DRAFT REPORT

California Condor Risk Assessment for the North Sky River Wind Energy Project, Kern County, California

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EXECUTIVE SUMMARY

NextEra Energy is currently considering a site for potential wind energy development in Kern County, California referred to as the North Sky River Project (NSR Project). The NSR Project is located on the east flank of the Piute Mountains approximately 17 miles northeast of the Tehachapi Mountains. The U.S. Fish and Wildlife Service (USFWS) has recently expressed concern that wind energy development in the Tehachapi Pass region may result in impacts to the California condor (*Gymnogyps californianus*), a state and federal endangered species that has been reintroduced to historic range in southern California. Because the U.S. Fish and Wildlife Service will not authorize incidental lethal take of California condors, it is important to understand the risk of potential take of California condors during the planning phase of future wind energy developments in the region. The purpose of this report is to develop a California condor risk assessment that outlines the potential risk to California condors associated with developing a wind energy facility within the NSR Project. This risk assessment includes a review of California condor life history, ecology, and behavior; uses a resource selection probability function (RSPF) analysis to evaluate habitat use of California condors in relation to available habitat in the NSR Project; reviews relevant information on wind energy development impacts to related species of vultures; and provides a qualitative assessment of the potential for California condor impacts at the NSR Project. Methods to avoid or minimize risk to condors are also provided.

Based on a review of the relevant literature, it is apparent that physical characteristics (e.g., high wing loading) and behavior (e.g., attraction to novel objects) would put California condors at risk of colliding with turbines. Also, data on flight heights indicate they can spend considerable time flying at heights within the potential rotor-swept heights of modern wind turbines. Furthermore, other related species, such as Griffon, Egyptian and turkey vultures, have been documented to collide with commercial wind turbines. Based on this information, a wind energy facility built where California condors commonly occur would likely be a risk for lethal take of this species.

Results of the RSPF analysis indicate that the NSR Project has habitat features that are suitable for use by California condors. Approximately half the 13,312 mi² study area used for the RSPF analysis above 200 m in elevation has higher probability of use than the NSR Project, and half has lower probability of use by condors. Therefore, the NSR Project is not more or less likely to be selected for by condors than the surrounding area. Results of the RSPF analysis also indicate that most of the NSR Project itself would be ranked either low or moderate in terms of the potential for use by California condors, although small portions of the project area would have the potential for relatively higher use.

Several measures can be undertaken to avoid and minimize any potential risk to condors. The approximately 11 miles of overhead transmission line associated with the project should be built to Avian Power Line Interaction Committee (APLIC) standards. Because these standards were made to protect golden eagles, the larger size of California condors should be taken into consideration when designing the overhead transmission line to prevent electrocutions. Other measures should include marking the transmission line with bird flight diverters following APLIC standards. All meteorological towers on the site should be unguyed. If guyed towers are used, the guy wires should also be extensively marked to increase their visibility. Carcasses of
medium to large mammals should be immediately removed if they are found within or near the boundaries of the wind energy facility. To reduce the potential for condor foraging in or near the area, livestock grazing should be prohibited, and hunting of big game should not be allowed on the ranch. In addition, efforts should be made to keep the site free of debris and microtrash. To the extent possible, project infrastructure such as Operations and Maintenance facilities as well as staging areas should be placed in areas with the least potential for use by condors based on the RSFP analysis. Fatality monitoring should be conducted over the life of the project to determine actual impacts to California condors. Prior to the start of construction of the project, Condor Recovery Program personnel monitoring California condor locations and movements in the vicinity of the project area should be contacted to determine the locations and status of condors in or near the project area. If a condor occurs at the construction site, construction activities that could result in injury to condors should cease until the condor leaves on its own or until techniques are employed by permitted personnel that results in the condor leaving the area. Construction workers and supervisors should be instructed to avoid interaction with condors and to immediately contact the Ventura office of the USFWS or The Condor Recovery Project personnel if condor(s) occur at a construction site. Non-permitted personnel should not be allowed to haze or otherwise interact with condors.

Results of the RSFP analysis indicate that at least portions of the NSR Project provide potentially suitable habitat for California condors. Based on current habitat and spatial use by California condors, construction of the NSR Project may result in some, albeit low risk to California condors. However, if the population continues to increase in size and expand its range, future use of the NSR Project may become more likely, but the extent to which condors may use this area in the future cannot accurately be predicted at this time. Any potential risks to California condors can be avoided and minimized by following the avoidance and minimization measures outlined above. Contributions to the California condor recovery effort could also be considered that might be used for a variety of purposes, including additional research on California condor habitat use in relation to wind energy development in California, or for support of the captive breeding program that would lead to additional condor establishment in appropriate areas.
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INTRODUCTION AND BACKGROUND

NextEra Energy is currently considering a site for potential wind energy development in Kern County, California referred to as the North Sky River Project (NSR Project). The NSR Project is located on the east flank of the Piute Mountains approximately 17 miles northeast of the Tehachapi Mountains. The U.S. Fish and Wildlife Service (USFWS) has recently expressed concern that wind energy development in the Tehachapi Pass region may result in impacts to the California condor (*Gymnogyps californianus*), a state and federal endangered species that has been reintroduced to historic range in southern California. Because the U.S. Fish and Wildlife Service will not authorize incidental lethal take of California condors (Sorenson et al. 2009), it is important to understand the risk of potential take of California condors during the planning phase of future wind energy developments in the region. The purpose of this report is to develop a California condor risk assessment that outlines the potential risk to California condors associated with developing a wind energy facility within the NSR Project. This risk assessment includes a review of California condor life history, ecology, and behavior; uses a resource selection probability function (RSPF) analysis to evaluate habitat use of California condors in relation to available habitat in the NSR Project; reviews relevant information on wind energy development impacts to related species of vultures; and provides a qualitative assessment of the potential for California condor impacts at the NSR Project.

STUDY AREA

The NSR Project consists of approximately 12,582 acres in the western Mojave Desert on the east flank of the Piute Mountains. The project is located in southern Kern County approximately 10 miles west of Cantil, California (Figure 1). Elevations in the project area range from 924 to 1,655 m (3,031–5,430 feet). Land ownership consists of private land; however, some project access roads, underground transmission collector lines, and an overhead generation-tie line would be located on Bureau of Land Management (BLM) land (Figure 2).

Based on landcover mapping (NLCD 2001; Figure 3), the predominant landcover type at the NSR Project is shrub/sage-steppe (77.4%), followed by grassland (19.6%) and evergreen forest (2.9%; Table 1). Minor landcover types each composing <0.1% of the project area include deciduous forest, crops, and wetlands. Based on California Atlas data, the eastern portion of the project area is dominated by desert shrub, with some areas of grassland, while the western portion of the project area is dominated by shrubland and hardwood woodland (Figure 4).

The proposed wind energy project will consist of up to 102 Wind Turbine Generators (WTGs) with rotor-swept heights of up to 500 feet. The project will also require construction of approximately 11 miles of new overhead high-voltage transmission line that will extend south of the project area (Figure 5).
CALIFORNIA CONDOR

Description

The California condor is one of the world’s rarest birds and is currently classified as endangered by both the State of California and USFWS. The California condor was first listed as endangered with the establishment of the federal Endangered Species Act (ESA) in 1967. It is one of the largest flying birds in the world, with adults weighing up to 22 pounds and with wing spans of up to 9.5 feet. Adults are black with white under wing linings. The head and neck are largely unfeathered and range in color from gray in juveniles to various shades of red, yellow and orange in adults. Males and females look alike. The California condor is a member of the New World vulture family, which includes the South American Andean condor (Vultur gryphus) as well as the turkey vulture (Cathartes aura) in North America. New World vultures are currently classified by the American Ornithologists Union (AOU) as raptors (Order Falconiformes), but many taxonomists believe they are more closely related to storks (Kiff et al. 1996).

Range and Population Trends

Condors in the genus Gymnogyps have been found in the fossil record back to about 100,000 years ago. During prehistoric times, California condors ranged over much of the southern U.S., from western Mexico to Florida. Evidence indicates that California condor nested in west Texas, Arizona, and New Mexico during the late Pleistocene. California condors disappeared in much of this range 10,000-11,000 years ago during the Pleistocene extinction of much of North America’s megafauna. By the early 1800s, California condors were present only along the Pacific Coast from British Columbia, Canada to Baja California, Mexico. In modern times, prior to 1987, California condors occurred only in a six-county area just north of Los Angeles, California (Kiff et al. 1996).

The entire California condor population was estimated at around 60 individuals from the late 1930s through the mid 1940s. By the late 1960s the population was estimated at 50-60. By the late 1970s the population had dropped to 25-30. In the 1980s the population declined from 21 in 1982 to 9 in 1985. All but two California condors were captured at the end of 1986 for safekeeping and genetic security. On April 19, 1987 the last wild condor was captured (Kiff et al. 1996).

The first California condors were brought into captivity for captive breeding purposes in 1982. The captive population grew from 27 birds in 1987 to 86 by 1994. In the late 1980s and early 1990s, Andean condors were released in the wild in California to identify environmental hazards associated with releasing condors and to develop and implement measures to eliminate those hazards prior to releasing California condors. The first California condors were released in 1992. After several birds released collided with power lines, aversion training was implemented to teach California condors to avoid power lines. As part of the release program, California condors are also provided food in the form of stillborn dairy calves (Kiff et al. 1996). Condor releases to the wild began in 1992 in southern California, 1996 in Arizona, 1997 in central coastal California, and 2002 in Baja California, Mexico. None of these releases have achieved
viable wild populations, primarily because of high mortality associated with lead poisoning (Snyder and Schmitt 2002).

As of November 30, 2010, there were 373 California condors, including 176 birds in captivity and 197 birds living in the wild (UFWS 2010a). The reintroduced flock near the NSR Project is referred to as the southern California population. This flock currently (November 30, 2010) consists of 40 released free-flying adults and eight wild-fledged young for a total of 48. Other flocks in California include the Pinnacles National Monument flock, currently with 29 birds, and the Central Coast flock, currently comprised of 27 birds. The Arizona population currently contains 74 birds in the wild, and another 19 California condors are in the wild in Baja California, Mexico. The 176 California condors in captivity are spread among seven zoos or are in release pens being prepared for release (USFWS 2010a).

The foraging range for condors in California prior to when the last one was trapped covered a wishbone shaped mountainous area that extended from the Coastal Range (San Benito and Monterey counties in the north, to Ventura and Los Angeles counties in the south), to the Transverse Range including the Tehachapi Mountains of Kern and Los Angeles counties, and the southern Sierra Nevada Range (Fresno and Madera counties in the north through Tulare and Kern counties in the south). Captive-bred condors released in southern California have begun to use much of this historic range, although not as extensively into the southern Sierra as in the 1980s (Dudek 2009). Although most current observations continue to occur in this historic range, observations have occurred outside this area and it is expected other foraging ranges may be used as condor populations continue to increase and expand their range.

Life History

Nesting

Paired California condors typically lay one egg between late January and early April. Eggs are incubated by both parents and the incubation period is around 56 days. Both parents feed the nestling until it reaches three months of age, when the chicks leave the nest but remain in the vicinity of the nest where they are still fed by their parents. Chicks begin to fly at six to seven months of age, but do not become fully independent from the parents until the following year. Although most California condors only nest once every two years, some pairs will nest annually. California condors typically do not nest until they are at least six years old, but their life span is long, reaching up to 50 years. Nesting sites are typically on rock formations associated with crevices, overhung ledges, or potholes. They will also rarely nest in cavities in giant sequoia (Sequoia giganteus) trees. Nesting California condors are easily disturbed by human activities and typically nest in remote areas with little disturbance (Kiff et al. 1996).

Although suitable condor nesting habitat exists over a relatively large portion of the coastal and interior mountains in central and Southern California, prior to the captive-breeding program, wild condors used a much more limited area. After 1910, all known nesting sites were located in the Coast, Transverse, and southern Sierra Nevada mountain ranges (Meretsky and Snyder 1992), and all but one of the nest sites used between 1979 and 1986 were in a narrow belt of chaparral and coniferous forested mountains from central Santa Barbara County across northern and central Ventura County to northwestern Los Angeles County. All recent California condor nest sites have been located on public lands within the Los Padres, Angeles, and Sequoia National Forests (Dudek 2009).
**Foraging**

California condors feed only on the carcasses of dead animals. Condors forage over large areas, an adaptation for reliance on an unpredictable food source. California condors feed socially and typically circle the carcass high in the air before landing to feed, which may serve as a way to signal other condors of an available food source. Prior to arrival of Europeans, the principal condor food items were likely big game species such as elk (*Cervus canadensis*), mule deer (*Odocoileus hemionus*) and pronghorn antelope (*Antilocapra americana*) in the interior and carcasses of sea mammals such as whales and sea lions along the Pacific Coast. Smaller animals also comprise a portion of their diet. Since human settlement, condors forage primarily on domestic livestock, with cattle comprising about half of their diet. Other species consumed include sheep and horses as well as native species such as deer and ground squirrels; some evidence indicates California condors prefer deer over cattle (Kiff et al. 1996). In one study of carcass remains at nest sites, it was determined that cattle comprised 41% of individual food items, while various ground squirrels were second in importance, comprising 16% of individual food items (Snyder and Schmitt 2002). When choices are available, some evidence indicates that condors show preference for small to medium sized carcasses partly because bones are more digestible and it is easier for condors to penetrate the hides to access meat. Ingestion of bone is required as a source of calcium (Snyder and Schmitt 2002). Condors do not use their sense of smell to locate food but instead rely on sight and the presence of other scavengers such as eagles and ravens (Kiff et al. 1996). Wild California condors prior to the captive release program preferred to feed in isolated areas and typically left if approached within 1,000 feet. They seldom fed on road-killed animals along highways or in areas subject to regular human disturbance (Wilbur 1978).

**Roosting**

California condors require roost sites throughout their range for resting and for protection during inclement weather (Mallette 1970). They often have traditional roosting sites located near important foraging grounds and breeding areas (USFWS 1984). Roosts in breeding areas are often on cliffs or trees, especially snags or conifers. Roosts in the vicinity of foraging areas are usually found on tall, open-branched trees rather than on cliffs (Palmer 1988). California condors often spend the majority of their time perched at a roost. They normally stay on roosts until mid-morning and return in mid to late afternoon, although they often stay on the roost all day long (Kiff et al. 1996).

**Movements**

California condors are non-migratory (Snyder and Schmitt 2002). Studies in the 1980’s of the last California condors remaining in the wild showed that California condors were capable of covering large areas during daily movements. Immature and unpaired condors were especially mobile, with one daily flight of 141 miles recorded. Paired birds tended to forage closer to their nests, with most flights typically less than 44 miles from their nest site, although one nesting pair was documented to travel 113 miles in one day. Outside the nesting season paired birds expand their foraging range (Kiff et al. 1996). Because open grasslands necessary for foraging are not typically associated with nesting areas, which are primarily wooded areas, substantial commutes are often required between primary nesting and foraging regions (Snyder and Schmitt 2002).
Although most breeding sites are 20 miles or more from principal foraging grounds, the birds can cover these distances quickly (Palmer 1988).

Habitat Use

According to Snyder and Schmitt (2002), the most important habitat requirements for California condors are adequate food supplies, sufficient open habitat so that food can be readily found and accessed, and reliable air movements allowing extended soaring flight. California condors typically forage over open areas of foothill grassland and oak savannah habitats. Foraging is confined primarily to open areas because carrion is easier to find and condors require some space for easy take-offs and landings (Kiff et al. 1996). Recent condor populations in southern California were found to avoid the bottom of the San Joaquin Valley, possibly because of continued conversion of grazing lands to croplands in the valley bottom and because the flat valley bottom does not provide optimal conditions for takeoff and attainment of soaring flight. California condors prefer to forage in open areas with sufficient topography that allows them to easily launch into flight from nearly any location by running downhill (Snyder and Schmitt 2002). Wild California condor foraging areas in the 1960s and 1970s in the Coast Ranges, the Tehachapi Mountains, and the foothills of the Sierra Nevada included vast areas of open grassland dominated by introduced annual grasses. Some foraging areas were nearly treeless, while some had scatterings of oaks and walnut (Wilbur 1978).

After 1982, most observations of feeding by the small remaining wild population of California condors occurred in the Elkhorn Hills–Cuyama Valley–Carrizo Plain complex and in the foothills of the southern San Joaquin Valley (Meretsky and Snyder 1992). Current foraging areas are almost entirely on private land used for livestock grazing (Ogden 1985). Most condor foraging occurs during the warmer periods of the day when atmospheric conditions suitable for soaring are present.

Prior to 1987, wild California condors in Kern County foraged extensively in the foothills adjacent to the northern boundaries of the Los Padres National Forest to Reyes Station in the west, to the Pleito Hills west of Interstate 5, and eastward throughout much of the region from the Tehachapi Mountains northward to Cummings Mountain. Other important foraging areas in Kern County included the foothill rangelands around Glenville (Kiff et al. 1996).

Stoms et al. (1993) used GIS land cover/land use data and analyzed over 7,000 California condor locations in California collected prior to condor releases from 1890 to 1984. Nest sites were found to be frequently observed in evergreen or deciduous shrubland, and were least frequent in grassland. Perched birds were associated with areas mapped as evergreen shrubland and mixed forest. Feeding birds were most often observed in grassland, with low frequency in many other types, including deciduous shrubland. Feeding was also positively associated with mixed forest and broadleaf forest. The presence of rock outcrops was found to be an important secondary indicator for perching in shrub dominated landscapes. Feeding was more common in grassland-evergreen shrubland and grassland-broadleaf woodland than in other grassland mosaics.

Most California condor nest sites known to be active since 1979 have been in chaparral and coniferous forests. Most nesting sites are typically on rock formations associated with crevices, overhung ledges, or potholes (Kiff et al. 1996), but two nests have been located in giant sequoia
trees in mixed conifer stands in the Sierra Nevada (USFWS 1984). Nonbreeding California condors also use mixed conifer stands in the higher portions of their range. In the Sierra Nevada, sites above 6,000 feet (1,800 m) were used for summer roosting (Wilbur 1978).

The Ventana Wildlife Society (Thorngate 2007) conducted a study to map the presence and movement patterns of California Condors within 16 miles of two proposed wind turbines near Gonzales, California. The study was conducted using 103,395 condor locations obtained from 27 free-flying, captive-reared California condors that were equipped with GPS transmitters from December 2, 2003 through March 31, 2007. Part of the study was to examine slopes and aspects associated with the condor locations. Although slope data indicated that slopes were fairly evenly distributed in the study area, the distribution of Condor detections over different landscape slope categories was significantly different than expected by chance. Condor detections were most frequent over landscapes with 51 to 60 degree slopes, and occurred least frequently over landscapes with slopes less than 20 degrees. More detections (138) occurred over landscapes with northern and northwestern aspects than over any other aspect. The fewest detections (24) occurred over eastern aspects. The Tejon Ranch, as part of a Habitat Conservation Plan (HCP) being completed for California condor, defined California condor habitat as being predominantly above 2,000 feet in elevation on the San Joaquin Valley side and above 3,100 feet elevation on the Antelope Valley side of the Tehachapi Mountains (Dudek 2009).

Flight Behavior

While in flight, condors normally flap only when taking off or landing, but long intervals of flapping flight sometimes occur when condors are chasing golden eagles, common ravens, or other condors from their nesting areas. Extended flights are always by soaring, when they either glide in uplifts along topographic features or progress by alternating between circling for altitude in thermals and losing altitude in long glides. Therefore, condors are dependent on uplift either from thermal cells or mass air movements over topographic features to stay aloft, and they normally forage only when air movements are adequate to sustain extended soaring flight (Snyder and Schmitt 2002).

The typical flight speed averages about 30 mph, but some individuals on long direct glides have been tracked in extended flights exceeding 44 mph (Snyder and Schmitt 2002). California Condors have a relatively high wing-loading, similar to the wing-loading of several species of Griffon vulture (\textit{Gyps} spp.) but much greater than turkey vultures (\textit{Cathartes aura}). The greater wing-loading of condors relative to turkey vultures may be one of the reasons why condors are reluctant to forage over the flat bottom of the San Joaquin Valley, while turkey vultures frequently do so (Snyder and Schmitt 2002).

Sorenson et al. (2009) evaluated potential effects of wind energy development in Monterey County, California, using GPS locations collected from 27 California condors between July 2003 and September 2008. The primary purpose of this study was to determine flight altitudes of condors in relation to wind turbine heights. Flight heights below 200 m were considered to be within the potential height that would put them at risk of turbine strikes. The GPS transmitters have an altitude error of 22 m, so the flight height estimates were not entirely precise. Flight height data were obtained for 132,701 condor detections, of which 87,071 (66%) were from
condors less than 200 m in height. Due to the altitude error of 22 m, some of the condors classified as flying below 200 m could have also been perched birds.

**Reasons for Decline**

The two main factors thought responsible for the decline of California condors were lead poisoning and shooting. It is thought that high lead levels found in California condors are the result of ingestion of lead bullet fragments in mammal carcasses. Eggshell thinning caused by the pesticide DDT may have been a serious cause of the decline in the 1950s and 1960s. Population modeling indicates that stable California condor populations can only be maintained if the annual mortality rate is less than 9% of adults coupled with 11% in immature birds, or 7% of adults coupled with 15% in immature birds. The known mean annual mortality rate from 1982-1986 was 23.8%. Direct mortality of California condors is believed to be the main cause of the decline, rather than low reproductive success (Kiff et al. 1996). Snyder and Schmitt (2002) reported that lead poisoning is likely the most important cause of the recent decline of California condors, and may have accounted for much of the historic decline. However, Sorenson et al. (2009) reported that in California, power lines are currently the number one cause of known death with lead poisoning a close second. Ten of the condors released in southern California since 2005 have collided with overhead wires or were electrocuted on power lines (Snyder 2007), and historical deaths from power line collisions also occurred.

Another problem affecting condor reproductive success is microtrash, or small bits of plastic and metal such as bottle caps, pop-tops, PVC pipe fragments, and broken glass that are inadvertently fed to hatchlings by their parents (Grantham 2007a). Bone fragments are fed to young condors because they provide an important source of calcium, and it is assumed that adult condors inadvertently feed bits of microtrash to young believing the hard pieces to be bone (Houston et al. 2007). Microtrash killed at least five wild-hatched California condor chicks between 2001 and 2006. Sixteen California condor chicks recently hatched in the wild have had microtrash in their digestive tracts. Of these 16, eight died, two were removed from the wild for recuperation, and two had emergency surgery and were returned to the wild (Dudek 2009). Because California condors lay only one egg per clutch, and must reach at least six years of age before reproducing, very low mortality rates are required to sustain populations. Annual mortality in the wild population during the 1980s was around 25%, and mortality rates of California condors released in southern California and Arizona are similar. Given these high levels of mortality, viable wild populations cannot be achieved (Snyder and Schmitt 2002). The California condor recovery team believes that lead poisoning, collisions with power lines, microtrash ingestion, and shooting will be the principal causes of California condor mortality as the species’ population recovers. Loss of habitat is not believed to be a major past or current threat to recovery of condors. However, according to Snyder (2007), loss of foraging habitat could become an important limiting factor after high mortality rates are brought under control and the condor population recovers.

**Conservation Measures**

The current strategy of the recovery program is to 1) increase reproduction in captivity to provide condors for the release program, 2) release condors into the wild, 3) minimize condor mortality factors, 4) maintain habitat for condor recovery, and 5) implement condor information and education programs. The primary objective of the recovery plan is recategorization of
California condor from endangered to threatened. To accomplish this, the minimum criteria include the maintenance of at least two wild populations and one captive population. Each of these populations must number at least 150 individuals, must have at least 15 breeding pairs, and must be reproductively self-sustaining and have a positive rate of population growth (Kiff et al. 1996). The California condor conservation project is the most expensive species conservation project in United States history, costing over $35 million, including $20 million in federal and state funding, since World War II (USFWS 2010b).

To facilitate recovery, critical habitat totaling approximately 570,400 acres has been designated in six southern California counties (Ventura, Los Angeles, Santa Barbara, San Louis Obispo, Kern and Tulare; Kiff et al. 1996) (Figure 6). To help address the issue of lead poisoning, the Ridley-Tree Condor Preservation Act went into effect July 1, 2008. This act requires all hunters to use non-lead bullets when hunting within the range of the California condor. To further provide clean food for California condors to reduce the potential for lead poisoning, supplemental food, primarily in the form of stillborn dairy calf carcasses, is provided at several feeding stations.

RISK ASSESSMENT

Potential for Turbine Collisions

According to Thorngate (2007), California condors have many features that may put them at high risk for turbine collisions, including: (1) high wing loading; (2) social foraging; (3) curiosity for novel objects; and (4) foraging preference for sloped grassland sites. Because condors have very high wing loading, and their flapping flight is clumsy, they are less maneuverable around objects. Condors routinely forage and roost in social groups, so the presence of one condor near wind turbines increases the risk of mortality not only for that individual, but for other individuals that may follow it. Because they are scavengers, condors also exhibit pronounced curiosity for novel objects in their environment, and therefore the presence of new wind turbines might increase condor activity at a site (Thorngate 2007). As an example of social foraging behavior of California condors, within a few days of providing fresh carcasses at a new feeding station in the Wind Wolves preserve, a flock of approximately 20 birds, or more than half of the current Southern California population, was observed foraging at the site (Dudek 2009). Based on flight height data collected by Sorenson et al. (2009) in Monterey county, California, their flight heights would also make them susceptible to turbine collisions, as approximately 66% of condor locations were of birds perched or flying <200 m above ground.

Vulture Mortality at Wind Energy Facilities

No California condor collision fatalities have been documented at any wind energy facility in North America. Although the cause of death for 16 of 43 released condors between 1992 and 2005 is unknown (Grantham 2007b), collisions with wind energy facilities are not suspected (Snyder 2007). The California condor is comparable to the Old World Griffon vultures (Gyps spp.) in size as well as ecological characteristics, in that they all have highly social feeding behavior, congregate in substantial numbers at carcasses and bathing sites, and commonly associate in communal roosts, both in nesting and foraging regions (Snyder and Schmitt 2002). Griffon vultures are known to be susceptible to turbine collisions at some wind energy facilities.
in Europe where this species is relatively common (Barrios and Rodriguez 2004, Telleria 2009). However, not all wind energy facilities where Griffon vultures are common experience high fatality rates. Based on an observational study in Spain, DeLucas et al. (2004) found that Griffon vultures (Gyps fulvus) are able to avoid wind turbines in most, but not all, situations. They reported that despite high numbers of Griffon vultures traveling through the Strait of Gibraltar, only one was found dead while conducting carcass searches twice a week over 14 months. Their observations indicated that Griffon vultures significantly increased their flight heights when crossing turbine strings. Only two bird fatalities were found during the study of which one was a Griffon vulture (DeLucas et al. 2004). Another vulture in Spain, the Egyptian vulture (Neophron percnopterus), has experienced significant population declines and like the California condor is listed as endangered. Although wind energy projects occur within the range of Egyptian vultures, very few fatalities have been found, on the order of three or less per year (Carrete et al. 2009, Carrete and Sanchez-Zapata 2010). Although these data indicate that other large vultures are sometimes susceptible to turbine collisions, these studies were conducted where vulture ranges overlapped wind energy facilities, and similar rates of mortality would not be expected for wind energy projects located outside the range of these species.

In North America, turkey vultures do not appear as susceptible to turbine collision mortality as other raptors. Of 58 wind energy facilities with publicly available fatality data, turkey vulture fatalities have been found only at eight (Table 2). Within California, at the Altamont Pass WRA, of 494 raptor fatalities found at turbines, only 10 (2.0%) were turkey vultures (Altamont Pass Avian Monitoring Team 2008). At the Tehachapi Pass wind energy development adjacent to the NSR Project, no turkey vulture fatalities were found during 829 carcass searches conducted from 2 October 1996 to 27 May 1998, even though 404 turkey vultures were observed during concurrent avian use surveys and 44 raptor fatalities were found (Anderson et al. 2004). At the Diablo wind energy facility in California, one turkey vulture was found out of 17 raptor fatalities (WEST 2006, WEST 2008), and four turkey vultures were among the 83 raptor fatalities found at the High Winds wind energy facility in California (Kerlinger 2006). Outside California, turkey vulture fatalities have rarely occurred, but turkey vultures have represented a higher percentage of the raptor fatalities at some projects (Table 2). For example, the nine turkey vulture fatalities found at the Mount Storm wind energy facility in West Virginia comprised all of the raptor mortality (Young et al. 2009, 2010). At Buffalo Gap, Texas, turkey vultures comprised 15 of the 16 raptor fatalities (Tierney 2007). For all 58 facilities in the U.S. with publicly-available fatality data, turkey vultures have comprised 42 (5.5%) of the 761 raptor fatalities (WEST, Inc. unpublished database, 2010).

California Condor Use of the Project Area

Designated critical habitats in the vicinity of the NSR Project were considered important as condor foraging, rather than nesting habitat. No condors have attempted to nest within the Tehachapi Mountains, likely due to the relative lack of suitable nesting habitat in this area (Dudek 2009). In addition, the closest traditional California condor roost site to the NSR Project is located on Tejon Ranch, approximately 25 miles southwest of the NSR Project. Therefore, potential effects of the NSR Project on California condors are likely limited to foraging birds and foraging habitats, with no impacts expected to nesting or roosting habitat. However, if condor populations expand, some possibility exists that nesting or roosting could occur in the vicinity of the NSR Project in the future.
The NSR Project is located in the western portion of the Mojave Desert and the east flank of the Piute Mountains. Based on radio telemetry data collected from condors between 2002 and 2008, condor concentration areas occur in the vicinity of Hopper Mountain National Wildlife Refuge, with additional locations at Bitter Creek National Wildlife Refuge and Tejon Ranch. Multiple telemetry locations also occur between the wildlife refuges and Tejon Ranch. Many of the telemetry location points centered around the national wildlife refuges are a result of recently released condors less than a year old that tend to be less mobile and do not yet forage far from the release sites (Dudek 2009). The Tejon Ranch critical habitat is the nearest California condor critical habitat to the NSR Project, and is located approximately 25 miles southwest of the project area (Figure 6).

Based on recent telemetry data collected from 2005 through 2010, the primary concentration area used by California condors begins approximately 18 miles southwest of the NSR Project and continues further to the southwest (Figure 7). Only five California condor GPS locations have occurred within 10 miles of the NSR Project, and the closest of these was approximately five miles due east of the NSR Project. The other four condor locations within 10 miles were all south or southwest of the NSR Project. However, if condor populations increase in size and expand their range, it is possible that use of the area in the vicinity of the NSR project could increase.

It is thought that provision of supplemental food has reduced the foraging range of condors (Grantham 2007b), and elimination of this practice in the Tehachapi Mountains at Tejon Ranch could increase the foraging range of the species. Although current plans call for continued feeding of condors at Tejon Ranch (Dudek 2009), it is thought that supplemental feeding will no longer be required once the ban on lead ammunition becomes fully effective (Snyder 2007, Mee and Snyder 2007). Therefore, condor foraging range in the Tehachapi Mountains could expand in the future, and portions of the NSR Project provide suitable grassland and oak savannah foraging habitat. In addition, the NSR Project provides suitable habitat for big game, primarily mule deer, and it is currently grazed by cattle, both of which are potential sources of food for condors.

In addition to the available telemetry data, avian use surveys were initiated at the NSR Project beginning on May 18, 2010 at 19 survey plots within the project area (Figure 8). No California condors have been observed during this period (WEST, Inc., unpublished data). Avian survey data are also available for several other WRAs in the vicinity of the NSR Project. Extensive avian use surveys were conducted at the Rising Tree WRA from March 14, 2005 through November 17, 2006 at eight survey plots within the project area. The Rising Tree WRA is located approximately 11 miles south of the NSR Project. Surveys were conducted at the Rising Tree WRA during all four seasons. Over the course of this 20-month study, avian surveys were conducted on 67 dates and a total of 1,048 plot surveys were conducted. During these surveys, 91 species of birds in 8,263 groups totaling 13,254 individuals were observed. No California condors were observed during the study (Johnson et al. 2007).

Raptor surveys were also conducted at the PdV WRA located approximately 18 miles southwest of the NSR Project in the falls of 2004 and 2005 and the spring of 2005. The PdV WRA is also located on the west end of the Mojave Desert but much closer to known condor use areas than
the NSR Project. No condors were detected during those surveys (Sapphos Environmental, Inc. 2006). Similarly, no condors were detected during five months of avian use surveys (February 4 – June 30, 2009) at the Alta Oak Creek Mojave WRA (Erickson et al. 2009), located approximately 15 miles south of the NSR Project and again closer to condor concentration areas.

Based on the available telemetry data and avian survey data collected at the NSR Project as well as at other nearby WRAs, California condor use - if occurring at all - is apparently currently extremely low in the vicinity of the NSR Project. If condor populations continue to increase and expand their range, however, the potential exists that condor use of areas in the vicinity of the NSR Project could increase.

**CALIFORNIA CONDOR RESOURCE SELECTION FUNCTION ANALYSIS**

**Area Evaluated**

The study area evaluated is bounded by a rectangle with the upper right corner at the northern end of the boundary between Kern and San Bernardino Counties and the lower left corner at 275304, 3757778 (UTM Zone 11). The lower left corner was formed by extending the vertical segment of the border between Santa Barbara and Ventura Counties south to meet the horizontal segment between Orange and Los Angeles Counties when extended west. This 13,312 mi² study area is a rectangle that is 104 miles by 128 miles (Figure 9). Parts of the study area below 200 m elevation were removed from the analysis because condors were highly unlikely to use those areas. This area was selected as the study area because it encompasses both the North Sky River project area and a large portion of the condor locations, and could be delineated with geopolitical boundaries.

**Methods**

Resource selection probability function (RSPF) analysis was designed to compare the characteristics of habitat used by condors in the region with the habitat available in the NSR Project. RSPF models predict the probability of detecting a condor group at a location as a function of habitat characteristics of the location (Manly et al. 2002). The negative binomial distribution was used to model the habitat characteristics associated with the relative frequency of condor locations.

A grid of points with 400 m spacing was placed in the study area for a total of 166,982 sample units. The empirical estimate of the relative frequency, the count of condor locations in the 12.6–ha area (a circle with 200 m radius) around each sample point, was the continuous response in the generalized linear model (Marzluff et al. 2004). The negative binomial distribution was applied instead of the Poisson distribution because of the overdispersion present in the data, a result of many sample units with zero condor locations (White and Bennetts 1996). The offset term in the model was the total number of condor locations (McCullagh and Nelder 1989).

Documented California condor locations were obtained from a file provided by the USFWS (USFWS_CondorLocs_GPS.xls). Within the study area there were 195,798 locations composed of hourly re-locations of 40 condor individuals over six years. Eleven birds were tracked for one
year, 14 birds were tracked for two years, eight birds were tracked for three years, four birds were tracked for four years, one bird was tracked for five years, and two birds were tracked for six years. Individual condors were associated with between 275 and over 14,000 relocations. This analysis assumes the condors that were marked with radio transmitters were a random sample of condors from the population and all behaviors are represented in the data including roosting, foraging, and perching. Multiple relocations for birds in cages at Bitter Creek National Wildlife Refuge were removed to avoid modeling selection during captive periods. Specifically, observations within 100 meters of 281779.62, 3866702.04 and 282775.02, 3866272.10 (UTM Zone 11) were not included in the model. There were 161,896 condor relocations in the model, including 822 locations from 2005, 4,149 from 2006, 13,622 from 2007, 38,147 from 2008, 54,964 from 2009, and 49,486 from 2010.

Variables were selected \textit{a priori} that in the literature have been identified as being associated with condor habitat (e.g., Thorngate 2007, Dudek 2009). Other variables may be important in predicting probability of use, but the analysis was limited to existing GIS data for the study area. The variables calculated to represent the habitat characteristics are given below. Using ArcGis, values were extracted for each study area point for the following variables:

- Elevation
- Slope
- Aspect
- Land cover

We also considered the quadratic effect for slope and elevation, to allow for a non-linear relationship between frequency of use and these variables. Aspect was modeled as a discrete class variable with five levels: north, east, south, west, and flat aspects (areas with slope=0) for the reference level. Land cover classes were obtained from the 2001 National Land Cover Database (Homer et al. 2007). The classes were condensed to represent open water (“water”), open space (“open”), low intensity development (“low”), medium and high intensity development (“med/high”), barren (reference level), deciduous and evergreen and mixed forest (“forest”), shrub/scrub (“shrub”), grassland (“grass”), pasture/hay and crops (“ag”), woody and emergent wetlands (“wetland”).

\textbf{Resource Selection Probability Function (RSPF)}

RSPFs were estimated using the data from the 161,190 study area points and the R statistical computing environment (R Development Core Team 2006). The form of the negative binomial regression model is

\[
\ln(\text{count}) = \ln(\text{total}) + (\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_p x_p)
\]

where count is the number of locations of condors within sample unit \(i\), \(total\) is the total number of locations, \(\beta_0\) is the intercept term, \(\beta_1, \beta_2, \ldots \beta_p\) are parameters that are estimated from the data,
and $x_1, x_2, \ldots, x_p$ are variables that describe habitat at the site. The offset term, $\ln(\text{total})$ converts the count to a frequency as in

$$\ln(\text{count})/ \ln(\text{total}) = (\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_p x_p).$$

The RSPF model selection procedure evaluated the influence of the habitat parameters on the frequency of use of a sample point. To produce the RSPF, a list of candidate models was developed through evaluation of convergence and significance of coefficients for the univariate models. An objective variable selection procedure, the Akaike Information Criterion (AIC), was used to evaluate each of the models. The AIC is a measure of the goodness of fit of a model that takes into account the number of variables included in the model. Significance of coefficients was evaluated with the model derived standard errors, though the model with the smallest AIC was taken as the final model despite non-significance of some effects.

**RSPF Predictions**

A map of the predicted relative probability of condor use was generated for the study area based on the RSPF model. Percentiles of the predicted values defined the color scale and provide a visual representation of the predictions of the relative probability of use by condors.

**Results**

The candidate model list included six models. The model with the lowest AIC statistic was taken as the final model (Table 3). The final model for condor resource selection contained the following variables: elevation, slope, aspect, and land cover. Maps were developed to depict land cover (Figure 10) as well as topography (Figures 11-12), elevation (Figures 13-14), slopes (Figures 15-16), and aspects (Figures 17-18) within the NSR Project and in relation to the surrounding region.

Aspect and land cover were represented with indicator variables defined using a slope of 0. The estimated coefficients of the final model are in Table 4. The coefficients in the model indicate that the probability of use by condors increased at higher elevations, and steeper slopes. In addition, the probability of use by condors was higher for all aspects relative to flat areas. The association between probability of use and land cover class was parameterized relative to the land cover class “barren” and the model results indicate higher probability of use was associated with open water, forest, and grassland. Lower probability of use was associated with open space, low, medium and high intensity development, shrub/scrub, agriculture, and wetlands.

The predicted relative probability of use for the entire study area is shown in Figure 19. This map depicts how the study area ranks in probabilities of use relative to the surrounding area. Based on this map, the NSR Project would be ranked moderate in terms of potential for use by California condor given the variables examined in the RSPF. The median value of the resource section function was estimated for the NSR Project and compared to the distribution of the values in the study area above 200 m in elevation (McDonald and McDonald 2002). There were 321 sample points that fell within the NSR Project. The median for the NSR Project is equivalent to the 56.2 percentile of the distribution of predicted values in the study area (Figure 20). Approximately half of the 13,312 mi$^2$ study area above 200 m in elevation has higher probability of use than the NSR Project, and half has lower probability of use by condors. Therefore, the
The predicted relative probabilities of use for the NSR Project itself are shown in Figure 21. This map depicts the areas within the project area that have relatively high versus relatively low predicted relative probabilities of use by condors. Based on this map, most of the NSR Project would be ranked either low or moderate in terms of the potential for use by California condors, although small portions of the project area would have the potential for relatively higher use.

MEASURES TO AVOID AND MINIMIZE RISK

The approximately 11 miles of overhead transmission line associated with the project should be built to Avian Power Line Interaction Committee (APLIC) standards (APLIC 2006). Because these standards were made to protect golden eagles, the larger size of California condors should be taken into consideration when designing the overhead transmission line to prevent electrocutions (APLIC 2006). Other measures should include marking the transmission line with bird flight diverters following APLIC standards. All meteorological towers on the site should be unguayed. If guyed towers are used, the guy wires should also be extensively marked to increase their visibility. Carcasses of medium to large mammals should be immediately removed if they are found within or near the boundaries of the wind energy facility. To reduce the potential for condor foraging in or near the area, livestock grazing should be prohibited, and hunting of big game should not be allowed on the ranch. In addition, efforts should be made to keep the site free of debris and microtrash. To the extent possible, project infrastructure such as Operations and Maintenance facilities as well as staging areas should be placed in areas with the least potential for use by condors based on the RSFP analysis. Fatality monitoring should be conducted over the life of the project to determine actual impacts to California condors.

Prior to the start of construction of the project, Condor Recovery Program personnel monitoring California condor locations and movements in the vicinity of the project area should be contacted to determine the locations and status of condors in or near the project area. If a condor occurs at the construction site, construction activities that could result in injury to condors should cease until the condor leaves on its own or until techniques are employed by permitted personnel that results in the condor leaving the area. Construction workers and supervisors should be instructed to avoid interaction with condors and to immediately contact the Ventura office of the USFWS or The Condor Recovery Project personnel if condor(s) occur at a construction site. Non-permitted personnel should not be allowed to haze or otherwise interact with condors.

CONCLUSIONS

Results of the RSFP analysis indicate that at least portions of the NSR Project provide potentially suitable habitat for California condors. Based on current habitat and spatial use by California condors, construction of the NSR Project may result in some, albeit low risk to California condors. However, if the population continues to increase in size and expand its range, future use of the NSR Project may become more likely, but the extent to which condors may use this area in the future cannot accurately be predicted at this time. Any potential risks to California condors can be avoided and minimized by following the avoidance and minimization measures outlined above. Contributions to the California condor recovery effort could also be considered
that might be used for a variety of purposes, including additional research on California condor habitat use in relation to wind energy development in California, or for support of the captive breeding program that would lead to additional condor establishment in appropriate areas.
LITERATURE CITED


