Appendix D

Effects of Artificial Light on Wildlife

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The following adverse and beneficial effects of artificial light on birds, fish, amphibians, mammals, aquatic invertebrates, and terrestrial invertebrates have been documented.

D.1 Birds

D.1.1 Direct Mortality

On December 10, 1991, thousands of eared grebes left the Great Salt Lake area en route to wintering grounds in southern California and Mexico. Their migratory route was generally southwesterly, paralleling the Wasatch Mountains and Interstate 15. Several hours into their flight, a snowstorm forced large numbers of these birds down. Hundreds of the birds died when they were apparently attracted to lights from towns and highway intersections, and then crashed into the ground or were hit by cars on the highway. It is possible that under the prevailing lighting conditions, many of the birds mistook the wet highway for open water (Jehl 1993).

This event, although exceptional, illustrates a potential adverse impact of artificial lighting at highway intersections on migratory birds in the project study area. Numerous examples of similar fatal light-related impacts on migratory birds have been documented in many areas throughout the United States (Dunbar 1954; James 1956; Kemper 1964, 1996). The U.S. Fish and Wildlife Service estimates that 4 million to 5 million birds are killed annually because of collisions with artificially lighted structures (Shire, Brown and Winegrad 2000).

The principal cause of these fatalities appears to be innate behavioral responses of the birds to artificial lights during inclement weather. Under clear skies, migrating birds commonly use multiple sensory cues to orient and find their way, including visual recognition of landscape features, prevailing winds, celestial (star) navigation, and orientation to the earth's geomagnetic fields (Emlen 1975). In dense fog or storms, these cues can be eliminated or muted, causing birds to become disoriented. Current research suggests that under these conditions, birds may be attracted to artificial lights, possibly as an escape response. Birds fly toward the brightest part of the night sky, which under natural conditions would be the moon (Beason 1999); by flying toward the moon, the birds would simply move above any fog or low-lying clouds and out of low-visibility areas. Songbirds appear particularly vulnerable to this hazard (Verheijen 1958; Avery et al. 1976; Able 1982; Larkin and Frase 1988), but larger species such as eared grebe, as described above, can also be affected.

Artificial lighting along the project study area could result in the mortality of migratory birds. The Legacy Parkway project is located on the Jordan River Delta, which is situated on a major migratory corridor used by thousands of waterfowl, shorebirds, and songbirds annually. The Legacy Parkway project would cross important wetlands that provide resting and foraging habitats for these birds. The area also

periodically experiences dense fog and/or sudden storms during the fall and spring migration periods. Combined, these conditions could result in adverse impacts on a variety of species in the area, particularly when the level of Great Salt Lake is high and the birds use the wetlands and uplands immediately adjacent to the project right-of-way. However, the occurrence of such events in the future is likely to be infrequent.

D.1.2 Changes in Diurnal Activity Patterns

Artificial lighting adjacent to occupied wildlife habitat extends the period of illumination much beyond the natural daylight cycle. In response to artificial lighting conditions, a variety of bird species, including avocet (Hill 1992), American robin (Nein no date), and American kestrel (Negro et al. 2000), have been shown to extend their daily foraging activities. This behavior could enhance the ability of these and other species to obtain extra food each day, which could be particularly important during the breeding season and migration. However, in some situations, it may also expose some species of waterbirds, predatory birds, and songbirds to increased predation from nocturnal predators such as foxes, feral and wild cats, and owls.

D.2 Fish

Artificial light can potentially affect fish by altering their normal behavior cycles (Contor and Griffith 1995) or making them more susceptible to predation. However, because of the low number of fish that actually occurs within the project study area, artificial lighting would be unlikely to affect any fish species.

D.3 Amphibians

Artificial lighting has been shown to affect both the physiology and behavior of frogs, toads and salamanders. Variation in light can alter normal testicular development, thyroid and pineal gland activity, and even DNA synthesis in frogs and toads (Biswas et al. 1978; Gancedo et al. 1996; Lee et al. 1997; Morgan and Mizell 1971). Artificial lighting can reduce the visual acuity of nocturnal frogs and toads, thereby affecting their ability to find and consume prey (Svensson and Rydell 1998). Foraging and mating periods of these species are also often timed to minimize competition between different species, each being active only during specific light levels (Sustare 1977; Jaeger 1981; Rand et al. 1997); when photoperiods are extended by artificial light, these natural rhythms can be affected (Baker 1990), potentially resulting in disrupted feeding and mating cycles and displacement of species from affected areas.

D.4 Mammals

Artificial lighting can affect mammals in a variety of ways. Numerous nocturnal mammals, both large and small, tend to avoid illuminated areas. However, some predatory species such as foxes can potentially benefit from artificial lighting because it could improve their ability to locate prey visually. Bats also can benefit from artificial lighting because streetlights tend to attract and concentrate large numbers of their preferred prey, such as moths and other aerial insects (Rydell 1991; Blake et al. 1994). The lighting proposed along the project right-of-way would not likely have adverse effects on mammals in the area, but it may have benefits for some species, such as foxes and bats.

D.5 Aquatic Invertebrates

Artificial lighting can affect aquatic invertebrates through modification of photoperiodic behaviors such as vertical migration, mating, and foraging (Pierce and Moore 1998; Moore et al. 2000). Such altered behaviors in zooplankton found in wetlands could potentially result in modified food-chain relationships that could have adverse results on some associated invertebrate species.

D.6 Terrestrial Invertebrates

Terrestrial invertebrates can be affected by artificial night lighting through alteration of their normal behavior patterns. Outdoor lighting can disrupt flight, navigation, vision, migration, dispersal, oviposition, mating, feeding, and crypsis in moths (Frank 1988). It may also disrupt natural circadian rhythms and photoperiodism resulting in altered reproduction and development cycles (Tessmer et al. 1995). Artificial lighting attracts moths and many other insect species, which exposes them to increased predation by birds, bats, spiders, and other predators (Kolligs 2000).

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