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Original Research Article

Effects of oil and gas development on vertebrate community composition in the southern San Joaquin Valley, California

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ABSTRACT

Oil and gas development in the southern San Joaquin Valley of California is extensive and has impacted natural habitats for sensitive species. The effects of this habitat loss and degradation on these species are not well understood. Our objective was to determine habitat characteristics, wildlife community composition, and species abundance relative to the level of oilfield development in saltbush scrub habitat. Sixteen study sites were identified with 4 each in areas with high (>100 well pads), medium (11–50 well pads), low (1–10 well pads), and no (0 well pads) oil field development, as measured by numbers of well pads with active oil production and the proportion of habitat disturbed. Surveys were conducted from March 2008 to May 2010 to assess the abundance and diversity of herbaceous plants, shrubs, birds, reptiles, and small and medium-sized mammals. As oilfield development and associated habitat disturbance increased, herbaceous plant cover and shrub abundance decreased while herbaceous plant diversity increased, largely due to colonization by non-native species. Among animals, generalist lizard, bird, and mammal species increased, as did non-endemic species particularly birds. Conversely, some endemic species, including several special status species, declined or were not detected as the level of oilfield development increased. Ecological community composition remains largely intact at low levels of oilfield development, but is profoundly altered at higher levels with some effects apparent at moderate levels. Best management practices such as spatially consolidating facilities, limiting road construction, and controlling non-native plants could reduce ecological impacts from oilfield activities in saltbush scrub habitat.

1. Introduction

Over 95% of the San Joaquin Valley in California has been converted from native habitat to urban or agricultural uses (U.S. Fish and Wildlife Service [USFWS], 1998). Oil and gas production occurs in much of the remaining areas (Feinstein et al., 2015). Such production began with the discovery of the McKittrick field in 1898 and has steadily expanded (Therkelsen, 1973). As of 2008, the 5 largest producing oilfields in California were located in Kern County, making it one of the nation's most important energy resource areas (California Division of Oil, Gas, and Geothermal Resources, 2009). Much of this production is in saltbush scrub habitat, which supports a number of rare species (USFWS, 1998; Germano et al.,

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2011). Consequently, this habitat type has experienced significant loss, degradation, and fragmentation associated with hydrocarbon production activities (USFWS, 1998; Cypher et al., 2000; Feinstein et al., 2015). Of the estimated 7041 km^2 of saltbush scrub habitat that occurred in the San Joaquin Valley, only approximately 25% (1733 km^2) remains (S. Phillips, California State University-Stanislaus, unpublished data).

The magnitude of impacts from oil and gas development on wildlife communities has not been well quantified (Feinstein et al., 2015). Unlike severe urbanization or intensive agriculture, oil and gas development and its associated infrastructure often retain some natural habitat components (Spiegel, 1996). Oil production activities such as well, road, and pipeline construction, generation of hazardous materials, increased vehicular and human activity and invasive non-native plants are some of the many threats to wildlife species in active oilfields. Despite these threats, many species of wildlife persist in active oilfields (O'Farrell and Scrivner, 1987). Impacts of oil and gas activities have been investigated for some sensitive species in the San Joaquin Valley including Hoover's wooly star (*Eriastrum hooveri*), San Joaquin kit fox (*Vulpes macrotis mutica*), giant kangaroo rat (*Dipodomys ingens*), and blunt-nosed leopard lizard (*Gambelia sila*) (Spiegel, 1996; Otten and Cypher, 1997; Cypher et al., 2000). However, impacts to wildlife and plant community composition and integrity associated with increasing levels of oil field disturbance have not been investigated.

The objective of this project was to determine habitat characteristics, vertebrate community composition, and species abundance in high, medium, and low intensity oil fields relative to undisturbed natural areas in western Kern County, California. This information will assist in the design and implementation of habitat mitigation measures and best management practices within active oil fields. This information will also contribute to assessments of cumulative effects on natural communities and endangered species occurring within oil production landscapes.

2. Methods

2.1. Study area

The study was conducted in the southwestern corner of the San Joaquin valley (Fig. 1). The region is part of the San Joaquin Desert (Germano et al., 2011), and has an arid Mediterranean climate with hot, dry summers and cool, wet winters (Dallman, 1998). At Taft, which is located approximately in the center of the study area, average high temperatures in July are 35.7 C and lows are 19.2 C, and average highs in January are 12.7 C and lows are 4.7 C (U.S. Climate Data, 2015). Average annual precipitation at Taft is 161 mm with most rain falling from late October through and early April. All study plots all were located in areas with flat or gently sloping (2–5%) terrain with alluvial soils classified as Kimberlina sandy loam or Kimberlina gravelly sandy loams (Soil Conservation Service, 1988).

The vegetation communities on the plots were a mosaic of arid shrubland, annual grassland, and disturbed oil production areas. The predominant natural community in the study area was Valley Saltbush Scrub (Holland, 1986). This community is characterized by open shrublands with a ground cover comprised of annual plants representative of Nonnative Grassland (Holland, 1986). Common shrubs on the plots included desert saltbush (*Atriplex polycarpa*), spiny saltbush (*Atriplex spinifera*), cheesebush (*Hymenoclea salsola*), bladderpod (*Isomeris arborea*), alkali goldenbush (*Isocoma acradenia*), and matchweed (*Guttierezia californica*). Common forbs included red-stemmed filaree (*Erodium cicutarium*), popcorn flower (*Plagiobothrys* sp.), fiddleneck (*Amsinckia* sp.), and shiny peppergrass (*Lepidium nitidum*). Common grasses included red brome (*Bromus madritensis* ssp. *rubens*), barley (*Hordeum murinum* ssp. *glaucum*), and Arabian grass (*Schismus arabicus*).

Sixteen 36-ha plots were established within the study area (Fig. 1). Most of the plots were on Federal lands managed by the U.S. Bureau of Land Management, while others were on private lands owned by Chevron Corporation, Occidental of Elk Hills Inc., and Plains Exploration and Production Company. Study plots were selected along a gradient of oilfield development intensity based on the number of well pads with active oil or gas wells present and the level of surface disturbance. Plots were grouped into Control, Low, Medium, and High treatments with 4 plots per treatment. Control plots had no producing oil or gas wells. The number of wells on the 4 Low plots was 1, 1, 2, and 9. The number of wells on the 4 Medium plots was 11, 12, 13, and 15. The number of wells on the 4 High plots was 102, 298, 347, and 393. Well pads generally were 0.5–2 ha in size. Pads typically had one well although occasionally more than one well was present.

The well pads provided a standardized indicator of disturbance, although actual disturbance was not only from pads but also from roads (mostly unpaved), well pads, oil collection and conveyance facilities, storage yards, offices and support buildings, and other vegetation clearing related to oilfield activities. We estimated habitat disturbance on each study plot using a point count method. High-resolution aerial imagery for each 36-ha plot was digitally overlain with a point grid containing 100 points. Each point was classified as disturbed or undisturbed. If the point fell in an area with human-made structures or areas without shrubs or any vegetation, it was classified as disturbed. Any point that was on natural vegetative cover was classified as undisturbed. The proportion of points with disturbance was calculated for each plot.

2.2. Species surveys

Beginning in March 2008 and continuing through May 2010, surveys were conducted to quantitatively describe the predominant wildlife and plant communities present on the various study plots. Specifically, we quantified habitat disturbance, and assessed species diversity and abundance for plants, birds, small mammals, medium mammals, and reptiles.