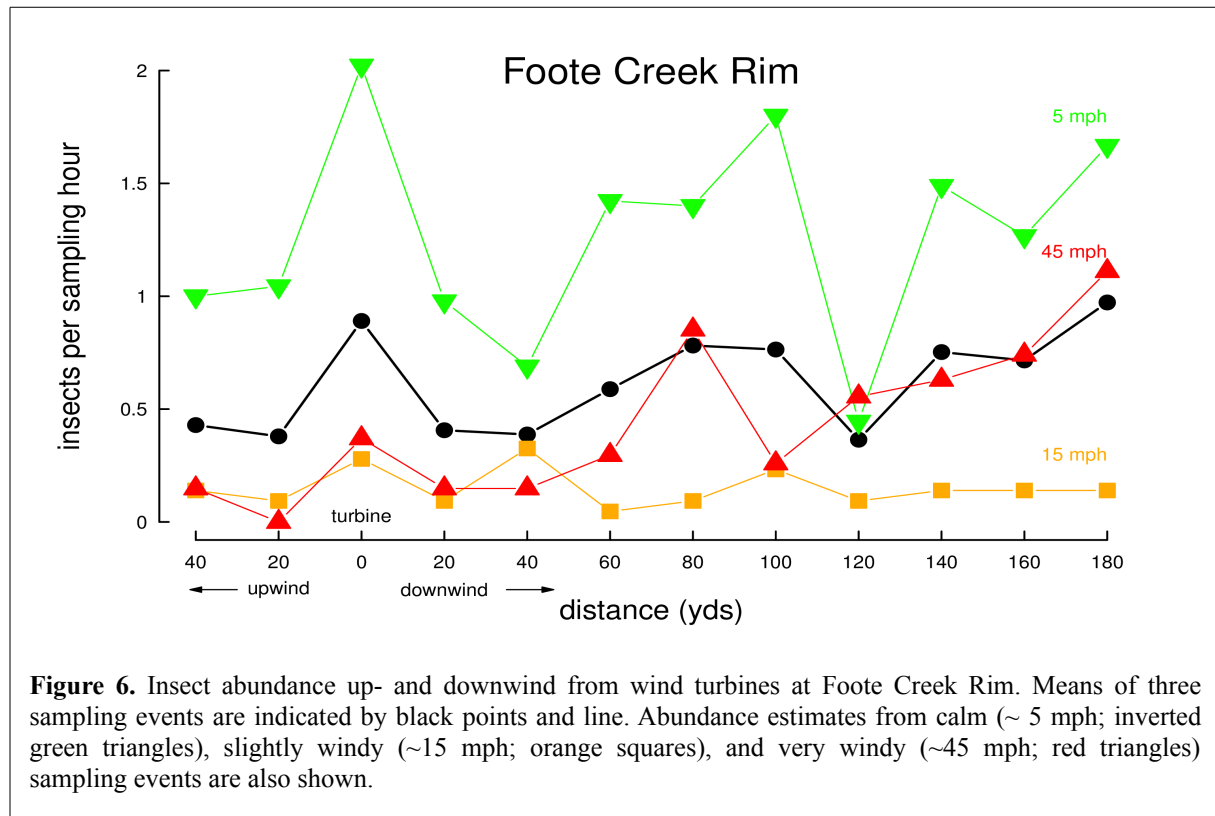
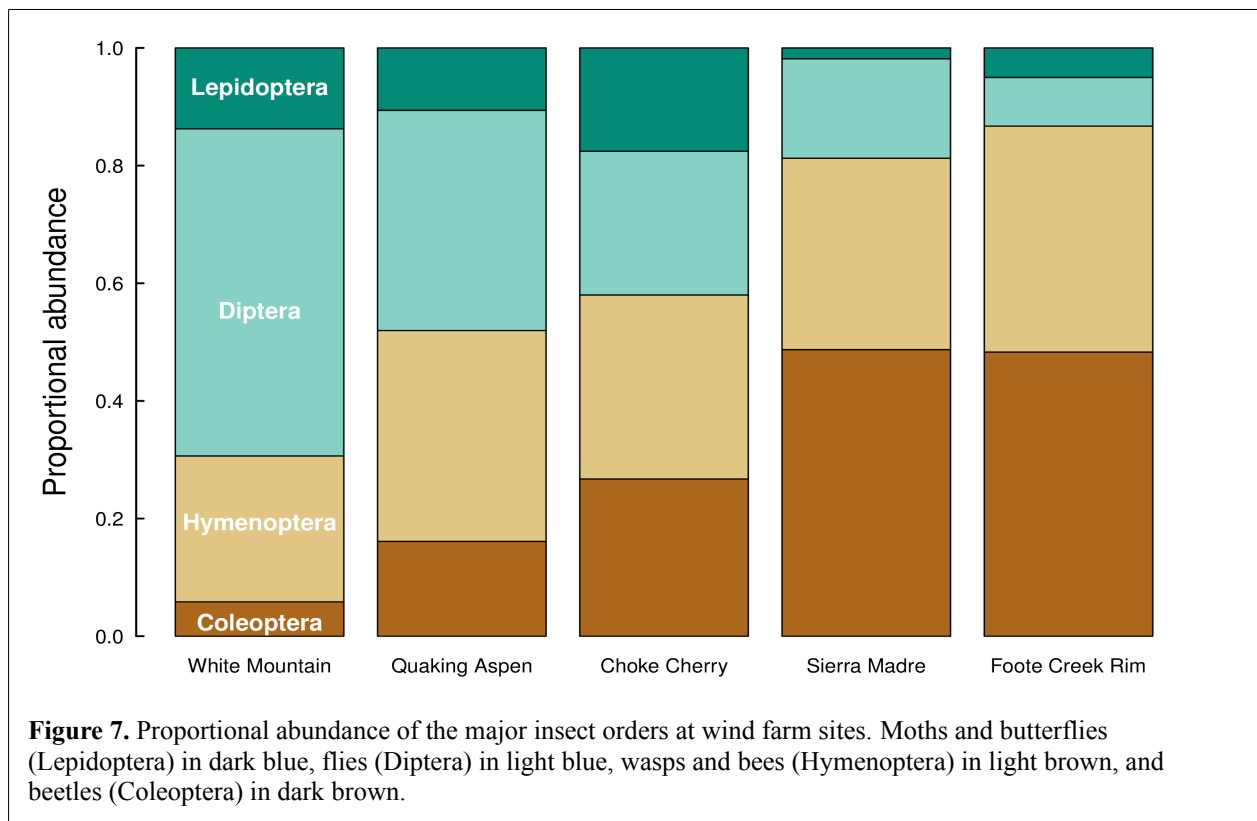


Figure 6. Insect abundance up- and downwind from wind turbines at Foote Creek Rim. Means of three sampling events are indicated by black points and line. Abundance estimates from calm (~5 mph; inverted green triangles), slightly windy (~15 mph; orange squares), and very windy (~45 mph; red triangles) sampling events are also shown.

Turbines may directly reduce local insect abundance by increasing mortality of insects on turbine blades. We tested for local reduction in insect abundance by placing vane traps at varying distances up- and downwind from existing wind turbines at Foote Creek Rim on 3 different days. These preliminary data suggest little variation in insect abundance downwind of the wind turbine (ANOVA, $F_{11,24}=0.34$, $P=0.966$, Figure 6). We collected many more insects on the calm (~5 mph winds at time of trap setup) vs. the windy (~45 mph winds at the time of setup) sampling events (Figure 6, green vs. red lines and triangles). Insect abundance during the low wind speed sampling event was high but variable across the transect. During the high wind speed sampling period, insect abundance was low from 40 yards upwind to 60 yards downwind of the turbine and increased further downwind. The sampling period with intermediate wind speeds yielded very few insects anywhere along the transect. These preliminary data suggest interactive effects of wind speed and distance from the turbine on insect abundance, but more data are necessary to test these hypotheses.

Insect community composition

The proportional representation of the major insect orders also varied among sites (Figure 7). Whereas flies (Diptera), and bees and wasps (Hymenoptera) dominated collections at White Mountain and Quaking Aspen, collections at Sierra Madre and Foote Creek Rim were predominantly beetles (Coleoptera), and bees and wasps. Choke Cherry had relatively even representation of flies, bees and wasps, and beetles, and also had the highest proportional collections of butterflies and moths, which were uncommon at all other sites.



Bat calls

Analysis of the bird calls is ongoing, but we report on the bat call data here. We recorded bat calls at Quaking Aspen and White Mountain. We recorded calls from 5 bat species at Quaking Aspen (Western Long-eared Myotis, Western Small-footed Myotis, Little Brown Myotis, Big Brown Bat, and Townsend’s Big-eared Bat). We recorded 207 calls in one night which is considered moderate bat activity. At White Mountain, we recorded only 2 calls during the night both of which were the Silver-haired Bat, suggesting low bat activity at this site.

2013 Plans

Field work for the 2013 field season began in May and will continue through August. Sarah DePaolo is the graduate student who is leading the project. We hired a University of Wyoming student to assist with field work and 2 Chicago Botanical Garden interns. Data will be collected at each potential wind farm area as well as control areas. We intend to collect data at 36 sites within each area to characterize insect abundance and diversity across a variety of landforms and habitat types for a spatial model. At each site, we will collect insects using bee cups and vane traps (Figure 4 a, b). We will also estimate pollinator resources by counting the number of blooming flowers by species in 5 1-m² quadrats per site. To understand how fewer pollinators may affect flowering plants, we will manipulate selected plant species for seed-set experiments. Finally, we will record bat and bird calls in each area, and do bird point counts. All collections, flowering plant data, and call data will be processed and analyzed through the winter.