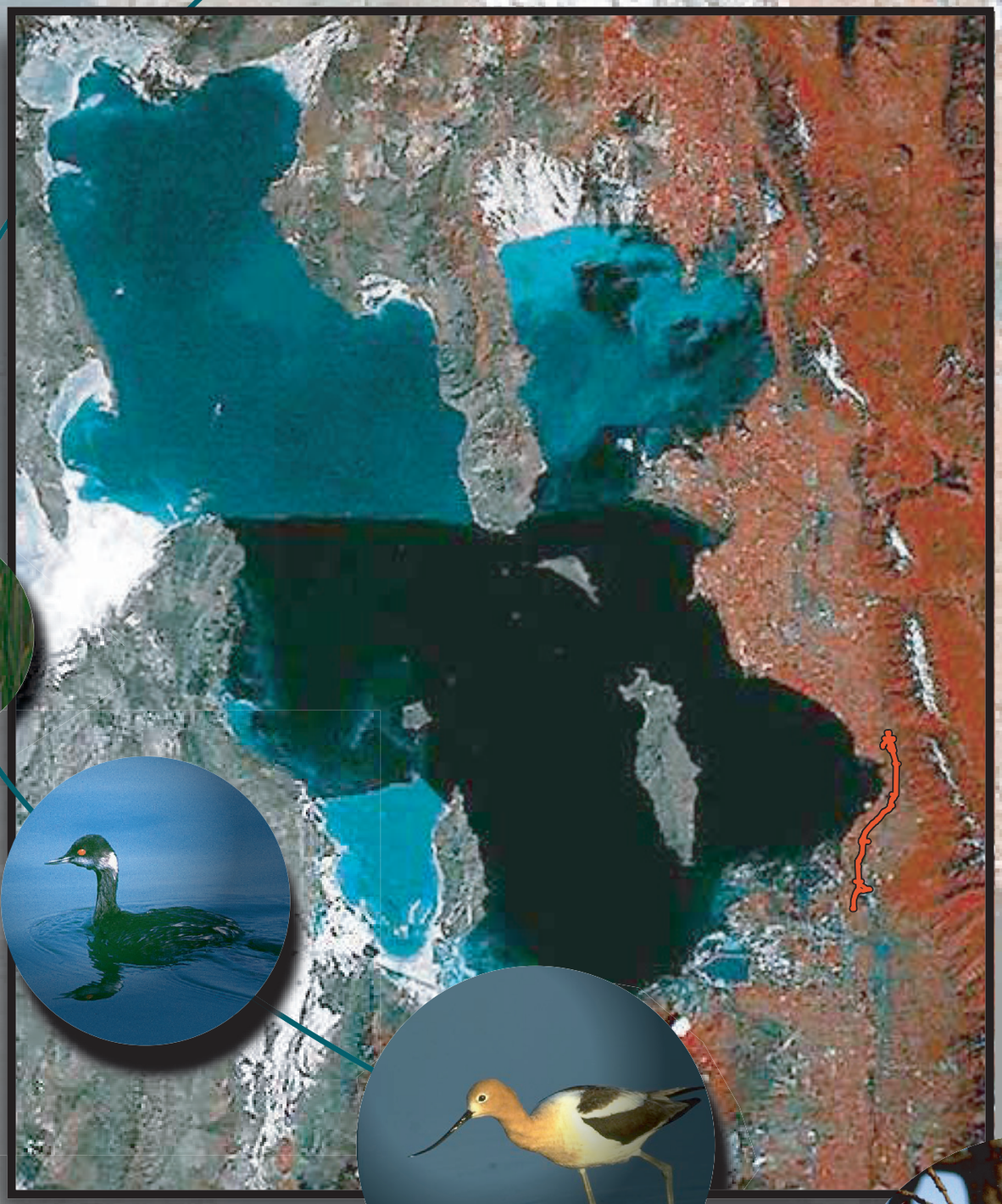

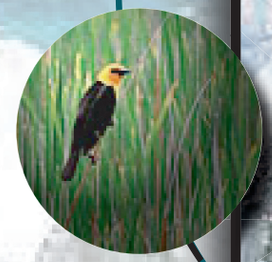

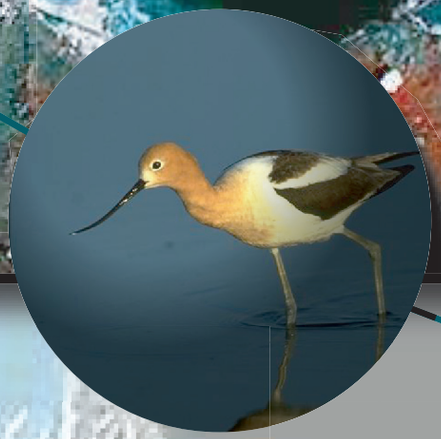

Legacy Parkway Wildlife Impacts Analysis Technical Memorandum

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Jones & Stokes. 2004. *Legacy Parkway wildlife impacts analysis technical memorandum*. December. (J&S 03-076.) Sacramento, CA.

Executive Summary

The U.S. Court of Appeals for the Tenth Circuit remanded the Legacy Parkway final environmental impact statement (Final EIS) (Federal Highway Administration et al. 2000) for additional consideration of the following five areas.

1. Practicability of a narrower right-of-way.
2. Elimination of the Denver & Rio Grande (D&RG) regional alignment as a feasible alternative based on cost and substantial impacts on existing development.
3. Alternative sequencing of the Shared Solution.
4. Integration of the Legacy Parkway project and mass transit.
5. Impacts on wildlife, including migratory birds.

This technical memorandum addresses the fifth issue identified by the court, impacts on wildlife. The court's remand found that the Federal Highway Administration (FHWA) and the U.S. Army Corps of Engineers (Corps) failed to adequately consider impacts on wildlife, both in the Final EIS and when making the determination to issue the Clean Water Act (CWA) Section 404 individual permit authorizing construction of the Legacy Parkway project. The court found that, by limiting the impact evaluation to habitat structure within a 305-meter (m) (1,000-foot [ft]) area, the federal lead agencies had failed to consider impacts on migratory bird populations that use the larger Great Salt Lake Ecosystem (GSLE). This technical memorandum expands on the Final EIS analysis of impacts on wildlife by considering direct, indirect, and cumulative impacts on wildlife, particularly migratory species, within and beyond a 305-m (1,000-ft) project study area in the GSLE.

ES.1 Approach to Preparing this Memorandum

This technical memorandum was prepared with input from ecologists and biologists from FHWA, the Corps, Utah Department of Transportation (UDOT), and their representative technical consultants, as well as wildlife biologists and technical experts from the U.S. Fish and Wildlife Service (USFWS), U.S. Environmental Protection Agency (EPA), and Utah Department of Natural Resources (UDNR). This inclusive approach was intended to ensure that the best available scientific information was acquired and appropriately analyzed. The methods and analyses used to evaluate the potential impacts on wildlife from the Legacy Parkway project are introduced below.

ES.1.1 Methods Used to Acquire Information

- **Habitat Delineation.** Wildlife habitats—specifically open water, riparian, emergent marsh, wet meadow, mudflat/pickleweed, pasture, cropland, salt desert scrub, and developed (urban landscaping)—within the project study area were delineated and mapped.
- **GIS Mapping.** Wildlife habitats around Great Salt Lake for which spatial data were available were mapped using geographic information system (GIS) technology.
- **Species Identification.** Wildlife species that use or could potentially use the delineated habitats were identified, and their ecological status (e.g., seasonal occurrence, breeding and migratory status, habitat requirements) within the project study area and around Great Salt Lake was documented.
- **Habitat Evaluation.** The ecological importance of the different habitats to migratory wildlife within the project study area and around Great Salt Lake was evaluated.
- **Literature Review.** Scientific literature on the potential impacts of highway noise, artificial light, highway mortality, habitat modification, and human disturbance on wildlife was reviewed.

ES.1.2 Analysis

- **GIS Analysis of Habitat Change.** A GIS analysis was conducted to determine how wildlife habitat would change within the project study area with implementation of the Legacy Parkway project. The analysis focused on habitat loss, fragmentation, and degradation, and how these changes could potentially affect species that use the habitats locally and regionally around Great Salt Lake.
- **GIS Analysis of Changes in Lake Level and dynamics of habitat availability and distribution.** A GIS analysis was conducted to characterize how natural changes in the level of Great Salt Lake affect the availability of wildlife habitat in the project study area and around Great Salt Lake combined with the different build alternatives.
- **Bioacoustics Analysis.** A bioacoustics analysis was conducted to determine the biological nature and geographic extent of potential adverse effects of highway noise on migratory birds.
- **Highway Noise Model Analysis.** Highway noise levels for the different project alternatives were modeled to determine the spatial extent of noise effects and how different wildlife habitats would be affected.

ES.2 Results of Technical Analysis

The Great Salt Lake Ecosystem is internationally important to millions of migratory birds as a major stopover, staging, and breeding area. The proposed Legacy Parkway project is located within the GSLE. The analyses conducted for this study evaluated the potential impacts of implementation of the Proposed Action on wildlife resources within the project study area and around the GSLE. The results of the analyses are briefly summarized below

ES.2.1 Direct Habitat Loss from Proposed Action

The Legacy Parkway project would result in the direct loss of between 252 hectares (ha) (624 acres [ac]) and 350 ha (864 ac) of wildlife habitat within the project study area. These losses are summarized by alternative in Table ES-1.

Table ES-1. Direct Habitat Loss

Alternative	Wetland/Riparian Habitats	Upland Habitats	Total Habitat Loss
No Build	0 ha (0 ac)	0 ha (0 ac)	0 ha (0 ac)
Alternative A	44.4 ha (109.8 ac)	201.3 ha (497.4 ac)	245.7 ha (607.2 ac)
Alternative B	79.4 ha (196.2 ac)	270.2 ha (667.8 ac)	349.6 ha (864.1 ac)
Alternative C	63.4 ha (156.7 ac)	198.1 ha (489.5 ac)	261.5 ha (646.2 ac)
Alternative E	52.3 ha (129.3 ac)	200.2 ha (494.8 ac)	252.5 ha (624.1 ac)

Note: See Section 3.1.2, page 3-2, for a discussion of discrepancies between wetland/riparian habitats and jurisdictional wetlands.

ES.2.2 Change in Level of Great Salt Lake

As the level of Great Salt Lake rises, existing terrestrial habitats are inundated and converted to saline open water habitat. The lake reached a historic high of approximately 1,283.7 m (4,211.5 ft) on April 15, 1987, and a low of 1,277.4 m (4,191 ft) on October 15, 1963. As the lake level rises, the total amount of available terrestrial habitat within the project study area decreases. As the lake level recedes, the former ecological communities regenerate slowly. The combined effects of natural inundation from changes in lake level and implementation of each build alternative were examined to determine how these factors act in concert to affect the temporal pattern of overall availability of wildlife habitats within the project study area. The results of this analysis are summarized below.

- At the regional level, there is relatively little change in upland habitats (pasture, cropland, scrub) as lake level changes rises, but there is a 64 percent reduction at high water of both mudflat/pickleweed and emergent marsh habitats, a 30 percent reduction in wet meadow, and a 15 percent reduction in available riparian habitat. However, the amount of any habitat that would be lost under any build alternative on a regional basis would be proportionally very small both at low lake level (<0.4 percent) and at high lake level (<0.5 percent) because of the very large area of these habitats available regionally.

- At the project study area level, the change in the areas of habitats that would be lost to the Proposed Action is proportionally greater than at the regional level, both at low and high lake levels. For example, mudflat/pickleweed habitat lost under Alternative C changes from 5 percent of available habitat in the project study area at low lake level to 27 percent of the habitat in the project study area at high lake level—a difference of 22 percent. Under Alternative B, loss of emergent marsh habitat changes from 9 percent at low lake level to 20 percent at high lake level—a difference of 11 percent. Changes between low and high lake level percentages for all other habitats are smaller. These project study area changes represent the local effects of lake level change on habitat availability.

- The rate of change of availability of each habitat type as inundation occurs varies depending largely on the habitat's distribution within each inundation zone. For example, the extent of available

mudflat/pickleweed changes rapidly between 1,281.4 m (4,204 ft) and 1,283.8 m (4,212 ft), the inundation zone in which most of that habitat occurs; this rate surpasses the rates of change of other low-elevation wetland/riparian habitats (emergent marsh, wet meadow, and riparian). Overall, the lower-elevation wetland/riparian habitats become inundated at higher rates than do upland habitats within the same inundation zones.

- Except for open water habitat, the alignments of the different project alternatives are located such that the highest levels of impact from habitat loss occur mostly in the middle elevation zones (1,281.4–1,282.6 m [4,204–4,208 ft] and 1,282.6–1,283.8 m [4,208–4,212 ft]). This is characteristic of both wetland/riparian and upland habitats. Open water habitat (fresh water) is mostly affected in the lower inundation zones.

- The probability of inundation, as estimated from historic conditions (pre-settlement; before 1847) (Figure 2-4), is highest for the two inundation zones below 1,282.6 m (4,208 ft) (24–33 percent for these zones, contrasted with 1.7–8.3 percent for zones above 1,282.6 m [4,208 ft]). This trend indicates that when assessing the relative level of impacts of each alternative, these impacts should be evaluated relative to the probability of inundation, with emphasis on those zones subject to the greatest potential impact but with low probability of inundation (i.e., zones above 1,282.6 m [4,208 ft]).

- Wetland and riparian habitats are distributed largely at the lower elevations of the project study area, and are therefore inundated at initial increases of lake level. Upland habitats occur primarily at the higher elevations. At the historic high-water level (1,283.8 m [4,212 ft]), 97.6 percent of open water habitat (e.g., freshwater ponds), 73.4 percent of mudflat/pickleweed, 74.8 percent of emergent marsh, 69.6 percent of riparian, and 46.6 percent of wet meadow habitats are converted (i.e., lost) to saline open water. By contrast, only 20.0 percent of cropland, 21.7 percent of pasture, and 38.7 percent of salt desert scrub habitat are converted by the same rise in lake level. Should the lake level rise to 1,286.3 m (4,220 ft), only 13.8 percent of any wetland/riparian habitat and 33.6 percent of upland habitat would remain within the project study area.

- With rising lake level, inundation combines with direct habitat loss that would result from the build alternatives to reduce the overall availability of habitat to wildlife. Because the portion of the highway footprint that is inundated would not be available whether or not the alternative were constructed, the direct loss of available habitat caused by the build alternatives is lowest at high lake levels and highest at low lake levels. (It should be noted that the highway itself would not be inundated because it would be raised above ground level.)

- In the project study area, the rise in lake level reduces the availability of wetland habitats and progressively forces birds to move inland, closer to the proposed highway alignment. This process could potentially increase the risk of project-related impacts on birds (e.g., collisions with vehicles, noise, human disturbance). Such consequences would pertain especially to wetland species that typically use upland areas for refuge during inclement weather and for roosting. The Proposed Action would potentially compound the effects of habitat loss from inundation by reducing the availability of associated upland habitat used by these species. However, these effects would be temporally scaled to the frequency, height, and duration of inundation in the project study area. Inundation at the higher elevations has a much lower probability of occurrence, but would have an increasingly pronounced effect as habitat availability diminishes. With recession of lake levels, these effects decrease as former habitat regenerates.

- If increasing lake level occurs rapidly, some less mobile wildlife (e.g. mice, snakes, frogs, nonflying insects) will perish unless they can move to suitable habitat above the waterline. If the rise is gradual (e.g., over several seasons), local populations will change in size in proportion to the reduced carrying capacity of the remaining habitat.

- The above-described effects of lake level change were determined for existing conditions. Projected future build-out within the project study area would result in a marked reduction in the amount of remaining natural habitat in the project study area. The combined affects of lake level rise, future build-out and the Proposed Action would leave little habitat available for wildlife within the project study area at high water. The overall habitat loss/fragmentation effects of the Proposed Action on the remaining small amount of natural habitat would be proportionally greater with future build-out.

ES.2.3 Habitat Fragmentation

In addition to direct habitat loss, the Proposed Action would result in fragmentation of existing habitats. On the most general level, each of the build alternatives would dissect the matrix of wildlife habitats in the project study area into east and west areas. The area east of the proposed rights-of-way has been largely modified by development and is currently experiencing continued rapid urban growth. Projected future growth in this area is likely to result in complete build-out. This area does not appear to support any ecologically unique habitats that are not also represented west of the proposed alignments. The area west of the proposed rights-of-way retains a greater proportion of wetlands and wildlife habitats. This primary fragmentation effect of the Proposed Action is not expected to reduce the diversity of habitat types within the project study area. In addition to this primary effect, all the build alternatives would result in the finer scale fragmentation of many existing wildlife habitat patches within the project study area. Each build alternative would result in a general decrease in the size of habitat patches available to wildlife in the area and a decrease in the number of larger patches, particularly in upland habitats. There would be a declining trend in the total amount of habitat in most size classes in most habitat types, with the exception of wetland habitats in the <0.4-ha (<1-ac) size class.

The overall effects of construction of the Legacy Parkway project on habitat fragmentation are summarized below.

- Alternatives A and E would have the least impact on fragmentation across the habitat types. Alternative A is located more to the east and would reduce the amount of habitat isolated between the right-of-way and existing development east of the alignment.

- The number of upland patches would increase under all build alternatives. Alternatives A and E would cause the least increase in the number of upland patches. Alternative B would cause the largest increase in the number of upland patches, predominantly in the smaller patch sizes. The changes in mean patch size reflect the same pattern.

- The number of wetland patches would increase under all build alternatives. Alternative E would cause the least increase in the number of wetland/riparian patches. Alternative A would cause the highest increase, but would result in very little change in mean patch size.

- In the area east of the proposed alignments, there are no unique or unusually valuable habitat types, either terrestrial or wetland/riparian, that would not still be represented in the remaining area west of the alignments. This primary fragmentation effect of the project would not therefore reduce the diversity of habitat types in the project study area or in the GSLE in general.

- The fragmentation effects of the build alternatives on local wildlife populations would be additive to existing levels of fragmentation and all reasonably foreseeable future fragmentation that is likely to occur in the area (see Section 4.13.3.3, *Cumulative Effects*). Physical segregation of upland habitats from wetlands in the project study area could potentially have an adverse regional effect on migratory shorebirds and waterfowl that traditionally use both habitats in the area.

These changes would likely result in a number of effects on wildlife habitat, including reduction in habitat patch size, increase in the perimeter-to-area ratio of patches and associated edge effects, reduced connectivity between habitat patches, and introduction of barriers to dispersal for some species. Reduced habitat patch size can decrease the resources available to wildlife species, in turn reducing the local carrying capacity for those species. Moreover, smaller habitat patches are typically characterized by an increase in the length of the patch edge relative to the patch area, as well as a reduction in the distance from the edge to the center of the patch. These changes can favor a reduction in the ecological buffering capacity of the patch for species sensitive to detrimental factors outside the patch (e.g., microclimate, competition from other species, predation, noise and human disturbance, pollution, highway mortality). Construction of any build alternative could also introduce a physical barrier to movement and dispersal of some species, especially those with low dispersal capabilities, such as small mammals, reptiles, and amphibians.

However, because the existing habitat in the project study area is already highly fragmented by a diversity of human activities (e.g., agriculture, fences, roads, urban development), the additional fragmentation effects that the build alternatives would have on wildlife would likely be less than, but additive to, the effects of direct habitat loss. The fragmentation metrics of the build alternatives display detectable variation, but the differences are small and biologically indistinguishable at the scale of this analysis. The results of the assessment of the effects of direct habitat loss on special-status species, including area lost as a result of fragmentation, indicate that local populations of some species would be affected by loss of individuals and/or habitat. Analysis of the effects of fragmentation relative to those of direct habitat loss show that in landscapes with loss of more than 30 percent of suitable habitats, changes in patch size and isolation will complement the effects of habitat loss, and the loss of species or declines in population size will be greater than those expected to result from habitat loss alone. The Ogden hydrologic unit, where the majority of the Proposed Action would be located, has already lost nearly 70 percent of its estimated historic wetland/wildlife habitats. Under these conditions, there is a potential for a substantial increase in isolation of species populations, leading to declines in species numbers. These losses, however, would occur locally. Because extensive areas of suitable wildlife habitat are still present in the region as a whole, the population declines precipitated by the Proposed Action would not result in a notable change in the long-term viability of these species in the GSLE.

ES.2.4 Changes in Habitat Quality

Water Quality

Preliminary hydrological analyses of surface and subsurface water flow in the project study area, conducted since publication of the Final EIS, indicate that, with installation of appropriate drainage structures, the Proposed Action would not significantly impede normal water flow among wetland habitats. Implementation of pollutant management BMPs, including the vegetated biofiltration median strip proposed in the Final EIS, would reduce highway-associated pollution and degradation of water quality. Catastrophic spills of ecologically harmful materials are possible, but hazardous materials transportation regulations and spill response contingency programs would minimize the adverse effects of

these events to the extent possible. Changes in water quality would be similar under all build alternatives. With minimization of roadside pollutant runoff to adjacent wildlife habitats, the effects of the Proposed Action on species occurring there would be low and would not likely affect the long-term viability of those species. However, catastrophic spills could have significant adverse effects on species found within a spill area.

Air Quality

Changes in air quality in the project study area would consist primarily of an increase in highway-related pollutants. This change would likely have little effect on migratory species passing through the area. However, resident species could be subjected to increased levels of air pollutants, particularly during temperature inversion periods. Analysis of future (2020) air quality conditions indicate that carbon monoxide and particulate matter will likely be higher along the alignment of the Proposed Action. Ozone is not expected to cause new exceedances of the National Ambient Air Quality Standards (Utah Department of Environmental Quality, Division of Air Quality 1997), but the potential effects on wildlife caused by the Proposed Action are unknown. Similarly, future concentrations of nitrogen dioxide and lead are not expected to change from existing conditions in the project study area, but their effects on wildlife are unknown. Any effect on wildlife and wildlife habitat quality resulting from changes in air quality would be similar for all build alternatives.

Catastrophic Hazardous Materials Spills

Hazardous waste or other chemical spills in wetland habitats could potentially have adverse effects on wildlife, particularly when water levels are high. Existing UDOT and FHWA/EPA requirements for safe transport of these materials and emergency spill containment programs would minimize these effects under most conditions. However, unavoidable accidents could occur. Most spills would be localized and would therefore vary in effect between build alternatives, but the effects would be worst in aquatic habitats. Alternative B, which crosses the most wetland habitat, would be most susceptible to adverse effects on wildlife from an accidental hazardous materials spill. Because of their alignment in more upland locations, Alternatives A and E would be less susceptible.

ES.2.5 Habitat Modification

Hydrology

Based on the results of preliminary hydrological investigations, the effects of the Proposed Action on local habitat are expected to be minimal under all build alternatives, assuming fill heights are minimized and equalization culverts and horizontal strip drains are installed under all build alternatives to equalize surface and groundwater levels.

Highway Landscaping

Highway landscaping could provide both beneficial and negative effects. It could provide some habitat for wildlife, particularly migrating passerine birds and possibly raptors. However, landscaping could also favor conditions for increased highway-related mortality of these species. Use of pesticides and treated sewage water to maintain the landscaping could also add to the highway-associated contaminant load in

adjacent wildlife habitats, particularly wetlands. The beneficial and adverse effects of artificial landscaping would be similar under all build alternatives.

ES.2.6 Wildlife Mortality

With increased vehicular traffic in the project study area, road mortality of individuals of some species—particularly birds flying between habitats on different sides of the highway and dispersing amphibians, reptiles, and small mammals—is likely to increase. This would be particularly evident during periods of high lake level, when bird species would be more likely to use upland habitats adjacent to the highway. The three fences proposed to border the highway right-of-way would help minimize these impacts by forcing birds to take higher flight paths and deterring cross-highway movement of all species. Numerous drainage culverts proposed to be installed under the highway would also facilitate wildlife movement without road mortality. The effects of the Proposed Action on highway-related road mortality of wildlife would be expected to be similar under all build alternatives

ES.2.7 Artificial Light Disturbance

Artificial light from highway lamps could potentially attract migrating birds during foggy/low visibility weather conditions. Some incidental mortality could occur from disoriented birds colliding with vehicles and light standards, but the frequency of these events would likely be low and would not adversely affect the viability of any species. The light could also provide a benefit to bats by attracting insects on which bats forage. The potential effect of additional light on wildlife would be comparable under all build alternatives.

ES.2.8 Highway Noise Disturbance

The modeled areal extent of potential highway noise effects on wildlife habitat shows differences among alternatives in each noise level contour interval relative to the position of the alignment and the spatial distribution of wildlife habitat patches. The total area of wildlife habitat exposed to the different noise levels within the area analyzed is summarized in Table ES-2.

Table ES-2 Acres of Wildlife Habitat Exposed to Noise under Build Alternatives[1]

Alternative	Noise Level Interval (acres exposed to noise level)			
	>/= 60 dB	>/= 55 < 60 dB	>/= 50 < 55 dB	>/= 45 < 50 dB
No-Build (Existing Conditions)	6,908	5,632	8,438	26,551
Alternative A	10,501	7,848	10,726	25,333
Alternative B	11,124	8,884	12,462	25,582
Alternative C	9,814	8,041	11,669	25,298
Alternative E	10,670	6,686	11,985	25,057

[1] These estimates are for reference comparison of alternatives only. The noise level contours generated by the FHWA TNM have not been tested for accuracy beyond 396 m (1,300 ft). The locations of contours beyond this distance are projected estimates only and could vary significantly depending on existing background noise, atmospheric conditions, and substrate type. The noise levels shown within each

contour interval, particularly those farthest from the proposed highway alignments, are likely to have only minimal, if any, effect on birds if background wind noise is prevalent (Jones & Stokes 2004).

Analysis of the total area of wildlife habitat that would be affected by highway noise in each noise contour interval showed an increase of 42–61 percent in the 60+ dB impact area, depending on the alternative; an increase of 19–58 percent in the 55 to 60 dB area; and an increase of 27–47 percent in the 50 to 55 dB area. The noise level interval of 45–50 dB showed slight decreases in the area affected within the analysis area.

Highway noise is typically neither loud nor startling enough to cause marked stress effects on wildlife (Saigul-Klin et al. 1977). However, highway noise can mask important vocal communication and natural sounds important for mate attraction, social cohesion, predator avoidance, prey detection, navigation, and other basic behaviors. Masking of vocal communication occurs when highway noise interferes with signal transmission by swamping out the signal or parts of the signal (e.g., low-amplitude elements of a song) or degrading the signal to a point at which it is no longer recognizable to other members of a species. When such masking or degradation occurs, the normal communication and associated biological functions of the species can be impaired. Depending on the degree of masking and the particular species' capacity to adapt (e.g., to sing louder), masking can potentially result in abandonment of an area or reduced productivity and survival. Signal masking may result in the inability of males to effectively attract mates and/or repel territorial rivals. Excess energy may be required to physically maintain a territory and to sing louder. Predator warning and parent-offspring signals can be impaired. All these factors could potentially result in reduced survival and reproductive success of affected populations adjacent to the highway.

Traffic noise associated with all the build alternatives could potentially mask vocal communication among some birds. These masking effects are highly species-specific and depend largely on the unique bioacoustics characteristics of each species' vocal signals. The potential impact on American Bitterns (*Botaurus lentiginosus*) represents the greatest distance for possible masking effects (4.8 km [3 mi]; see Appendix E), but this species is only a rare summer visitant to the GSLE that has not been observed in the project study area. Other species such as Black-necked Stilts (*Himantopus mexicanus*), which are common breeders within the project study area, would only be minimally affected by traffic noise close to the highway (76 m [250 ft]; see Appendix E). For territorial songbirds such as Brewer's Sparrows (*Spizella breweri*), noise would have a potential masking effect at intermediate distances.

Potential Effects of Highway Noise on Special-Status Species

Nine special-status bird species (Bald Eagle [*Haliaeetus leucocephalus*], Swainson's Hawk [*Buteo swainsoni*], Peregrine Falcon [*Falco peregrinus*], Prairie Falcon [*Falco mexicanus*], Burrowing Owl [*Athene cunicularia*], Short-eared Owl [*Asio flammeus*], Wilson's Phalarope [*Phalaropus tricolor*], Bobolink [*Dolichonyx oryzivorus*], and American Avocet [*Recurvirostra americana*]) are known to breed in or near the project study area. The potential effects on these species of highway noise that would result from the build alternatives are described in detail in Chapter 3, *Environmental Consequences*, and Appendix E , *Bioacoustics Analysis of Potential Effects of Highway Noise on Wildlife of Great Salt Lake*. Based on an analysis of minimum-amplitude vocal signals, the potential effects distance of highway noise for bird species of concern could extend from less than 38 m (125 ft) to much more than 610 m (2,000 ft) from the highway. For example, Wilson's Phalaropes would have to be more than 610 m (2,000 ft) from the highway to transmit minimum-amplitude signals. Burrowing Owls would need to be 305 m (1000 ft) or more from the highway to avoid noise masking of inter-territorial communication.

It is not known exactly how highway noise would affect the local density and reproductive capacity of individual special-status species currently using habitats in the project study area. Highly noise-sensitive species may leave the affected areas; others may experience reduced reproductive success due to poor communication or reduced ability to detect predators and potential prey. Published research on highway noise impacts on grassland bird species in acoustic habitat similar to that found in the project study area shows reduced bird densities in response to traffic noise levels higher than 45 dB(A). Using 45-dB(A) as an outward-limit benchmark of effects, the area potentially affected by noise from the Proposed Action could extend on average 4 km (2.5 mi) from the highway.

ES.2.9 Human Disturbance

Access of humans and domestic pets (especially cats) to wildlife habitats adjacent to the highway could result in some level of habitat degradation and wildlife mortality. The existing design for the Legacy Parkway project includes three fences that would restrict access to sensitive wildlife areas; this design component is expected to minimize these effects. Localized disturbance from human use of the proposed trail corridor is also possible, but such adverse effects would likely be secondary to traffic noise effects. Alternative B, which crosses the largest extent of wetland habitats, would probably cause the greatest wildlife disturbance, particularly when the lake level is high. Because Alternatives A and E are located in more upland alignments than Alternatives B and C, they would probably disturb wildlife to a lesser extent. However, many wildlife species, particularly shorebirds, use these upland areas. Fencing of the highway right-of-way and protection of the Legacy Nature Preserve would reduce human impacts under all build alternatives.

ES.2.10 Effects on Special-Status Wildlife

The principal potential effects of the Proposed Action on special-status wildlife would be direct loss of foraging habitat, disturbance of nesting sites, and masking of communication near the highway. The magnitude of these effects would be proportional to the level that individual species use each habitat. The effects of the Proposed Action on special-status wildlife are directly related to the amount of direct habitat loss. The project would result in a reduction in population of some special-status species within the project study area, but the overall impact of these losses alone would not affect the long-term viability of any of these species in the GSLE.

ES.2.11 Cumulative Impacts: Historic, Foreseeable Future, and Proposed Action

Historic Conditions: Cumulative Habitat Loss

Historic land use changes within the GSLE have significantly reduced available wildlife habitat for migratory birds and other species, both around Great Salt Lake and within the project study area, as summarized below.

- An estimated 58 percent of historic wetland/wildlife habitat in the GSLE (159,439 ha [393,980 ac] of 274,633 ha [678,630 ac]) has been lost to past activities, primarily due to agriculture and urban development.

- In the Ogden and Jordan River hydrologic units, where the Proposed Action is located, approximately 66 percent of historic wetland/wildlife habitat has been lost.

Foreseeable Future Conditions

Reasonably foreseeable future land use changes would add to the large historic loss of habitat. Approximately 47 percent (55,002 ha [135,915 ac]) of the remaining wetland/wildlife habitat in the regional study area (117,027 ha [289,181 ac]) is on private lands, which are subject to reasonably foreseeable future land use changes.

Foreseeable future cumulative effects estimated by potential habitat loss from build-out vary by alternative. Two categories of development were identified in the potential future development dataset: areas developed since 1997 (developed), and areas potentially developable in the future (developable). Table ES-3 summarizes the potential loss of wetland and upland habitats in the project study area from both development categories under each alternative.

Proposed Action Proportion of Available Habitat

The project study area does not contain unique wildlife habitats not found in other areas of the GSLE, but it is located within a system of extensive wetlands that includes the Farmington Bay Waterfowl Management Area, which is used by many thousands of migratory birds each year. The loss of habitat resulting from the Proposed Action would contribute proportionally to the combined historic and estimated future cumulative impacts in the project study area and the GSLE.

Less than 0.1 percent of regionally available wildlife habitat around Great Salt Lake that is used by migratory species would be directly lost because of implementation of the Legacy Parkway project. The percentage lost for each build alternative is summarized in Table ES-4.

Table ES-4. Percentage of Available Wildlife Habitat Loss by Alternative

Alternative	Wetland/Riparian Habitats	Upland Habitats
No Build	0 ha (0 ac)	0 ha (0 ac)
Alternative A	0.022%	0.019%
Alternative B	0.059%	0.021%
Alternative C	0.049%	0.017%
Alternative E	0.032%	0.019%

A natural rise in lake level from existing conditions (approximately 1,278 m [4,194 ft]) to its historic high (1,283 m [4,212 ft]) would result in conversion of approximately 47–99 percent of existing wetland/riparian habitat to saline open water habitat. A total of approximately 813.6 ha (2,010.4 ac) of wetland/riparian habitats would be affected. The amount of publicly owned wetland/wildlife habitat in the Ogden hydrologic unit would drop from 55 percent to 5 percent with inundation. This conversion would make the habitat unsuitable for traditional habitat-specific use by many migratory species. Future global climate change could potentially result in higher lake levels.

ES.3 Conclusion

In conclusion, all the build alternatives of the Legacy Parkway project would have adverse direct and indirect effects and would contribute to cumulative effects on local wildlife populations, including migratory birds. These adverse effects would contribute to declines in the local density of affected species. In addition, traffic noise could potentially affect the behavior and reproductive capacity of various migratory bird species within the project study area and vicinity.

The area of wildlife habitat affected by direct habitat loss would be small—approximately 0.1 percent of the total amount of wildlife habitat available throughout the regional study area. Highway noise effects would affect a larger area—approximately 1.3 percent of existing wildlife habitat in the regional study area. Loss or degradation of these areas and biological functions (reproductive capacity of birds affected by noise) would add to the cumulative historic and foreseeable future habitat loss and associated impacts on wildlife in the GSLE. The impacts resulting from the Proposed Action alone, however, would not likely affect the long-term viability of any wildlife species in the GSLE.

Table ES-3. Summary of Direct Habitat Loss (acres) of Wetland/Riparian and Upland Wildlife Habitats in Conjunction with Full Build-Out

Habitat	Total Project Study Area	Build-Out		Alternative A and Build-Out		Alternative B and Build-Out		Alternative C and Build-Out		Alternative E and Build-Out	
		Developed	Developable	Developed	Developable	Developed	Developable	Developed	Developable	Developed	Developable
Wetland/Riparian	2649.7	138.1	945.6	230.4	878.9	293.5	841.8	138.1	843.1	246.0	866.4
Upland	5978.6	1020.2	3609.6	1417.8	3221.7	1564.9	3231.2	1020.2	3233.0	1444.8	3207.4

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Chapter 1

Approach

Chapter 1
Approach

This technical memorandum presents an analysis of potential impacts on wildlife that could result from implementation of the Legacy Parkway project. The analysis focuses on direct, indirect, and cumulative impacts that could affect wildlife species—particularly migratory species—that use the Great Salt Lake Ecosystem (GSLE).

To address the concerns raised by the U.S. Court of Appeals for the Tenth Circuit regarding the analysis of impacts on wildlife, the area considered in this analysis extends beyond the boundaries of the wildlife study area considered in the final environmental impact statement (Final EIS) (Federal Highway Administration et al. 2000). This study analyzes impacts on species known to occur within the project study area at both project and regional levels. (The geographic extent of the project-level and regional-level analyses is described in Chapter 2, *Affected Environment*.) The following effects were analyzed.

- Direct habitat loss.
- Combined effects of changes in lake level and direct habitat loss from project alternatives.
- Habitat fragmentation.
- Changes in habitat quality (e.g., from changes in air and water quality).
- Habitat modification (e.g., from changes in hydrology and impacts associated with proposed landscaping).
- Wildlife highway mortality.
- Artificial light disturbance.
- Highway noise disturbance.
- Human disturbance.
- Effects on special-status wildlife.
- Cumulative impacts (including effects of historic, present, and reasonably foreseeable future actions).

To ensure that the best available scientific information was acquired and appropriately analyzed for this memorandum, a two-tiered technical review process was established. For the first tier of the process, a wildlife technical team (WTT) was formed, consisting of ecologists and biologists from the Federal Highway Administration (FHWA), the U.S. Army Corps of Engineers (Corps), the Utah Department of

Transportation (UDOT), and these agencies' representative technical consultants. The WTT was responsible for reviewing and making recommendations on the general technical analysis approach and the methods used to identify technical issues requiring a higher level of review.

For the second tier, a science technical team (STT) was formed, consisting of the WTT members and wildlife biologists and technical experts from the U.S. Fish and Wildlife Service (USFWS), the U.S. Environmental Protection Agency (EPA), and the Utah Department of Natural Resources (UDNR). The STT provided focused review of and recommendations on specific scientific aspects of data and methods used, and on the results of analyses as they were completed.

This two-tiered review process was designed to provide an efficient and comprehensive approach for completing the technical analysis and for ensuring quality control of the results presented in this technical memorandum. Chapter 5, *List of Preparers*, provides a complete list of the members of the WTT and the STT.

Chapter 2

Affected Environment

Chapter 2

Affected Environment

2.1 Project Location

Potential impacts of the proposed Legacy Parkway project on wildlife were analyzed at two geographic levels: the project study area and the regional study area. These areas, lying within the GSLE, are spatially defined in Figures 2-1 and 2-2 and are described below.

2.1.1 Project Study Area

The study area for the project-level analysis encompassed the Final EIS wildlife study area, the proposed mitigation area, and additional lands included in the wetland delineation study (Baseline Data Inc. et al. 1998) (Figure 2-3). The project study area encompasses approximately 4,186 hectares (ha) (10,344 acres); it is the total area for which high-resolution GIS data were available for mapping wetlands and wildlife habitats. The project-level analysis was conducted using this high-resolution dataset. Each build alternative's footprint, or area of direct impacts, lies entirely within the project study area.

2.1.2 Regional Study Area

The study area for the regional-level wildlife analysis was defined by three parameters: (1) a subset of U.S. Geological Survey (USGS) hydrologic units in the eastern portion of the GSLE, (2) the extent of these units for which comprehensive regional GIS land-use data were available, and (3) the portion of these areas below 1,433 m (4,700 ft) in elevation. The 1,433-m (4,700-ft) elevational boundary was selected to include wetland habitats associated with Utah Lake that could potentially be used by migrating birds that also use the project study area. A variety of migrating bird species are likely to use both areas despite the differences in ecology (Utah Lake is a freshwater lake, whereas the project study area is associated with Great Salt Lake's saltwater ecosystem). The geographic extent of the regional study area is shown in Figure 2-3. The regional study area was used to evaluate the direct, indirect, and cumulative effects on wildlife beyond the project study area.

2.1.3 Great Salt Lake Ecosystem

The proposed Legacy Parkway project is located on the southeast shore of Great Salt Lake. Technically, the GSLE encompasses all wildlife habitats within the full drainage basin of Great Salt Lake, including the ancient lakebed and drainages of Lake Bonneville and the complete watersheds of the Bear, Ogden/Weber, and Jordan Rivers (Figure 2-1). In this report, the GSLE refers to Great Salt Lake, its

floodplains, and all wildlife habitats that are used by migratory bird species (Figure 2-2) as mapped in Aldrich and Paul (2002).

Alternatives analyzed in this study include modified versions of alternatives analyzed in the Final EIS. The alternatives were modified to accommodate a reduced median width, resulting in a 95-m (312-ft) total right-of-way width, which is reduced from the total right-of-way width of 100 m (328 ft) that was used to define the alternatives analyzed in the Final EIS. The following alternatives lie within the project study area for this wildlife impact analysis.

- Alternative A – 95-m (312-ft) right-of-way width.
- Alternative B – 95-m (312-ft) right-of-way width.
- Alternative C – 95-m (312-ft) right-of-way width.
- Alternative E – 95-m (312-ft) right-of-way width.

Alternative E follows the same alignment as Alternative D (the Final EIS Preferred Alternative), but Alternative E has a reduced median and narrower right-of-way width. Alternatives A, B, and C follow the same alignments as shown in the Final EIS.

2.2 Physical Setting

Great Salt Lake is one of the four largest terminal saline lakes in the world (Stephens 1990). It encompasses between 2,165 square kilometers (km^2) (835.9 square miles [mi^2]) and 6,361 km^2 (2,456 mi^2), depending on the lake's surface elevation. It is located on the eastern edge of the Great Basin, which is characterized by a cold, high-desert climate. Average daily temperatures in the Great Salt Lake basin range between -2ºC (28ºF) in January and 25ºC (78ºF) in July. Winter lows may reach -18ºC (0ºF), and summer highs can exceed 38ºC (100ºF). Temperature inversions are characteristic of the basin. Precipitation variations around the lake are attributed to the local differences in temperature and local topography, with averages ranging from less than 25 centimeters (cm) (9.8 inches) along the xeric (drier) west side to 38 cm (14.9 inches) along the eastern shore at the base of the Wasatch Mountains. The Great Salt Lake area receives an average annual snowfall of 158 cm (63 inches) (National Weather Service 1997).

Great Salt Lake is a remnant of Pleistocene Lake Bonneville and is the lowest point in a 57,000-km^2 (22,008-mi^2) drainage basin (Figure 2-1). The average annual freshwater inflow to the lake is approximately 0.4 million hectare-meters (3.25 million acre-feet (maf) (Stauffer 1980), with surface flow, precipitation, and groundwater discharge accounting for 65%, 28%, and 8%, respectively, of the total inflow. The Bear River contributes approximately 55% of the surface flow, the Weber River contributes 23%, and the Jordan River contributes 14%. An additional 8% comes from ungauged flows from sewage plants and other small tributaries (Aldrich and Paul 2002). Although precipitation contributes less water than does surface flow, it plays a vital part in Great Salt Lake hydrology by refreshing sediments in small nearshore playas and mudflats that are often isolated from other sources of water.

Great Salt Lake is a shallow, low-gradient playa lake, with an average depth of only 4 m (13 ft) when the surface elevation is 1,281 m (4,202 ft) above sea level (ASL) (Aldrich and Paul 2002). With variable seasonal inflow of water from the rivers and countervailing high levels of evaporation, the water depth of the lake fluctuates dramatically, creating a highly transitory shoreline. The average seasonal variation in

Great Salt Lake's surface elevation is approximately 0.46 m (18 inches), but it may fluctuate as much as 1.5 m (5 ft) in a single year (Aldrich and Paul 2002). Consequently, some areas of the shoreline can migrate more than 800 m (2,625 ft) between spring and fall. This naturally shifting shoreline effectively creates a dynamic landscape of expansive mudflats, emerging and subsiding sandbars, and ephemeral saline pools that are important for many migratory shorebirds and waterfowl. Regional climate patterns typically result in overriding multi-year cycles in lake levels (up to 6 m [20 ft]) that dramatically affect the temporal and spatial nature of these annual shoreline changes. Figure 2-4 shows the lake level patterns of Great Salt Lake from 1840 to present. Relatively high lake levels in the late 1980s resulted in a 3.4-m (11-ft) rise of Great Salt Lake over 4 years and the inundation of approximately 80% of shoreline wetlands around the lake.

The shallow water and expansive surface area of Great Salt Lake also creates conditions favorable for wind-driven seiches that can elevate lake levels between 1.5 m (5 ft) and 2 m (7 ft) on downwind shores (Utah Department of Natural Resources 1999). The combined effects of this wind setup and wave action can push the saline waters of the lake over many thousands of acres of mudflats and into shoreline marsh areas, often disrupting established plant communities and/or the nesting areas of many waterbirds. While these events tend to be short lived, they are an important stochastic and integral part of the many dynamic changes constantly sculpting the shoreline of Great Salt Lake.

2.3 Regulatory Setting for Special-Status Wildlife

Several of the species discussed in this technical memorandum are considered *special-status species*, or species that are protected by one or more state or federal environmental laws (Table 2-1). In this technical memorandum, special-status wildlife includes species identified on the following lists and/or covered by the following regulations.

- Federal
  - Federally listed endangered and threatened species.
  - Federal candidate species.
  - Migratory Bird Treaty Act (MBTA) species (16 USC 703–711).
  - Fish and Wildlife Conservation Act species (16 USC 2901–2911).
- State of Utah
  - Utah wildlife species of concern (Utah Administrative Rule R657-48).
  - State of Utah conservation agreement species.

Table 2-1 summarizes the legal and protected status, habitat use, and seasonal occurrence of each special-status species. The table also describes each species' abundance within the GSLE and the project study area, as well as its migratory, breeding, and habitat use patterns in these areas. The abundance and residence status of each of these species is described in further detail in Tables 2-2 through 2-10, as well as in the comprehensive species-habitat matrix (Appendix A). Additional information on each species appears in Section 2.4.3 below. The occurrence in and use of specific habitats within the project study area by the special-status species is discussed under each habitat description in Section 2.4.1 below.

The following federal and state laws guide regulatory authority over special-status species that occur or could potentially occur in the regional and project study areas.

2.3.1 Federal

Endangered Species Act (16 USC 1531 et seq.)

Federally Listed Species

The federal Endangered Species Act (ESA) provides certain protections for species that are listed or proposed for listing as threatened or endangered under the ESA. Under Section 7 of the ESA, federal agencies are required to ensure that their actions do not jeopardize the continued existence of species listed as endangered or threatened, or result in destruction or adverse modification of designated critical habitats used by those species. Section 9 of the ESA makes it unlawful for a person to *take* a listed species, where *take* is defined as to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct (16 USC 1532). Further, the term *harass* is defined as an intentional or negligent act that creates the likelihood of injuring wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns such as breeding, feeding, or sheltering (50 CFR 17.3). *Harm* is an act that either kills or injures a listed species. Such an act may include habitat modification or degradation that actually kills or injures a listed species by significantly impairing essential behavior patterns such as breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 217.12). Habitat degradation can cause take through either the *harm* or *harass* pathways outlined above. Acceptable levels of incidental take may be allowed under the authorities of Sections 4(d), 7(b), and 10(a) of the ESA.

USFWS is one of the federal agencies that administers the ESA and has primary responsibility for terrestrial and freshwater species. Bald Eagles are the only federally listed species known to occur in the GSLE and the project study area (Table 2-1). However, Peregrine Falcons, which were federally listed until recently (now delisted), also occur in the project study area.

Federal Candidate Species

The ESA also designates species that are candidates for listing as threatened or endangered. Candidate species are species that are being considered to be proposed for listing. State and federal agencies typically carry out conservation actions for candidate species to prevent their further decline and possibly eliminate the need to list them in the future. Table 2-1 includes candidate species that occur or could potentially occur in the GSLE and the project study area.

Migratory Bird Treaty Act (16 USC 703–711)

The MBTA prohibits the *take* of any migratory bird, or any part, nest, or egg of any such bird, where *take* is defined as the attempt to "pursue, hunt, shoot, capture, collect, or kill." This act applies to all persons and organizations in the United States, including federal and state agencies. The MBTA is administered by USFWS, with regulation of listed migratory birds delegated to the agency staff handling Section 7 of the ESA, and regulation of unlisted migratory birds delegated to USFWS's Migratory Bird Division. A list of designated migratory bird species that occur or could potentially occur in the project study area is provided in Appendix A.

Fish and Wildlife Conservation Act (16 USC 2901–2911)

The 1988 amendment to the Fish and Wildlife Conservation Act (FWCA) mandates that USFWS identify migratory and nonmigratory birds of the United States and its territories that, without additional conservation actions, are likely to become candidates for listing under the ESA. These species are designated as Birds of Conservation Concern (BCC) and include ESA candidate, proposed endangered or threatened, and recently delisted species (U.S. Fish and Wildlife Service 2002).

BCC species are listed according to three different geographic scales: national, regional, and local. BCC species identified in this technical memorandum are part of the Great Basin Bird Conservation Region (BCR), representing the smallest and ecologically most relevant geographic scale for this analysis. BCC species that occur or could potentially occur in the project study area are identified in Table 2-1.

2.3.2 State of Utah

Conservation Agreement Species

Conservation agreement species are those wildlife species and subspecies that meet the UDNR criteria of endangered, threatened, or special concern. This category does not include species and subspecies that are currently listed under the federal ESA as threatened or endangered. Conservation agreement species are currently receiving sufficient special management under a conservation agreement developed and/or implemented by the state to preclude their federal listing. If a conservation agreement is not implemented, the species could be elevated to the appropriate category. A list of the conservation agreement species that occur or could potentially occur in the GSLE and the project study area is provided in Table 2-1.

Utah Wildlife Species of Concern (Utah Administrative Rule R657-48)

Utah wildlife species of concern (WSC), which are listed on *Utah's Sensitive Species List* (Utah Division of Wildlife Resources 2003), are those species for which there is credible scientific evidence to substantiate a threat to continued population viability in the state of Utah. WSC designations are intended to promote conservation actions that will ultimately prevent the species from being listed as threatened or endangered under the ESA.

The Utah Division of Wildlife Resources (UDWR) is the state agency responsible for monitoring WSC. A list of the WSC species that occur or could potentially occur in the GSLE and the project study area is provided in Table 2-1.

2.4 Ecological Setting

This section describes the ecological setting of the proposed Legacy Parkway project. The following areas are discussed in detail.

- Existing wildlife habitats.
- Existing distribution and use of wildlife habitats.
- Special-status species.

- Existing habitat fragmentation.
- Status of existing habitat quality.
- Status of existing wetland hydrology.
- Existing artificial landscaping.
- Existing sources of direct wildlife mortality.
- Existing sources and levels of noise.
- Existing sources of artificial light.
- Existing sources of human disturbance.

2.4.1 Existing Wildlife Habitats in Project Study Area

Great Salt Lake and the wetlands surrounding its shoreline provide important habitat for a great variety of amphibians, reptiles, birds, and mammals, some of which are rare and have small geographical distributions.

The wetlands of Great Salt Lake account for 75% of all wetlands in Utah; only 1.5% of the state's total land area comprises wetlands (Jensen 1974). The shores of Great Salt Lake are internationally important because they constitute a link of the Pacific Flyway for migratory waterfowl and a link of the Western Hemisphere Shorebird Reserve Network (Figure 2-5). Between 2 million and 5 million birds use Great Salt Lake yearly; 90% of that use is concentrated on the eastern shore (Paul and Manning 2002).

The proposed Legacy Parkway project crosses portions of an intricate patchwork of wetlands, wetland-associated habitats, and uplands used by a broad diversity of wildlife species. The wetland habitats are formed and maintained by a complex interplay between surface and subsurface fresh water and the fluctuating dynamics of Great Salt Lake's lake level (Figure 2-4). Many of the habitats directly associated with the shoreline, such as mudflats, nearshore playas, and emergent marshes, develop and subside with the rise and fall of the lake. Other more interior habitats, including wet meadows, permanent and ephemeral ponds, and riparian corridors, are more responsive to seasonal precipitation patterns and fluctuations in the water table. The upland habitats are more stable, providing important refuge, resting, and foraging habitat for many species, particularly when the lake level is high and the lower-elevation habitats are flooded.

This section provides descriptions of the habitats within the project study area and around Great Salt Lake and the wildlife species frequently associated with these habitats. Nine wildlife habitats—five wetland/riparian and four upland habitats—were identified within the project study area.

- Wetland/riparian wildlife habitats.
  - Open water.
  - Riparian.
  - Emergent marsh.

- Wet meadow.
- Mudflat/Pickleweed.

- Upland wildlife habitats.
  - Pasture.
  - Cropland.
  - Salt desert scrub.
  - Developed (including urban landscaping).

Of the 4,186-ha (10,344-acre) project study area, 3,492 ha (8,628 acres) are considered wildlife habitat.[1] Figure 2-6 shows the areal extent of mapped habitat types in the project study area; Figure 2-7 is a map of these habitats. Information on how these habitats were delineated and mapped is presented in Appendix B. Wildlife species known to occur or that could potentially occur within each habitat in the project study area are summarized in Tables 2-2 through 2-10. Information on their seasonal occurrence and abundance within the project study area, their migratory and breeding status in the habitats, and their use of other habitats in the study area is also provided in these tables. It should be noted that individual bird species can be assigned to more than one seasonal abundance category. For example, in open water habitat (Table 2-2), Pied-billed Grebe has been documented both as an uncommon summer visitant and a rare winter visitant. A comprehensive species-habitat matrix of species that occur in the regional study area is provided in Appendix A. A list of scientific names of wildlife species discussed in this technical memorandum is provided in Appendix C. Table 2-1 lists all special-status species and their designations.

Open Water

Habitat Description

Open water habitat consists of inundated or flooded areas with no emergent vegetation. The water in these areas may be fresh (e.g., ponds, the Jordan River), brackish, or saline (e.g., Great Salt Lake). The amount of open water habitat can vary tremendously with the rise and fall of the lake level. If high-water inundation periods last long, the saline waters of the lake will denude the vegetated habitats they cover, thereby converting shoreline vegetated wetlands, mudflats, and uplands to saline open water habitat. Within the project study area, the majority of open water areas are located on the eastern edge of Farmington Bay Waterfowl Management Area.

Wildlife

Five fish species, 78 bird species, and one mammal species (muskrat) comprise the vertebrate species potentially associated with open water habitats within the project study area (Table 2-2). Forty-eight of

[1] Some discrepancies are evident between wildlife habitat quantified in this analysis and the extent of wetland habitat specified in the Final EIS. These discrepancies are primarily the result of differences between the habitat classification system developed by the WTT for the wildlife technical memorandum and the classification system used to identify jurisdictional waters (including wetlands) in the Final EIS. This matter is discussed in greater detail in Chapter 3 and Appendix B.

the bird species have been documented as occurring within the project study area. Another 30 bird species could potentially occur there based on their general abundance in the GSLE and their known use of open water habitat. Nineteen of these 78 bird species, mostly waterfowl, are generally found exclusively in open water habitat (Table 2-2); of these 19, three (Common Goldeneye, Osprey, and Caspian Tern) have been documented within the project study area. Seven of the 48 documented bird species can usually be found year-round within the GSLE, 18 are common to uncommon during the summer, four are winter visitants, and 24 only migrate through the region. The bird species potentially associated with open water habitat in the project study area include up to 26 waterfowl species, 14 species of gulls and terns, seven shorebird species, five grebe species, five heron and egret species, and seven swallow species. Sixteen of the bird species, including American Avocet and Wilson's Phalarope, breed or could potentially breed within the project study area.

Five special-status species (American White Pelican, Peregrine Falcon, American Avocet, Marbled Godwit, and Wilson's Phalarope) use or could potentially use open water habitat in the project study area. Other common birds associated with open water habitat or the shoreline areas include Red-necked Phalarope, Eared Grebe, Marbled Godwit, Black-necked Stilt, and Long-billed Dowitcher. These species, like those listed above, depend largely on many of the food resources found in or around this habitat. Also, in areas where fresh water is sufficient to support fish, ephemeral fisheries provide food for a variety of fish-eating birds, including American White Pelican, Double-crested Cormorant, Western and Clark's Grebes, and Forster's and Caspian Terns. Wintering waterfowl, such as Common Goldeneye and Bufflehead, also use open water habitats extensively. Bald Eagle and Peregrine Falcon prey on the large flocks of shorebirds and waterfowl that concentrate in these areas.

Riparian

Habitat Description

Riparian habitat is the least abundant habitat type within the project study area. This habitat is generally severely degraded and is restricted to small patches of riparian vegetation along stream courses and irrigation canals. The Jordan River supports the majority of this habitat type in the project study area. Remnant native vegetation includes Fremont cottonwood (*Populus fremontii*), sandbar willow (*Salix exigua*), and narrowleaf cottonwood (*Populus angustifolia*). In many areas, however, these species have been replaced by Russian olive (*Elaeagnus angustifolius*), Siberian elm (*Ulmus pumila*), and salt cedar (*Tamarix ramoisissima*). No jurisdictional wetlands were delineated within these riparian areas (Baseline Data, Inc. et al. 1998).

Wildlife

While limited in extent, riparian habitat in the project study area provides food and shelter for one amphibian species, three reptiles, 107 birds, and 26 mammals (Table 2-3). Of these species, only beaver is generally found exclusively associated with this habitat. Seventy-eight of the bird species have been documented in riparian areas in the project study area. Another 29 species have the potential to occur there based on their general abundance in the GSLE and their common use of riparian habitats in the region. Seventeen of the 78 documented species occur year-round in the GSLE, 13 are common to uncommon during the summer, 14 are winter visitants, and 39 only migrate through the region. Of the 107 documented and potential species, 103 are migratory; most are Neotropical passerines that use the riparian trees and shrubs for food, shelter, and roosting. Twenty-nine of these bird species breed in riparian habitat.

Nine special-status species (Bald Eagle, Northern Goshawk, Swainson's Hawk, Solitary Sandpiper, Yellow-billed Cuckoo, Willow Flycatcher, Loggerhead Shrike, Virginia's Warbler, Brewer's Sparrow, and Townsend's big-eared bat) use or could potentially use riparian habitat in the project study area. However, Northern Goshawk, Yellow-billed Cuckoo, and Virginia's Warbler are rare migrants in the GSLE and their use of the project study area is infrequent.

The riparian habitats throughout the GSLE provide insects for many species of migrating/summer visitant insectivores such as warblers, kinglets, sparrows, flycatchers, swallows, and several species of bats. Although they are limited and widely dispersed in the project study area, these habitat patches provide links within a long network of similar patches along the Wasatch Front, a principal migratory corridor for these species. Russian olive trees also provide forage and shelter for a variety of fruit-eating species, such as Bohemian and Cedar Waxwings, Hermit Thrush, and American Robin, as well ground-foraging Ring-necked Pheasant and California Quail. Eleven rodent species, seven bat species, porcupine, red fox, raccoon, long-tailed weasel, striped and spotted skunks, and mule deer also use these riparian areas. All the reptiles found in this habitat are snakes, which feed on the abundance of rodents, fish, birds, amphibians, and various invertebrates in the area.

Emergent Marsh

Habitat Description

Emergent marshes are wetlands dominated by herbaceous vegetation adapted to seasonally or semi-permanently flooded conditions. Water depth varies, but is not deep enough to restrict the growth of emergent plants. Vegetation commonly observed in these marshes include hard stem bulrush, (*Scirpus acutus*), alkali bulrush (*Scirpus maritimus*), three square bulrush (*Scirpus americanus* and *Scirpus pungens*), cattail (*Typha latifolia*), creeping spikerush (*Eleocharis palustris*), reed canary grass (*Phalaris arundinacea*), common reed (*Phragmites australis*), blister buttercup (*Ranunculus scleratus*), water buttercup (*Ranunculus aquatilis*), and Nebraska sedge (*Carex nebrascensis*).

These marshes can be located in depressions where the ground surface lies below the level of the water table or in areas with sufficient surface water or groundwater discharge. For this reason, groundwater, runoff, and surface water may all contribute to the hydrologic regime of emergent marshes. In the Great Salt Lake basin, these areas are generally inundated during spring, when the water table is high due to snowmelt and seasonal rain. Within the project study area, emergent marshes are found in large tracts fringing the open water habitats along the eastern boundary of Farmington Bay Waterfowl Management Area, west of Centerville.

Agriculture and urbanization along the western edge of the Wasatch Mountains (Figures 2-7a–c) have greatly influenced the number and types of emergent marsh habitats in the area. Agricultural runoff has increased the frequency and duration of inundation and soil saturation in many locations. Emergent marshes have also been created by impoundment of both ground and surface water by roads and dikes.

Wildlife

Emergent marsh provides suitable habitat for five fish species, six amphibians, two reptiles, up to 79 birds, and 16 mammals (Table 2-4). American Bittern and masked shrew are the only species considered to be exclusively associated with this habitat. Sixty-six of the bird species have been documented in the project study area; another 12 species could potentially occur there based on their typical use of this habitat in the GSLE. Seventeen of the 66 documented bird species stay within the GSLE all year, 22 are

common to uncommon during the summer, nine (in addition to permanent residents) are winter visitants, and 25 only migrate through the region. All the bird species that use emergent marsh habitat are migratory, and 31 breed or could potentially breed in this habitat. The most common species that use this habitat include Canada Goose, Mallard, Gadwall, American Coot, and Red-winged Blackbird. Black-crowned Night Heron, White-faced Ibis, Virginia Rail, Sora, and Franklin's Gull are also common during the summer.

Nine special-status species (American White Pelican, Bald Eagle, Peregrine Falcon, American Avocet, Wilson's Phalarope, Short-eared Owl, Loggerhead Shrike, Preble's shrew, and Townsend's big-eared bat) use or could potentially use emergent marsh habitat in the project study area. Fish in these marshes, particularly carp, provide food for numerous fish-eating bird species in the area, including Western and Clark's Grebes, Great Blue Herons, Snowy and Great Egrets, American White Pelicans, Double-crested Cormorants, California Gulls, and Forster's Tern.

An abundance of aquatic and terrestrial insects produced in emergent marshes provides food for a broad diversity of insectivorous birds including swallows, poorwills, swifts, warblers, sparrows, shrikes, and blackbirds, as well as up to seven species of bats. The shallow waters of the marshes provide suitable habitat for all six amphibian species that are represented in the project study area. Amphibians and reptiles common to emergent marshes of the project study area are also comparably common in wet meadow habitat (see *Wet Meadow* below). Common mammals in this habitat include voles, muskrat, and raccoon.

Wet Meadow

Habitat Description

Wet meadow habitats are the most abundant type of wetland in the project study area. They are typically found in areas with a high water table or groundwater discharge, where poorly drained soils cause seasonally saturated and sometimes flooded conditions. Surface water flows can contribute to or prolong seasonally wet conditions. Inundation occurs less frequently and for shorter duration in wet meadows than in emergent marshes. Agriculture and urbanization have modified the hydrologic regime of wet meadows in the project study area much as they have affected emergent marshes. Plant species commonly observed in wet meadows within the project study area include Baltic rush (*Juncus balticus*), clustered field sedge (C*arex praegracilis*), Nebraska sedge, rabbits-foot grass (*Polypogon monspeliensis*), foxtail barley (*Hordeum jubatum*), little barley (*Hordeum pusillum*), curly dock (*Rumex crispus*), and saltgrass (*Distlichlis spicata*).

Wildlife

Wet meadows in the project study area provide food, shelter, and rest area resources for six amphibian species, three reptiles, 102 birds, and 13 mammals (Table 2-5). Insects and other invertebrates and vegetation are the principal food resources for birds in the meadows; the birds, amphibians, and rodents also provide food for the various reptilian, avian, and mammalian predators that use this habitat. Eighty-seven of the bird species have been documented within the project study area. Another 15 species could potentially occur there based on their general habitat use patterns and abundance in the GSLE. Twenty-seven of the 87 documented species remain within the GSLE all year, 21 are common to uncommon during the summer, 11 are winter visitants, and 35 only migrate through the region. Of the documented and potentially occurring bird species, 100 are migratory and 41 breed or could potentially breed in this

habitat. All the bat species listed in Table 2-5 migrate seasonally or hibernate in local caves, mines, or abandoned buildings.

Seventeen special-status species (Bald Eagle, Swainson's Hawk, Ferruginous Hawk, Golden Eagle, Peregrine Falcon, Prairie Falcon, American Golden Plover, American Avocet, Solitary Sandpiper [rare], Long-billed Curlew, Marbled Godwit, Wilson's Phalarope, Short-eared Owl, Loggerhead Shrike, Brewer's Sparrow, Bobolink, and Townsend's big-eared bat) use or could potentially use wet meadow habitat in the project study area. Many of the migratory bird species listed in Table 2-5 are the same as those that use the emergent marsh habitat (Table 2-4); however, a broader diversity of shorebirds are found in wet meadows, including breeding Willet, Long-billed Curlew, Wilson's Phalarope, and Wilson's Snipe, as well as migrant Black-bellied Plover, American Golden-Plover (rare), Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper (rare), Marbled Godwit, and Pectoral Sandpiper. Three species of hummingbird, Rough-legged Hawk, and Cattle Egret have also been documented using this habitat within the project study area. Mountain Bluebirds may forage and rest in wet meadows in the area on occasion.

Mudflat/Pickleweed

Habitat Description

Mudflats are typically barren or sparsely vegetated playas with deep or moderately deep, poorly drained to very poorly drained clay soils formed from Pleistocene lakebed sediments. In the project study area, mudflats are usually located in low areas along the Great Salt Lake fringe or depressional areas within scrub and wet meadow habitats. After a rain or as snow cover melts, these playa/mudflats collect much of the runoff from surrounding areas and form ephemeral pools. Generally, the waters and substrate are strongly alkaline due to evaporation, which deposits salts in the water and brings salts in the soils to the surface. Vegetation found on mudflats within the study area includes western seepweed (*Suaeda occidentalis*), slender seepweed (*Suaeda depressa*), and pickleweed (*Salicornia europea*). This habitat type includes mudflats associated with the shoreline of Great Salt Lake, which are periodically covered with shallow water, as well as mudflats associated with deeper, ponded water.

Wildlife

Mudflat/pickleweed habitat provides an abundance of mudflat invertebrates and windrow concentrations of brine shrimp and brine flies that supply the energy needs of thousands of shorebirds and other insectivorous species. This habitat can potentially be used by 1 amphibian species, 109 birds, and four mammals. Ninety of these bird species have been documented within the project study area; another 19 species could potentially occur there based on their general abundance and habitat use patterns in the region. Seven species of shorebirds are generally found exclusively associated with this habitat (Table 2-6). Twenty-five of the 90 documented bird species can be found year-round in the GSLE, 22 are common to uncommon during the summer, 11 are winter visitants, and 35 only migrate through the region. All of the 109 documented and potential species, with the exception of Ring-necked Pheasant, are migratory; 39 breed or could potentially breed within the project study area.

Nineteen special-status species (Bald Eagle, Swainson's Hawk, Ferruginous Hawk [rare], Golden Eagle, Peregrine Falcon, Prairie Falcon, American Golden-Plover [rare], Snowy Plover, American Avocet, Solitary Sandpiper [rare], Whimbrel [rare], Long-billed Curlew, Marbled Godwit, Sanderling, Wilson's Phalarope, Burrowing Owl, Short-eared Owl, Loggerhead Shrike, and Brewer's Sparrow) use or could potentially use this habitat within the project study area. Mudflats of Great Salt Lake are extremely

important to shorebirds because of the abundance of invertebrates they provide during the shorebird nesting and migration periods.

Pasture

Habitat Description

Much of the farmland in the project study area consists of pasture. It is the most abundant habitat type found in the project study area. Prior to conversion for agricultural purposes, pastures were typically wet meadows or salt desert scrub habitats. Pastures are generally located on flat or gently sloping lands and are vegetated with a mix of perennial nonnative grasses. Typical forage species planted in pastures include meadow brome (*Bromus riparius*), smooth brome (*B. inermis*), tall fescue (*Festuca arundinacea*), meadow fescue (*F. pratensis*), perennial ryegrass (*Lolium perenne*), creeping meadow foxtail (*Alopecurus arundinaceus*), intermediate wheatgrass (*Elymus hispidus*), tall wheatgrass (*E. elongatus*), and timothy (*Phleum pratense*). The height of the vegetation varies according to season, level of irrigation, drainage, fertilization, mowing, and livestock stocking levels; it ranges from as little as 7–8 cm (3 inches) to 60 cm (2 ft) or more on fertile soils before grazing.

Wildlife

Pastures, like wet meadows, are potentially used by a diverse assemblage of wildlife, comprising one amphibian species, four reptiles, 103 birds, and 32 mammals (Table 2-7). Ninety-four of the bird species that use pastures also use wet meadows, which provide similar food and shelter resources. Eighty-nine of these 103 species have been documented within the project study area; the remaining 14 species could potentially occur there. Twenty-six of the 89 documented species can be found year-round in the Great Salt Lake basin, 23 are common to uncommon during the summer, 12 are winter visitants, and 35 only migrate through the region. All but three of the 103 bird species that use pastures are migratory, and 42 breed or could potentially breed within the project study area.

Nineteen special-status species (Bald Eagle, Swainson’s Hawk, Ferruginous Hawk [rare], Golden Eagle, Peregrine Falcon, Prairie Falcon, American Golden Plover [rare], American Avocet, Solitary Sandpiper [rare], Whimbrel [rare], Marbled Godwit, Wilson’s Phalarope, Burrowing Owl, Short-eared owl, Loggerhead Shrike, Brewer’s Sparrow, Bobolink, spotted bat, and Townsend’s big-eared bat) use or could potentially use this habitat within the project study area. Bald Eagles prey and scavenge on some of the larger bird species that use this habitat (Buehler 2000). Pastures are dry at times, but flood irrigation of the fields provides rich foraging habitat for species such as White-faced Ibis, Franklin’s Gull, California Gull, Short-eared Owl, and Bobolink (rare). Many common Great Salt Lake shorebirds, such as Greater and Lesser Yellowlegs, Least and Pectoral Sandpipers, Black-necked Stilt, and American Avocet, are opportunistic feeders and are commonly observed forging in flooded pastures. Ground-nesting birds, including Ring-necked Pheasant, Killdeer, Black-necked Stilt, Willet, and Wilson’s Snipe, use undisturbed pastures for nesting (Table 2-7). Common rodents (e.g., meadow voles and ground squirrels) and lagomorphs (rabbits and hares) provide prey for many raptors, including Red-tailed Hawk, Swainson’s Hawk, Rough-legged Hawk, Golden Eagle, and Short-eared Owl. Many species of waterfowl also forage on the grasses in pasture habitat.

Cropland

Habitat Description

Large tracts of cropland are located within the project study area (Figures 2-7a–c). The major crops actively farmed on these lands include corn, wheat, sod, and alfalfa.

Wildlife

Because of the active rotation of crops, much of the cropland habitat is regularly disturbed, limiting the activities of wildlife species that occur there. Most species use these lands when the fields are fallow, but some find food and shelter in or along the periphery of planted cropland. Croplands within the project study area can potentially be used by one reptile species, 85 birds, and 15 mammals (Table 2-8). Seventy-one of the bird species have been documented as occurring within the project study area; another 14 species could potentially occur there. Twenty-three of the 71 documented species can be found year-round in the Great Salt Lake basin, 13 are common to uncommon during the summer, 13 are winter visitants, and 27 only migrate through the region. Eighty-one of the documented and potential species are migratory, and 31 breed or could potentially breed within the project study area.

Ten special-status species (Swainson's Hawk, Ferruginous Hawk [rare], Golden Eagle, Peregrine Falcon, Prairie Falcon, Burrowing Owl, Short-eared Owl, Loggerhead Shrike, Brewer's Sparrow, and Bobolink) use or could potentially use this habitat within the project study area. Ground-nesting birds (Ring-necked Pheasant, California Quail, Killdeer, Canada Goose, Northern Harrier, Short-eared Owl, and Western Meadowlark) commonly forage in planted fields but nest in non-crop vegetation around their periphery as well as in fallow fields. Meadow voles, gophers, ground squirrels, and rabbits occurring in these peripheral habitats are prey for a variety of raptors, foxes, coyotes, and gopher snakes. Waterfowl, including Canada and Snow Geese, Mallard, Northern Pintail, and American Wigeon, regularly forage in fallow croplands.

Salt Desert Scrub

Habitat Description

Salt desert scrub occurs primarily in the saline upland areas of the study area. It is characterized by shadscale (*Atriplex confertifolia*), Gardner saltbush (*Atriplex gardneri*), and greasewood (*Sarcobatus vermiculatus*). Within the project study area, this habitat has been heavily grazed by free-range livestock. Native grasses have been largely replaced by exotic grasses and forbs, including abundant cheatgrass (*Bromus tectorum*). Japanese brome (*Bromus japonicus*), wheatgrass (*Elymus* spp.), bulbous bluegrass (*Poa bulbosa*), whitetop (*Caldaria draba*), storksbill (*Erodium cicutarium*), and gumweed (*Grindelia squarrosa*) are also abundant throughout the project study area.

Wildlife

Where limited disturbance has occurred, salt desert scrub habitat provides suitable nesting and foraging resources for one amphibian species, eight reptiles, 101 birds, and 36 mammals (Table 2-9). Eighty-one of the bird species have been documented within the project study area; an additional 20 could potentially occur there. Twenty of the 80 documented bird species can be found year-round in the GSLE, 13 are common to uncommon during the summer, 12 occur in the area throughout the winter, and 42 only

migrate through the region. Ninety-nine of the 101 bird species are migratory, and 28 breed or could potentially breed in the project study area.

Eighteen special-status species (Bald Eagle, Northern Goshawk, Swainson's Hawk, Ferruginous Hawk, Golden Eagle, Peregrine Falcon, Prairie Falcon, Long-billed Curlew, Burrowing Owl, Short-eared Owl, Willow Flycatcher, Loggerhead Shrike, Virginia's Warbler, Brewer's Sparrow, Bobolink, Preble's shres, spotted bat, and Townsend's big-eared bat) use or could potentially use this habitat within the project study area. Bald Eagles regularly prey and scavenge on some of the larger birds and small mammals that use this habitat (Buehler 2000). Many migratory birds find shelter and food resources (insects, fruit, and seeds) in this habitat, including various warblers, swallows, and sparrows. Characteristic mammals of the area include numerous desert-adapted rodents as well as carnivores that prey on them (e.g., foxes, coyotes, bobcats, weasels, badgers). A variety of bats forage for aerial insects at night. Salt desert scrub is the only habitat within the project study area that is likely to support populations of sagebrush and side-blotched lizards.

Developed/Urban Landscaping

Habitat Description

Developed/urban landscaping comprises areas that are used for residential, commercial, or industrial purposes. Most of these areas are covered by pavement and buildings. However, much of the urban landscaping (lawns, shrubs, and trees) provides food and shelter resources for a variety of wildlife.

Wildlife

While the more common wildlife species in developed areas are generally nonnative species (e.g., Rock Pigeon, House Sparrow, European Starling, house mouse, black rat) or highly urbanized native species (e.g., Mourning Dove), many other native species find much needed resources in the patchwork of urban forests and shrubbery scattered throughout housing areas and parks. Table 2-10 lists the 108 bird species and 11 mammals that occur in developed/urban landscaping in the project study area. Seventy-nine of the bird species have been documented in developed habitat within the project study area; another 29 are likely to occur there, at least infrequently. Of the 79 documented bird species, 22 occur within the Great Salt Lake basin all year, eight are common to uncommon during the summer, 16 occur in the area throughout the winter, and 37 only migrate through the region. One hundred four of the 108 bird species are migratory, and 28 breed or could potentially breed in developed habitat.

Five special-status species (Peregrine Falcon, Yellow-billed Cuckoo, Loggerhead Shrike, Virginia's Warbler, and Brewer's Sparrow) use or could potentially use this habitat within the project study area. Most of the bird species are migrant songbirds that occur sporadically in areas with trees and shrubs. Barn and Cliff Swallows typically nest in large colonies in abandoned buildings and on bridges, often in developed areas. Mammals typical of developed areas include mice and rats that use buildings; opportunistic raccoons and muskrats that find habitat (often marginal) in parks, preserves, and scattered woodlots; and wide-ranging predators such as red foxes, coyotes, and bobcats that negotiate patches of remnant habitat in search of prey. Because much of the native vegetation that formerly occurred in developed areas is now gone, the replacement urban shrubbery and trees in housing areas and parks can provide food and roosting habitat for many species of migratory and resident wildlife.

2.4.2 Existing Distribution and Use of Wildlife Habitats

In this report, the relative abundance of different species is characterized by the following qualitative criteria.

- **Common:** Found consistently in moderate to large numbers in appropriate habitats and seasons.
- **Uncommon:** Found consistently in small numbers in appropriate habitats and seasons.
- **Rare:** Found infrequently, but regularly, in very small numbers in appropriate habitats and seasons.

The occurrence, breeding status, and habitat use patterns of the wildlife studied for this report are summarized in Tables 2-2 through 2-10. In total, 12 fish species, eight amphibians, 10 reptiles, 219 birds, and 50 mammals have been documented as occurring within the project study area, or are believed to have the potential to occur there based on the presence of suitable habitat and the general abundance of the species in the GSLE. Of these almost 300 species, 224 (216 birds and 8 bats) are migratory. One hundred thirty-six species are known to occur in the project study area, and an additional 139 species could potentially occur there. Up to 120 of these species could potentially breed within the project study area. The 28 special-status species comprise 24 migratory bird species, two migratory bats, one shrew, and one fox. The predominance of migratory birds that characterizes the project study area highlights the ecological importance of this area to these species (see *Regional Importance of the Great Salt Lake Ecosystem* below).

Wildlife habitats occur in a patchwork distribution across the project study area (Figures 2-7a–c). All habitat types in the project study area support a variety of amphibians, reptiles, birds, and mammals, and open water habitats support some fish species (Table 2-11). Because most species occupy many different habitats, it is important to consider these multiple habitat associations when addressing impacts on species in any single habitat. Tables 2-2 through 2-10 show which wildlife species use each habitat and what other habitats they also use in the project study area. Table 2-12 illustrates the degree that bird communities overlap in habitat use. For example, 75 bird species occur in open water habitat, 14 of which also occur in riparian habitat; 45 of the same 75 species occur in emergent marsh habitat. Furthermore, 14% of the 98 bird species that occur in riparian habitat also occur in open water. Table 2-12 illustrates that some habitats support very similar communities of bird species; this is most evident in pasture, wet meadow, and mudflat/pickleweed habitats, which have more than 90% of their species in common. This does not mean that the habitats are used equally, however. Each species uses each habitat in proportion to the availability and suitability of resources in that habitat.

Birds use habitats for breeding, foraging, resting, and cover. Some habitats support the same species because the habitats fulfill similar needs; other habitats support the same species because the habitats fulfill different needs for different groups of species. Table 2-13 summarizes the diversity (species richness), seasonal abundance, and breeding patterns of migratory species that use each habitat. This overlap in habitat use may, however, mask the relative importance for each habitat to each species. Some species primarily occupy one habitat but will opportunistically use another habitat in response to changes in conditions, such as a population outbreak of prey or flooding of upland habitats. These relationships underscore the fact that species often rely on a variety of habitats for different aspects of their natural history and in different seasons.

Regional Importance of Great Salt Lake to Migratory Birds

Great Salt Lake, with its unique mosaic of wetland, upland, mudflat, river delta, brackish and freshwater marshes, and ephemeral pond habitats, has long been recognized for its importance to migratory birds (Behle 1958; Knopf 1975; Jehl 1988; Paton 1994; Shuford et al. 1995; Paul and Manning 2002; Ivey et al. 2000). These habitats, and the ecological features of this large inland oasis, provide important refuge and resources for more than 5 million birds a year. The many thousands of tons of brine shrimp (*Artemesia fransiscana*) and brine flies (*Ephydra cinerea*) produced each year in the saline waters provide a key food source for millions of migratory shorebirds and waterfowl that pass through the area annually. Many of these species travel more than 3,000 km (1,860 mi) from their breeding grounds in the Arctic to Great Salt Lake (Aldrich and Paul 2002). This distance is commonly only the halfway point in their biannual migrations, making Great Salt Lake a critical refueling site for many long-range migrants. For example, more than a third of the world's population of Wilson's Phalaropes arrive at Great Salt Lake from their breeding grounds and typically double their weight on Great Salt Lake brine flies and brine shrimp before flying 8,800 km (5,400 mi) to wintering grounds in central South America (Colwell and Jehl 1994; Aldrich and Paul 2002).

Great Salt Lake provides important resources for some of the continent's largest congregations of migrating Eared Grebes, American Avocets, Black-necked Stilts, and Red-necked Phalaropes to molt, fatten, court, and stage for migration. Smaller but nonetheless substantial populations of Eared Grebes, American Avocets, and Black-necked Stilts also migrate to the GSLE to reproduce and rear their young (Aldrich and Paul 2002). The GSLE supports the largest breeding population of Snowy Plovers in North America (Aldrich and Paul 2002). Additionally, the GSLE is a major wintering area for a variety of species, particularly raptors, including a wintering population of more than 500 Bald Eagles (Aldrich and Paul 2002). Many of these migratory species rely on the abundance and diversity of ecological resources available in the GSLE, including those found in the Farmington Bay Waterfowl Management Area immediately adjacent to the project study area (Appendix A).

Because of its ecological importance to migratory birds, Great Salt Lake has been designated as a Western Hemisphere Shorebird Reserve Network (WHSRN) site of hemispheric importance (hemispheric site). The requisite screening criteria for the three categories of WHSRN sites are described below.

- **Hemispheric Sites** support at least 500,000 shorebirds annually, or 30% of a species' flyway population. Hemispheric sites are intended to include areas supporting major concentrations of shorebirds, with daily totals reaching about 50,000 birds during migration.

- **International Sites** support at least 100,000 shorebirds annually, or 15% of a species' flyway population.

- **Regional Sites** support at least 20,000 shorebirds annually, or 5% of a species' flyway population.

Each WHSRN site (Figure 2-5) is situated at an important location along the migratory pathways of these shorebirds. Table 2-14 shows that Great Salt Lake meets all the population size criteria for its hemispheric classification. Conservation of the ecologically important features of Great Salt Lake is integral to the National and Intermountain Region Shorebird Plans, the North American Waterfowl Plan, and the Great Salt Lake Comprehensive Management Plan (Paul and Manning 2002).

Migratory Bird Use of the Project Study Area and the Great Salt Lake Ecosystem

A principal objective of this technical study is to determine the potential impacts on migratory species that could result from construction of a highway within the project study area. Fundamental to this determination is an understanding not only of what species use the project study area, but also how these species use other areas of the GSLE. To have a clear understanding of the potential impacts of habitat loss within the project study area, it is necessary to have a firm understanding of which other areas within the GSLE provide the same or similar habitat for special-status species. An assessment of the wildlife use patterns of the project study area is presented above. The following discussion provides information on how these same species use other areas within the GSLE; this discussion provides a regional perspective of the ecological significance of the project study area relative to total wildlife habitat availability throughout the GSLE.

A 5-year survey and monitoring program (1997–2001), which determined the abundance and habitat use patterns of migratory waterbirds in the GSLE, shows site-specific differences in importance to overall bird populations as well as to individual species (Figures 2-8 and 2-9) (Paul and Manning 2002). Figure 2-8 shows the survey locations; Figure 2-9 illustrates the relative importance of each survey area for large populations of waterbirds as well as the broad distribution of most species throughout the southern and eastern sections of the GSLE. Figure 2-9 also includes each species' seasonal abundance data and seasonal status in the project study area.

The project study area does not support high abundances of many of the waterbird species that are common in the GSLE. Of the 47 waterbird species included in this survey, only Canada Goose (year-round), Killdeer (year-round), White-faced Ibis (summer only), Black-crowned Night Heron (summer only), Eared Grebe (migrant only), and Franklin's Gull (migrant only) are common in the project study area (Paul and Manning 2002). The remaining 41 species on the survey list are uncommon, rare, or do not occur in the project study area. By contrast, 34 of the 47 species are common in the GSLE. Of the six USFWS Birds of Conservation Concern, Snowy Plover, American Avocet, Wilson's Phalarope, Marbled Godwit, and Long-billed Curlew are seasonally common in the GSLE; Sanderling is uncommon. None of these species are common in the project study area. Wilson's Phalarope, Marbled Godwit, and Long-billed Curlew are rare migrants in the project study area; American Avocet is uncommon; and there are no records for Sanderling or Snowy Plover (Figure 2-9).

The numbers of birds using the project study area vary with season, year, and lake level. Table 2-15 shows the mean and peak values for species common to the project study area surveyed at site 42 (East Farmington Bay), which includes part of the project study area. The average surface elevation during the 5-year study period was 1,280.7 m (4,201.9 ft) (range: 1,280.0–1,281.5 m [4,199.3–4,204.6 ft]). Comparison of the numbers of these species throughout the full survey area indicates that numbers counted at high lake level (1999 elevation of 4,204.6 ft [1,281.6 m]) were generally less than those at low lake level (2001 elevation of 4,199.3 ft [1,279.9 m]) (Paul and Manning 2002). Although specific surveys of the project study area were not conducted at these times, it is presumed that bird use of the project study area would reflect a similar relationship to lake level as that indicated by the Paul and Manning study results.

The different abundance values for each species at each survey site in the GSLE undoubtedly reflect local differences in the availability and quality of important food and shelter resources in the wetland areas (Paul and Manning 2002). Certain sites, such as Bear River Refuge (29), South Bear River (27), Farmington Bay Waterfowl Management Area (12), Ogden Bay Wildlife Management Area (20), and Bear River Bay (37), support high densities of a large number of species (Figures 2-8 and 2-9). Other sites support high densities of fewer species, as shown below.

- Ogden Bay (38) – Eared Grebe and California Gull.
- Magcorp (40) – Wilson's Phalarope, Least Sandpiper, Red-necked Phalarope.
- Interstate 80 North (a) (5a) – California Gull, Killdeer.
- Stansbury Island South (a) (3a) – Least and Baird's Sandpipers.

2.4.3 Special-Status Species

Federally Listed Species

Bald Eagle (Threatened)

Bald Eagles are federally listed as threatened (68 FR 34585 34586). They are common winter visitants but rare summer breeders in the GSLE (Table 2-1). One of the top 10 wintering areas for Bald Eagles in the contiguous United States, the GSLE supports a population of more than 500 eagles during this season (U.S. Geological Survey 2001). No critical habitat has been designated in Utah for Bald Eagle (U.S. Fish and Wildlife Service 1999).

Bald Eagles move regularly from roosts in the Wasatch Mountains down to the wetlands of the project study area and vicinity to forage (J. Salt pers. comm.). They are opportunistic feeders that prey on a variety of mammals (including carrion), birds, reptiles, amphibians, and crustaceans. However, they generally prefer fish, when available, to other food types (Buehler 2000). Bald Eagles eat a great variety of aquatic and terrestrial mammals, including muskrats, jackrabbits, and ground squirrels, as well as many species of waterfowl, gulls, and even Great Blue Herons (Buehler 2000). All these prey types are available within the project study area. Hunter-induced waterfowl mortality in and around the duck clubs west of the project study area also provide a reliable supply of waterfowl carcasses for scavenging eagles (Griffin et al.1982, as cited in Buehler 2000). The shallow waters of Great Salt Lake, especially along the shore and in delta bays, also provide good habitat for the eagles to prey on a variety of fish, including carp, suckers, and catfish.

Federally Delisted Species

Peregrine Falcon

Peregrine Falcons are rare permanent residents and breeders in the GSLE. They are aggressive, on-the-wing predators that take avian prey, most commonly by blunt force attacks in full flight or during high-speed stoops. Prey species include most medium-sized passerines, shorebirds, game birds, doves, and pigeons, but species the size of geese have been killed (Johnsgard 1990). Peregrine Falcons typically nest on inaccessible cliffs or utility structures relatively near water and prey.

Federal Candidate Species

Yellow-Billed Cuckoo

Yellow-billed Cuckoo in the western United States is classified as a federal Candidate Species (67 FR 71193 71194). Yellow-billed Cuckoos historically bred along the riparian corridors of the Great Salt Lake

basin (U.S. Fish and Wildlife Service 2002). The Jordan River and Delta once provided large areas of habitat suitable for cuckoos (Mitigation Commission and U.S. Fish and Wildlife Service 2000). However, habitat loss and fragmentation from dewatering, stream canalization, encroachment by nonnative tamarisk, grazing, and oil and gas development have removed most of this species' historical habitat. The current breeding range for Yellow-billed Cuckoos in Utah includes Salt Lake, Tooele, and Washington Counties. Preferred breeding habitat in this area includes riparian woodlands characterized by willow, Fremont cottonwood, and dense mesquite. (Walters 1983; Hughes 1999.) Nests are commonly placed in willows, but cottonwoods are used extensively for foraging. In other areas of the United States, Yellow-billed Cuckoos occupy human-modified habitats including abandoned farmlands, overgrown fruit orchards, successional shrubland, shade trees, and gardens. The principal foods of this species are large insects including caterpillars, cicadas, grasshoppers, and crickets (Hughes 1999). Small frogs, the eggs and young of other birds, and fruit and seeds are also eaten on occasion.

Conservation Agreement Species

Northern Goshawk

Northern Goshawks are rare migrants in the GSLE (Table 2-1), but are more abundant in the higher forested reaches of the watersheds of the GSL and elsewhere in Utah. Ryser (1985) noted that in the Great Basin during winter there is some altitudinal migration of goshawks from mountain forests down into the foothills and valleys, as well as immigration of individuals into the Great Basin from the north. Goshawks have been observed foraging in open sagebrush areas in Nevada where they prey on ground squirrels (Younk and Bechard 1992). Also, wintering goshawks use cottonwood riparian areas in the Rocky Mountains and Intermountain Region (Squires and Ruggiero 1995) as well as adjacent open areas (Hughes 1999). Northern Goshawks prey mostly on large passerine birds, grouse, woodpeckers, corvids, squirrels, rabbits, and hares (Squires and Reynolds 1997).

U.S. Fish and Wildlife Service Birds of Conservation Concern

Swainson's Hawk

Swainson's Hawks are rare summer breeders and uncommon migrants in the GSLE (Table 2-1). They typically breed in riparian habitat but forage in more open habitats such as grassland, shrubland, and agricultural landscapes (England et al. 1997). In agricultural areas of the Central Valley in California Swainson's Hawks forage in row, grain, and hay crop agriculture, particularly during and after harvest when prey animals are both numerous and conspicuous. These birds are also attracted to areas with flood irrigation (especially alfalfa fields); flooded conditions can concentrate rodents in field margins where they are more exposed to predation. During the breeding season, Swainson's Hawks prey mainly on vertebrates (small mammals, birds, and reptiles) (Schmutz et al. 1980; Bednarz 1988; England et al. 1997). Ground squirrels, pocket gophers, voles, and deer mice comprise most of the mammalian prey; however, Swainson's Hawks routinely take rabbits in Utah and New Mexico (Smith and Murphy 1973; Bednarz 1988). The diet of nonbreeders consists largely of insects, particularly grasshoppers and dragonflies (Sherrod 1978; Jarmillo 1993).

Ferruginous Hawk

Ferruginous Hawks are uncommon summer visitants and rare migrants to the GSLE (Table 2-1). These hawks typically occur in flat and rolling terrain in grassland or shrub-steppe regions (Bechard and

Schmutz 1995), including grasslands, sagebrush country, saltbush-greasewood shrublands, and along the periphery of western pinyon and other forests (Olendorff 1993). Nest sites tend to be at elevated sites such as boulders, knolls, low cliffs, trees, large shrubs, and utility structures. While foraging, these hawks commonly perch in trees; on telephone and powerline poles, farm buildings, fence posts, or outcrops; or on the ground. Their principal prey comprises jackrabbits, cottontail rabbits, ground squirrels, and gophers (Olendorff 1993; Bechard and Schmutz 1995).

Golden Eagle

Golden Eagles occur in nearly all habitats of the western states from desert grasslands to above timberline (Johnsgard 1990). They are most common in grass-shrub and young woodland habitats, or in forests with open lands nearby for hunting. Golden Eagles favor hilly terrain over flat country because updrafts in such settings facilitate soaring. The prey species commonly taken include jackrabbits, cottontail rabbits, ground squirrels, and game birds, but Golden Eagles may also eat insects, snakes, juvenile ungulates, and carrion. Individual eagles range over large areas while hunting; they are likely to pass only occasionally through the project study area. Habitats in the project study area that are most suitable for foraging are wet meadow, mudflat/pickleweed, pasture cropland, and salt desert scrub.

Prairie Falcon

Prairie Falcons prefer open habitat (e.g., shrub-steppe desert, grassland, mixed shrub and grassland, alpine tundra) at elevations up to 3,350 m (11,000 ft). In Utah, they prefer open grassland habitats and nest mainly near areas of cheatgrass and mixed shrubs (Peterson 1988). During the winter they frequently hunt in grassland flats and dry-farm wheat fields (White and Ruseneau 1970). Ground squirrels comprise the majority of the diet, with horned larks and western meadowlarks as secondary prey (Steenhof 1998). Mourning doves, lizards, and various open-land passerines are also taken.

American Golden-Plover

American Golden-Plovers forage in wet meadow, mudflat, or pasture habitats. The primary foods taken by this species include various terrestrial invertebrates, leaves, seeds, and berries (Johnson and Connors 1996). Common invertebrates taken include grasshoppers, beetles, bees, ants, flies, weevils, spiders, cutworms, grubs, small molluscs, slugs, and earthworms (Johnson and Connors 1996).

Snowy Plover

Snowy Plovers typically breed on barren to sparsely vegetated ground at alkaline or saline lakes, reservoirs, and ponds (Page et al. 1995). They are closely tied to the dynamic nature of the Great Salt Lake shoreline and mudflats (Aldrich and Paul 2002). Snowy Plovers rely heavily on the tremendous abundance of insects, mostly brine flies, associated with the saline soils of the open shorelines and mudflats. They breed and feed in the same habitat, but breeding and feeding areas are often separate locations. Nests are built on the ground, usually in open or sparsely vegetated areas near water (Page et al. 1995). Nesting locations often change relative to the rise and fall of the Great Salt Lake shoreline (Aldrich and Paul 2002). Accordingly, Snowy Plovers are considered pioneer species, often establishing new nesting sites in areas recently exposed by receding waters of Great Salt Lake during dry cycles. The Great Salt Lake population of Snowy Plovers is the largest known concentration of the species in interior North America, numbering approximately 10,000 individuals (Patton and Edwards 1992 in Aldrich and Paul

2002). In contrast with the resident Pacific coast population, the Great Salt Lake population migrates to the beaches of the Gulf of California during the winter.

American Avocet

American Avocets are common breeders in the GSLE; the breeding population around the lake can reach 53,000 individuals (Aldrich and Paul 2002). Single-day counts at Great Salt Lake have reached 250,000 (including nonbreeders), the highest count of any wetland area in the Pacific Flyway (Shuford et al. 1995; Aldrich and Paul 2002). Mean annual counts of avocets in the Farmington Bay wetlands adjacent to the project study area exceed 9,000 birds (Paul and Manning 2002). Around Great Salt Lake, American Avocets breed primarily in salt ponds, potholes, and shallow alkaline wetlands, where they place nests on barren mudflats, dikes, or islands with sparse vegetation (Robinson et al. 1997). In mudflat and shallow-water habitats, they forage mostly on (midge) larvae (CHIRONOMIDAE); in the water column, they forage on brine flies and waterboatman nymphs and adults (HEMIPTERA: CORIXIDAE) while wading in open water 0–20 cm (0–7.9 in) deep (Aldrich and Paul 2002). While on shore, they consume brine flies concentrated in windrows along the shore, as well as grasshoppers, caterpillars, and spiders. The abundance and distribution of American Avocets around Great Salt Lake is closely tied to the fluctuating lake levels, following the shoreline as it changes with and during the seasons (Aldrich and Paul 2002).

Solitary Sandpiper

Solitary Sandpipers are rare migrants in the GSLE. During spring and fall migration they are generally found around enclosed wet or muddy habitats along riparian corridors, drainage ditches, wet meadows, mudflats, and pastures. Major food items include mosquito larvae, grasshoppers, beetles, dragonfly nymphs, water boatman, spiders, and worms (Moskoff 1995).

Whimbrel

Whimbrels are rare migrants in the GSLE. Migrant Whimbrels typically forage and rest in meadows, fields, river deltas, estuaries, salt marshes, and sandy beaches. The principal foods taken by this species during migration are crayfish, where available; otherwise grasshoppers and similar insects constitute the mainstay (Skeel and Mallory 1996).

Long-Billed Curlew

Long-billed Curlews are uncommon breeders and common migrants in the GSLE. They typically forage in higher and drier meadowlands than many other shorebirds, preferring areas with mixed short grass cover and bare ground components. Long-billed Curlews breed and/or forage in mudflat/pickleweed, shallow open water, cropland, pasture, and wet meadow habitats. Uncultivated rangelands and pastures as well as rice and alfalfa fields support most of the Long-billed Curlew populations throughout the West (Dugger and Dugger 2002). Curlews feed on a variety of crustaceans, molluscs, worms, frogs and toads, various insects, and berries.

Marbled Godwit

Marbled Godwits are common migrants in the GSLE. During migration, godwits tend to congregate around emergent marshes, lake and pond shorelines, open fields, mudflats, and sandy beaches. Marbled

Godwits in the GSLE forage in shallow open water along the lakeshore, wet meadows, mudflats, and pasture. They feed on insects, aquatic invertebrates, plant tubers, and small fish (Gratto-Trevor 2000).

Sanderling

Sanderlings are uncommon migrants and rare winter visitants in the GSLE. During migration they are most likely to be found along the beaches and mudflats around the lakeshore. Principal foods likely comprise invertebrates (e.g., brine flies, brine shrimp) washed up on the beaches.

Wilson's Phalarope

Wilson's Phalaropes annually form enormous aggregations (up to 600,000) around Great Salt Lake from mid-June to September as they stage during migration (Colwell and Jehl 1994). Wilson Phalaropes are salt lake specialists and rely heavily on the brine shrimp and brine flies in Great Salt Lake to provide sufficient fuel for migration. While staging at Great Salt Lake and Mono Lake, these birds may double their body mass with stored fat (Colwell and Jehl 1994; Aldrich and Paul 2002). The extensive open water and shallow shorelines of Great Salt Lake's south arm provide the primary foraging habitats for Wilson's Phalaropes. During high-water periods, former uplands become shoreline habitats that tend to concentrate food resources for this species. It is largely because of the tremendous concentrations of Wilson's Phalaropes at Great Salt Lake and their strong dependence on the abundant food resources of the lake that the GSLE has been designated an internationally important WHSRN site. Wilson's Phalarope is the only shorebird species that molts at Great Salt Lake. Some individuals nest in Great Salt Lake wetlands.

Burrowing Owl

Burrowing Owls are rare breeders in the GSLE. During the breeding season they prefer dry, open shortgrass habitats, generally without trees. They are typically associated with burrowing mammals such as ground squirrels. Across their range, Burrowing Owls nest in burrows in pastures, agricultural fields, vacant lots in residential areas, golf courses, cemeteries, university campuses, and fairgrounds. Burrowing Owls are generally opportunistic feeders and prey upon arthropods, small mammals, birds, amphibians, and reptiles (Haug et al. 1993).

Loggerhead Shrike

Loggerhead Shrikes are uncommon residents and breeders in the GSLE. They breed in short trees and shrubs and forage primarily in pasture, salt desert scrub, and cropland habitats. Shrikes prey upon a variety of arthropods, amphibians, reptiles, small mammals, and birds (Yosef 1996); they also feed on carrion. They forage in open landscapes characterized by well-spaced, often spiny shrubs and low trees, usually interspersed with short grasses, forbs, and bare ground. Shrikes impale prey on spines on shrubs and/or barbed wire for storage or to secure it during feeding.

Virginia's Warbler

Virginia's Warblers are rare migrants in the GSLE. During fall and spring migration they forage and rest in cottonwood- and willow-dominated riparian areas. These insectivores forage by gleaning insects from plant foliage or by "hawking" insects from the air (Olson and Martin 1999).

Brewer's Sparrow

Brewer's Sparrows are common breeders and migrants in the GSLE. They favor sagebrush shrublands and salt desert scrub habitat, especially areas dominated by saltbush and creosote species, occasionally mixed with grasses (Rottenberry et al. 1999). During spring and summer, they are often the most abundant birds in these habitats. Brewer's Sparrows are largely insectivorous, gleaning insects from the foliage and bark of shrubs and small trees; they also forage for seeds on the ground.

Utah Division of Wildlife Resources Wildlife Species of Concern

American White Pelican

American White Pelicans are common breeders on islands in the GSLE. They are found almost exclusively in open water habitat and occasionally in the open water areas of emergent marshes. Pelicans feed on fish that concentrate in shallow water areas around the lake. The only breeding colony of American White Pelicans in Utah is on Gunnison Island in Great Salt Lake's north arm (Aldrich and Paul 2002). Exceeding 20,000 in some years, this colony is one of the largest breeding populations in North America. However, this colony is some distance from reliable fisheries, most of which are associated with freshwater outflow from the streams and rivers on the east side of the lake (especially Bear River National Wildlife Refuge and Farmington Bay). Consequently, pelicans must commute from Gunnison Island to these areas, a minimum 90-km (60-mi) round trip for foraging adults (Aldrich and Paul 2002).

Short-Eared Owl

Short-eared Owls are common breeders throughout the GSLE. They are commonly associated with open country (e.g., grasslands and shrub-steppe habitat) (Holt and Leasure 1993). Short-eared Owls breed and/or forage in mudflat/pickleweed, emergent marsh, cropland, pasture, salt desert scrub, and wet meadow habitats. Nest sites are typically on slight ridges in areas with enough vegetation to conceal the incubating female. During the nonbreeding season these owls commonly forage and roost in large open woodlots, stubble fields, and shrub thickets. They feed primarily on small mammals (e.g., voles, deer mice, rats, shrews, rabbits, and pocket gophers), as well as on a variety of birds (e.g., shorebirds, rails, gulls, terns, and passerines).

Bobolink

Bobolinks are rare migrants in the GSLE. Isolated breeding populations of this species occur in northern Utah. These populations occur in or near Centerville, Logan, Brigham City, Kamas, Heber, Morgan, Mountain Green, West Layton, and Provo. Bobolinks nest and forage in wet meadows, wet grasslands, and irrigated areas (primarily pasture and hay fields). Although historically common in northern Utah, Bobolinks are now rare in the area, and they often exhibit unpredictable fluctuations in population numbers. During the breeding season, their diet includes weed and grain seeds, a variety of larval and adult insects, spiders, and harvestmen. The young are exclusively fed invertebrates. During migration and winter periods, grain seeds are the staple diet, supplemented occasionally with insects (Martin and Gavin 1995).

Grasshopper Sparrow

Grasshopper Sparrows occur in the Great Basin region of Utah (McIvor 1998) (Appendix A). They breed in shrub steppe habitats in Utah and may nest and/or forage in wet meadow, cropland, and pasture habitats as well. Their preferred habitats in the western United States comprise lush portions of open grasslands that also include a sparse shrub component. Grasshopper Sparrows consume mostly large insects, such as grasshoppers, in the summer. They capture insects exclusively on the ground; exposed, bare areas are required for successful foraging (Vickery 1996).

Preble's Shrew

Very little is known about the distribution of Preble's shrew in Utah. Its range, as it is currently understood, includes much of Montana, central Idaho, eastern Oregon, and surrounding areas in semiarid to arid habitats. Records of its occurrence in Timpie Springs along the southern shore of Great Salt Lake indicate its presence in this region. The known habitat of this species includes marshy areas such as creeks and bogs bordered by willows and other brushy plants. Preble's shrews have recently been found in a montane sagebrush community in northern California, suggesting that the species may also use drier habitats (Zeveloff and Collett 1988). Because similar habitats are found within the project study area the species may occur there; however, until comprehensive surveys are conducted, its status in the project study area is unknown. Habitats with the highest potential for supporting this species include emergent marsh and remnant riparian areas.

Spotted Bat

Very little is known about the distribution or biology of spotted bats in Utah. This species is considered one of North America's rarest mammals (Zeiner et al. 1990). While Great Salt Lake is well within the known distribution of this species (Zeveloff and Collett 1988), virtually nothing is known about its local distribution. The species occurs in a variety of habitats, commonly rough, desert-like terrain characterized by vertical cliffs suitable for roosting. Spotted Bats often roost in caves and occasionally in buildings. Radiotelemetry studies of this species at the Grand Canyon in Arizona indicate that individuals can travel long distances to forage. One bat was tracked 38.5 km (24 mi) from its roosting cliff at the bottom of the canyon to foraging areas in the forests on the North Rim (Rabe et al. 1998). This long-range commute capability suggests that individuals roosting in cliffs in the Wasatch Mountains could commute to foraging grounds around Great Salt Lake. However, because no local studies have been conducted, it is not known whether spotted bats visit the project study area.

Townsend's Big-Eared Bat

Townsend's big-eared bats are common in the highlands of the West, often found in scrub plant communities, pinyon-juniper and pine forests, and deciduous woodlands (Zeveloff and Collett 1988). However, they appear to be generally uncommon in dry regions. Local distribution is closely tied to the presence of roosting caves, mines, or buildings within reasonable commute distances (up to 32.2 km [20 mi]) of foraging areas (Pearson 1952). Prey items include small moths, flies, lacewings, dung beetles, and sawflies (Davis and Schmidly 1994). In Utah, this species frequently hibernates in mines and caves (Zevelloff and Collett 1988). Such features are likely present in many locations around Great Salt Lake, especially in the Wasatch Mountains and nearby desert hills.

Kit Fox

Great Salt Lake is located on the northeastern edge of the known distribution of kit fox (Zevellof and Collett 1988). Kit foxes are found throughout Utah in desert and semiarid regions with flat shrub or shrub-grass communities with little ground cover. Where these foxes occur in the Great Basin, shadscale, greasewood, and sagebrush communities are common. Major prey items include desert rodents, jackrabbits, cottontail rabbits, groundnesting birds, reptiles, and insects.

2.4.4 Existing Habitat Fragmentation

Habitat fragmentation, by definition, results in the formation of smaller patches of habitat where larger, more contiguous patches once existed (Meffe et al. 1997). As a result of fragmentation, a larger population of a species that inhabited the original patch may become divided into several smaller subpopulations that are connected only by migrating individuals rather than by contiguous habitat (Primack 2000). Habitat fragmentation results not only in direct habitat loss, but also in changes in the geometry and biological connectivity between patches (Meffe et al. 1997). Each of these changes can result in modifications of the availability and suitability of habitat to extant wildlife in an affected area. Over time, extinction rates in smaller, more isolated populations are generally higher than those in larger populations because of loss of genetic variation, inbreeding, genetic drift, and greater susceptibility to random population fluctuations and environmental changes, all of which ultimately affect the long-term viability of wildlife populations (Soulé 1987; Forman 1995; Primack 2000). In general, such results are most likely to affect relatively sedentary species with low dispersal capabilities (e.g., amphibians, reptiles, small mammals, and many invertebrates).

Roadway construction can divide the landscape, resulting in local and regional habitat loss and fragmentation (change in spatial pattern) and disrupting animal movement patterns. The existing habitats within the project study area have already experienced extensive fragmentation due to previous construction of railroad corridors (Union Pacific Railroad [UP] and Denver & Rio Grande Railroad [D&RG]), I-15, and many smaller roads, as well as other forms of disturbance (e.g., farming, grazing, dikes, fences) in many areas in the project vicinity. Consequently, the wildlife populations present in the area may already have experienced population changes that are often associated with habitat fragmentation (e.g., reduced carrying capacity, lower reproductive success, higher susceptibility to predation). These populations will continue to respond to changes in habitat quality and quantity that have already occurred and that could occur as a result of the proposed Legacy Parkway project and future development in the GSLE. Figure 2-10 illustrates the size and number of habitat patches currently extant in the project study area.

2.4.5 Status of Existing Habitat Quality

Water Quality

The water quality status of the project study area is described in the Final EIS (Federal Highway Administration et al. 2002). Since publication of the Final EIS, the Jordan River has been listed as an impaired water that does not meet Class 3B (warmwater species of game fish) and Class 3C (non-game fish) standards under the Clean Water Act due to low dissolved oxygen (Toole 2002; HDR Engineering, Inc. 2004).

Air Quality

Air quality in the region is considered to be generally good. The air quality monitoring site nearest the project study area is in Bountiful (65 West 300 South). Levels of ozone, sulfur dioxide, carbon monoxide, and particulate matter (PM10 and PM2.5) are monitored at the site. Salt Lake and Davis Counties are nonattainment areas for ozone and PM10. Since 1997, there have been two exceedances of the 1-hour standard for ozone (0.125 ppm) and two for the new PM2.5 standard (65 jg/cu m) (King pers. comm. 2003).

2.4.6 Status of Existing Wetland Hydrology

The hydrology of the project study area is a function of both seasonal and spatial patterns of water flow, both on the surface and underground. The surface water bodies within the study area include the Jordan River, nine creeks, and wetlands associated with Great Salt Lake and along ditches and canals. The wetlands respond to a shallow water table associated with groundwater discharge and periodic precipitation. The project study area is located over a multilayered groundwater flow system consisting of a shallow unconfined aquifer and a deeper principal aquifer that is part of a larger east shore aquifer system. The depth of the shallow groundwater varies between 0 and 3 m (9 ft).

The principal aquifer lies at a depth of approximately 60 m (200 ft) and is separated from the shallow groundwater by a layer of fine-grained soil of varying thickness. It is recharged primarily by precipitation at the base of the Wasatch Mountains, outside the project study area. Subsurface groundwater flow generally moves from this recharge area west toward Great Salt Lake, but there is also an equal or greater component of vertical flow from deeper confined zones of the principal aquifer (Forster and Neff 2002).

2.4.7 Existing Artificial Landscaping in Project Vicinity

Portions of the project study area have been artificially landscaped in residential, commercial, and industrial areas. Some of this landscaping also exists in rural residential areas, particularly around ranch houses and other ranch buildings. Artificial landscaping incorporates many nonnative and native trees, shrubs, and other vegetation.

2.4.8 Existing Sources of Direct Wildlife Mortality in Project Vicinity

There is little information on existing sources of wildlife mortality within the project study area. Aside from natural causes of death (e.g., predation, disease, old age), there is undoubtedly some roadkill associated with existing roads in the area, particularly for amphibians, reptiles, and small mammals found in adjacent habitats, as well as predatory birds and mammals that may be attracted to the carcasses.

2.4.9 Existing Sources and Levels of Noise in Project Vicinity

The noise levels within the project study area were measured to determine existing conditions. This analysis included both short-term (1-hour) and long-term (3-day) measurements at various locations within the project study area and up to approximately 6 km (3.7 mi) beyond the project study area. Existing noise levels in the project study area are elevated by traffic noise from I-15 and aircraft overflight.

Short-Term Noise Measurements

Table 2-16 summarizes the sound levels for the short-term measurements at each sampling location in the project study area (Figure 2-11). The loudest noise values (Lmax) ranged between 53 and 79 decibels (A-weighted) (dB[A]); the lowest noise values (Lmin) ranged between 31 and 45 dB(A). During the measurement periods, the sound levels on average exceeded 51 dB(A) 10% of the time, 43 dB(A) 50% of the time, and 39 dB(A) 90% of the time. The highest sound levels were generally associated with plane overflights; the highest wildlife signals (duck vocalizations) were approximately 52 dB(A) (at approximately 30 meters from the microphone). The mean equivalent steady state sound level (Leq) across the entire study area was 48.6 dB(A) (S.D. = +/- 6.6), with a minimum value of 37.1 dB(A) and a maximum value of 59.9 dB(A).

Long-Term Noise Measurements

Figure 2-12 shows the long-term hourly sound levels and the local wind speeds measured at survey location L1 in the project study area. The wind speed profile shows the wind speeds recorded at Salt Lake City International Airport for July 1–3, 2003.

Table 2-17 presents the average, minimum, and maximum sound levels measured at the three long-term measurement stations in the project study area (Figure 2-11). The highest noise level (81 dB[A]) was recorded at location 1 (L1), closest to 1-15; the lowest value (32 dB[A]) was recorded at location 2 (L2). The average sound level across the entire area surveyed was 50 dB(A), with a minimum value of 36 dB(A) and a maximum value of 78 dB(A) (Leq, L1-L3).

Overall, sound levels exceeded 51 dB(A) 10% of the time, 45 dB(A) 50% of the time, and 40 dB(A) 90% of the time. There were no differences in the average values between the long-term sound level measurements (Table 2-17) and the short-term measurements (Table 2-16). However, the ranges of sound levels recorded for these values were larger for the long-term measurements. On average, the noise levels recorded at L2 were lower than those recorded at L1 and at L3.

2.4.10 Existing Sources of Artificial Light in Project Vicinity

Increased lighting and glare can affect wildlife in a variety of ways, both positive and negative. Some species, such as bats and foxes, benefit from artificial light because it attracts aerial insects or small mammals, their primary prey. Other species, including some fish, amphibians, birds, mammals, and invertebrates, may have their diurnal or reproductive cycles interrupted or may experience direct mortality and increased predation rates because of artificial light and glare (Appendix D).

The project study area is affected by artificial lighting from residential and commercial developments in the greater Salt Lake City region. Some of the major industrial sources of artificial light and glare in the project vicinity are listed below.

- Chevron USA, Inc., petroleum refinery in Salt Lake City.
- Amoco Oil Company petroleum refinery in Salt Lake City.
- Tesoro petroleum refinery in Salt Lake City.
- Flying J petroleum refinery in North Salt Lake.

- Portland Cement plant in North Salt Lake.
- Phillips 66 petroleum refinery in Woods Cross.
- Crysen Refining petroleum refinery in Woods Cross.
- Golden Eagle Refinery, Inc., petroleum refinery in Woods Cross.
- Utah Power and Light substation in Centerville.
- Salt Lake City International Airport, located just west of the project's southern terminus (runway, building, and control tower lights, as well as aircraft lights).

2.4.11 Existing Sources of Human Disturbance in Project Vicinity

Human disturbance can have adverse effects on wildlife, and many bird species are sensitive to some level of direct disturbance of their nest sites or intrusions into their nesting territories. Portions of the project study area have already been converted to residential, commercial, and industrial uses; wildlife using these areas often experiences frequent disturbance from human activities and domestic pets. Human and domestic pet access to the wildlife habitat adjacent to the highway could result in some level of habitat degradation and wildlife mortality; cats pose a particular threat to wildlife (especially avian) mortality. Other portions of the project study area are currently low-density, rural residential areas or ranches. In those areas, potential human sources of wildlife disturbance include vehicle traffic on the unsurfaced roads and off-highway vehicle use in unroaded areas. The actions of horses and cattle (e.g., grazing, trampling) are likely to remove cover and alter species habitat. In addition, unauthorized hunting and shooting that may occur in some areas can result in direct wildlife mortality.

Chapter 2

Tables

Table 2-1. Special-Status Wildlife Species of the Legacy Parkway Project Study Area/Great Salt Lake Ecosystem

Species	Migratory Species[1]	GSL Ecosystem					Legacy Parkway Project Study Area							Habitat Use								
		Seasonal Abundance				Breeds in GSLE	Seasonal Abundance				Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
		P	S	W	T		P	S	W	T												
Federally Listed Species[2]																						
Bald Eagle (Threatened)	X		RS	CW		X		RS	CW		X	X			FB	F	F	F	F		F	
Federal Candidate Species[2]																						
Yellow-billed Cuckoo	X				RT								X		F							F
Conservation Agreement Species[3]																						
Northern Goshawk	X				RT							(x)			F						F	
USFWS Birds of Conservation Concern[4]																						
Swainson's Hawk	X		RS		UT	X		RS			X	X			B		F	F	F	F	F	
Ferruginous Hawk (also WSC species)	X		US		RT								X				F	F	F	F	F	
Golden Eagle	X	RP								RT		X					F	F	F	F	F	
Peregrine Falcon	X	RP				X	RP				X	X				F	F	F	F	F	F	F
Prairie Falcon	X	RP				X	RP					X					F	F	F	F	F	
American Golden-Plover	X				RT								X				F	F	F			
Snowy Plover	X		CS			X							X					FB				
American Avocet	X		CS			X		CS			X	X		F		FB	FB	FB	FB			
Solitary Sandpiper	X				RT					RT		X			F		F	F	F			
Whimbrel	X				RT								X					F	F			
Long-billed Curlew	X		US		CT	X				RT		X					F	FB			FB	
Marbled Godwit	X				CT					RT		X		F			F	F	F			
Sanderling	X			RW	UT								X					F				
Wilson's Phalarope	X		US		CT	X		RS		UT	X	X		F		F	FB	F	F			
Burrowing Owl (also WSC species)	X		RS			X		RS			X	X						F	F		FB	
Loggerhead Shrike	X	UP				X	UP					X			F						FB	F
Virginia's Warbler	X				RT								X		F						F	F
Brewer's Sparrow	X		CS		CT	X		RS				X			F		F	F	F	F	FB	F
Utah DWR Wildlife Species of Concern[3]																						
American White Pelican	X		CS			X		RS				X		F		F						
Short-eared Owl	X	CP				X	UP				X	X				F	F	F	F	F	FB	
Bobolink	X		RS										X				F		F	F	F	
Preble's shrew		D											(x)				X					
Spotted bat		R											X		X		X	X		X		X
Townsend's big-eared bat		C											X		X		X	X		X		X
Kit fox		A											X								X	
Summary: Total number of cells with values	24	9	11	2	13	13	4	7	1	5	7	16	12	4	10	6	18	20	16	10	14	7

[1] Species identified in the Migratory Bird Treaty Act
[2] Species listed under the Endangered Species Act
[3] UDWR (2003)
[4] USFWS (2002)

Bird Codes

Abundance Status

C = Common: Found consistently in fair numbers in appropriate habit and season
U = Uncommon: Found consistently in small numbers in appropriate habitat and season
R = Rare: Found infrequently but regularly in very small numbers in appropriate habitat and season

Residence Status

P = Permanent Resident: Found year-round
S = Summer visitant: Present during the nesting season
W = Winter visitant: Present during January and February
T = Transient: Migrates through the area in the spring and/or fall
X = Column heading status applies
(X) = Very few GSLE records; low probability of occurrence at Legacy Parkway project study area

Habitat Use Codes

F = Foraging Habitat
B = Breeding Habitat
FB = Foraging and Breeding Habitat

Codes for Amphibians, Reptiles, and Mammals

C = Common
R = Rare
D = Within species range but insufficient data to determine abundance
A = Accidental
X = Column heading status applies

Table 2-2. Wildlife and Fish of Open Water Habitat

	Migratory Species	Legacy Parkway Project Study Area							Habitat Use								
		Seasonal Abundance				Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
		P	S	W	T												
Birds																	
Pacific Loon	X							X	F								
Common Loon	X							X	F								
Pied-billed Grebe	X		US	RW		X	X		F		FB	F					
Horned Grebe	X							X	F		F						
Eared Grebe	X		RS		CT		X		FB		B						
Western Grebe	X				RT		X		FB		B						
Clark's Grebe	X							X	FB		B						
American White Pelican (WSC)	X		RS				X		F		F						
Double-crested Cormorant	X		RS			X	X		F	B	F						
Great Blue Heron	X	CP				X	X		F	FB	FB	F					
Great Egret	X							X	F		F						
Snowy Egret	X		US				X		F	B	FB	F	F	F			
Black-crowned Night-Heron	X		CS			X	X		F	B	FB	F	F	F			
White-faced Ibis	X		CS				X		F		FB	F	F	F	F		
Tundra Swan	X							X	F								
Trumpeter Swan	X							X	F								
Canada Goose	X	CP				X	X		F		F	F	F	FB	F	F	F
Greater White-fronted Goose	X							X	F						F		
Wood Duck	X							X	F								F
Green-winged Teal	X				UT		X		F		FB	FB	F	F	F		
Mallard	X	UP				X	X		F	F	FB	FB	F	FB	FB		F
Northern Pintail	X				UT		X		F		FB	FB	F	F	F	B	
Blue-winged Teal	X		RS				X		F		FB	FB	F	F			
Cinnamon Teal	X		RS				X		F		FB	FB	F	F	F		
Northern Shoveler	X				UT		X		F		FB	FB	F	F		B	
Gadwall	X		US	UT		X	X		F		FB	FB	FB	FB	FB	B	
Eurasian Wigeon	X				RT		X		F		F	F	F	F	F		
American Wigeon	X				RT		X		F		F	F	F	F	F		
Canvasback	X							X	F		FB						
Redhead	X							X	F		FB						
Ring-necked Duck	X							X	F								
Greater Scaup	X							X	F								
Lesser Scaup	X							X	F								
Long-tailed Duck	X							X	F								
White-winged Scoter	X							X	F								
Surf Scoter	X							X	F								
Common Goldeneye	X			RW			X		F								
Barrow's Goldeneye	X							X	F								
Bufflehead	X							X	F								
Hooded Merganser	X							X	F								
Common Merganser	X							X	F								
Red-breasted Merganser	X							X	F								
Ruddy Duck	X				RT		X		F		FB						
Osprey	X				RT		X		F								
Peregrine Falcon (BCC)	X	RP				X	X		F		F	F	F	F	F	F	F
Common moorhen	X							X	F		FB						
American Coot	X	UP				X	X		F		FB	FB	F	F	F		
Sandhill Crane	X				RT		X		F		FB	F	F	F	F		
Black-necked Stilt	X		CS			X	X		F		FB	FB	FB	FB			
American Avocet (BCC)	X		CS			X	X		F		FB	FB	FB	FB			
Greater Yellowlegs	X				UT		X		F			F	F	F			
Lesser Yellowlegs	X				UT		X		F			F	F	F			
Marbled Godwit (BCC)	X				RT		X		F			F	F	F			
Short-billed Dowitcher	X							X	F		F	F	F				
Long-billed Dowitcher	X				RT		X		F		F	F	F				
Wilson's Phalarope (BCC)	X		RS		UT	X	X		F		F	FB	F	F			
Red-necked Phalarope	X				RT		X		F								
Franklin's Gull	X				CT		X		F		FB	F	F	F	F		
Bonaparte's Gull	X				RT		X		F		F						
Ring-billed Gull	X			UW			X		F		F	F	F	F	F		F
California Gull	X	UP					X		F		F	F	F	F	F	F	F
Herring Gull	X							X	F								F
Thayer's Gull	X							X	F								F
Glaucous Gull	X							X	F								F
Caspian Tern	X		RS				X		F								
Common Tern	X							X	F								
Forster's Tern	X		CS			X	X		F		FB						
Black Tern	X		RS				X		F								
Common Nighthawk	X				UT		X		F	F	F	F	F	F	F	F	F
Common Poorwill	X				RT			X	F	F	F	F		F	F	F	F
Belted Kingfisher	X	UP				X	X		F	FB							
Purple Martin	X							X	F	F	F	F	F	F	F	F	F
Tree Swallow	X				CT		X		F	F	F	F	F	F	F	F	F
Violet-green Swallow	X				UT		X		F	F	F	F	F	F	F	F	F
Northern Rough-winged Swallow	X				UT		X		F	F	F	F	F	F	F	F	F
Bank Swallow	X				CT		X		F	F	F	F	F	F	F	F	F
Cliff Swallow	X		CS			X	X		F	F	F	F	F	F	F	F	B
Barn Swallow	X		CS			X	X		F	F	F	F	F	F	F	F	B
Fish																	
Carp		C				X	X		X		X						
Utah sucker								X	X		X						
Channel catfish								X	X		X						
Bullhead								X	X		X						
Green sunfish								X	X		X						
Mammals																	
Muskrat		C					X		X	X	X	X					X

	Migratory Species	Legacy Parkway Project Study Area							Habitat Use								
		Seasonal Abundance				Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
		P	S	W	T												
Summary																	
Birds	78	7	18	4	24	16	48	30	78	15	48	38	35	34	25	15	18
Fish	0	1	0	0	0	1	1	4	5	0	5	0	0	0	0	0	0
Mammals	0	1	0	0	0	0	1	0	1	1	1	1	0	0	0	0	1

Special-Status Species

FT	Federally Listed as Threatened
FC	Federal Candidate Species
BCC	Birds of Conservation Concern
CAS	Conservation Agreement Species
WSC	Wildlife Species of Concern
X	Breeds in Project Study Area

Bird Codes

Abundance Status

C = Common: Found consistently in fair numbers in appropriate habitat and season
U = Uncommon: Found consistently in small numbers in appropriate habitat and season
R = Rare: Found infrequently but regularly in very small numbers in appropriate habitat and season

Residence Status

P = Permanent Resident: Found year-round
S = Summer visitant: Present during the nesting season
W = Winter visitant: Present during January and February
T = Transient: Migrates through the area in the spring and/or fall
X = Column heading status applies
(X) = Very few GSLE records; low probability of occurrence at Legacy Parkway project study area

Examples of Combined Codes

CP = Common Permanent Resident
RW = Rare Winter Visitant
UT = Uncommon Transient

Habitat Use Codes

F = Foraging Habitat
B = Breeding Habitat
FB = Foraging and Breeding Habitat

Codes for Amphibians, Reptiles, and Mammals

C = Common
R = Rare
D = Within species range but insufficient data to determine abundance
X = Column heading status applies

Table 2-3. Wildlife of Riparian Habitat

Species	Migratory Species	Legacy Parkway Project Study Area							Habitat Use								
		Seasonal Abundance				Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur Within Project Study Area	Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
		P	S	W	T												
Birds																	
Double-crested Cormorant	X		RS			X	X		F	B	F						
Great Blue Heron	X	CP				X	X		F	FB	FB	F					
Snowy Egret	X		US				X		F	B	FB	F	F	F			
Black-crowned Night-Heron	X		CS			X	X		F	B	FB	F	F	F			
Mallard	X	UP				X	X		F	F	FB	FB	F	FB	FB		F
Bald Eagle (FT)	X		RS	CW		X	X			FB	F	F	F	F		F	
Northern Harrier	X	CP				X	X			F	FB	F	F	FB	F	FB	F
Sharp-shinned Hawk	X				RT		X			F			F	F	F	F	F
Cooper's Hawk	X				RT		X			F			F	F	F	F	F
Northern Goshawk (CAS)	X							(X)		F						F	
Swainson's Hawk (BCC)	X		RS			X	X			B		F	F	F	F	F	
Red-tailed Hawk	X	UP				X	X			B		F	F	F	F	F	F
American Kestrel	X	CP				X	X			B		F	F	F	F	F	F
Ring-necked Pheasant		RP				X	X			F		F	F	FB	FB	FB	FB
California Quail								X		FB					F		FB
Solitary Sandpiper (BCC)	X				RT		X			F		F	F	F			
Spotted Sandpiper	X				RT		X			FB			F				
Mourning Dove	X		US	RW		X	X			FB			F	F	F	F	FB
Yellow-billed Cuckoo (FC)	X							X		F							F
Great Horned Owl	X	UP				X	X			FB	F	F	F	F	F	F	FB
Long-eared Owl	X							X		F		F	F	F		F	
Common Nighthawk	X				UT		X		F	F	F	F	F	F	F	F	F
Common Poorwill	X				RT			X	F	F	F	F		F	F	F	F
White-throated Swift	X				RT			X		F	F	F		F	F	F	F
Black-chinned Hummingbird	X				RT		X			F		F	F	F	F	F	F
Calliope Hummingbird	X							X		F		F	F	F	F	F	F
Broad-tailed Hummingbird	X				RT		X			F		F	F	F	F	F	F
Rufous Hummingbird	X				RT		X			F		F	F	F	F	F	F
Belted Kingfisher	X	UP				X	X		F	FB							
Red-naped Sapsucker	X							X		F							F
Downy Woodpecker	X							X		F							F
Northern Flicker	X				RT		X			FB						F	FB
Olive-sided Flycatcher	X				RT		X			F						F	F
Western Wood-Pewee	X				RT		X			F						F	F
Cordilleran Flycatcher	X				RT		(X)			F						F	F
Willow Flycatcher (BCC)	X				RT		(X)			F						F	F
Hammond's Flycatcher	X				RT		(X)			F						F	F
Dusky Flycatcher	X				RT		(X)			F						F	F
Gray Flycatcher	X				RT		(X)			F						F	F
Ash-throated Flycatcher	X				RT		(X)			F						F	F
Western Kingbird	X		US			X	X			FB		F	F	F	F	F	FB
Eastern Kingbird	X							X		F							F
Northern Shrike	X			UW			X			F	F	F	F	F	F	F	F
Loggerhead Shrike (BCC)	X	UP					X			F	F	F	F	F	F	FB	F
Plumbeous Vireo	X							X		F							F
Warbling Vireo	X				RT		X			F						F	F
Black-billed Magpie	X	UP				X	X			FB		F	F	F	F	F	FB
Common Raven	X	CP				X	X			B	F	F	F	F	F	F	FB
Purple Martin	X							X	F	F	F	F	F	F	F	F	F
Tree Swallow	X				CT		X		F	F	F	F	F	F	F	F	F
Violet-green Swallow	X				UT		X		F	F	F	F	F	F	F	F	F
Northern Rough-winged Swallow	X				UT		X		F	F	F	F	F	F	F	F	F
Bank Swallow	X				CT		X		F	F	F	F	F	F	F	F	F
Cliff Swallow	X		CS			X	X		F	F	F	F	F	F	F	F	B
Barn Swallow	X		CS			X	X		F	F	F	F	F	F	F	F	B
Black-capped Chickadee	X			RW	RT		X			F						F	F
Mountain Chickadee	X							X		F							F
House Wren	X							X		F						F	F
Ruby-crowned Kinglet	X				RT		X			F						F	F
Blue-gray Gnatcatcher	X							X		F						F	F
Hermit Thrush	X							X		F							F
Swainson's Thrush	X							X		F							F
American Robin	X	UP				X	X			FB		F	F	F	F		FB
Gray Catbird	X							X		FB							
Northern Mockingbird	X							X		F						F	F
European Starling			US	CW		X	X			FB		F	F	F	F	F	FB
American Pipit	X				CT		X			F		F	F	F	F		
Bohemian Waxwing	X			RW			X			F							F
Cedar Waxwing	X			RW			X			F							F
Orange-crowned Warbler	X				RT		X			F						F	F
Nashville Warbler	X				RT		X			F							F
Virginia's Warbler (BCC)	X							X		F						F	F
Yellow Warbler	X				UT		X			F	F					F	F
Yellow-rumped Warbler	X				CT		X			F	F					F	F
Townsend's Warbler	X				RT		X			F							F
American Redstart	X							X		F							F
Northern Waterthrush	X							X		F							
MacGillvray's Warbler	X				RT		X			F	F					F	F
Common Yellowthroat	X		US			X	X			F	FB						
Wilson's Warbler	X				RT		X			F	F					F	F
Western Tanager	X							X		F							F
Black-headed Grosbeak	X							X		F							F
Lazuli Bunting	X				UT		X			F						F	F
Green-tailed Towhee	X							X		F							F
Spotted Towhee	X				RT		X			F						F	F
American Tree Sparrow	X			UW			X			F	F	F	F	F	F	F	F
Chipping Sparrow	X				CT		X			F		F	F	F	F	F	F
Brewer's Sparrow (BCC)	X		RS				X			F		F	F	F	F	FB	F
Vesper Sparrow	X				RT		X			F		F	F	F	F	F	F
Lark Sparrow	X				RT		X			F		F	F	F	F	F	F
Song Sparrow	X	UP				X	X			FB	F	F		F			F

Species	Migratory Species	Legacy Parkway Project Study Area: Seasonal Abundance				Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur Within Project Study Area	Habitat Use: Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
		P	S	W	T												
Lincoln's Sparrow	X				RT		X			F		F		F	F	F	F
Harris' Sparrow	X							X		F		F	F	F	F	F	F
White-throated Sparrow	X							X		F		F	F	F	F	F	F
White-crowned Sparrow	X			CW			X			F	F	F	F	F	F	F	F
Dark-eyed Junco	X			CW			X			F	F	F	F	F	F	F	F
Red-winged Blackbird	X	CP				X	X			F	FB	F	F	F	F		F
Yellow-headed Blackbird	X		CS			X	X			F	FB	F	F	F	F	F	F
Brewer's Blackbird	X	UP				X	X			F	F	F	F	FB	FB	F	F
Brown-headed Cowbird	X	UP				X	X			FB	FB	FB	FB	FB	FB	FB	FB
Northern Oriole	X		US			X	X			FB							FB
Cassin's Finch	X							X		F							F
House Finch	X	CP				X	X			FB	F	F	F	F	F	FB	FB
Pine Siskin	X			CW			X			F					F	F	F
American Goldfinch	X			UW			X			F	F	F			F	F	F
Evening Grosbeak	X			RW				X		F							F
House Sparrow				UP		X	X			F				F	F		FB
Amphibians																	
Woodhouse's toad								X		X	X	X		X			
Reptiles																	
Gopher snake		CP				X	X			X				X	X	X	
Common garter snake		CP				X	X			X	X	X		X			
Terrestrial garter snake								X		X	X	X		X			
Mammals																	
Western small-footed myotis	X							X		X	X	X		X		X	
Little brown bat	X							X		X	X	X		X		X	
Long-legged myotis	X							X		X	X	X		X		X	
Big brown bat	X							X		X	X	X		X		X	
Hoary bat	X							X		X							
Townsend's big-eared bat (WSC)	X							X		X	X	X		X		X	
Northern pocket gopher								X		X				X	X		
Botta's pocket gopher								X		X				X	X	X	
Beaver		R					X			X							
Western harvest mouse								X		X				X		X	
Deer mouse		C				X	X			X				X	X	X	X
Meadow vole		C				X	X			X		X		X		X	
Montane vole		D						X		X		X			X		
Long-tailed vole								X		X				X			
Muskrat		C				X	X		X	X	X	X					X
House mouse		C				X	X			X				X	X	X	X
Black rat		C					X			X							X
Norway rat						X	X			X	X	X		X	X		X
Porcupine								X		X							
Red Fox		C				X	X			X				X	X	X	X
Raccoon		C				X	X			X	X	X		X	X	X	X
Long-tailed weasel		R				X	X			X				X		X	X
Mink								X		X	X	X					
Spotted skunk		R				X	X			X				X			
Striped skunk		C				X	X			X				X	X	X	X
Mule deer		C				X	X			X	X			X	X	X	
Summary																	
Birds	103	17	13	14	39	29	78	29	15	107	36	52	50	54	51	71	92
Amphibians	0	0	0	0	0	0	0	1	0	1	1	1	0	1	0	0	0
Reptiles	0	2	0	0	0	2	2	1	0	3	2	2	0	3	1	1	0
Mammals	6	13	0	0	0	11	13	13	1	26	10	11	0	19	10	15	9

Special-Status Species

FT	Federally Listed as Threatened
FC	Federal Candidate Species
BCC	Birds of Conservation Concern
CAS	Conservation Agreement Species
WSC	Wildlife Species of Concern
X	Breeds in Project Study Area

Bird Codes

Abundance Status

C = Common: Found consistently in fair numbers in appropriate habitat and season
U = Uncommon: Found consistently in small numbers in appropriate habitat and season
R = Rare: Found infrequently but regularly in very small numbers in appropriate habitat and season

Residence Status

P = Permanent resident: Found year-round
S = Summer visitant: Present during the nesting season
W = Winter visitant: Present during January and February
T = Transient: Migrates through the area in spring and/or fall
X = Column heading status applies
(X) = Very few GSLE records; low probability of occurrence at Legacy Parkway project study area

Examples of Combined Codes

CP = Common Permanent resident
RW = Rare Winter visitant
UT = Uncommon Transient

Habitat Use Codes

F = Foraging habitat
B = Breeding habitat
FB = Foraging and Breeding habitat

Codes for Amphibians, Reptiles, and Mammals

C = Common
U = Uncommon
R = Rare
D = Within species range but insufficient data to determine abundance
A = Accidental
X = Column heading status applies

Table 2-4. Wildlife and Fish of Emergent Marsh Habitat

Species	Migratory Species	Legacy Parkway Project Study Area							Habitat Use								
		Seasonal Abundance				Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
		P	S	W	T												
Birds																	
Pied-billed Grebe	X		US	RW		X	X		F		FB	F					
Horned Grebe	X							X	F		F						
Eared Grebe	X		RS		CT		X		FB		B						
Western Grebe	X				RT		X		FB		B						
Clark's Grebe	X							X	FB		B						
American White Pelican (WSC)	X		RS				X		F		F						
Double-crested Cormorant	X		RS			X	X		F	B	F						
American Bittern	X							X			FB						
Great Blue Heron	X	CP				X	X		F	FB	FB	F					
Great Egret	X							X	F		F						
Snowy Egret	X		US				X		F	B	FB	F	F	F			
Cattle Egret	X				RT		X				B	F		F	F		
Black-crowned Night-Heron	X		CS			X	X		F	B	FB	F	F	F			
White-faced Ibis	X		CS				X		F		FB	F	F	F	F		
Snow Goose	X							X			F				F		
Ross' Goose	X							X			F				F		
Canada Goose	X	CP				X	X		F		F	F	F	FB	F	F	F
Green-winged Teal	X				UT		X		F		FB	FB	F	F	F		
Mallard	X	UP				X	X		F	F	FB	FB	F	FB	FB		F
Northern Pintail	X				UT		X		F		FB	FB	F	F	F	B	
Blue-winged Teal	X		RS				X		F		FB	FB	F	F			
Cinnamon Teal	X		RS				X		F		FB	FB	F	F	F		
Northern Shoveler	X				UT		X		F		FB	FB	F	F		B	
Gadwall	X		US	UT		X	X		F		FB	FB	FB	FB	FB	B	
Eurasian Wigeon	X				RT		X		F		F	F	F	F	F		
American Wigeon	X				RT		X		F		F	F	F	F	F		
Canvasback	X							X	F		FB						
Redhead	X							X	F		FB						
Ruddy Duck	X				RT		X		F		FB						
Bald Eagle (FT)	X		RS	CW		X	X			FB	F	F	F	F		F	
Northern Harrier	X	CP				X	X			F	FB	F	F	FB	F	FB	F
Peregrine Falcon (BCC)	X	RP				X	X		F		F	F	F	F	F	F	F
Virginia Rail	X		RS			X	X				FB	F	F	F			
Sora	X		RS			X	X				FB	F	F	F			
Common moorhen	X							X	F		FB						
American Coot	X	UP				X	X		F		FB	FB	F	F	F		
Sandhill Crane	X				RT		X		F		FB	F	F	F	F		
Black-necked Stilt	X		CS			X	X		F		FB	FB	FB	FB			
American Avocet (BCC)	X		CS			X	X		F		FB	FB	FB	FB			
Short-billed Dowitcher	X							X	F		F	F	F				
Long-billed Dowitcher	X				RT		X		F		F	F	F				
Wilson's Snipe	X	CP				X	X				F	FB	F	FB			
Wilson's Phalarope (BCC)	X		RS		UT	X	X		F		F	FB	F	F			
Franklin's Gull	X				CT		X		F		FB	F	F	F	F		
Bonaparte's Gull	X				RT		X		F		F						
Ring-billed Gull	X			UW			X		F		F	F	F	F	F		F
California Gull	X	UP					X		F		F	F	F	F	F	F	F
Forster's Tern	X		CS			X	X		F		FB						
Great Horned Owl	X	UP				X	X			FB	F	F	F	F	F	F	FB
Short-eared Owl (WSC)	X	UP				X	X				F	F	F	F	F	FB	
Common Nighthawk	X				UT		X		F	F	F	F	F	F	F	F	F
Common Poorwill	X				RT			X	F	F	F	F		F	F	F	F
White-throated Swift	X				RT			X		F	F	F		F	F	F	F
Northern Shrike	X			UW			X			F	F	F	F	F	F	F	F
Loggerhead Shrike (BCC)	X	UP					X			F	F	F	F	F	F	FB	F
Common Raven	X	CP				X	X			B	F	F	F	F	F	F	FB
Purple Martin	X							X	F	F	F	F	F	F	F	F	F
Tree Swallow	X				CT		X		F	F	F	F	F	F	F	F	F
Violet-green Swallow	X				UT		X		F	F	F	F	F	F	F	F	F
Northern Rough-winged Swallow	X				UT		X		F	F	F	F	F	F	F	F	F
Bank Swallow	X				CT		X		F	F	F	F	F	F	F	F	F
Cliff Swallow	X		CS			X	X		F	F	F	F	F	F	F	F	B
Barn Swallow	X		CS			X	X		F	F	F	F	F	F	F	F	B
Marsh Wren	X		US			X	X				FB						
Yellow Warbler	X				UT		X			F	F					F	F
Yellow-rumped Warbler	X				CT		X			F	F					F	F
MacGillvray's Warbler	X				RT		X			F	F					F	F
Common Yellowthroat	X		US			X	X			F	FB						
Wilson's Warbler	X				RT		X			F	F					F	F
American Tree Sparrow	X			UW			X			F	F	F	F	F	F	F	F
Song Sparrow	X	UP				X	X			FB	F	F		F			F
White-crowned Sparrow	X			CW			X			F	F	F	F	F	F	F	F
Dark-eyed Junco	X			CW			X			F	F	F	F	F	F	F	F
Red-winged Blackbird	X	CP				X	X			F	FB	F	F	F	F		F
Yellow-headed Blackbird	X		CS			X	X			F	FB	F	F	F	F	F	F
Brewer's Blackbird	X	UP				X	X			F	F	F	F	FB	FB	F	F
Brown-headed Cowbird	X	UP				X	X			FB	FB	FB	FB	FB	FB	FB	FB
House Finch	X	CP				X	X			FB	F	F	F	F	F	FB	FB
American Goldfinch	X			UW			X			F	F	F			F	F	F
Fish																	
Carp		C				X	X				X						
Utah sucker								X	X		X						
Channel catfish								X	X		X						
Bullhead								X	X		X						
Green sunfish								X	X		X						

Species	Migratory Species	Legacy Parkway Project Study Area: Seasonal Abundance P	S	W	T	Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Habitat Use: Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
Amphibians																	
Tiger salamander								X			X	X					
Great Basin spadefoot								X			X	X				X	
Woodhouse's toad								X		X	X	X		X			
Western chorus frog		C					X				X	X					
Northern leopard frog								X			X	X					
American bullfrog		R					X				X	X					
Reptiles																	
Common garter snake		C					X			X	X	X		X			
Terrestrial garter snake							X	X		X	X	X		X			
Mammals																	
Vagrant shrew		D						X			X					X	
Masked shrew		D						X			X						
Preble's shrew (WSC)		D						X			X					X	
Western small-footed myotis	X							X		X	X	X		X		X	
Little brown bat	X							X		X	X	X		X			
Long-legged myotis	X							X		X	X	X		X		X	
Western pipistrelle	X							X		X	X	X		X		X	
Big brown bat	X							X		X	X	X		X		X	
Townsend's big-eared bat (WSC)	X							X		X	X	X		X		X	
Brazilian free-tailed bat	X							X		X	X	X		X		X	
Montane vole		D						X			X	X			X		
Muskrat		C					X		X	X	X	X					X
Norway rat							X			X	X	X		X	X		X
Raccoon		C				X	X			X	X	X		X	X	X	X
Mink								X		X	X	X					
Mule deer		C				X	X			X	X			X	X	X	
Summary																	
Birds	79	17	22	9	25	31	66	13	48	36	79	57	50	52	43	35	34
Fish	0	1	0	0	0	1	1	4	4	0	5	0	0	0	0	0	0
Amphibians	0	2	0	0	0	0	2	4	0	1	6	6	0	1	0	1	0
Reptiles	0	1	0	0	0	0	2	1	0	2	2	2	0	2	0	0	0
Mammals	7	7	0	0	0	2	4	12	1	12	16	12	0	10	4	10	3

Special-Status Species

FT	Federally Listed as Threatened
FC	Federal Candidate Species
BCC	Birds of Conservation Concern
CAS	Conservation Agreement Species
WSC	Wildlife Species of Concern
X	Breeds in Project Study Area

Bird Codes

Abundance Status

C = Common: Found consistently in fair numbers in appropriate habitat and season
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R = Rare: Found infrequently but regularly in very small numbers in appropriate habitat and season

Residence Status

P = Permanent resident: Found year-round
S = Summer visitant: Present during the nesting season
W = Winter visitant: Present during January and February
T = Transient: Migrates through the area in the spring and/or fall
X = Column heading status applies
(X) = Very few GSLE records; low probability of occurrence at Legacy Parkway project study area

Examples of Combined Codes

CP = Common Permanent resident
RW = Rare Winter visitant
UT = Uncommon Transient

Habitat Use Codes

F = Foraging habitat
B = Breeding habitat
FB = Foraging and Breeding habitat

Codes for Amphibians, Reptiles, and Mammals

P = Potential occurrence
C = Common
U = Uncommon
R = Rare
D = Within species range but insufficient data to determine abundance
A = Accidental
X = Column heading status applies

Table 2-5. Wildlife of Wet Meadow Habitat

Species	Migratory Species	Legacy Parkway Project Study Area							Habitat Use								
		Seasonal Abundance				Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
		P	S	W	T												
Birds																	
Pied-billed Grebe	X		US	RW		X	X		F		FB	F					
Great Blue Heron	X	CP				X	X		F	FB	FB	F					
Snowy Egret	X		US				X		F	B	FB	F	F	F			
Cattle Egret	X				RT		X				B	F		F	F		
Black-crowned Night-Heron	X		CS			X	X		F	B	FB	F	F	F			
White-faced Ibis	X		CS				X		F		FB	F	F	F	F		
Canada Goose	X	CP				X	X		F		F	F	F	FB	F	F	F
Green-winged Teal	X				UT		X		F		FB	FB	F	F	F		
Mallard	X	UP				X	X		F	F	FB	FB	F	FB	FB		F
Northern Pintail	X				UT		X		F		FB	FB	F	F	F	B	
Blue-winged Teal	X		RS				X		F		FB	FB	F	F			
Cinnamon Teal	X		RS				X		F		FB	FB	F	F	F		
Northern Shoveler	X				UT		X		F		FB	FB	F	F		B	
Gadwall	X		US	UT		X	X		F		FB	FB	FB	FB	FB	B	
Eurasian Wigeon	X				RT		X		F		F	F	F	F	F		
American Wigeon	X				RT		X		F		F	F	F	F	F		
Bald Eagle (FT)	X		RS	CW		X	X			FB	F	F	F	F		F	
Northern Harrier	X	CP				X	X			F	FB	F	F	FB	F	FB	F
Swainson's Hawk (BCC)	X		RS			X	X			B		F	F	F	F	F	
Red-tailed Hawk	X	UP				X	X			B		F	F	F	F	F	F
Ferruginous Hawk (BCC; WSC)	X							X				F	F	F	F	F	
Rough-legged Hawk	X			CW			X					F	F	F	F	F	F
Golden Eagle (BCC)	X				RT		X					F	F	F	F	F	
American Kestrel	X	CP				X	X			B		F	F	F	F	F	F
Peregrine Falcon (BCC)	X	RP				X	X		F		F	F	F	F	F	F	F
Prairie Falcon (BCC)	X	RP					X					F	F	F	F	F	
Ring-necked Pheasant		RP				X	X			F		F	F	FB	FB	FB	FB
Virginia Rail	X		RS			X	X				FB	F	F	F			
Sora	X		RS			X	X				FB	F	F	F			
American Coot	X	UP				X	X		F		FB	FB	F	F	F		
Sandhill Crane	X				RT		X		F		FB	F	F	F	F		
Black-bellied Plover	X				RT		X					F	F	F			
American Golden-Plover (BCC)	X							X				F	F	F			
Killdeer	X	CP				X	X					FB	FB	FB	FB	FB	FB
Black-necked Stilt	X		CS			X	X		F		FB	FB	FB	FB			
American Avocet (BCC)	X		CS			X	X		F		FB	FB	FB	FB			
Greater Yellowlegs	X				UT		X		F			F	F	F			
Lesser Yellowlegs	X				UT		X		F			F	F	F			
Solitary Sandpiper (BCC)	X				RT		X			F		F	F	F			
Willet	X		RS			X	X					FB	FB	FB	FB	FB	
Long-billed Curlew (BCC)	X				RT		X					F	FB			FB	
Marbled Godwit (BCC)	X				RT		X		F			F	F	F			
Pectoral Sandpiper	X				RT		X					F	F	F			
Short-billed Dowitcher	X							X	F		F	F	F				
Long-billed Dowitcher	X				RT		X		F		F	F	F				
Wilson's Snipe	X	CP				X	X				F	FB	F	FB			
Wilson's Phalarope (BCC)	X		RS		UT	X	X		F		F	FB	F	F			
Franklin's Gull	X				CT		X		F		FB	F	F	F	F		
Ring-billed Gull	X			UW			X		F		F	F	F	F	F		F
California Gull	X	UP					X		F		F	F	F	F	F	F	F
Barn Owl	X	RP				X	X					F	F	F	F	F	FB
Great Horned Owl	X	UP				X	X			FB	F	F	F	F	F	F	FB
Long-eared Owl	X							X		F		F	F	F		F	
Short-eared Owl (WSC)	X	UP				X	X				F	F	F	F	F	FB	
Common Nighthawk	X				UT		X		F	F	F	F	F	F	F	F	F
Common Poorwill	X				RT			X	F	F	F	F		F	F	F	F
White-throated Swift	X				RT			X		F	F	F		F	F	F	F
Black-chinned Hummingbird	X				RT		X			F		F	F	F	F	F	F
Calliope Hummingbird	X							X		F		F	F	F	F	F	F
Broad-tailed Hummingbird	X				RT		X			F		F	F	F	F	F	F
Rufous Hummingbird	X				RT		X			F		F	F	F	F	F	F
Western Kingbird	X		US			X	X			FB		F	F	F	F	F	FB
Northern Shrike	X			UW			X			F	F	F	F	F	F	F	F
Loggerhead Shrike (BCC)	X	UP					X			F	F	F	F	F	F	FB	F
Black-billed Magpie	X	UP				X	X			FB		F	F	F	F	F	FB
American Crow	X							X				F		F	F	F	F
Common Raven	X	CP				X	X			B	F	F	F	F	F	F	FB
Horned Lark	X	CP				X	X					F	FB	F		FB	
Purple Martin	X							X	F	F	F	F	F	F	F	F	F
Tree Swallow	X				CT		X		F	F	F	F	F	F	F	F	F
Violet-green Swallow	X				UT		X		F	F	F	F	F	F	F	F	F
Northern Rough-winged Swallow	X				UT		X		F	F	F	F	F	F	F	F	F
Bank Swallow	X				CT		X		F	F	F	F	F	F	F	F	F
Cliff Swallow	X		CS			X	X		F	F	F	F	F	F	F	F	B
Barn Swallow	X		CS			X	X		F	F	F	F	F	F	F	F	B
Mountain Bluebird	X				RT		X					F	F	F	F	F	
Townsend's Solitaire	X				RT			X				F		F	F	F	
American Robin	X	UP				X	X			FB		F	F	F	F		FB
European Starling			US	CW		X	X			FB		F	F	F	F	F	FB
American Pipit	X				CT		X			F		F	F	F	F		
American Tree Sparrow	X			UW			X			F	F	F	F	F	F	F	F
Chipping Sparrow	X				CT		X			F		F	F	F	F	F	F
Brewer's Sparrow (BCC)	X		RS				X			F		F	F	F	F	FB	F
Vesper Sparrow	X				RT		X			F		F	F	F	F	F	F
Lark Sparrow	X				RT		X			F		F	F	F	F	F	F
Savannah Sparrow	X		US			X	X					FB		F			
Song Sparrow	X	UP				X	X			FB	F	F		F			F
Lincoln's Sparrow	X				RT		X			F		F		F	F	F	F

Species	Migratory Species	Legacy Parkway Project Study Area: Seasonal Abundance P	S	W	T	Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Habitat Use: Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
Harris' Sparrow	X							X		F		F	F	F	F	F	F
White-throated Sparrow	X							X		F		F	F	F	F	F	F
White-crowned Sparrow	X			CW			X			F	F	F	F	F	F	F	F
Dark-eyed Junco	X			CW			X			F	F	F	F	F	F	F	F
Lapland Longspur	X							X				F	F			F	
Snow Bunting	X							X				F	F			F	
Red-winged Blackbird	X	CP				X	X			F	FB	F	F	F	F		F
Western Meadowlark	X	CP				X	X					F	F	FB	F	FB	F
Bobolink (WSC)	X							X				F		F	F	F	
Yellow-headed Blackbird	X		CS			X	X			F	FB	F	F	F	F	F	F
Brewer's Blackbird	X	UP				X	X			F	F	F	F	FB	FB	F	F
Brown-headed Cowbird	X	UP				X	X			FB	FB	FB	FB	FB	FB	FB	FB
House Finch	X	CP				X	X			FB	F	F	F	F	F	FB	FB
American Goldfinch	X			UW			X			F	F	F			F	F	F
Amphibians																	
Tiger salamander								X			X	X					
Great Basin spadefoot								X			X	X				X	
Woodhouse's toad								X		X	X	X		X			
Western chorus frog		C					X				X	X					
Northern leopard frog								X			X	X					
American bullfrog		R					X				X	X					
Reptiles																	
Eastern racer		C					X					X		X		X	
Common garter snake		C					X			X	X	X		X			
Terrestrial garter snake								X		X	X	X		X			
Mammals																	
Western small-footed myotis	X							X		X	X	X		X		X	
Little brown bat	X							X		X	X	X		X		X	
Long-legged myotis	X							X		X	X	X		X		X	
Western pipistrelle	X							X		X	X	X		X		X	
Big brown bat	X							X		X	X	X		X		X	
Townsend's big-eared bat (WSC)	X							X		X	X	X		X		X	
Brazilian free-tailed bat	X							X		X	X	X		X		X	
Meadow vole		C					X			X		X		X		X	
Montane vole		D						X			X	X			X		
Muskrat		C					X		X	X	X	X					X
Norway rat							X			X	X	X		X	X		X
Raccoon		C				X	X			X	X	X		X	X	X	X
Mink								X		X	X	X					
Summary																	
Birds	100	27	21	11	35	41	87	15	38	52	57	102	90	94	73	66	53
Amphibians	0	2	0	0	0	0	2	4	0	1	6	6	0	1	0	1	0
Reptiles	0	2	0	0	0	0	2	1	0	2	2	3	0	3	0	1	0
Mammals	7	4	0	0	0	1	4	9	1	12	12	13	0	10	3	9	3

Special-Status Species

FT	Federally Listed as Threatened
FC	Federal Candidate Species
BCC	Birds of Conservation Concern
CAS	Conservation Agreement Species
WSC	Wildlife Species of Concern
X	Breeds in Project Study Area

Bird Codes

Abundance Status

C = Common: Found consistently in fair numbers in appropriate habitat and season
U = Uncommon: Found consistently in small numbers in appropriate habitat and season
R = Rare: Found infrequently but regularly in very small numbers in appropriate habitat and season

Residence Status

P = Permanent resident: Found year-round
S = Summer visitant: Present during the nesting season
W = Winter visitant: Present during January and February
T = Transient: Migrates through the area in the spring and/or fall
X = Column heading status applies
(X) = Very few GSLE records; low probability of occurrence at Legacy Parkway project study area

Examples of Combined Codes

CP = Common Permanent resident
RW = Rare Winter visitant
UT = Uncommon Transient

Habitat Use Codes

F = Foraging habitat
B = Breeding habitat
FB = Foraging and Breeding habitat

Codes for Amphibians, Reptiles, and Mammals

P = Potential occurrence
C = Common
U = Uncommon
R = Rare
D = Within species range but insufficient data to determine abundance
A = Accidental
X = Column heading status applies

Table 2-6. Wildlife of Mudflat/Pickleweed Habitat

Species	Migratory Species	Legacy Parkway Project Study Area							Habitat Use								
		Seasonal Abundance				Breeds in Project Study Area	Documented Occurrence Within Project Study Area	Could Potentially Occur Within Project Study Area	Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
		P	S	W	T												
Birds																	
Snowy Egret	X		US				X		F	B	FB	F	F	F			
Black-crowned Night-Heron	X		CS			X	X		F	B	FB	F	F	F			
White-faced Ibis	X		CS				X		F		FB	F	F	F	F		
Canada Goose	X	CP				X	X		F		F	F	F	FB	F	F	F
Green-winged Teal	X				UT		X		F		FB	FB	F	F	F		
Mallard	X	UP				X	X		F	F	FB	FB	F	FB	FB		F
Northern Pintail	X				UT		X		F		FB	FB	F	F	F	B	
Blue-winged Teal	X		RS				X		F		FB	FB	F	F			
Cinnamon Teal	X		RS				X		F		FB	FB	F	F	F		
Northern Shoveler	X				UT		X		F		FB	FB	F	F		B	
Gadwall	X		US	UT		X	X		F		FB	FB	FB	FB	FB	B	
Eurasian Wigeon	X				RT		X		F		F	F	F	F	F		
American Wigeon	X				RT		X		F		F	F	F	F	F		
Turkey Vulture	X		US				X						F	F	F	F	F
Bald Eagle (FT)	X		RS	CW		X	X			FB	F	F	F	F		F	
Northern Harrier	X	CP				X	X			F	FB	F	F	FB	F	FB	F
Sharp-shinned Hawk	X				RT		X			F			F	F	F	F	F
Cooper's Hawk	X				RT		X			F			F	F	F	F	F
Swainson's Hawk (BCC)	X		RS			X	X			B		F	F	F	F	F	
Red-tailed Hawk	X	UP				X	X			B		F	F	F	F	F	F
Ferruginous Hawk (BCC; WSC)	X							X				F	F	F	F	F	
Rough-legged Hawk	X			CW			X					F	F	F	F	F	F
Golden Eagle (BCC)	X				RT		X					F	F	F	F	F	
American Kestrel	X	CP				X	X			B		F	F	F	F	F	F
Merlin	X			RW			X						F	F	F	F	F
Peregrine Falcon (BCC)	X	RP				X	X		F		F	F	F	F	F	F	F
Prairie Falcon (BCC)	X	RP					X					F	F	F	F	F	
Ring-necked Pheasant		RP				X	X			F		F	F	FB	FB	FB	FB
Virginia Rail	X		RS			X	X				FB	F	F	F			
Sora	X		RS			X	X				FB	F	F	F			
American Coot	X	UP				X	X		F		FB	FB	F	F	F		
Sandhill Crane	X				RT		X		F		FB	F	F	F	F		
Black-bellied Plover	X				RT		X					F	F	F			
American Golden-Plover (BCC)	X							X				F	F	F			
Snowy Plover (BCC)	X							X					FB				
Semipalmated Plover	X							X					F				
Killdeer	X	CP				X	X					FB	FB	FB	FB	FB	FB
Black-necked Stilt	X		CS			X	X		F		FB	FB	FB	FB			
American Avocet (BCC)	X		CS			X	X		F		FB	FB	FB	FB			
Greater Yellowlegs	X				UT		X		F			F	F	F			
Lesser Yellowlegs	X				UT		X		F			F	F	F			
Solitary Sandpiper (BCC)	X				RT		X			F		F	F	F			
Willet	X		RS			X	X					FB	FB	FB	FB	FB	
Spotted Sandpiper	X				RT		X			FB			F				
Whimbrel (BCC)	X							X					F	F			
Long-billed Curlew (BCC)	X				RT		X					F	FB			FB	
Marbled Godwit (BCC)	X				RT		X		F			F	F	F			
Ruddy Turnstone	X							X					F				
Red Knot	X							X					F	F			
Sanderling (BCC)	X							X					F				
Semipalmated Sandpiper	X							X					F				
Western Sandpiper	X				RT		X						F				
Least Sandpiper	X				RT		X						F				
Baird's Sandpiper	X				RT		X						F				
Pectoral Sandpiper	X				RT		X					F	F	F			
Dunlin	X							X					F				
Stilt Sandpiper	X							X					F				
Short-billed Dowitcher	X							X	F		F	F	F				
Long-billed Dowitcher	X				RT		X		F		F	F	F				
Wilson's Snipe	X	CP				X	X				F	FB	F	FB			
Wilson's Phalarope (BCC)	X		RS		UT	X	X		F		F	FB	F	F			
Franklin's Gull	X				CT		X		F		FB	F	F	F	F		
Ring-billed Gull	X			UW			X		F		F	F	F	F	F		F
California Gull	X	UP					X		F		F	F	F	F	F	F	F
Mourning Dove	X		US	RW		X	X			FB			F	F	F	F	FB
Barn Owl	X	RP				X	X					F	F	F	F	F	FB
Great Horned Owl	X	UP				X	X			FB	F	F	F	F	F	F	FB
Burrowing Owl (BCC; WSC)	X		RS			X	X						F	F	F	FB	
Long-eared Owl	X							X		F		F	F	F		F	
Short-eared Owl (WSC)	X	UP				X	X				F	F	F	F	F	FB	
Common Nighthawk	X				UT		X		F	F	F	F	F	F	F	F	F
Black-chinned Hummingbird	X				RT		X			F		F	F	F	F	F	F
Calliope Hummingbird	X							X		F		F	F	F	F	F	F
Broad-tailed Hummingbird	X				RT		X			F		F	F	F	F	F	F
Rufous Hummingbird	X				RT		X			F		F	F	F	F	F	F
Western Kingbird	X		US			X	X			FB		F	F	F	F	F	FB
Northern Shrike	X			UW			X			F	F	F	F	F	F	F	F
Loggerhead Shrike (BCC)	X	UP					X			F	F	F	F	F	F	FB	F
Black-billed Magpie	X	UP				X	X			FB		F	F	F	F	F	FB
Common Raven	X	CP				X	X			B	F	F	F	F	F	F	FB
Horned Lark	X	CP				X	X					F	FB	F		FB	
Purple Martin	X							X	F	F	F	F	F	F	F	F	F
Tree Swallow	X				CT		X		F	F	F	F	F	F	F	F	F
Violet-green Swallow	X				UT		X		F	F	F	F	F	F	F	F	F

Species	Migratory Species	Legacy Parkway Project Study Area: Seasonal Abundance P	S	W	T	Breeds in Project Study Area	Documented Occurrence Within Project Study Area	Could Potentially Occur Within Project Study Area	Habitat Use: Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
Northern Rough-winged Swallow	X				UT		X		F	F	F	F	F	F	F	F	F
Bank Swallow	X				CT		X		F	F	F	F	F	F	F	F	F
Cliff Swallow	X		CS			X	X		F	F	F	F	F	F	F	F	B
Barn Swallow	X		CS			X	X		F	F	F	F	F	F	F	F	B
Mountain Bluebird	X				RT		X					F	F	F	F	F	
American Robin	X	UP				X	X			FB		F	F	F	F		FB
European Starling			US	CW		X	X			FB		F	F	F	F	F	FB
American Pipit	X				CT		X			F		F	F	F	F		
American Tree Sparrow	X			UW			X			F	F	F	F	F	F	F	F
Chipping Sparrow	X				CT		X			F		F	F	F	F	F	F
Brewer's Sparrow (BCC)	X		RS				X			F		F	F	F	F	FB	F
Vesper Sparrow	X				RT		X			F		F	F	F	F	F	F
Lark Sparrow	X				RT		X			F		F	F	F	F	F	F
Harris' Sparrow	X							X		F		F	F	F	F	F	F
White-throated Sparrow	X							X		F		F	F	F	F	F	F
White-crowned Sparrow	X			CW			X			F	F	F	F	F	F	F	F
Dark-eyed Junco	X			CW			X			F	F	F	F	F	F	F	F
Lapland Longspur	X							X				F	F			F	
Snow Bunting	X							X				F	F			F	
Red-winged Blackbird	X	CP				X	X			F	FB	F	F	F	F		F
Western Meadowlark	X	CP				X	X					F	F	FB	F	FB	F
Yellow-headed Blackbird	X		CS			X	X			F	FB	F	F	F	F	F	F
Brewer's Blackbird	X	UP				X	X			F	F	F	F	FB	FB	F	F
Brown-headed Cowbird	X	UP				X	X			FB	FB	FB	FB	FB	FB	FB	FB
House Finch	X	CP				X	X			FB	F	F	F	F	F	FB	FB
Amphibians																	
Great Basin spadefoot								X			X	X	F			X	
Mammals																	
Coyote		R				X	X						F	X	X	X	X
Red fox		C				X	X			X			F	X	X	X	X
Raccoon		C				X	X			X	X	X	F	X	X	X	X
Mink								X		X	X	X	F				
Summary																	
Birds	107	25	22	11	35	39	90	19	35	50	50	90	109	93	71	65	52
Fish																	
Amphibians	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	1	0
Reptiles																	
Mammals	0	3	0	0	0	3	3	1	0	3	2	2	4	3	3	3	3

Special-Status Species

FT	Federally Listed as Threatened
FC	Federal Candidate Species
BCC	Birds of Conservation Concern
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X	Breeds in Project Study Area

Bird Codes

Abundance Status

C = Common: Found consistently in fair numbers in appropriate habitat and season
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Residence Status

P = Permanent resident: Found year-round
S = Summer visitant: Present during the nesting season
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Examples of Combined Codes

CP = Common Permanent resident
RW = Rare Winter visitant
UT = Uncommon Transient

Habitat Use Codes

F = Foraging habitat
B = Breeding habitat
FB = Foraging and Breeding habitat

Codes for Amphibians, Reptiles, and Mammals

P = Potential occurrence
C = Common
U = Uncommon
R = Rare
D = Within species range but insufficient data to determine abundance
A = Accidental
X = Column heading status applies

Table 2-7. Wildlife of Pasture Habitat

Species	Migratory Species	Legacy Parkway Project Study Area							Habitat Use								
		Seasonal Abundance				Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
		P	S	W	T												
Birds																	
Snowy Egret	X		US				X		F	B	FB	F	F	F			
Cattle Egret	X				RT		X				B	F		F	F		
Black-crowned Night-Heron	X		CS			X	X		F	B	FB	F	F	F			
White-faced Ibis	X		CS				X		F		FB	F	F	F	F		
Canada Goose	X	CP				X	X		F		F	F	F	FB	F	F	F
Green-winged Teal	X				UT		X		F		FB	FB	F	F	F		
Mallard	X	UP				X	X		F	F	FB	FB	F	FB	FB		F
Northern Pintail	X				UT		X		F		FB	FB	F	F	F	B	
Blue-winged Teal	X		RS				X		F		FB	FB	F	F			
Cinnamon Teal	X		RS				X		F		FB	FB	F	F	F		
Northern Shoveler	X				UT		X		F		FB	FB	F	F		B	
Gadwall	X		US	UT		X	X		F		FB	FB	FB	FB	FB	B	
Eurasian Wigeon	X				RT		X		F		F	F	F	F	F		
American Wigeon	X				RT		X		F		F	F	F	F	F		
Turkey Vulture	X		US				X						F	F	F	F	F
Bald Eagle (FT)	X		RS	CW		X	X			FB	F	F	F	F		F	
Northern Harrier	X	CP				X	X			F	FB	F	F	FB	F	FB	F
Sharp-shinned Hawk	X				RT		X			F			F	F	F	F	F
Cooper's Hawk	X				RT		X			F			F	F	F	F	F
Swainson's Hawk (BCC)	X		RS			X	X			B		F	F	F	F	F	
Red-tailed Hawk	X	UP				X	X			B		F	F	F	F	F	F
Ferruginous Hawk (BCC; WSC)	X							X				F	F	F	F	F	
Rough-legged Hawk	X			CW			X					F	F	F	F	F	F
Golden Eagle (BCC)	X				RT		X					F	F	F	F	F	
American Kestrel	X	CP				X	X			B		F	F	F	F	F	F
Merlin	X			RW			X						F	F	F	F	F
Peregrine Falcon (BCC)	X	RP				X	X		F		F	F	F	F	F	F	F
Prairie Falcon (BCC)	X	RP					X					F	F	F	F	F	
Ring-necked Pheasant		RP				X	X			F		F	F	FB	FB	FB	FB
Virginia Rail	X		RS			X	X				FB	F	F	F			
Sora	X		RS			X	X				FB	F	F	F			
American Coot	X	UP				X	X		F		FB	FB	F	F	F		
Sandhill Crane	X				RT		X		F		FB	F	F	F	F		
Black-bellied Plover	X				RT		X					F	F	F			
American Golden-Plover (BCC)	X							X				F	F	F			
Killdeer	X	CP				X	X					FB	FB	FB	FB	FB	FB
Black-necked Stilt	X		CS			X	X		F		FB	FB	FB	FB			
American Avocet (BCC)	X		CS			X	X		F		FB	FB	FB	FB			
Greater Yellowlegs	X				UT		X		F			F	F	F			
Lesser Yellowlegs	X				UT		X		F			F	F	F			
Solitary Sandpiper (BCC)	X				RT		X			F		F	F	F			
Willet	X		RS			X	X					FB	FB	FB	FB	FB	
Whimbrel (BCC)	X							X					F	F			
Marbled Godwit (BCC)	X				RT		X		F			F	F	F			
Red Knot	X							X					F	F			
Pectoral Sandpiper	X				RT		X					F	F	F			
Common Snipe	X	CP				X	X				F	FB	F	FB			
Wilson's Phalarope (BCC)	X		RS		UT	X	X		F		F	FB	F	F			
Franklin's Gull	X				CT		X		F		FB	F	F	F	F		
Ring-billed Gull	X			UW			X		F		F	F	F	F	F		F
California Gull	X	UP					X		F		F	F	F	F	F	F	F
Mourning Dove	X		US	RW		X	X			FB			F	F	F	F	FB
Barn Owl	X	RP				X	X					F	F	F	F	F	FB
Great Horned Owl	X	UP				X	X			FB	F	F	F	F	F	F	FB
Burrowing Owl (BCC; WSC)	X		RS			X	X						F	F	F	FB	
Long-eared Owl	X							X		F		F	F	F		F	
Short-eared Owl (WSC)	X	UP				X	X				F	F	F	F	F	FB	
Common Nighthawk	X				UT		X		F	F	F	F	F	F	F	F	F
Common Poorwill	X				RT			X	F	F	F	F		F	F	F	F
White-throated Swift	X				RT			X		F	F	F		F	F	F	F
Black-chinned Hummingbird	X				RT		X			F		F	F	F	F	F	F
Calliope Hummingbird	X							X		F		F	F	F	F	F	F
Broad-tailed Hummingbird	X				RT		X			F		F	F	F	F	F	F
Rufous Hummingbird	X				RT		X			F		F	F	F	F	F	F
Western Kingbird	X		US			X	X			FB		F	F	F	F	F	FB
Northern Shrike	X			UW			X			F	F	F	F	F	F	F	F
Loggerhead Shrike (BCC)	X	UP					X			F	F	F	F	F	F	FB	F
Black-billed Magpie	X	UP				X	X			FB		F	F	F	F	F	FB
American Crow	X							X				F		F	F	F	F
Common Raven	X	CP				X	X			B	F	F	F	F	F	F	FB
Horned Lark	X	CP				X	X					F	FB	F		FB	
Purple Martin	X							X	F	F	F	F	F	F	F	F	F
Tree Swallow	X				CT		X		F	F	F	F	F	F	F	F	F
Violet-green Swallow	X				UT		X		F	F	F	F	F	F	F	F	F
Northern Rough-winged Swallow	X				UT		X		F	F	F	F	F	F	F	F	F
Bank Swallow	X				CT		X		F	F	F	F	F	F	F	F	F
Cliff Swallow	X		CS			X	X		F	F	F	F	F	F	F	F	B
Barn Swallow	X		CS			X	X		F	F	F	F	F	F	F	F	B
Mountain Bluebird	X				RT		X					F	F	F	F	F	
Townsend's Solitaire	X				RT			X				F		F	F	F	
American Robin	X	UP				X	X			FB		F	F	F	F		FB
European Starling			US	CW		X	X			FB		F	F	F	F	F	FB
American Pipit	X				CT		X			F		F	F	F	F		
American Tree Sparrow	X			UW			X			F	F	F	F	F	F	F	F

Species	Migratory Species	Legacy Parkway Project Study Area: Seasonal Abundance				Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Habitat Use: Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
		P	S	W	T												
Chipping Sparrow	X				CT		X			F		F	F	F	F	F	F
Brewer's Sparrow (BCC)	X		RS				X			F		F	F	F	F	FB	F
Vesper Sparrow	X				RT		X			F		F	F	F	F	F	F
Lark Sparrow	X				RT		X			F		F	F	F	F	F	F
Savannah Sparrow	X		US			X	X					FB		F			
Song Sparrow	X	UP				X	X			FB	F	F		F			F
Lincoln's Sparrow	X				RT		X			F		F		F	F	F	F
Harris' Sparrow	X							X		F		F	F	F	F	F	F
White-throated Sparrow	X							X		F		F	F	F	F	F	F
White-crowned Sparrow	X			CW			X			F	F	F	F	F	F	F	F
Dark-eyed Junco	X			CW			X			F	F	F	F	F	F	F	F
Red-winged Blackbird	X	CP				X	X			F	FB	F	F	F	F		F
Western Meadowlark	X	CP				X	X					F	F	FB	F	FB	F
Bobolink (WSC)	X							X				F		F	F	F	
Yellow-headed Blackbird	X		CS			X	X			F	FB	F	F	F	F	F	F
Brewer's Blackbird	X	UP				X	X			F	F	F	F	FB	FB	F	F
Brown-headed Cowbird	X	UP				X	X			FB	FB	FB	FB	FB	FB	FB	FB
House Finch	X	CP				X	X			FB	F	F	F	F	F	FB	FB
House Sparrow				UP		X	X			F				F	F		FB
Amphibians																	
Woodhouse's toad								X		X	X	X		X			
Reptiles																	
Eastern racer		C					X					X		X		X	
Gopher snake		C					X			X				X	X	X	
Common garter snake		C					X			X	X	X		X			
Terrestrial garter snake								X		X	X	X		X			
Mammals																	
Western small-footed myotis	X							X		X	X	X		X		X	
Little brown bat	X							X		X	X	X		X		X	
Long-legged myotis	X							X		X	X	X		X		X	
Western pipistrelle	X							X		X	X	X		X		X	
Big brown bat	X							X		X	X	X		X		X	
Spotted bat (WSC)	X							X						X			
Townsend's big-eared bat (WSC)	X							X		X	X	X		X		X	
Brazilian free-tailed bat	X							X		X	X	X		X		X	
Nuttall's cottontail								X						X	X	X	
White-tailed jackrabbit							X							X			
Black-tailed jackrabbit		C					X							X	X	X	
Piute ground squirrel		D						X						X	X	X	
Rock squirrel		C					X							X	X	X	
Northern pocket gopher								X		X				X	X		
Botta's pocket gopher								X		X				X	X	X	
Western harvest mouse								X		X				X		X	
Deer mouse		C					X			X				X	X	X	X
Desert woodrat		D						X						X		X	
Bushy-tailed woodrat		D						X						X		X	
Meadow vole		C					X			X		X		X		X	
Long-tailed vole								X		X				X			
House mouse		C					X			X				X	X	X	X
Norway rat							X			X	X	X		X	X		X
Coyote		R				X	X							X	X	X	X
Red fox		C				X	X			X				X	X	X	X
Raccoon		C				X	X			X	X	X		X	X	X	X
Long-tailed weasel		R				X	X			X				X		X	X
Badger		D						X						X		X	
Spotted skunk		R					X			X				X			
Striped skunk		C				X	X			X				X	X	X	X
Mule deer		C				X	X			X	X			X	X	X	
Pronghorn								X						X		X	
Summary																	
Birds	100	26	23	12	35	42	89	14	34	54	52	94	93	103	79	68	58
Amphibians	0	0	0	0	0	0	0	1	0	1	1	1	0	1	0	0	0
Reptiles	0	3	0	0	0	0	3	1	0	3	2	3	0	4	1	2	0
Mammals	8	13	0	0	0	6	14	18	0	21	10	10	0	32	14	26	8

Special-Status Species

FT	Federally Listed as Threatened
FC	Federal Candidate Species
BCC	Birds of Conservation Concern
CAS	Conservation Agreement Species
WSC	Wildlife Species of Concern
X	Breeds in Project Study Area

Bird Codes

Abundance Status

C = Common: Found consistently in fair numbers in appropriate habitat and season
U = Uncommon: Found consistently in small numbers in appropriate habitat and season
R = Rare: Found infrequently but regularly in very small numbers in appropriate habitat and season

Residence Status

P = Permanent resident: Found year-round
S = Summer visitant: Present during the nesting season
W = Winter visitant: Present during January and February
T = Transient: Migrates through the area in the spring and/or fall
X = Column heading status applies

(X) = Very few GSLE records; low probability of occurrence at Legacy Parkway project study area

Examples of Combined Codes
CP = Common Permanent resident
RW = Rare Winter visitant
UT = Uncommon Transient

Habitat Use Codes
F = Foraging habitat
B = Breeding habitat
FB = Foraging and Breeding habitat

Codes for Amphibians, Reptiles, and Mammals
P = Potential occurrence
C = Common
U = Uncommon
R = Rare
D = Within species range but insufficient data to determine abundance
A = Accidental
X = Column heading status applies

Table 2-8. Wildlife of Cropland Habitat

Species	Migratory Species	Legacy Parkway Project Study Area: Seasonal Abundance				Breeds in Project Study Area	Documented Occurrence Within Project Study Area	Could Potentially Occur Within Project Study Area	Habitat Use								
		P	S	W	T				Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
Birds																	
Cattle Egret	X				RT		X				B	F		F	F		
White-faced Ibis	X		CS				X		F		FB	F	F	F	F		
Snow Goose	X							X			F				F		
Ross' Goose	X							X			F				F		
Canada Goose	X	CP				X	X		F		F	F	F	FB	F	F	F
Greater White-fronted Goose	X							X	F						F		
Green-winged Teal	X				UT		X		F		FB	FB	F	F	F		
Mallard	X	UP				X	X		F	F	FB	FB	F	FB	FB		F
Northern Pintail	X				UT		X		F		FB	FB	F	F	F	B	
Cinnamon Teal	X		RS				X		F		FB	FB	F	F	F		
Gadwall	X		US	UT		X	X		F		FB	FB	FB	FB	FB	B	
Eurasian Wigeon	X				RT		X		F		F	F	F	F	F		
American Wigeon	X				RT		X		F		F	F	F	F	F		
Turkey Vulture	X		US				X						F	F	F	F	F
Northern Harrier	X	CP				X	X			F	FB	F	F	FB	F	FB	F
Sharp-shinned Hawk	X				RT		X			F			F	F	F	F	F
Cooper's Hawk	X				RT		X			F			F	F	F	F	F
Swainson's Hawk (BCC)	X		RS			X	X			B		F	F	F	F	F	
Red-tailed Hawk	X	UP				X	X			B		F	F	F	F	F	F
Ferruginous Hawk (BCC; WSC)	X							X				F	F	F	F	F	
Rough-legged Hawk	X			CW			X					F	F	F	F	F	F
Golden Eagle (BCC)	X				RT		X					F	F	F	F	F	
American Kestrel	X	CP				X	X			B		F	F	F	F	F	F
Merlin	X			RW			X						F	F	F	F	F
Peregrine Falcon (BCC)	X	RP				X	X		F		F	F	F	F	F	F	F
Prairie Falcon (BCC)	X	RP					X					F	F	F	F	F	
Ring-necked Pheasant		RP				X	X			F		F	F	FB	FB	FB	FB
California Quail								X		FB					F		FB
American Coot	X	UP				X	X		F		FB	FB	F	F	F		
Sandhill Crane	X				RT		X		F		FB	F	F	F	F		
Killdeer	X	CP				X	X					FB	FB	FB	FB	FB	FB
Willet	X		RS			X	X					FB	FB	FB	FB	FB	
Franklin's Gull	X				CT		X		F		FB	F	F	F	F		
Ring-billed Gull	X			UW			X		F		F	F	F	F	F		F
California Gull	X	UP					X		F		F	F	F	F	F	F	F
Mourning Dove	X		US	RW		X	X			FB			F	F	F	F	FB
Barn Owl	X	RP				X	X					F	F	F	F	F	FB
Great Horned Owl	X	UP				X	X			FB	F	F	F	F	F	F	FB
Burrowing Owl (BCC; WSC)	X		RS			X	X						F	F	F	FB	
Short-eared Owl (WSC)	X	UP				X	X				F	F	F	F	F	FB	
Common Nighthawk	X				UT		X		F	F	F	F	F	F	F	F	F
Common Poorwill	X				RT			X	F	F	F	F		F	F	F	F
White-throated Swift	X				RT			X		F	F	F		F	F	F	F
Black-chinned Hummingbird	X				RT		X			F		F	F	F	F	F	F
Calliope Hummingbird	X							X		F		F	F	F	F	F	F
Broad-tailed Hummingbird	X				RT		X			F		F	F	F	F	F	F
Rufous Hummingbird	X				RT		X			F		F	F	F	F	F	F
Western Kingbird	X		US			X	X			FB		F	F	F	F	F	FB
Northern Shrike	X			UW			X			F	F	F	F	F	F	F	F
Loggerhead Shrike (BCC)	X	UP					X			F	F	F	F	F	F	FB	F
Black-billed Magpie	X	UP				X	X			FB		F	F	F	F	F	FB
American Crow	X							X				F		F	F	F	F
Common Raven	X	CP				X	X			B	F	F	F	F	F	F	FB
Purple Martin	X							X	F	F	F	F	F	F	F	F	F
Tree Swallow	X				CT		X		F	F	F	F	F	F	F	F	F
Violet-green Swallow	X				UT		X		F	F	F	F	F	F	F	F	F
Northern Rough-winged Swallow	X				UT		X		F	F	F	F	F	F	F	F	F
Bank Swallow	X				CT		X		F	F	F	F	F	F	F	F	F
Cliff Swallow	X		CS			X	X		F	F	F	F	F	F	F	F	B
Barn Swallow	X		CS			X	X		F	F	F	F	F	F	F	F	B
Mountain Bluebird	X				RT		X					F	F	F	F	F	
Townsend's Solitaire	X				RT			X				F		F	F	F	
American Robin	X	UP				X	X			FB		F	F	F	F		FB
European Starling			US	CW		X	X			FB		F	F	F	F	F	FB
American Pipit	X				CT		X			F		F	F	F	F		
American Tree Sparrow	X			UW			X			F	F	F	F	F	F	F	F
Chipping Sparrow	X				CT		X			F		F	F	F	F	F	F
Brewer's Sparrow (BCC)	X		RS				X			F		F	F	F	F	FB	F
Vesper Sparrow	X				RT		X			F		F	F	F	F	F	F
Lark Sparrow	X				RT		X			F		F	F	F	F	F	F
Lincoln's Sparrow	X				RT		X			F		F		F	F	F	F
Harris' Sparrow	X							X		F		F	F	F	F	F	F
White-throated Sparrow	X							X		F		F	F	F	F	F	F
White-crowned Sparrow	X			CW			X			F	F	F	F	F	F	F	F
Dark-eyed Junco	X			CW			X			F	F	F	F	F	F	F	F
Red-winged Blackbird	X	CP				X	X			F	FB	F	F	F	F		F
Western Meadowlark	X	CP				X	X					F	F	FB	F	FB	F
Bobolink (WSC)	X							X				F		F	F	F	
Yellow-headed Blackbird	X		CS			X	X			F	FB	F	F	F	F	F	F
Brewer's Blackbird	X	UP				X	X			F	F	F	F	FB	FB	F	F
Brown-headed Cowbird	X	UP				X	X			FB	FB	FB	FB	FB	FB	FB	FB

Species	Migratory Species	Legacy Parkway Project Study Area: Seasonal Abundance P	S	W	T	Breeds in Project Study Area	Documented Occurrence Within Project Study Area	Could Potentially Occur Within Project Study Area	Habitat Use: Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
House Finch	X	CP				X	X			FB	F	F	F	F	F	FB	FB
Pine Siskin	X			CW			X			F					F	F	F
American Goldfinch	X			UW			X			F	F	F			F	F	F
House Sparrow				UP		X	X			F				F	F		FB
Reptiles																	
Gopher snake		C					X			X				X	X	X	
Mammals																	
Nuttall's cottontail								X						X	X	X	
Black-tailed jackrabbit		C					X							X	X	X	
Piute ground squirrel		D						X						X	X	X	
Rock squirrel		C					X							X	X	X	
Northern pocket gopher								X		X				X	X		
Botta's pocket gopher								X		X				X	X	X	
Deer mouse		C					X			X				X	X	X	X
Montane vole		D						X			X	X			X		
House mouse		C					X			X				X	X	X	X
Norway rat							X			X	X	X		X	X		X
Coyote		R				X	X							X	X	X	X
Red fox		C				X	X			X				X	X	X	X
Raccoon		C				X	X			X	X	X		X	X	X	X
Striped skunk		C				X	X			X				X	X	X	X
Mule deer		C				X	X			X	X			X	X	X	
Summary																	
Birds	81	23	13	13	27	31	71	14	25	51	43	73	71	79	85	66	60
Reptiles	0	1	0	0	0	0	1	0	0	1	0	0	0	1	1	1	0
Mammals	0	11	0	0	0	5	10	5	0	9	4	3	0	14	15	12	7

Special-Status Species

FT	Federally Listed as Threatened
FC	Federal Candidate Species
BCC	Birds of Conservation Concern
CAS	Conservation Agreement Species
WSC	Wildlife Species of Concern
X	Breeds in Project Study Area

Bird Codes

Abundance Status

C = Common: Found consistently in fair numbers in appropriate habitat and season
U = Uncommon: Found consistently in small numbers in appropriate habitat and season
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Residence Status

P = Permanent resident: Found year-round
S = Summer visitant: Present during the nesting season
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X = Column heading status applies
(X) = Very few GSLE records; low probability of occurrence at Legacy Parkway project study area

Examples of Combined Codes

CP = Common Permanent resident
RW = Rare Winter visitant
UT = Uncommon Transient

Habitat Use Codes

F = Foraging habitat
B = Breeding habitat
FB = Foraging and Breeding habitat

Codes for Amphibians, Reptiles, and Mammals

P = Potential occurrence
C = Common
U = Uncommon
R = Rare
D = Within species range but insufficient data to determine abundance
A = Accidental
X = Column heading status applies

Table 2-9. Wildlife of Salt Desert Scrub Habitat

Species	Migratory Species	Legacy Parkway Project Study Area							Habitat Use								
		Seasonal Abundance				Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
		P	S	W	T												
Birds																	
Canada Goose	X	CP				X	X		F		F	F	F	FB	F	F	F
Northern Pintail	X				UT		X		F		FB	FB	F	F	F	B	
Gadwall	X		US		UT	X	X		F		FB	FB	FB	FB	FB	B	
Northern Shoveler	X				UT		X		F		FB	FB	F	F		B	
Turkey Vulture	X		US				X						F	F	F	F	F
Bald Eagle (FT)	X		RS	CW		X	X			FB	F	F	F	F		F	
Northern Harrier	X	CP				X	X			F	FB	F	F	FB	F	FB	F
Sharp-shinned Hawk	X				RT		X			F			F	F	F	F	F
Cooper's Hawk	X				RT		X			F			F	F	F	F	F
Northern Goshawk (CAS)	X						(X)			F						F	
Swainson's Hawk (BCC)	X		RS			X	X			B		F	F	F	F	F	
Red-tailed Hawk	X	UP				X	X			B		F	F	F	F	F	F
Ferruginous Hawk (BCC; WSC)	X							X				F	F	F	F	F	
Rough-legged Hawk	X			CW			X					F	F	F	F	F	F
Golden Eagle (BCC)	X				RT		X					F	F	F	F	F	
American Kestrel	X	CP				X	X			B		F	F	F	F	F	F
Merlin	X			RW			X						F	F	F	F	F
Peregrine Falcon (BCC)	X	RP				X	X		F		F	F	F	F	F	F	F
Prairie Falcon (BCC)	X	RP					X					F	F	F	F	F	
Ring-necked Pheasant		RP				X	X			F		F	F	FB	FB	FB	FB
Killdeer	X	CP				X	X					FB	FB	FB	FB	FB	FB
Willet	X		RS			X	X					FB	FB	FB	FB	FB	
Long-billed Curlew (BCC)	X				RT		X					F	FB			FB	
California Gull	X	UP					X		F		F	F	F	F	F	F	F
Mourning Dove	X		US	RW		X	X			FB			F	F	F	F	FB
Barn Owl	X	RP				X	X					F	F	F	F	F	FB
Great Horned Owl	X	UP				X	X			FB	F	F	F	F	F	F	FB
Burrowing Owl (BCC; WSC)	X		RS			X	X						F	F	F	FB	
Long-eared Owl	X							X		F		F	F	F		F	
Short-eared Owl (WSC)	X	UP				X	X				F	F	F	F	F	FB	
Common Nighthawk	X				UT		X		F	F	F	F	F	F	F	F	F
Common Poorwill	X				RT			X	F	F	F	F		F	F	F	F
White-throated Swift	X				RT			X		F	F	F		F	F	F	F
Black-chinned Hummingbird	X				RT		X			F		F	F	F	F	F	F
Calliope Hummingbird	X							X		F		F	F	F	F	F	F
Broad-tailed Hummingbird	X				RT		X			F		F	F	F	F	F	F
Rufous Hummingbird	X				RT		X			F		F	F	F	F	F	F
Northern Flicker	X				RT		X			FB						F	FB
Olive-sided Flycatcher	X				RT		X			F						F	F
Western Wood-Pewee	X				RT		X			F						F	F
Cordilleran Flycatcher	X				RT		(x)			F						F	F
Willow Flycatcher (BCC)	X				RT		(X)			F						F	F
Hammond's Flycatcher	X				RT		(X)			F						F	F
Dusky Flycatcher	X				RT		(X)			F						F	F
Gray Flycatcher	X				RT		(X)			F						F	F
Say's Phoebe	X							X								FB	
Ash-throated Flycatcher	X				RT		(X)			F						F	F
Western Kingbird	X		US			X	X			FB		F	F	F	F	F	FB
Northern Shrike	X			UW			X			F	F	F	F	F	F	F	F
Loggerhead Shrike (BCC)	X	UP					X			F	F	F	F	F	F	FB	F
Warbling Vireo	X				RT		X			F						F	F
Black-billed Magpie	X	UP				X	X			FB		F	F	F	F	F	FB
American Crow	X							X				F		F	F	F	F
Common Raven	X	CP				X	X			B	F	F	F	F	F	F	FB
Horned Lark	X	CP				X	X					F	FB	F		FB	
Purple Martin	X							X	F	F	F	F	F	F	F	F	F
Tree Swallow	X				CT		X		F	F	F	F	F	F	F	F	F
Violet-green Swallow	X				UT		X		F	F	F	F	F	F	F	F	F
Northern Rough-winged Swallow	X				UT		X		F	F	F	F	F	F	F	F	F
Bank Swallow	X				CT		X		F	F	F	F	F	F	F	F	F
Cliff Swallow	X		CS			X	X		F	F	F	F	F	F	F	F	B
Barn Swallow	X		CS			X	X		F	F	F	F	F	F	F	F	B
Black-capped Chickadee	X			RW	RT		X			F						F	F
Rock Wren	X							X								F	
House Wren	X							X		F						F	F
Ruby-crowned Kinglet	X				RT		X			F						F	F
Blue-gray Gnatcatcher	X							X		F						F	F
Mountain Bluebird	X				RT		X					F	F	F	F	F	
Townsend's Solitaire	X				RT			X				F		F	F	F	
Northern Mockingbird	X							X		F						F	F
Sage Thrasher	X		RS				X									FB	
European Starling			US	CW		X	X			FB		F	F	F	F	F	FB
Orange-crowned Warbler	X				RT		X			F						F	F
Virginia's Warbler (BCC)	X							X		F						F	F
Yellow Warbler	X				UT		X			F	F					F	F
Yellow-rumped Warbler	X				CT		X			F	F					F	F
MacGillvray's Warbler	X				RT		X			F	F					F	F
Wilson's Warbler	X				RT		X			F	F					F	F
Lazuli Bunting	X				UT		X			F						F	F

Table 2-9. Continued

Species	Migratory Species	Legacy Parkway Project Study Area: Seasonal Abundance P	S	W	T	Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Habitat Use: Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
Spotted Towhee	X				RT		X			F						F	F
American Tree Sparrow	X			UW			X			F	F	F	F	F	F	F	F
Chipping Sparrow	X				CT		X			F		F	F	F	F	F	F
Brewer's Sparrow (BCC)	X		RS				X			F		F	F	F	F	FB	F
Vesper Sparrow	X				RT		X			F		F	F	F	F	F	F
Lark Sparrow	X				RT		X			F		F	F	F	F	F	F
Lark Bunting	X							X								F	
Lincoln's Sparrow	X				RT		X			F		F		F	F	F	F
Harris' Sparrow	X							X		F		F	F	F	F	F	F
White-throated Sparrow	X							X		F		F	F	F	F	F	F
White-crowned Sparrow	X			CW			X			F	F	F	F	F	F	F	F
Dark-eyed Junco	X			CW			X			F	F	F	F	F	F	F	F
Lapland Longspur	X							X				F	F			F	
Snow Bunting	X							X				F	F			F	
Western Meadowlark	X	CP				X	X					F	F	FB	F	FB	F
Bobolink (WSC)	X							X				F		F	F	F	
Yellow-headed Blackbird	X		CS			X	X			F	FB	F	F	F	F	F	F
Brewer's Blackbird	X	UP				X	X			F	F	F	F	FB	FB	F	F
Brown-headed Cowbird	X	UP				X	X			FB	FB	FB	FB	FB	FB	FB	FB
House Finch	X	CP				X	X			FB	F	F	F	F	F	FB	FB
Pine Siskin	X			CW			X			F					F	F	F
American Goldfinch	X			UW			X			F	F	F			F	F	F
Amphibians																	
Great Basin spadefoot								X			X	X				X	
Reptiles																	
Common sagebrush lizard								X								X	
Side-blotched lizard								X								X	
Desert horned lizard		D						X								X	
Tiger whiptail		D						X								X	
Eastern racer		C					X					X		X		X	
Gopher snake		C					X			X				X	X	X	
Night snake		D														X	
Western rattlesnake		D														X	
Mammals																	
Vagrant shrew		D						X								X	
Preble's shrew (WSC)		D						X								X	
Western Small-footed myotis								X		X	X	X		X		X	
Little brown bat	X							X		X	X	X		X		X	
Long-legged myotis	X							X		X	X	X		X		X	
Western pipistrelle	X							X		X	X	X		X		X	
Big brown bat	X							X		X	X	X		X		X	
Spotted bat (WSC)	X							X									
Townsend's big-eared bat (WSC)	X							X		X	X	X		X		X	
Brazilian free-tailed bat	X							X		X	X	X		X		X	
Nuttall's cottontail								X						X	X	X	
Black-tailed jackrabbit		C					X							X	X	X	
Least chipmunk		D						X								X	
Piute ground squirrel		D						X								X	
Rock squirrel		C					X							X	X	X	
Botta's pocket gopher								X		X				X	X	X	
Great Basin pocket mouse		D						X								X	
Ord's kangaroo rat								X								X	
Western harvest mouse								X		X				X		X	
Deer mouse		C					X			X				X	X	X	X
Northern grasshopper mouse								X								X	
Desert woodrat		D						X						X		X	
Bushy-tailed woodrat		D						X						X		X	
Meadow vole		C					X			X		X		X		X	
Sagebrush vole		D						X								X	
House mouse		C					X			X				X	X	X	X
Coyote		R				X	X							X	X	X	X
Red fox		C				X	X			X				X	X	X	X
Kit fox								X								X	
Raccoon		C				X	X			X	X	X		X	X	X	X
Long-tailed weasel		R				X	X			X				X		X	X
Badger								X						X		X	
Striped skunk		C				X	X			X				X	X	X	X
Bobcat								X								X	X
Mule deer		C				X	X			X	X			X	X	X	
Pronghorn								X						X		X	

Summary

Birds	99	20	13	12	42	28	81	20	15	71	35	66	65	68	66	101	77
Amphibians	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0
Reptiles	0	4	0	0	0	0	2	4	0	1	0	1	0	2	1	6	0
Mammals	7	15	0	0	0	6	11	25	0	17	9	9	0	25	11	33	8

Special-Status Species

FT	Federally Listed as Threatened
FC	Federal Candidate Species
BCC	Birds of Conservation Concern
CAS	Conservation Agreement Species
WSC	Wildlife Species of Concern
X	Breeds in Project Study Area

Bird Codes

Abundance Status

C = Common: Found consistently in fair numbers in appropriate habitat and season
U = Uncommon: Found consistently in small numbers in appropriate habitat and season
R = Rare: Found infrequently but regularly in very small numbers in appropriate habitat and season

Residence Status

P = Permanent resident: Found year-round
S = Summer visitant: Present during the nesting season
W = Winter visitant: Present during January and February
T = Transient: Migrates through the area in the spring and/or fall
X = Column heading status applies
(X) = Very few GSLE records; low probability of occurrence at Legacy Parkway project study area

Examples of Combined Codes

CP = Common Permanent resident
RW = Rare Winter visitant
UT = Uncommon Transient

Habitat Use Codes

F = Foraging habitat
B = Breeding habitat
FB = Foraging and Breeding habitat

Codes for Amphibians, Reptiles, and Mammals

P = Potential occurrence
C = Common
U = Uncommon
R = Rare
D = Within species range but insufficient data to determine abundance
A = Accidental
X = Column heading status applies

Table 2-10. Wildlife of Developed Habitat (including Urban Landscaping)

Species	Migratory Species	Legacy Parkway Project Study Area							Habitat Use								
		Seasonal Abundance				Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
		P	S	W	T												
Birds																	
Canada Goose	X	CP				X	X		F		F	F	F	FB	F	F	F
Wood Duck	X							X	F								F
Mallard	X	UP				X	X		F	F	FB	FB	F	FB	FB		F
Turkey Vulture	X		US				X						F	F	F	F	F
Northern Harrier	X	CP				X	X			F	FB	F	F	FB	F	FB	F
Sharp-shinned Hawk	X				RT		X			F			F	F	F	F	F
Cooper's Hawk	X				RT		X			F			F	F	F	F	F
Red-tailed Hawk	X	UP				X	X			B		F	F	F	F	F	F
Rough-legged Hawk	X			CW			X					F	F	F	F	F	F
American Kestrel	X	CP				X	X			B		F	F	F	F	F	F
Merlin	X			RW			X						F	F	F	F	F
Peregrine Falcon (BCC)	X	RP				X	X		F		F	F	F	F	F	F	F
Ring-necked Pheasant		RP				X	X			F		F	F	FB	FB	FB	FB
California Quail								X		FB					F		FB
Killdeer	X	CP				X	X					FB	FB	FB	FB	FB	FB
Ring-billed Gull	X			UW			X		F		F	F	F	F	F		F
California Gull	X	UP					X		F		F	F	F	F	F	F	F
Herring Gull	X							X	F								F
Thayer's Gull	X							X	F								F
Glaucous Gull	X							X	F								F
Rock Dove	X	UP				X	X										FB
Mourning Dove	X		US	RW		X	X			FB			F	F	F	F	FB
Yellow-billed Cuckoo (FC)	X							X		F							F
Barn Owl	X	RP				X	X					F	F	F	F	F	FB
Great Horned Owl	X	UP				X	X			FB	F	F	F	F	F	F	FB
Common Nighthawk	X				UT		X		F	F	F	F	F	F	F	F	F
Common Poorwill	X				RT			X	F	F	F	F		F	F	F	F
White-throated Swift	X				RT			X		F	F	F		F	F	F	F
Black-chinned Hummingbird	X				RT		X			F		F	F	F	F	F	F
Calliope Hummingbird	X							X		F		F	F	F	F	F	F
Broad-tailed Hummingbird	X				RT		X			F		F	F	F	F	F	F
Rufous Hummingbird	X				RT		X			F		F	F	F	F	F	F
Red-naped Sapsucker	X							X		F							F
Downy Woodpecker	X							X		F							F
Northern Flicker	X				RT		X			FB						F	FB
Olive-sided Flycatcher	X				RT		X			F						F	F
Western Wood-Pewee	X				RT		X			F						F	F
Cordilleran Flycatcher	X				RT		(X)			F						F	F
Willow Flycatcher	X				RT		(X)			F						F	F
Hammond's Flycatcher	X				RT		(X)			F						F	F
Dusky Flycatcher	X				RT		(X)			F						F	F
Gray Flycatcher	X				RT		(X)			F						F	F
Ash-throated Flycatcher	X				RT		(X)			F						F	F
Western Kingbird	X		US			X	X			FB		F	F	F	F	F	FB
Eastern Kingbird	X							X		F							F
Northern Shrike	X			UW			X			F	F	F	F	F	F	F	F
Loggerhead Shrike	X	UP					X			F	F	F	F	F	F	FB	F
Plumbeous Vireo	X							X		F							F
Warbling Vireo	X				RT		X			F						F	F
Black-billed Magpie	X	UP				X	X			FB		F	F	F	F	F	FB
American Crow	X							X				F		F	F	F	F
Common Raven	X	CP				X	X			B	F	F	F	F	F	F	FB
Purple Martin	X							X	F	F	F	F	F	F	F	F	F
Tree Swallow	X				CT		X		F	F	F	F	F	F	F	F	F
Violet-green Swallow	X				UT		X		F	F	F	F	F	F	F	F	F
Northern Rough-winged Swallow	X				UT		X		F	F	F	F	F	F	F	F	F
Bank Swallow	X				CT		X		F	F	F	F	F	F	F	F	F
Cliff Swallow	X		CS			X	X		F	F	F	F	F	F	F	F	B
Barn Swallow	X		CS			X	X		F	F	F	F	F	F	F	F	B
Black-capped Chickadee	X			RW	RT		X			F						F	F
Mountain Chickadee	X							X		F							F
House Wren	X							X		F						F	F
Ruby-crowned Kinglet	X				RT		X			F						F	F
Blue-gray Gnatcatcher	X							X		F						F	F
Hermit Thrush	X							X		F							F
Swainson's Thrush	X							X		F							F
American Robin	X	UP				X	X			FB		F	F	F	F		FB
Northern Mockingbird	X							X		F						F	F
European Starling			US	CW		X	X			FB		F	F	F	F	F	FB
Bohemian Waxwing	X			RW			X			F							F
Cedar Waxwing	X			RW			X			F							F
Orange-crowned Warbler	X				RT		X			F						F	F
Nashville Warbler	X				RT		X			F							F
Virginia's Warbler (BCC)	X							X		F						F	F
Yellow Warbler	X				UT		X			F	F					F	F
Yellow-rumped Warbler	X				CT		X			F	F					F	F
Townsend's Warbler	X				RT		X			F							F
American Redstart	X							X		F							F
MacGillvray's Warbler	X				RT		X			F	F					F	F

Species	Migratory Species	Legacy Parkway Project Study Area: Seasonal Abundance				Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Habitat Use								
		P	S	W	T				Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
Wilson's Warbler	X				RT		X			F	F					F	F
Western Tanager	X							X		F							F
Black-headed Grosbeak	X							X		F							F
Lazuli Bunting	X				UT		X			F						F	F
Green-tailed Towhee	X							X		F							F
Spotted Towhee	X				RT		X			F						F	F
American Tree Sparrow	X			UW			X			F	F	F	F	F	F	F	F
Chipping Sparrow	X				CT		X			F		F	F	F	F	F	F
Brewer's Sparrow (BCC)	X		RS				X			F		F	F	F	F	FB	F
Vesper Sparrow	X				RT		X			F		F	F	F	F	F	F
Lark Sparrow	X				RT		X			F		F	F	F	F	F	F
Song Sparrow	X	UP				X	X			FB	F	F		F			F
Lincoln's Sparrow	X				RT		X			F		F		F	F	F	F
Harris' Sparrow	X							X		F		F	F	F	F	F	F
White-throated Sparrow	X							X		F		F	F	F	F	F	F
White-crowned Sparrow	X			CW			X			F	F	F	F	F	F	F	F
Dark-eyed Junco	X			CW			X			F	F	F	F	F	F	F	F
Red-winged Blackbird	X	CP				X	X			F	FB	F	F	F	F		F
Western Meadowlark	X	CP				X	X					F	F	FB	F	FB	F
Yellow-headed Blackbird	X		CS			X	X			F	FB	F	F	F	F	F	F
Brewer's Blackbird	X	UP				X	X			F	F	F	F	FB	FB	F	F
Brown-headed Cowbird	X	UP				X	X			FB	FB	FB	FB	FB	FB	FB	FB
Northern Oriole	X		US			X	X			FB							FB
Cassin's Finch	X							X		F							F
House Finch	X	CP				X	X			FB	F	F	F	F	F	FB	FB
Pine Siskin	X			CW			X			F					F	F	F
American Goldfinch	X			UW			X			F	F	F			F	F	F
Evening Grosbeak	X			RW			X			F							F
House Sparrow				UP		X	X			F				F	F		FB
Mammals	M	P	S	W	T	B	DO	PO	OW	R	EM	WM	M	P	C	S	D
Deer mouse		C					X			X				X	X	X	X
Muskrat		C					X		X	X	X	X					X
House mouse		C					X			X				X	X	X	X
Black rat								X		X							X
Norway rat							X			X	X	X		X	X		X
Coyote		R				X	X							X	X	X	X
Red fox		C				X	X			X				X	X	X	X
Raccoon		C				X	X			X	X	X		X	X	X	X
Long-tailed weasel		R				X	X			X				X		X	X
Striped skunk		C				X	X			X				X	X	X	X
Bobcat								X								X	X
Summary																	
Birds	104	22	8	16	37	28	79	29	18	92	34	53	52	58	60	77	108
Mammals	0	8	0	0	0	5	9	2	1	9	3	3	0	8	7	8	11

Special-Status Species

FT	Federally Listed as Threatened
FC	Federal Candidate Species
BCC	Birds of Conservation Concern
CAS	Conservation Agreement Species
WSC	Wildlife Species of Concern
X	Breeds in Project Study Area

Bird Codes

Abundance Status

C = Common: Found consistently in fair numbers in appropriate habitat and season
U = Uncommon: Found consistently in small numbers in appropriate habitat and season
R = Rare: Found infrequently but regularly in very small numbers in appropriate habitat and season

Residence Status

P = Permanent Resident: Found year-round
S = Summer visitant: Present during the nesting season
W = Winter visitant: Present during January and February
T = Transient: Migrates through the area in spring and/or fall
X = Column heading status applies
(X) = Very few GSLE records; low probability of occurrence at Legacy Parkway project study area

Examples of Combined Codes

CP = Common Permanent resident
RW = Rare Winter visitant
UT = Uncommon Transient

Habitat Use Codes

F = Foraging habitat
B = Breeding habitat
FB = Foraging and Breeding habitat

Codes for Amphibians, Reptiles, and Mammals

C = Common
U = Uncommon
R = Rare
D = Within species range but insufficient data to determine abundance
A = Accidental
X = Column heading status applies

Table 2-11. Wildlife Species Summary: Number of Species by Status and Habitat Use

	Species Status						Habitat Use								
	Project Study Area Occurrence	Migratory Species[1]	Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Special-Status Species	Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed (incl. Urban Landscaping)
Birds	219	215	51	140	79	24	78	107	79	102	109	103	85	101	108
Fish	12	0	12	1	11	0	5	0	5	0	0	0	0	0	0
Amphibians	6	0	6	1	5	0	0	1	6	6	1	1	0	1	0
Reptiles	10	0	10	4	6	0	0	3	2	3	0	4	1	8	0
Mammals	50	8	41	15	35	4	1	26	16	13	4	32	15	36	11
Total	297	223	120	161	136	28	84	139	108	124	114	140	101	144	119

[1] Migratory species identified in the Migratory Bird Treaty Act

Table 2-12. Bird Species' Common Use of Habitats

Habitat	Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed	Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
	Number of Shared Species									Percentage of Shared Species								
Open Water	78	15	48	38	35	34	25	15	18	100	19	62	49	45	44	32	19	23
Riparian	15	107	36	52	50	54	51	71	92	14	100	34	49	47	50	48	66	86
Emergent Marsh	48	36	79	57	50	52	43	35	34	61	46	100	72	63	66	54	44	43
Wet Meadow	38	52	57	102	89	93	72	66	53	37	51	56	100	87	91	71	65	52
Mudflat	35	50	50	89	109	93	71	65	53	32	46	46	82	100	85	65	60	49
Pasture	34	54	52	93	93	103	79	68	58	33	52	50	90	90	100	77	66	56
Cropland	25	51	43	72	71	79	85	66	59	29	60	51	85	84	93	100	78	69
Scrub	15	71	35	66	65	68	66	101	76	15	70	35	65	64	67	65	100	75
Developed	18	92	34	53	53	58	59	76	108	17	85	31	49	49	54	55	70	100

Table 2-13. Summary of Bird Use of Habitats in the Project Study Area (number of species)

Habitat	Species	Seasonal Abundance				Breeds in Project Study Area	Documented Occurrence in Project Study Area	Potential Occurrence in Project Study Area
		P	S	W	T			
Open Water	78	7	18	4	24	16	48	30
Riparian	107	17	13	14	39	29	78	29
Emergent Marsh	79	17	22	9	25	31	65	13
Wet Meadow	102	27	21	11	35	41	86	15
Mudflat	109	25	22	11	35	39	90	19
Pasture	103	26	23	12	35	42	88	15
Cropland	85	23	13	13	27	31	71	14
Scrub	101	20	13	12	42	28	81	20
Developed	108	22	8	16	37	28	79	29
Maximum	108	27	23	16	42	42	90	30
Minimum	78	7	8	4	24	16	48	13
Mean	96.9	20.4	17.0	11.3	33.2	31.7	76.2	20.4
STDEV	12.6	6.2	5.4	3.4	6.4	8.1	13.3	7.0

P = Permanent Resident: Found year round

S = Summer visitant: Present during the nesting season.

W = Winter visitant: Present during January and February

T = Transient: Migrates through the area in the spring and/or fall.

Table 2-14. Population Status and Habitat Use of Representative Migratory Birds Using Habitats in Project and Regional Study Areas

Species	Great Salt Lake Population Estimate	Habitat Use
Wilson's Phalarope	500,000	Largest staging concentration in the world (Jehl 1988)
Northern Pintail	9,436	Breeding population (Aldrich and Paul 2002)
Ruddy Duck	16,389	Breeding population (Aldrich and Paul 2002)
American Avocet	250,000 / 63,806[1]	Many times higher than any other Pacific Flyway wetland (Shuford 1984)
Northern Shoveler	25,510	Breeding population (Aldrich and Paul 2002)
Gadwall	59,944	Breeding population (Aldrich and Paul 2002)
California Gull	160,000 / 95,183[1]	Breeding adults: largest staging population in North America (Jehl 1994)
Cinnamon Teal	40,702	Breeding population (Aldrich and Paul 2002)
Mallard	48,099	Breeding population (Aldrich and Paul 2002)
Franklin's Gull	30,652[1]	Breeding adults
Long-billed Dowitcher	32,000	Single day count (Shuford 1994)
Eared Grebe	400,000 / 1.6 million[1]	Largest staging population in North America (Jehl 1994)
Black-necked Stilt	65,000 / 20,502[1]	Many times higher than any other wetland in the Pacific Flyway (Shuford 1984)
Red-necked Phalarope	280,000	GSL single day estimate (Paul 1986)
Western Sandpiper	17,000	This GSL measure is for one flock (1994)
Redhead	29,642	Breeding population (Aldrich and Paul 2002)
White-faced Ibis	75,000 / 28,626[1]	Breeding adults: world's largest breeding population (USFWS Status Report 1982)
American White Pelican	18,000 / 9,898[1]	Breeding adults; one of the three largest colonies in the western United States (Paul 1994)
Canvasback	347[1]	Breeding population (Aldrich and Paul 2002)
Snowy Egret	1,353[1]	Breeding adults
Forster's Tern	1,586[1]	Breeding adults
Marbled Godwit	30,000	The only staging area in the interior United States (Shuford 1984)

[1] Peak numbers are the largest 5-year survey period mean (1997–2001) in Paul and Manning (2002)

Table 2-15. Mean and Peak Survey Values for Selected Species at Survey Site 42 (East Farmington Bay) 1997–2001

Species	Mean Survey Count[1]	Peak Survey Count[2]
Black-crowned Night Heron	0.1	0.5
Canada Goose	64.9	195.7
Eared Grebe	0.2	25.3
Franklin's Gull	0.6	34.0
Killdeer	8.0	25.7
White-faced Ibis	33.6	619.3

Note: Surveys were conducted in three years during the 5-year study period.
[1] Average of 3 years of survey counts.
[2] Largest period mean for the 3 years surveyed.

Table 2-16. Short-Term Sound Level Measurements

Recording Location	Date	Start Time	Duration (min)	Average Wind Speed (mph)	Leq[1]	Lmin[2]	L90[3]	L50[3]	L10[3]	Lmax[4]	Distinct Noise Sources
5	1 Jul	12:43	16:00	8.4	52.2	41.8	43.9	47.1	53.5	67.3	Vehicle passages, crickets, wind in vegetation
6	1 Jul	13:50	16:00	11.6	52.3	40.2	44.8	49.3	56.3	62.6	Aircraft, wind in vegetation
7	1 Jul	14:48	10:00	14.8	52.3	45	47.1	51.3	55.1	66.6	Wind in vegetation, no audible human sound
8	1 Jul	15:36	15:00	8.6	59.5	39.2	42.3	48	60.5	79.1	Vehicle passages, distant traffic, aircraft, wind in vegetation
9	1 Jul	18:40	18:00	11.1	48.3	32.2	39.7	44.7	52.4	60.9	Wind in vegetation, aircraft
10	1 Jul	19:20	15:00	2.7	59.9	33.2	36.2	45	62	76.5	Aircraft, birds
11	1 Jul	19:59	15:00	4.4	51.9	33.1	40.2	45.4	51.5	71.4	Aircraft, birds
12	2 Jul	7:02	19:00	2.2	43.9	32	33.7	36.1	44	61.6	Aircraft, birds
13	2 Jul	7:57	14:00	2.8	46.8	39.8	41.8	43.4	46.6	61	Aircraft, distant birds
1	2 Jul	9:36	17:00	1.2	42.6	33.4	36.5	40.6	45.8	52.6	Aircraft, birds
2	2 Jul	10:33	18:00	2.9	45.1	31.2	33.8	40.8	49.2	57.1	Aircraft, crickets
6	2 Jul	12:33	15:00	4.1	40.8	31.7	33.8	36.7	42.1	57.6	Wind in vegetation, birds, aircraft
14	2 Jul	13:29	16:00	4.5	47.2	31.8	33.7	36.6	52.3	61.2	Wind in vegetation, birds, aircraft
4	2 Jul	14:53	15:00	4.8	37.1	30.8	31.6	33.6	38.4	53.1	Distant construction activity, aircraft
				Mean	48.6	35.4	38.5	42.8	50.7	64.3	
				STDEV	6.6	4.7	5.0	5.5	6.8	7.6	
				Min	37.1	30.8	31.6	33.6	38.4	53.1	
				Max	59.9	45	47.1	51.3	62	79.1	
				Range	22.8	14.2	15.5	17.7	23.6	26.0	

[1] **Leq.** Equivalent Sound Level. The equivalent steady-state sound level that, in a stated period of time, would contain the same acoustical energy.
[2] **Lmin.** Minimum Sound Level. The minimum sound level measured during the measurement period.
[3] **Lxx.** Percentile-Exceeded Sound Level. The sound level exceeded "x" percent of a specific time period. L10 is the sound level exceeded 10 percent of the time.
[4] **Lmax.** Maximum Sound Level. The maximum sound level measured during the measurement period.

Table 2-17. Mean, Standard Deviation, Minimum, and Maximum Noise Levels

SPL[1] (dBA)[2]	Leq[3]				L10[4]				L50[4]				L90[4]			
	L1	L2	L3	L1–L3	L1	L2	L3	L1–L3	L1	L2	L3	L1–L3	L1	L2	L3	L1–L3
Mean	53	45	52	50	55	48	54	51	47	41	46	45	43	36	41	40
SDEV	11	8	8	10	11	8	9	11	8	7	8	8	7	5	6	7
Minimum	41	36	40	36	42	37	41	35	37	34	36	34	36	32	35	32
Maximum	78	69	71	78	81	73	75	81	71	67	69	71	65	58	64	65

[1] **SPL.** Sound Pressure Level.
[2] **dBA.** A-Weighted Decibel. An overall frequency-weighted sound level in decibels that approximates the frequency response of the human ear.
[3] **Leq.** Equivalent Sound Level. The equivalent steady-state sound level that, in a stated period of time, would contain the same acoustical energy.
[4] **Lxx.** Percentile-Exceeded Sound Level. The sound level exceeded “x” percent of a specific time period. L10 is the sound level exceeded 10 percent of the time.

Chapter 2

Figures

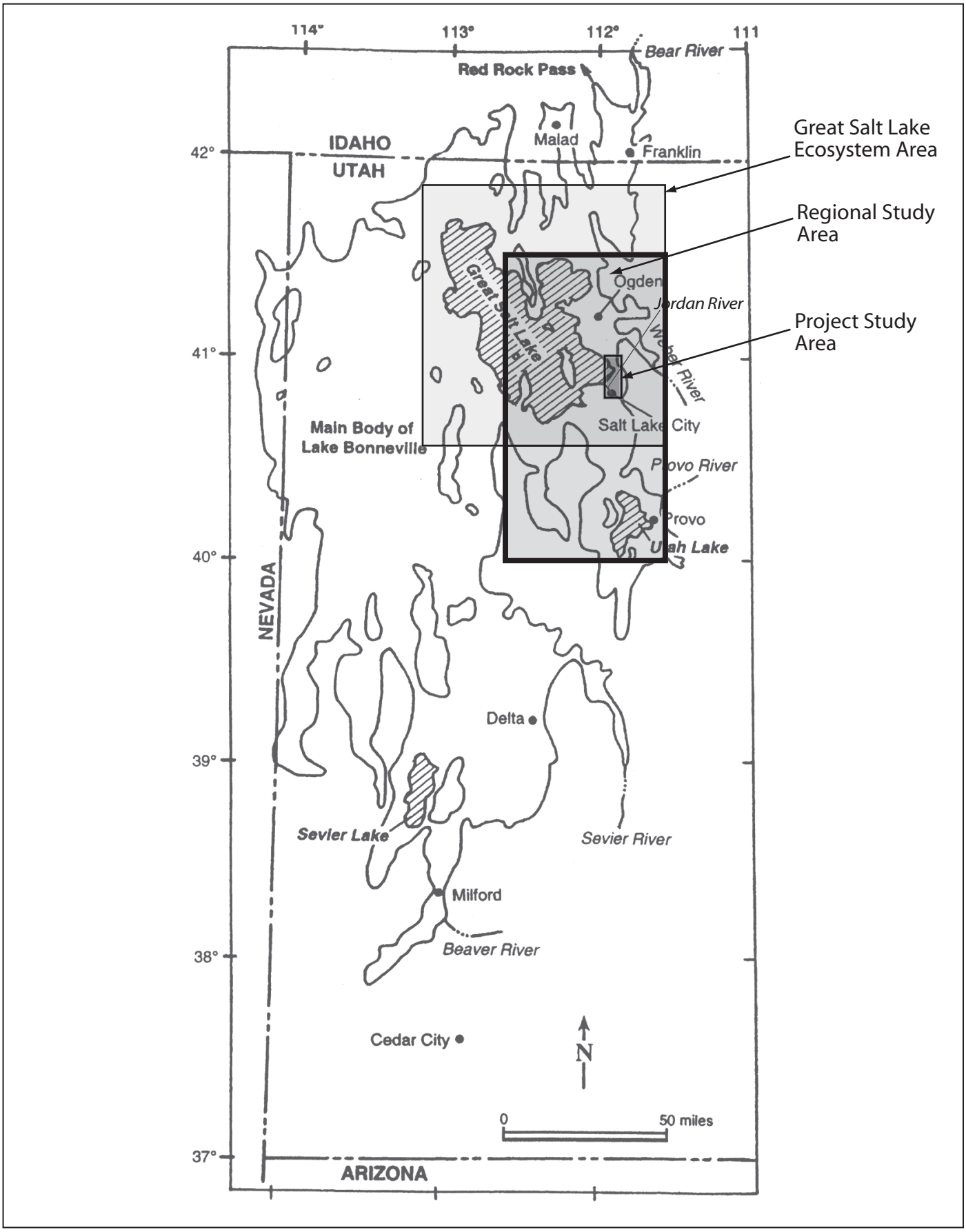

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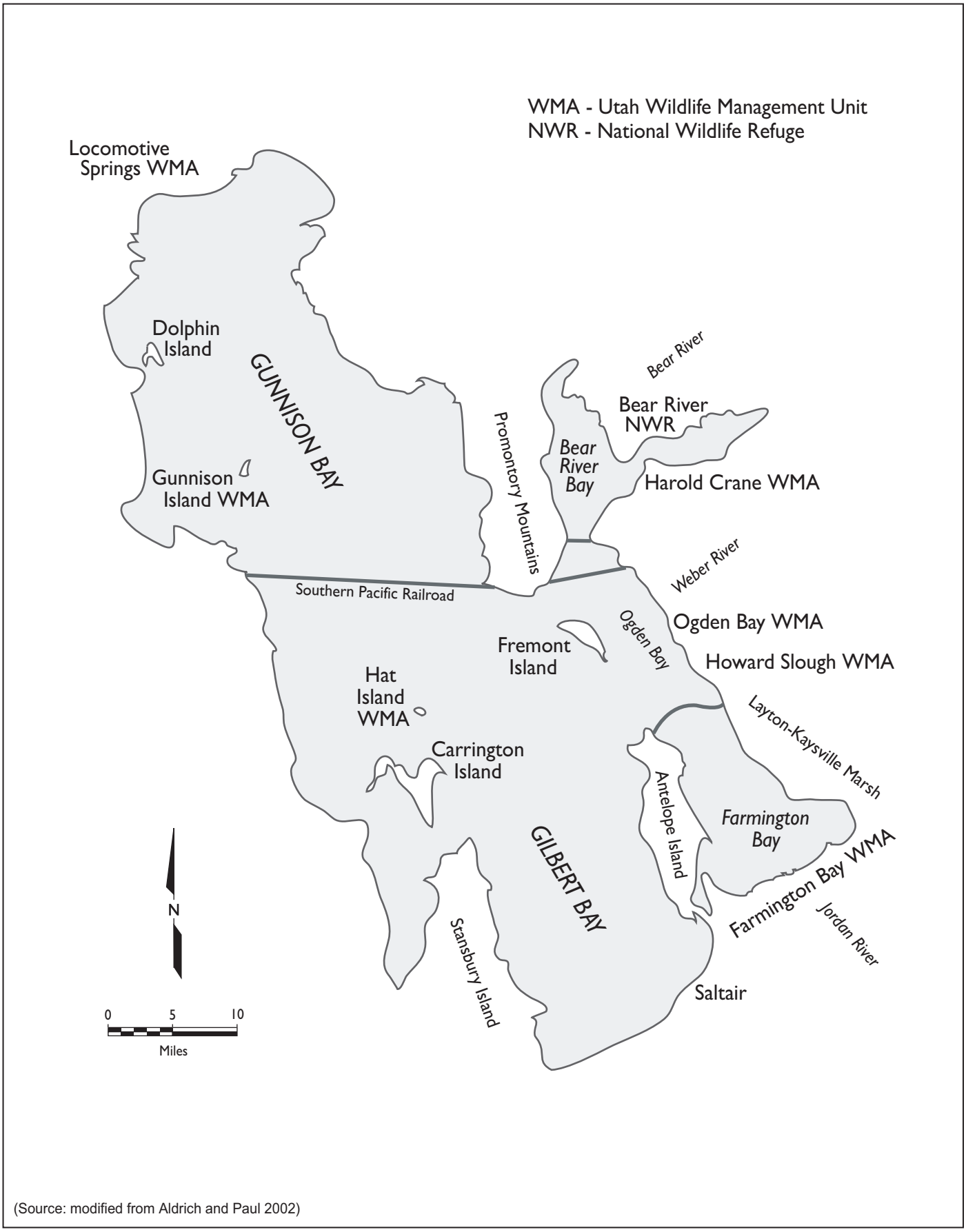
Figure 2-1
Location of Great Salt Lake in Lake Bonneville Basin



(Source: modified from Aldrich and Paul 2002)

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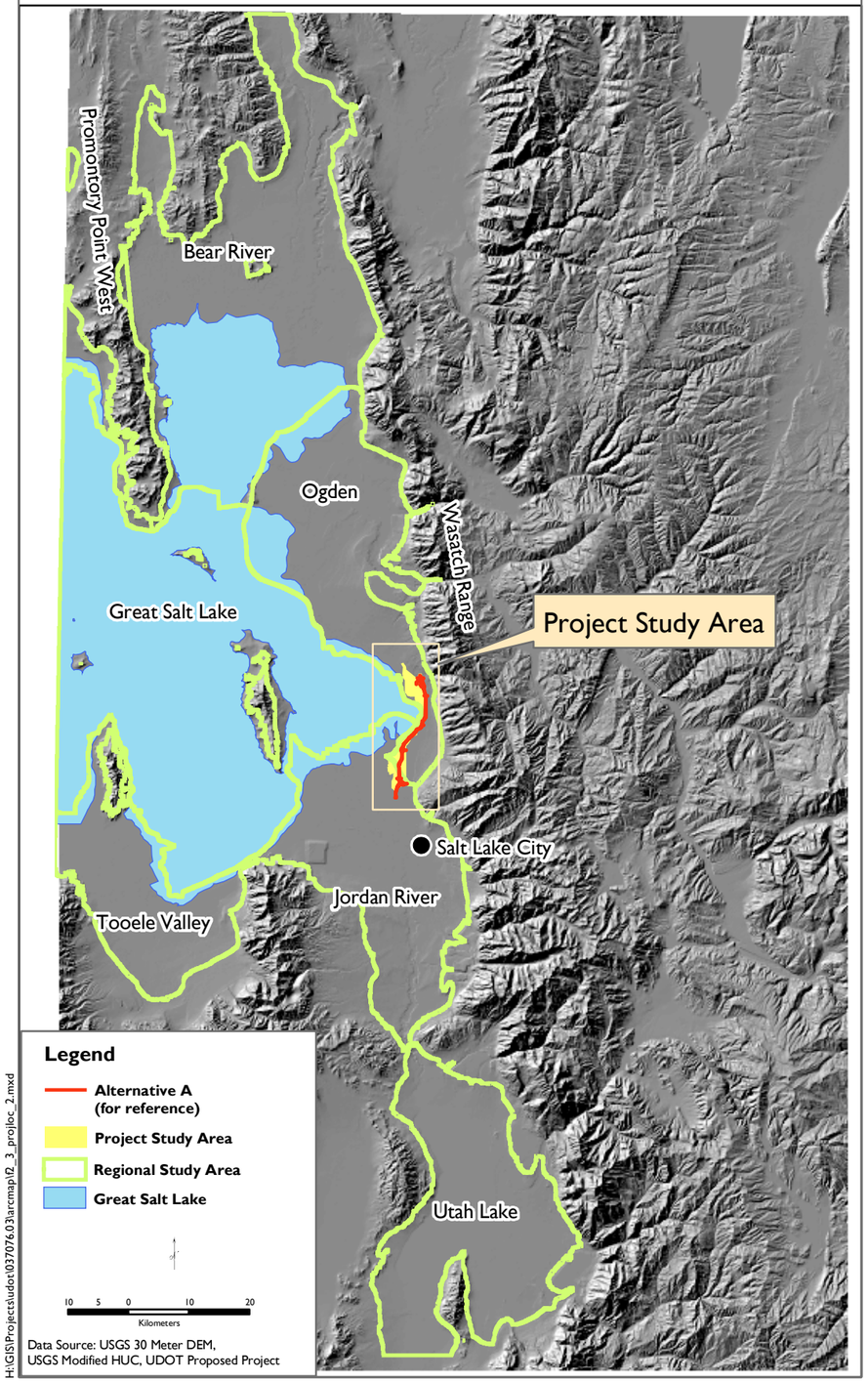
Figure 2-2
Great Salt Lake Ecosystem Area

Regional Study Area



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Jones & Stokes

Project Study Area

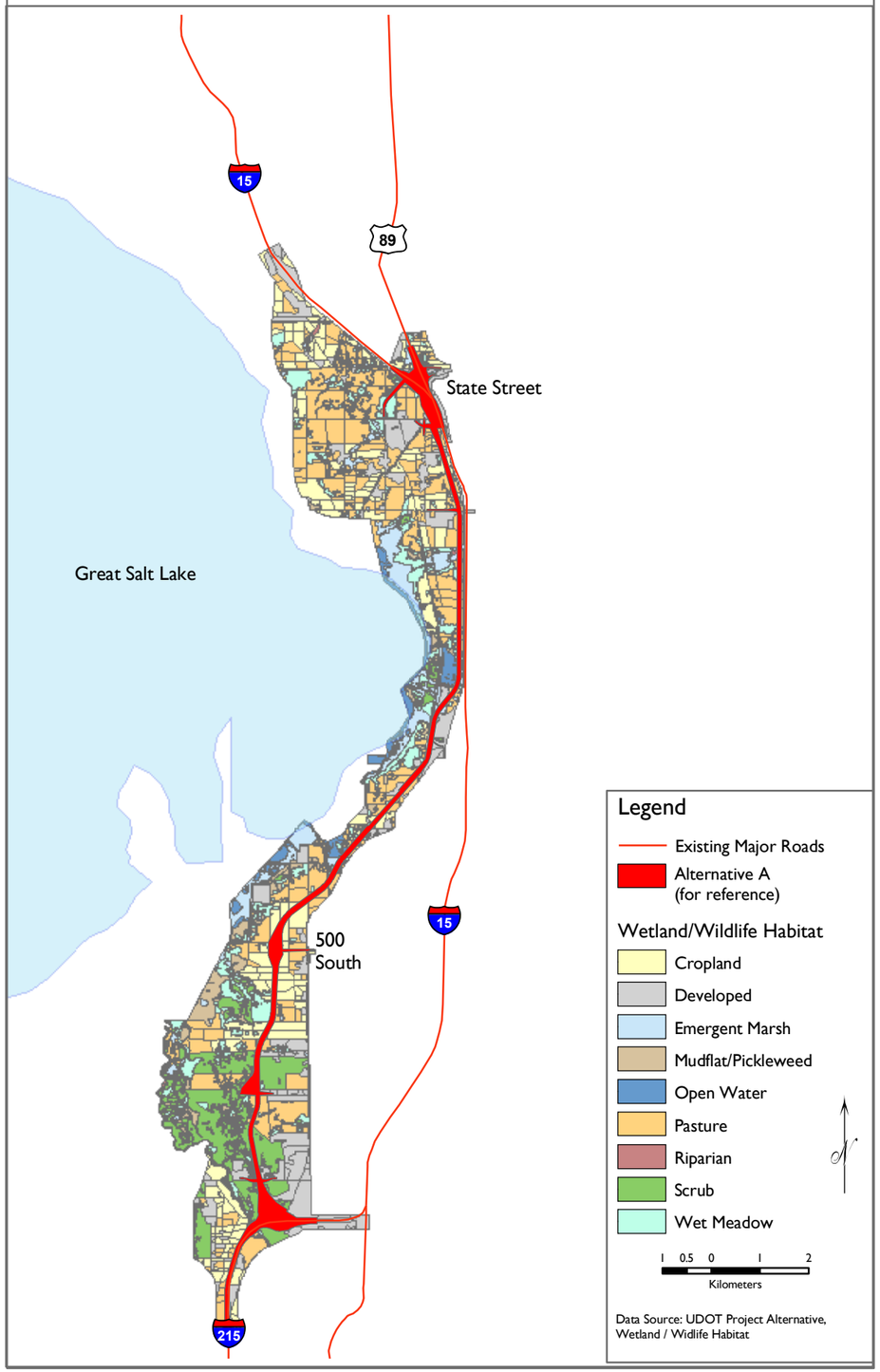

Figure 2-3
Legacy Parkway Regional and Project Study Areas

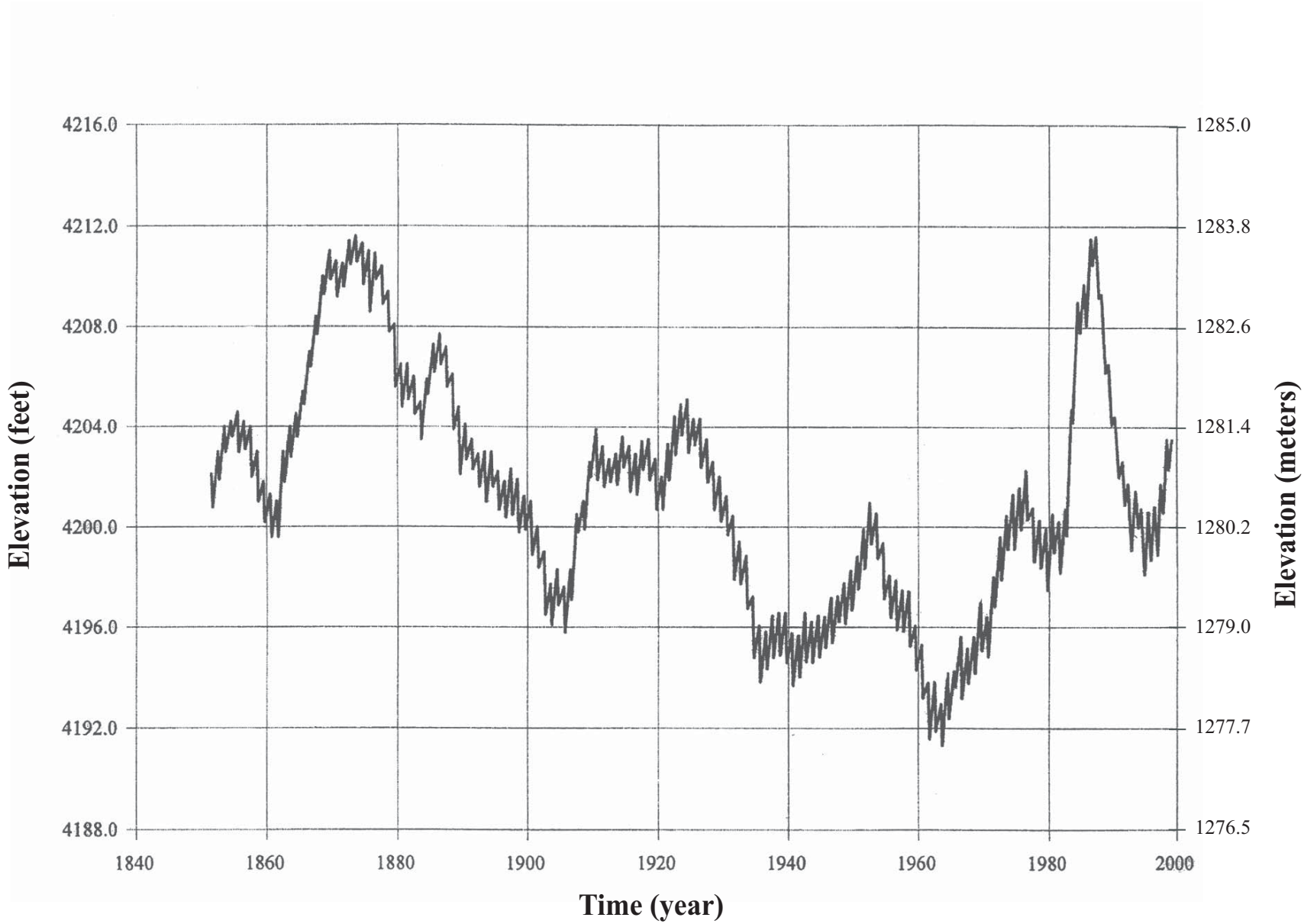

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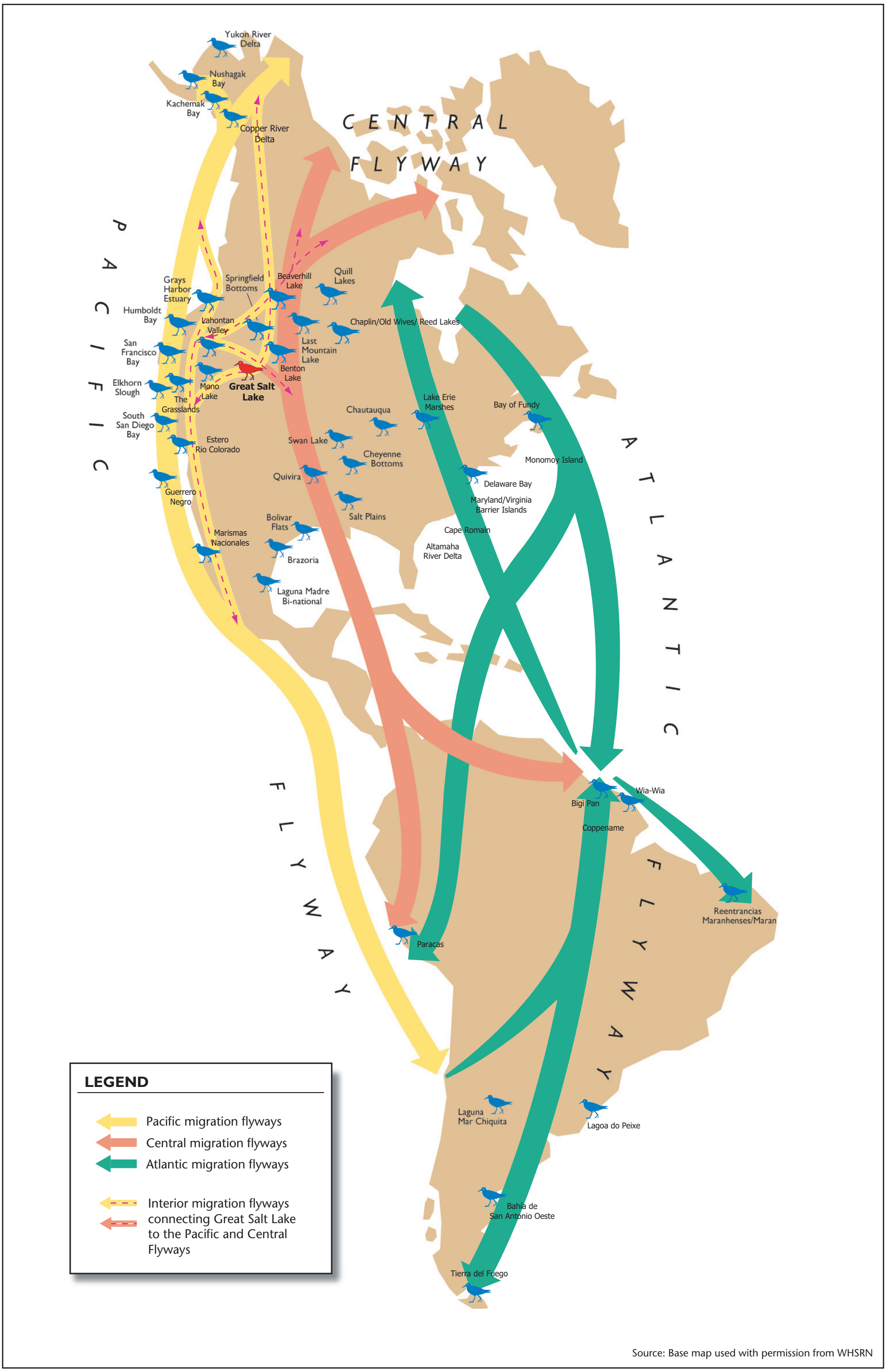
Figure 2-4
Historical Great Salt Lake Hydrograph



Source: Base map used with permission from WHSRN

03026.03 (4/03)

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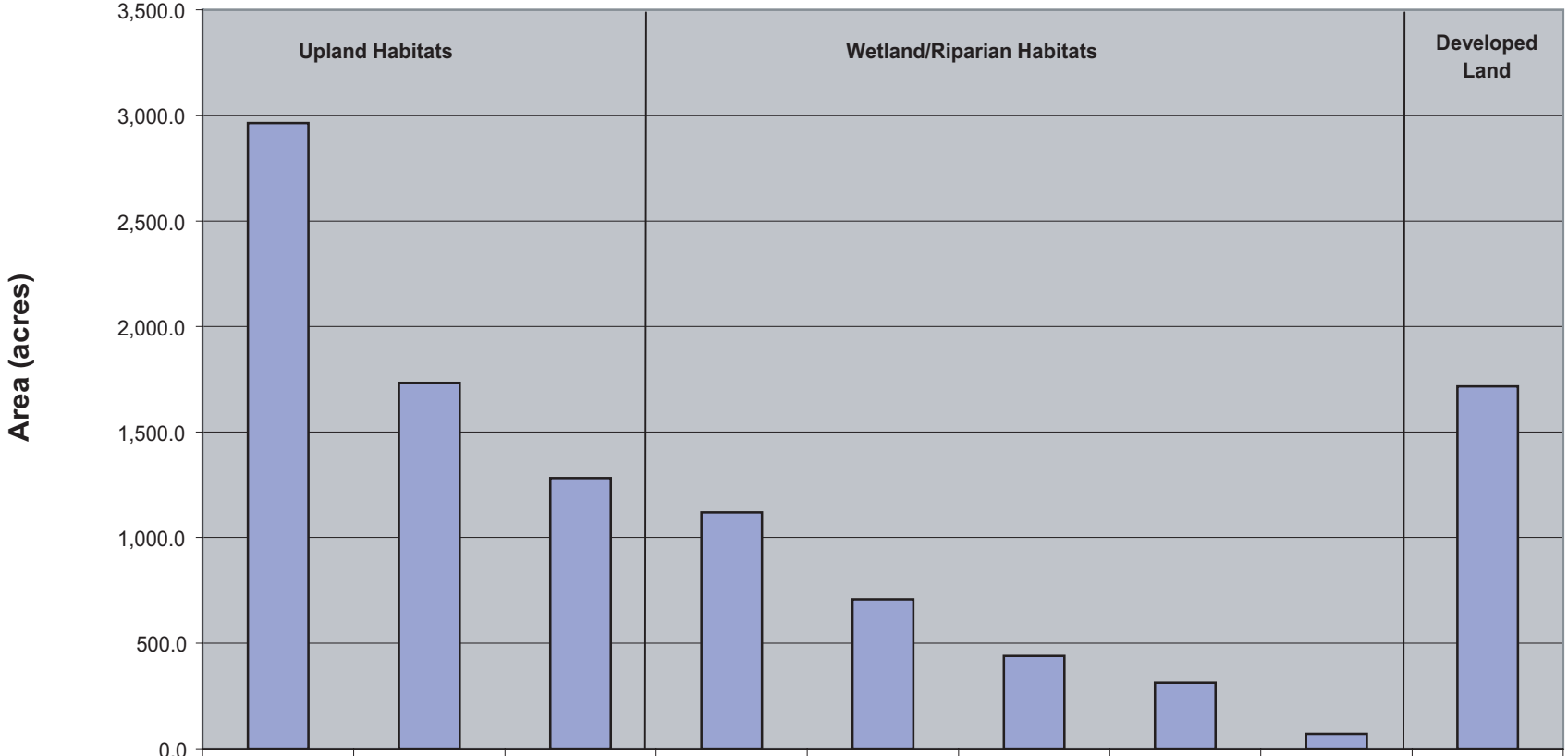
Figure 2-5
Western Hemisphere Shorebird Reserve Network (WHSRN) Sites



	Pasture	Cropland	Desert Scrub	Wet Meadow	Emergent Marsh	Mudflat/ Pickleweed	Open Water	Riparian	Developed
Habitat Area (acres)	2,963.3	1,733.1	1,282.2	1,118.9	707.2	439.8	312.8	70.9	1,715.9

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Figure 2-6
Total Existing Wildlife Habitat in Project Study Area

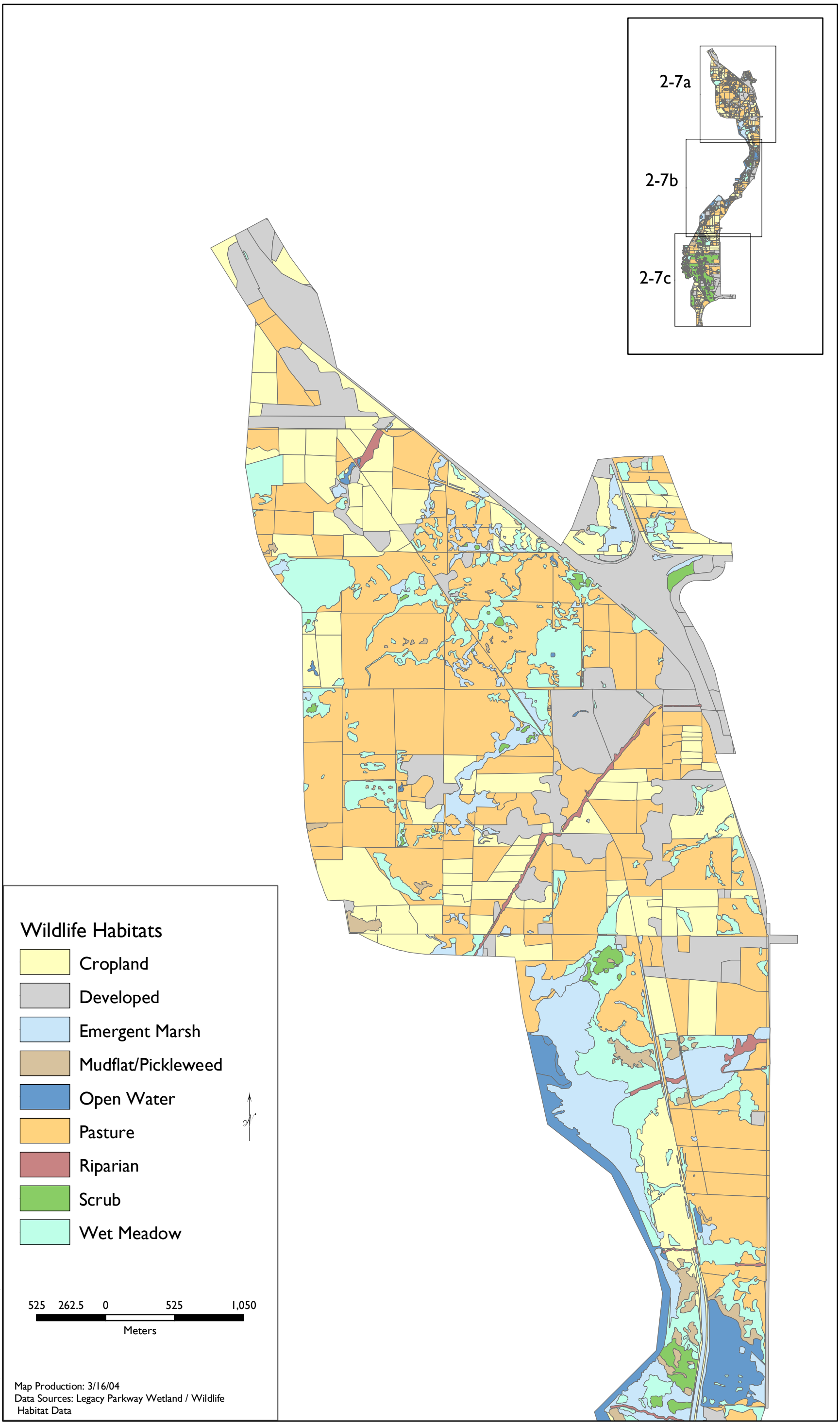

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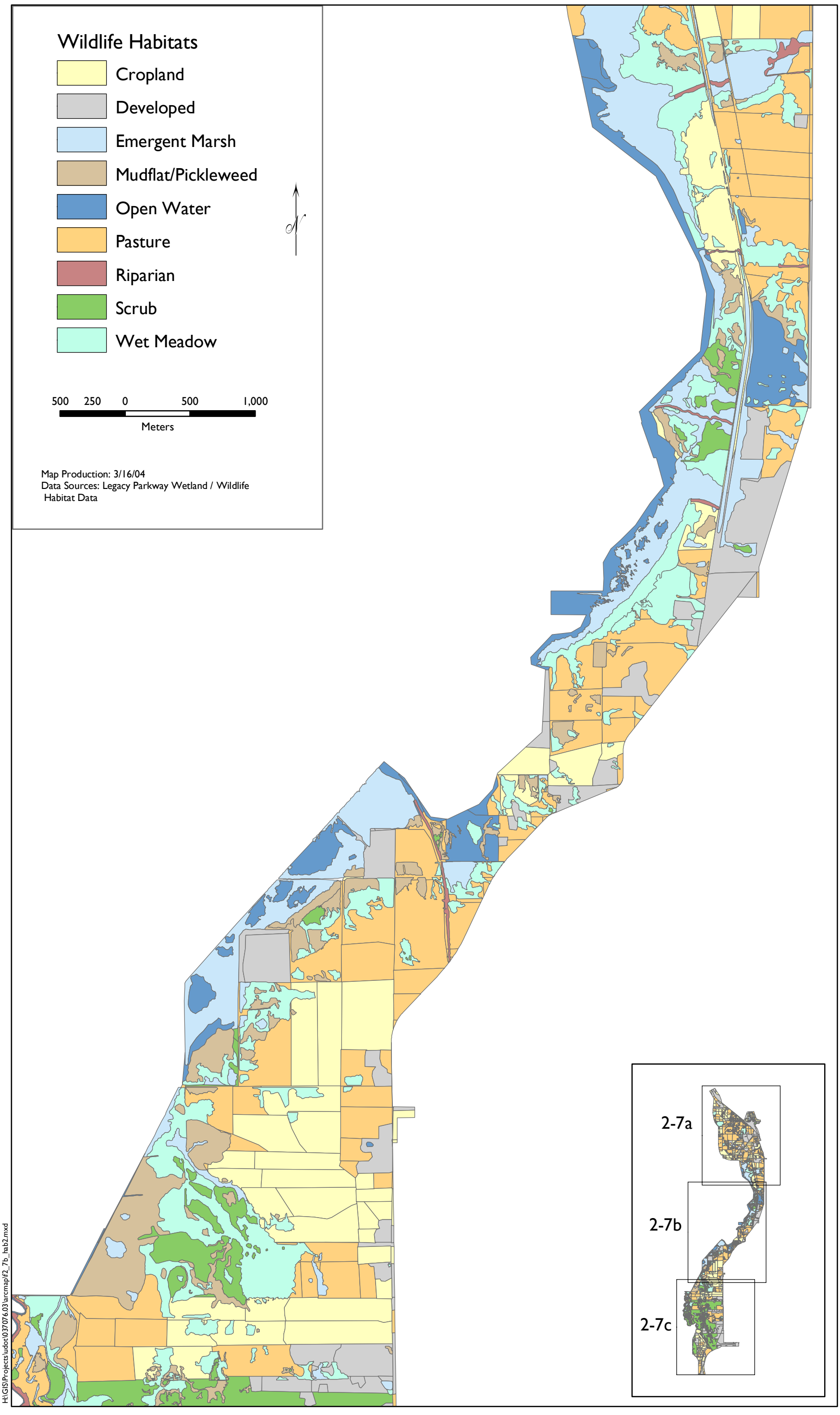
Figure 2-7a
Wildlife Habitats in the Legacy Parkway Project Study Area



Jones & Stokes

Figure 2-7b
Wildlife Habitats in the Legacy Parkway Project Study Area

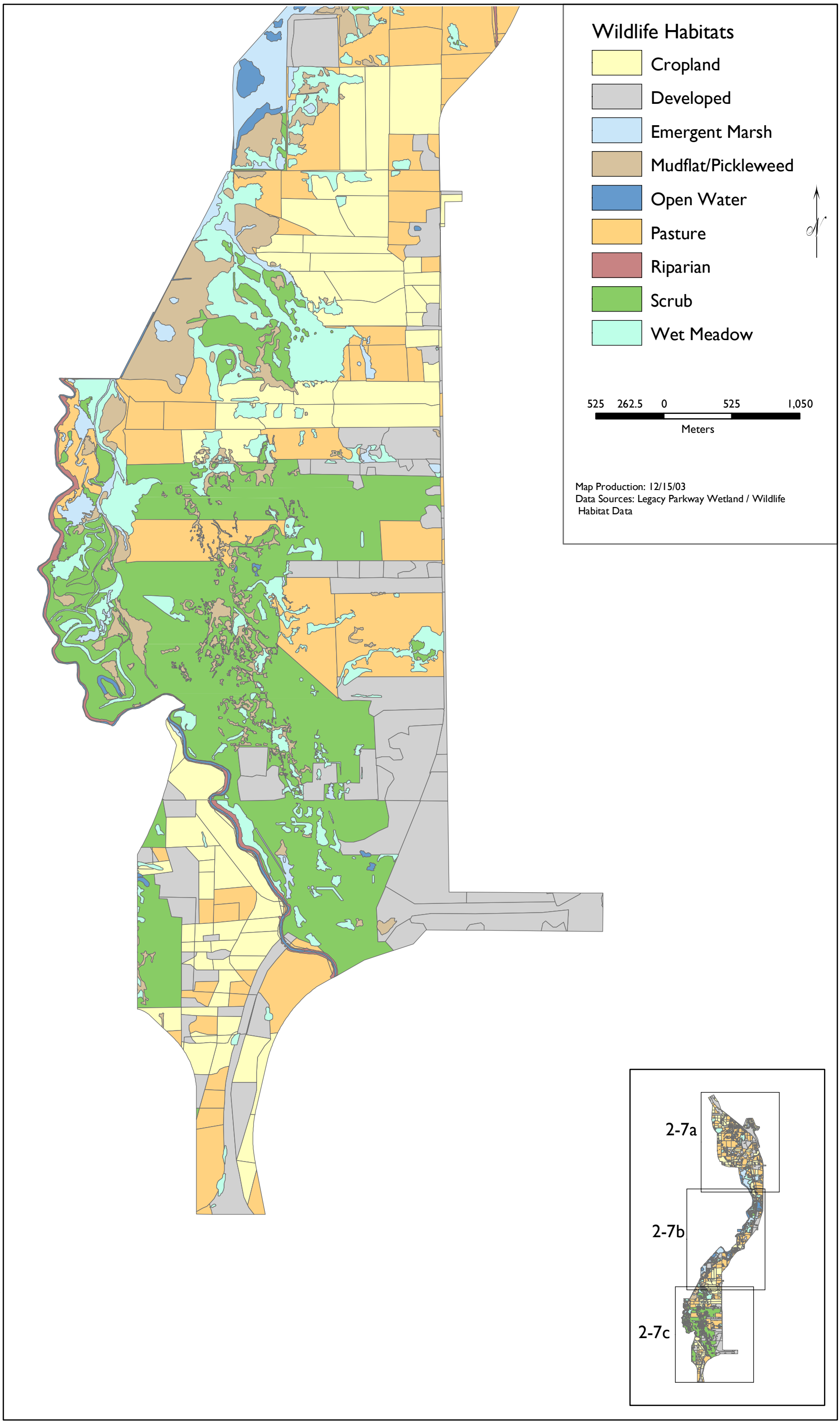


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Figure 2-7c
Wildlife Habitats in the Legacy Parkway Project Study Area

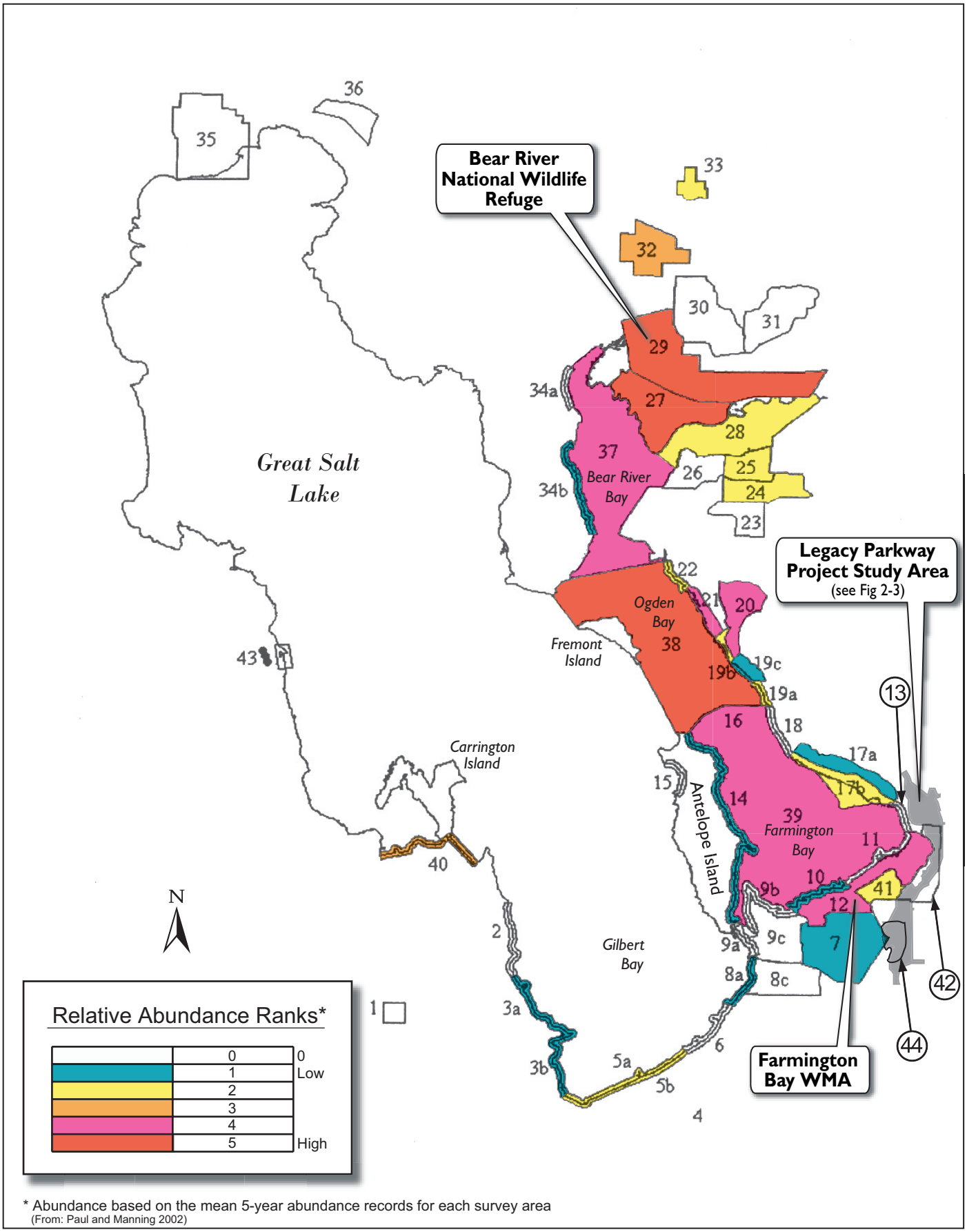

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Figure 2-8
Great Salt Lake Waterbird Survey Areas

Figure 2-9. Distribution and Abundance of Great Salt Lake Migratory Waterbirds [1]

Relative Abundance Ranking Charts	Species	GSL Ecosystem Status[2]	Legacy Parkway Project Area Status[2]	Bear River Refuge[3] 29 [4]	Ogden Bay 38	South Bear River 27	Farmington Bay WMA 12	Farmington Bay 39	Ogden Bay WMA 20	Bear River Bay 37	Ogden Bay Lakeside 21	Magcorp 40	Public Shooting Grounds WMA 32	Willard Spur 28	New State Duck Club 41	Interstate 80 North (a) 5a	Harold Crane WMA 25	West Kaysville (b) 17b	Ogden Bay North 22	South Harold Crane 24	Howard Slough (b) 19b	Interstate 80 North (b) 5b	Howard Slough (a) 19a	Salt Creek WMA 33	Stansbury Is. South (a) 3a	Kennecott (a) 8a	West Kaysville (a) 17a	East Promontory (b) 34b	Crystal Lakeside 10	Howard Slough (c) 19c
	Eared Grebe	CS/RW	CT/RS	3.7	85,164.2	31.8	194.5	10,168.5	9.6	1,342.0	4.4	376.6	0.6	64.1	0.9	2,105.8	7.1	83.2	0.0	0.6	296.5	0.7	119.3	0.7	170.5	55.8	76.4	165.1	30.3	11.3
	Western Grebe	CS		101.2	10.1	206.0	21.4	4.8	26.2	804.7	0.1	1.3	42.4	167.2	6.4	0.2	10.6	0.1	0.0	0.5	0.2	11.3	0.0	6.0	0.0	35.5	0.0	4.3	0.1	3.4
	American White Pelican	CS	RS	2,119.2	13.4	6,524.9	554.7	22.0	125.7	11,465.8	6.8	0.0	194.0	2,877.8	100.7	0.0	250.0	2.7	3.2	22.5	46.4	95.5	2.3	92.2	0.0	0.1	5.0	31.9	136.1	47.6
	White-faced Ibis	CS	CS	8,396.1	21.7	4,799.1	862.4	80.7	1,636.6	787.1	224.2	1.0	543.3	1,762.3	198.8	0.8	1,520.2	923.4	0.0	392.2	55.7	20.5	47.5	664.0	0.0	11.2	471.4	66.5	61.6	226.6
	Canada Goose	CP	CP	788.5	636.8	198.5	507.1	48.4	478.6	2,355.8	13.1	0.1	312.0	174.0	100.0	1.5	548.4	18.8	0.4	142.6	89.4	55.2	60.2	301.3	0.0	22.5	49.3	1,897.4	75.1	99.1
	Gadwall	CS/CT/UW	US/UT/RT	9,960.1	0.3	13,547.7	4,084.4	22.0	8,025.7	413.0	20.4	0.7	1,144.7	522.3	5,454.7	0.0	691.2	5.6	1.0	231.6	5.0	29.3	11.3	437.1	0.0	51.4	9.6	17.3	1.7	403.5
	American Wigeon	RT	RT	2,148.6	0.0	489.6	1,410.0	13.5	1,840.3	125.7	52.5	0.0	2,111.1	54.4	107.2	0.0	369.1	0.0	0.0	100.5	0.3	5.9	0.0	222.0	0.0	0.0	2.8	232.0	0.6	111.2
	Mallard	CP	UP	12,256.8	0.2	12,683.3	3,033.8	179.7	5,086.5	373.4	27.9	0.8	2,128.7	469.5	2,489.1	0.1	2,507.4	98.0	0.0	683.1	40.8	112.1	0.3	950.1	0.0	4.7	332.0	16.7	21.2	308.1
	Cinammon Teal	CS	RS	3,609.1	0.5	976.7	2,581.4	0.8	4,218.3	59.6	32.2	0.5	759.9	81.3	2,151.7	0.0	671.3	29.0	0.0	234.1	18.2	2.0	27.3	445.2	0.0	1.5	22.9	56.7	0.1	550.2
	Northern Shoveler	CT/UW	UT	12,630.1	681.6	9,266.1	9,359.5	17,278.7	5,188.7	2,937.8	1,023.8	0.0	951.5	1,349.5	2,944.8	0.3	1,092.8	422.2	2.3	297.5	460.0	8.1	568.4	463.7	0.0	110.7	1,272.8	232.8	1,102.6	1,139.2
0	Northern Pintail	CT/RS	UT	14,614.8	121.5	10,417.7	12,162.3	513.6	11,559.5	6,211.9	132.8	0.0	18,732.7	2,733.2	910.7	0.0	2,472.0	20.0	16.4	544.9	41.9	140.2	61.3	4,977.9	0.0	37.2	63.6	80.7	11.2	876.8
Low Abundance	Redhead	CS		643.9	13.5	97.1	1,054.7	171.7	438.4	3,032.9	9.5	0.0	66.8	458.1	299.7	0.0	342.6	13.3	0.8	56.6	4.2	38.3	0.3	40.2	0.0	2.1	21.9	266.3	9.7	71.3
	Common Goldeneye	CW	RW	3.8	2.1	6.8	0.0	1.8	1.1	365.3	0.1	0.0	0.0	3.3	0.2	0.3	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	4.1	0.0	1.1
	Ruddy Duck	CS	RT	1,116.0	14.7	481.0	7,004.0	2.7	961.2	653.2	2.7	0.8	84.3	773.7	873.8	0.0	161.2	5.5	0.0	2.3	3.8	0.5	4.7	29.1	0.0	0.2	24.0	84.4	0.4	159.6
	American Coot	RP		7,560.4	0.8	6,192.9	6,841.1	12.9	3,935.7	2,325.8	5.4	0.0	1,731.4	1,773.4	1,490.7	0.1	925.0	64.5	0.0	254.2	1.8	37.4	3.4	245.3	0.0	3.2	56.8	243.5	43.1	371.7
High Abundance	Black-bellied Plover	CT	RT	17.7	0.3	15.5	5.8	0.0	61.3	9.3	82.2	0.1	0.0	0.0	0.1	0.0	9.9	96.3	9.2	0.6	26.7	0.0	122.5	0.0	2.7	96.1	4.2	0.0	209.4	12.1
	American Avocet	CS	UP	13,626.0	475.6	11,289.8	9,354.3	12,441.4	1,872.0	2,628.8	4,858.5	2,323.5	271.4	2,032.8	380.6	624.8	1,670.9	7,313.6	830.0	9,029.9	1,867.5	127.6	1,661.3	502.1	4,062.9	3,952.0	1,264.7	998.6	2,340.5	718.7
	Black-necked Stilt	CS	UP	8,351.8	32.1	4,266.1	1,854.1	1,033.1	1,276.0	890.2	758.2	0.7	407.4	528.6	84.7	9.4	803.5	3,194.6	114.3	349.7	185.8	55.9	183.4	284.7	0.0	66.8	1,218.9	6.7	713.2	167.0
	Marbled Godwit	CT	RT	8,866.7	0.9	4,547.9	0.7	4.3	93.5	16.6	4.9	0.0	0.0	1,269.9	0.0	0.0	217.1	3.1	1.3	49.9	0.7	0.4	0.5	0.9	1.3	5.4	1.2	0.0	1.5	2.2
	Sanderling	UT		0.0	0.0	0.0	0.0	0.0	9.3	1.3	451.0	12.9	0.0	0.2	0.0	2.1	0.0	0.7	7.4	0.0	0.7	1.0	0.0	0.0	0.0	17.0	0.0	0.0	0.0	0.0
	Western Sandpiper	RT		11,597.8	0.0	4,952.5	884.8	0.0	62.7	0.0	985.9	311.5	0.4	2.0	17.5	0.0	0.0	309.5	2.1	0.0	0.0	1.2	8.1	3.6	1,182.2	476.9	14.5	0.0	524.9	1.4
	Baird's Sandpiper	CT	RT	5.2	0.0	1.6	0.0	0.0	7.6	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.0	0.1	0.0	0.0	0.0	53.2	7.3	0.0	0.0	0.0	0.0
	Long-billed Dowitcher	CT	RT	1,087.8	0.0	5,086.4	1,666.1	0.0	232.1	2,248.5	37.2	0.0	1.0	1,994.5	157.9	0.0	1,156.7	86.4	0.0	105.6	0.3	0.1	0.2	7.8	28.4	0.8	239.4	0.0	4.5	61.7
	Wilson's Phalarope	CT/US	UT/RS	5,590.0	17,084.8	1,237.0	1,633.1	1,231.0	3,838.7	6,945.6	32,876.9	36,082.1	33.3	1,151.4	8.3	5.3	314.4	432.6	9,353.3	32.4	808.7	17.4	296.3	61.3	385.4	8.4	2,981.5	0.0	854.7	280.1
	Red-necked Phalarope	UT	RT	0.7	309.7	0.1	1,213.3	268.4	321.1	8.3	1,010.6	1,258.9	0.0	0.0	302.0	0.0	0.0	34.8	0.0	0.0	17.6	0.0	0.0	7.3	0.0	2.8	141.3	0.0	0.0	0.1
	Franklin's Gull	CS	CT	2,806.7	3,714.3	2,327.4	789.0	9,679.7	2,344.8	1,412.7	4,834.9	92.9	121.0	300.5	27.2	2,302.4	328.8	1,295.5	2,097.3	60.9	4,227.3	1,744.0	6,621.2	26.2	884.5	578.7	358.9	980.1	622.0	440.0
	Ring-billed Gull	CW	UW	22.3	551.4	18.4	110.4	1,248.4	915.5	803.2	507.3	0.0	84.2	164.2	4.2	316.8	27.4	12.4	110.1	19.7	1,675.5	6.2	957.9	24.6	2.8	0.1	49.0	176.0	393.8	285.9
	California Gull	CP	UP	1,330.3	14,645.4	1,059.4	3,328.2	5,927.2	2,752.0	8,340.1	3,057.9	2,437.4	99.9	316.5	132.1	12,312.2	315.4	517.1	1,131.9	127.9	1,641.3	9,039.6	441.7	146.4	2,868.7	3,677.5	115.6	2,072.1	125.1	400.6
	Black Tern	US	RS	122.6	0.4	127.2	94.0	3.9	1.4	1.3	2.1	0.0	0.2	3.5	0.0	0.0	0.2	9.7	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	51.1	0.2
	Pied-billed Grebe	CS/UW	US/RW	12.0	0.0	0.6	33.2	0.0	27.7	0.0	0.0	0.0	18.4	0.0	10.9	0.0	1.0	0.0	0.0	0.2	96.0	0.7	0.0	3.6	0.0	0.0	0.0	0.0	0.5	15.7
	Double-crested Cormorant	CS	RS	215.6	0.8	97.6	73.3	6.4	47.4	130.6	4.8	0.0	10.0	51.5	17.5	0.0	27.3	1.1	1.6	3.6	5.4	3.2	0.6	9.4	0.0	1.9	0.4	0.3	7.4	9.0
	Great Blue Heron	RS		40.7	2.0	37.7	51.6	1.5	52.6	13.2	2.8	0.2	18.4	18.9	16.5	0.8	32.1	2.2	0.6	6.7	1.6	1.8	1.0	9.0	0.0	1.2	1.9	1.0	3.4	11.6
	Snowy Egret	CS	US	155.1	1.3	98.9	138.3	1.4	79.8	54.3	20.3	0.0	69.2	187.5	72.6	0.0	64.0	10.0	0.0	16.7	0.7	12.8	0.4	32.0	0.0	0.4	13.8	4.1	3.1	12.9
	Black-crowned Night Heron	CS/RW	CS	11.8	0.0	12.7	30.4	0.0	26.1	4.4	2.1	0.1	8.7	5.3	7.7	0.0	35.7	2.6	0.0	3.3	0.5	0.2	0.3	5.1	0.0	0.2	4.6	0.0	12.5	6.2
0	Blue-winged Teal	US	RS	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.4	0.0	1.5	0.0	1.0	0.0	0.0	0.6	0.0	0.0	4.5	0.0	1.9	173.4	0.0	3.6	0.6	0.0	3.3	2.5
Low Abundance	Canvasback	UT		26.9	0.0	130.9	36.0	0.0	278.6	8.3	0.0	0.0	12.3	87.3	12.7	0.0	8.5	0.3	0.0	0.3	0.6	1.5	0.3	3.0	0.0	0.1	0.4	0.3	0.0	0.3
	Bufflehead	CW	RW	18.4	0.3	49.5	39.7	0.0	17.5	6.9	0.0	0.0	17.5	9.3	1.6	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.2	4.1	0.0	0.0	1.4	0.3	0.0	2.2
	Sandhill Crane	UT/RS	UT	0.5	0.0	0.6	1.1	0.0	11.1	0.1	0.5	0.0	4.8	0.2	1.2	0.0	5.1	0.6	0.0	9.3	0.5	0.0	0.4	24.2	0.0	0.0	0.2	0.2	0.0	5.6
High Abundance	Killdeer	CP	CP	5.0	0.0	2.7	5.8	0.0	11.5	0.0	0.6	0.4	2.3	0.0	4.4	42.3	5.7	0.4	0.1	2.1	0.9	2.8	2.0	4.9	0.1	1.7	0.0	2.3	0.0	3.8
	Snowy Plover	RT		0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.4	0.0	0.0	0.0	0.0	0.3	0.5	0.8	4.9	0.7	0.3	0.5	0.0	0.0	72.8	45.1	0.0	0.0	0.1	0.1
	Greater Yellowlegs	CT	UT	15.7	0.0	5.6	0.8	0.0	40.9	0.0	0.5	0.2	7.3	0.2	7.5	0.0	2.2	0.0	0.0	0.2	0.0	0.8	0.3	8.3	0.0	0.4	0.0	0.0	9.6	2.8
	Lesser Yellowlegs	CT	UT	5.5	0.0	0.0	15.6	0.0	56.1	0.0	0.9	0.0	7.5	0.0	0.1	0.0	16.9	0.1	0.0	4.1	0.2	0.1	0.1	9.2	0.3	0.2	0.3	0.1	0.4	2.4
	Willet	CS	RS	16.0	0.2	10.7	6.7	0.0	126.5	1.9	254.1	0.1	7.9	9.0	10.8	16.3	7.9	49.1	23.0	4.3	45.1	5.4	45.3	6.3	0.0	39.9	15.6	7.5	35.3	11.4
	Long-billed Curlew	CT	RT	0.1	0.0	0.0	0.0	0.0	2.4	0.0	10.8	1.8	0.1	0.0	0.0	0.0	1.0	0.1	0.1	2.5	1.0	0.0	0.7	1.1	1.2	0.8	0.1	11.5	0.6	3.9
	Least Sandpiper	CT	RT	0.7	0.0	0.0	18.5	0.0	12.0	0.0	8.2	285.4	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.1	0.0	0.0	0.0	0.0	229.6	0.3	0.0	0.0	0.0	0.6
	Caspian Tern	US	RS	9.3	0.1	9.9	1.1	1.8	0.2	29.8	0.7	0.0	0.2	8.5	0.2	0.1	5.6	0.8	0.1	0.3	0.5	0.5	0.0	0.0	0.0	0.1	0.2	4.4	0.9	0.4
	Forster's Tern	RW		70.3	1.1	79.4	72.1	11.2	74.9	62.4	18.2	0.0	57.0	168.4	12.1	0.2	77.3	20.3	18.7	17.9	2.4	21.3	0.3	6.0	0.0	0.3	10.8	2.6	29.8	8.2
	Total No. Species	47	38	40	29	40	38	27	42	35	40	22	36	35	38	19	36	39	22	35	39	35	35	38	14	37	34	29	35	41
	Total Mean Abundance			129,901	123,501	101,296	71,038	60,369	58,096	56,780	51,312	42,903	30,008	21,397	18,409	17,742	16,620	15,062	13,712	12,791	11,673	11,580	11,252	10,232	9,716	9,321	8,837	7,649	7,410	6,837
	Abundance Rank			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27

Figure 2-9. Distribution and Abundance of Great Salt Lake Migratory Waterbirds [1]

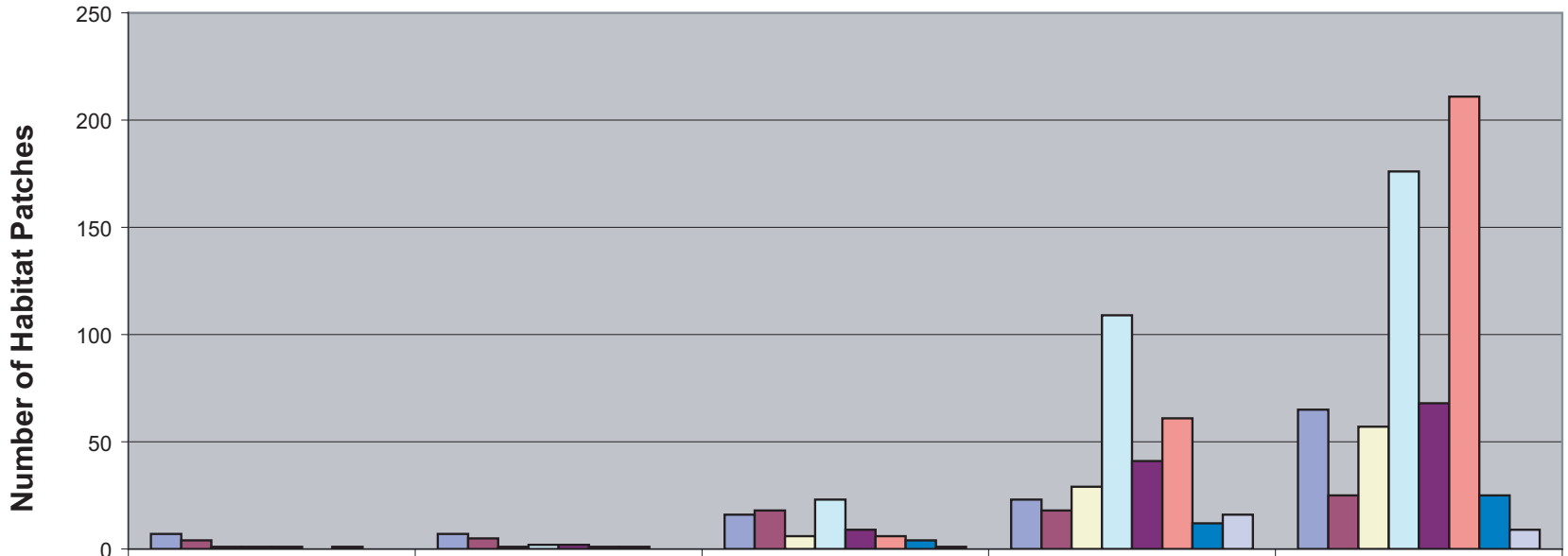
Relative Abundance Ranking Charts	Species	GSL Ecosystem	Legacy Parkway Project Area	Antelope Is. East	Associated Duck Club	Stansbury Is. South (b)	Farmington Bay Lakeside	West Layton	Saltair	Deardens Knoll	Audubon (b)	West Farmington	East Promontory (a)	Rainbow	Antelope Island Causeway	Kennecott (c)	Bear River Club	Stansbury Is. North	Antelope Is. West	Audubon (a)	Locomotive Springs WMA	Timpie Springs WMA	Salt Wells Flat WMA	East Farmington Bay	Jordan River
		Status[2]		14	7	3b	11	18	6	43	9b	13	34a	23	16	8c	30	2	15	9a	35	1	36	42	44
	Eared Grebe	CS/RW	CT/RS	1,238.1	0.3	0.0	65.3	101.4	206.7	916.7	92.8	56.2	0.2	0.0	344.5	1.3	3.1	85.2	794.4	0.0	0.6	0.2	0.3	0.2	3.8
	Western Grebe	CS		0.5	2.6	0.0	4.7	0.0	0.2	0.0	0.0	1.4	13.6	0.6	0.1	0.1	1.5	0.0	0.7	0.0	0.5	0.1	0.0	1.1	0.3
	American White Pelican	CS	RS	0.0	263.1	0.1	21.8	0.0	0.8	0.4	0.0	12.1	330.5	13.0	2.8	1.4	74.5	0.0	0.0	0.0	5.4	5.3	0.2	30.2	0.6
	White-faced Ibis	CS	CS	0.0	487.1	0.0	19.2	27.9	5.1	0.0	0.1	34.9	53.5	478.8	1.1	205.2	457.1	0.0	1.2	0.5	54.8	13.7	17.4	33.6	7.1
	Canada Goose	CP	CP	43.9	206.1	0.0	6.9	43.6	2.9	0.0	1.7	31.1	254.5	117.4	0.6	188.4	270.9	0.0	1.4	7.2	10.7	17.6	5.4	64.9	25.5
	Gadwall	CS/CT/UW	US/UT/RT	37.6	460.0	0.0	0.2	115.0	0.2	0.0	4.1	68.3	195.6	116.5	0.0	33.4	26.7	0.0	0.9	3.4	24.6	18.3	10.5	0.0	2.3
	American Wigeon	RT	RT	0.0	966.0	0.0	0.0	0.6	0.0	0.0	0.5	0.0	611.5	57.4	0.0	1.5	12.4	0.0	0.0	0.0	15.4	6.0	0.5	0.0	3.1
	Mallard	CP	UP	60.1	821.5	0.0	0.1	55.3	24.2	0.0	0.1	5.0	45.0	400.1	0.1	53.6	14.7	0.0	0.4	0.1	194.5	40.2	4.2	8.6	5.3
	Cinammon Teal	CS	RS	0.0	70.6	0.0	0.0	14.4	0.4	0.0	0.0	4.7	8.8	74.9	0.0	35.6	18.0	0.0	0.0	0.4	27.5	1.5	5.6	3.0	1.0
	Northern Shoveler	CT/UW	UT	120.0	60.9	0.0	376.7	1,065.4	0.9	0.0	170.5	426.6	654.5	254.2	59.1	119.0	79.6	0.0	0.2	20.0	27.1	6.9	1.6	0.0	2.5
0	Northern Pintail	CT/RS	UT	5.2	1,045.3	0.0	0.4	6.0	0.6	0.1	1.5	41.7	237.4	455.7	0.0	43.6	90.3	0.0	0.0	0.0	217.3	103.1	6.9	1.6	0.1
Low Abundance	Redhead	CS		0.0	9.4	0.0	0.2	0.5	10.7	0.0	3.7	1.3	1.5	19.9	0.1	2.9	1.2	0.0	0.1	0.0	156.1	10.8	1.5	0.0	0.9
	Common Goldeneye	CW	RW	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.4	0.8	0.1	0.0
	Ruddy Duck	CS	RT	0.0	65.3	0.0	0.8	0.0	10.1	0.0	0.0	5.0	16.0	7.0	0.0	0.5	7.2	0.0	0.8	0.0	8.2	1.8	0.6	0.5	0.0
	American Coot	RP		0.1	615.0	0.0	23.2	0.5	31.1	0.0	0.0	8.1	233.0	128.1	0.3	2.5	92.9	0.0	0.0	0.1	9.2	211.9	0.0	0.1	30.8
High Abundance	Black-bellied Plover	CT	RT	8.3	28.2	0.0	0.0	35.2	10.9	0.0	107.0	9.4	0.0	0.0	0.2	36.0	0.0	0.0	0.1	61.4	7.0	0.0	0.2	0.9	0.0
	American Avocet	CS	UP	3,078.9	657.9	1,166.9	170.1	1,217.9	1,733.8	835.7	2,253.3	641.4	181.4	239.7	51.5	1,251.6	490.3	669.7	111.6	547.6	20.2	87.2	16.1	10.0	1.0
	Black-necked Stilt	CS	UP	127.6	162.4	1.1	160.1	88.5	91.5	0.8	131.3	183.8	6.4	87.4	123.0	126.0	152.0	0.0	20.2	6.0	13.1	25.7	8.0	4.4	0.0
	Marbled Godwit	CT	RT	0.2	3.4	0.0	2.0	0.6	0.3	0.0	0.4	0.4	0.0	1.7	0.0	0.3	24.8	0.0	0.0	0.0	3.5	0.4	0.0	0.0	0.0
	Sanderling	UT		15.1	0.0	0.0	0.0	0.1	8.0	0.0	262.3	0.0	0.0	0.0	59.4	0.4	0.0	0.1	0.0	17.4	0.2	12.0	0.0	0.0	0.0
	Western Sandpiper	RT		0.6	0.3	176.0	1.1	9.3	26.4	45.0	233.1	1.0	0.2	0.0	0.0	60.8	0.1	0.0	0.0	3.1	62.1	0.2	24.3	0.3	0.0
	Baird's Sandpiper	CT	RT	0.0	0.0	0.7	0.0	0.0	0.0	0.0	8.8	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	1.8	0.3	1.2	0.0	0.0
	Long-billed Dowitcher	CT	RT	0.0	22.5	0.0	0.0	0.2	0.6	0.1	0.0	0.0	0.0	38.2	0.1	3.2	89.8	0.0	0.0	0.1	5.8	0.3	1.7	3.5	0.0
	Wilson's Phalarope	CT/US	UT/RS	54.9	3.4	56.3	3,348.0	358.4	3.1	1,796.9	37.1	2.5	0.1	12.3	182.0	9.5	5.4	0.0	83.5	14.8	117.4	5.5	21.8	0.0	0.0
	Red-necked Phalarope	UT	RT	0.0	17.3	0.0	0.0	0.8	0.2	0.0	4.6	229.8	0.5	0.0	71.1	89.6	2.6	0.0	1.8	0.0	14.3	10.6	0.0	0.0	0.0
	Franklin's Gull	CS	CT	676.7	43.2	2,067.8	76.4	772.2	34.4	4.7	78.1	1,037.0	97.4	38.0	140.4	15.6	81.6	1.3	20.3	30.7	0.3	0.0	0.4	0.6	0.4
	Ring-billed Gull	CW	UW	0.0	10.8	0.0	38.1	150.9	4.1	0.0	146.0	156.0	203.1	1.9	1,022.1	0.0	54.4	3.9	0.0	16.6	4.5	0.5	0.0	0.0	0.0
	California Gull	CP	UP	855.6	51.8	992.6	154.9	182.2	1,884.5	453.4	304.8	662.5	170.3	229.5	719.7	57.9	38.1	1,261.3	407.4	608.7	33.3	112.5	164.8	129.4	1.0
	Black Tern	US	RS	0.0	9.4	0.0	1.8	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0
	Pied-billed Grebe	CS/UW	US/RW	0.0	4.2	0.0	0.1	0.0	0.9	0.0	0.0	0.0	0.1	0.1	0.0	0.2	4.9	0.0	0.0	0.0	2.0	0.5	0.0	0.2	0.0
	Double-crested Cormorant	CS	RS	0.0	10.8	0.0	1.4	0.1	3.4	0.0	0.1	23.0	1.4	0.6	0.0	0.4	5.5	0.0	0.0	1.4	6.0	0.3	0.0	1.4	0.0
	Great Blue Heron	RS		0.4	26.4	0.0	1.6	0.2	0.7	0.0	0.3	2.0	2.7	8.6	0.0	2.3	7.9	0.0	0.1	0.3	8.9	3.7	1.2	4.9	0.0
	Snowy Egret	CS	US	0.0	69.5	0.0	8.2	0.2	11.6	0.0	0.0	3.2	8.1	24.1	0.2	3.9	59.3	0.0	0.0	0.1	1.6	1.6	0.2	5.8	0.8
	Black-crowned Night Heron	CS/RW	CS	0.0	8.9	0.0	0.5	0.0	0.2	0.0	0.0	0.5	0.3	2.6	0.0	0.2	4.9	0.0	0.0	0.2	4.4	3.1	0.1	0.1	0.0
0	Blue-winged Teal	US	RS	0.2	5.6	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	5.1	0.2	0.0	0.0	0.0	2.7	1.7	1.4	0.0	0.0
Low Abundance	Canvasback	UT		0.3	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.0	0.0	1.7	0.0	0.2	0.0	23.6	0.1	0.6	7.8	0.0
	Bufflehead	CW	RW	3.3	2.1	0.0	0.0	0.2	0.0	0.0	0.0	1.7	0.1	0.0	0.0	0.8	3.1	0.0	0.0	0.0	7.8	0.6	0.5	0.0	0.0
	Sandhill Crane	UT/RS	UT	0.0	1.0	0.0	0.0	0.4	0.0	0.0	0.0	0.2	1.8	2.7	0.0	0.0	17.9	0.0	0.0	0.0	0.7	0.2	0.3	0.9	0.0
High Abundance	Killdeer	CP	CP	2.8	17.3	0.5	0.5	1.9	12.3	0.2	0.2	7.0	3.1	3.3	2.4	26.0	5.9	0.0	2.9	0.9	15.2	1.9	9.5	8.0	0.0
	Snowy Plover	RT		0.0	0.7	38.3	0.6	12.9	5.3	0.0	34.3	0.2	0.2	0.3	0.1	8.8	0.3	0.0	0.1	0.1	59.5	1.1	72.2	1.0	0.0
	Greater Yellowlegs	CT	UT	0.1	1.1	0.0	0.0	0.2	1.2	0.0	0.0	1.9	0.7	0.0	4.5	1.6	5.5	0.0	0.0	0.0	3.9	2.3	1.7	0.6	0.0
	Lesser Yellowlegs	CT	UT	0.0	4.6	0.0	0.0	0.0	0.5	0.0	0.1	0.3	0.0	2.0	0.0	0.4	7.9	0.0	0.0	0.0	4.9	0.9	0.9	0.7	0.0
	Willet	CS	RS	11.7	4.9	3.1	4.8	39.6	7.9	1.0	9.4	10.6	18.5	3.3	12.8	22.9	3.5	0.8	30.7	6.1	76.3	9.0	34.5	0.9	0.1
	Long-billed Curlew	CT	RT	1.2	16.2	0.8	0.0	0.7	0.0	0.2	1.1	0.0	17.0	3.9	0.0	8.1	0.5	0.0	5.6	3.0	15.8	0.1	10.7	0.1	0.0
	Least Sandpiper	CT	RT	0.0	1.0	0.0	0.0	2.4	1.2	0.0	1.3	3.6	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.1	0.4	0.8	0.0
	Caspian Tern	US	RS	0.0	3.6	0.0	0.9	0.0	0.9	0.0	0.2	1.2	8.9	0.4	0.2	0.2	1.4	0.0	0.0	0.1	2.2	1.2	0.0	0.1	0.0
	Forster's Tern	RW		0.0	23.3	0.0	5.0	0.4	6.0	0.0	1.2	4.4	9.3	8.2	0.0	0.5	12.4	0.0	0.0	0.0	10.8	4.5	0.0	2.6	0.0
	Total No. Species	47	38	**24**	**41**	**11**	**29**	**32**	**36**	**12**	**28**	**35**	**34**	**32**	**25**	**39**	**40**	**7**	**21**	**24**	**42**	**40**	**34**	**30**	**18**
	Total Mean Abundance			**6,342**	**6,243**	**4,503**	**4,490**	**4,303**	**4,136**	**4,055**	**3,886**	**3,671**	**3,352**	**2,820**	**2,798**	**2,413**	**2,218**	**2,022**	**1,479**	**1,347**	**1,253**	**720**	**417**	**325**	**87**
	Abundance Rank			**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**

1. Abundance data are the mean 5-year abundance records for each species at each survey area described in Appendix 1 in Paul and Manning (2002). Color coding shows relative mean abundance for each species across all survey sites. Color coding varies with rank scale for each species (see left) as shown in Appendix 2 of Paul and Manning. Species are sorted in descending order of seasonal abundance for GSL Ecosystem. Species names in yellow colored cells are USFWS Birds of Conservation Concern for the Great Basin (U.S. Fish and Wildlife Service 2002. http://migratorybirds.fws.gov/reports/BCC02/BCC2002.pdf).

2. Abundance Codes: C - common (Found consistently in fair numbers in appropriate habitat and season); **U** - uncommon - (Found consistently in small numbers in appropriate habitat and season); **R** - Rare (Found infrequently but regularly in very small numbers in proper habitat and season); **Season Codes: P** - permanent (Found year round); **S** - summer (Present during the nesting season); **W** - winter (Present during January and/or February); **T** - transient (Migrates through in the spring and/or fall).

3. Survey Site Name. Survey site columns are sequentially presented in order of descending total mean abundance.

4. Survey Site Number (see Figure 2-7).



	100+ Acres	50-99 Acres	10-49 Acres	1-9 Acres	0-1 Acre
Pasture	7	7	16	23	65
Cropland	4	5	18	18	25
Desert Scrub	1	1	6	29	57
Wet Meadow	1	2	23	109	176
Wemergent Marsh	1	2	9	41	68
Mudflat/Pickleweed	0	1	6	61	211
Open Water	1	1	4	12	25
Riparian	0	0	1	16	9

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Figure 2-10
Number of Existing Habitat Patches within the Project Study Area

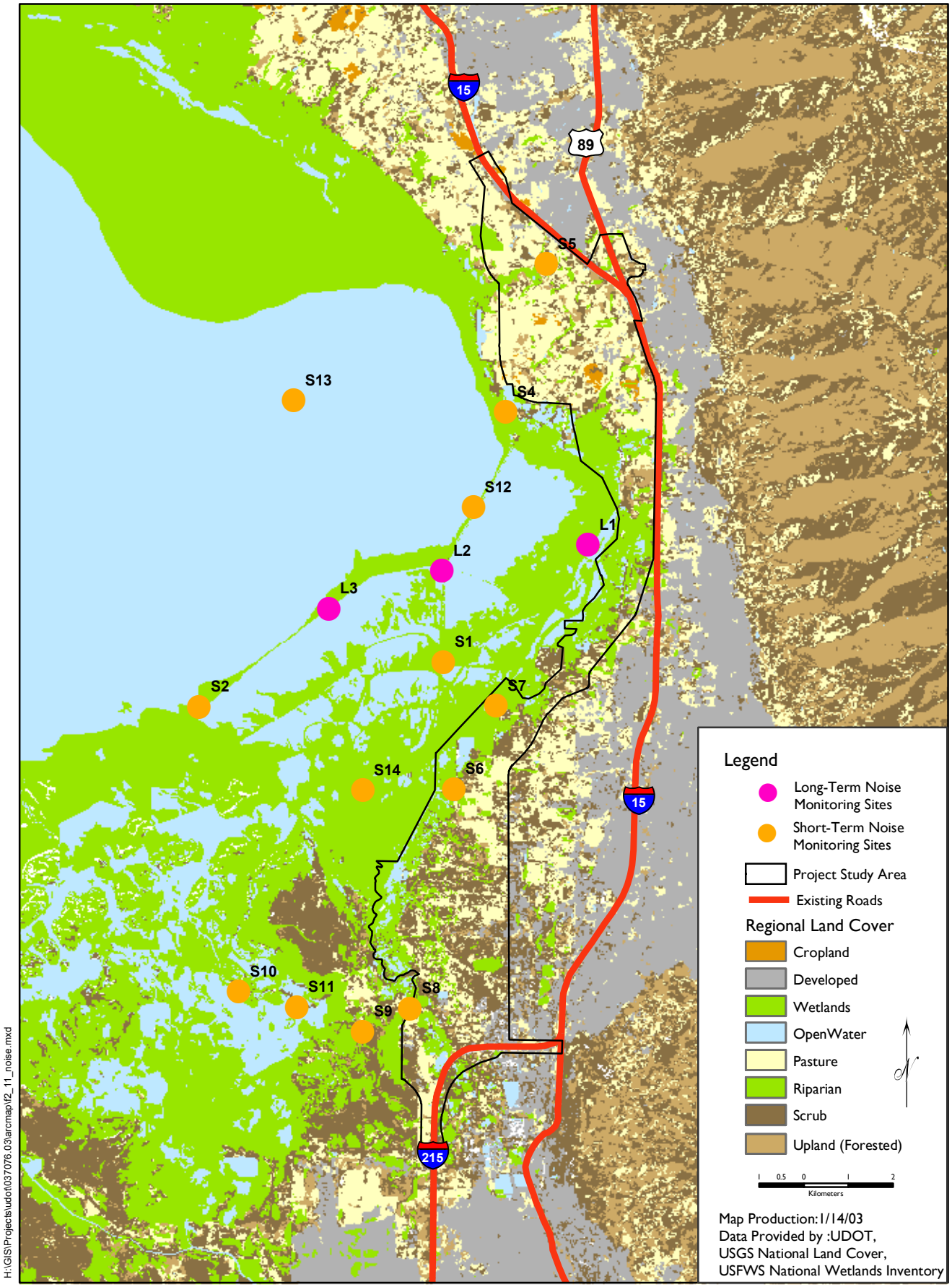

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Figure 2-11
Noise Monitoring Sites in the Legacy Parkway Project Study Area

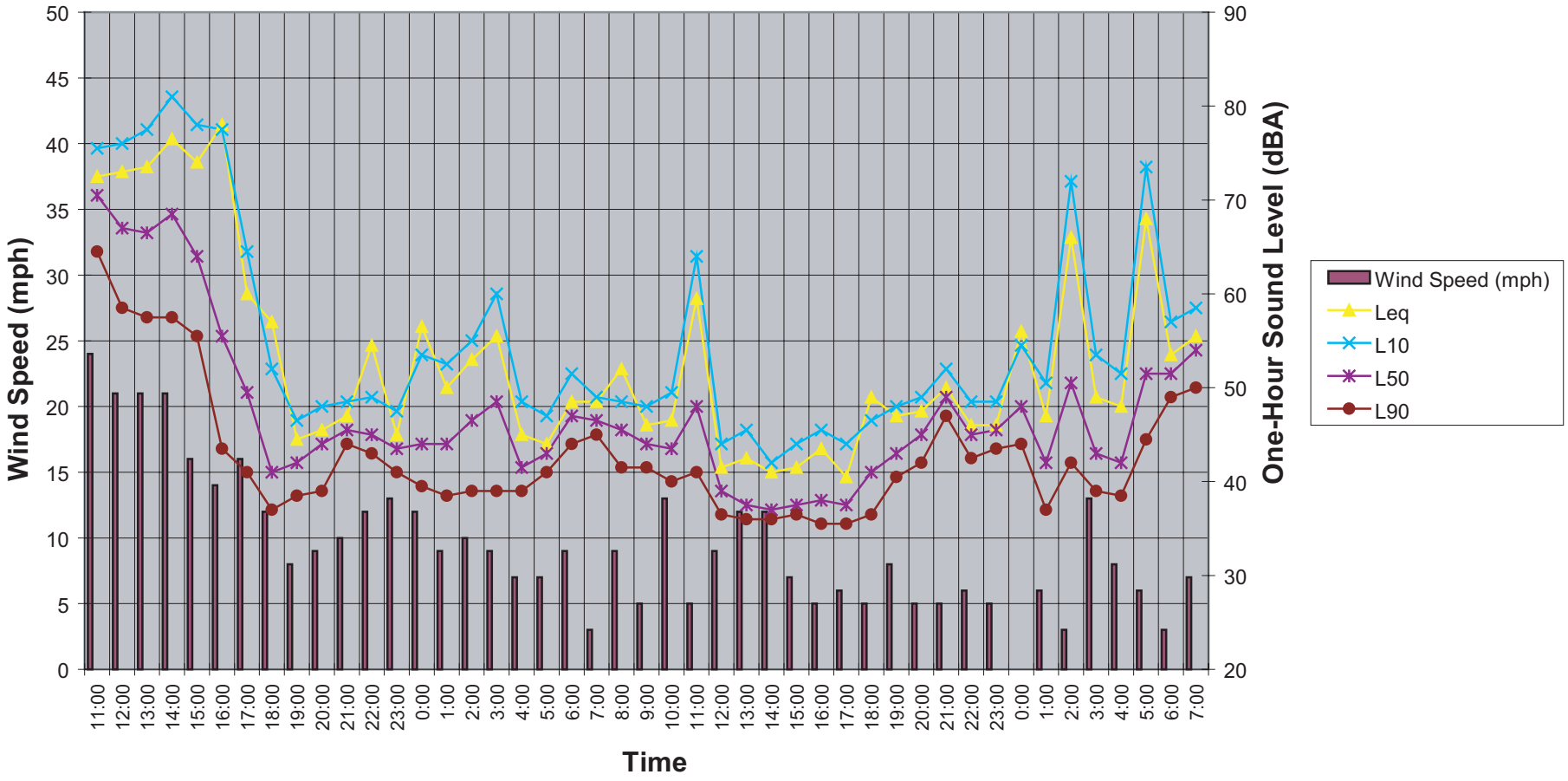

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Figure 2-12
Background Sound and Wind Levels at Long-Term Position 1

Chapter 3

Environmental Consequences

Chapter 3

Environmental Consequences

This chapter discloses potential direct, indirect, and cumulative effects on wildlife. The impacts listed below are examined in detail.

- Direct habitat loss.
- Potential effects of direct habitat loss on wildlife species.
- Potential combined effects of changes in lake level on habitat availability and habitat fragmentation.
- Changes in habitat quality.
- Habitat modification.
- Artificial light disturbance.
- Highway noise disturbance.
- Human disturbance.
- Effects on special-status wildlife.
- Cumulative effects.

3.1 Direct Habitat Loss

Construction of any of the build alternatives of the Legacy Parkway project would result in direct loss of wildlife habitat in the project right-of-way. Habitat losses would be caused by such activities as excavation, grading, highway construction, and development and use of staging and access areas. The extent and character of these losses would be a function of the location of the alignment within the matrix of habitats in the project study area (Figures 3-1a and b).

3.1.1 Methods

Direct wildlife habitat loss that could occur as a result of highway construction was determined by overlaying the footprint boundary for each alternative onto the wildlife habitat map (Figures 3-1a and b) and using GIS software to measure the total area of each habitat within those boundaries. The relative impact levels of each alternative were determined by identifying the build alternative that represents the

highest impact level on a given habitat type. This value was then established as the benchmark against which the remaining alternatives were compared. This method facilitates visual representation of the relative effect of each alternative on each habitat category. Detailed information on the development of the wildlife habitat maps and the habitat loss analysis methods are provided in Appendix B.

3.1.2 Results

Table 3-1 summarizes the direct habitat losses of wetland/riparian and upland habitats.

Total Available Habitat

Figure 2-6 shows the total amount of each habitat that occurs in the project study area (including the proposed mitigation lands). Upland habitats (pasture, cropland, and salt desert scrub) comprise much larger areas than do wetland/riparian habitats (wet meadow, emergent marsh, mudflat/pickleweed, open water, and riparian). Pasture is the most extensive upland habitat; wet meadow is the most extensive wetland/riparian habitat. Developed lands are excluded from this discussion because construction of any of the build alternatives would cause a net increase of this habitat category.

Some discrepancies are evident between direct habitat loss of wildlife habitat quantified in this analysis and the extent of wetland loss specified in the Final EIS. These discrepancies are primarily the result of differences between the habitat classification system developed by the WTT for this technical memorandum and the classification system used to identify jurisdictional waters (including wetlands) in the Final EIS. Specifically, this technical memorandum examines wildlife habitats, whereas the analysis in the Final EIS was based on the results of the wetland delineation. Accordingly, open water and riparian habitats have been mapped differently for purposes of this wildlife habitat analysis; the habitats mapped for this analysis include areas excluded from the Final EIS analysis because they did not qualify as jurisdictional waters. Moreover, the mapping undertaken in the preparation of this technical memorandum encompassed all habitats in the project study area, resulting in a dataset markedly different from that produced by the wetland delineation effort. The mapping methodologies are discussed in detail in Appendix B. For the purpose of this document, unless otherwise specified, the term *wildlife habitat* refers to wetland/riparian habitats and the associated upland habitats that are present in the project study area, as described in Chapter 2.

No-Build Alternative

Existing Conditions

The No-Build Alternative would result in no direct loss (0 percent) of any wildlife habitat in the project study area as a result of construction of the Legacy Parkway project.

Future No-Build Scenario

The proposed Legacy Parkway project is not the only potential cause of habitat loss in the project study area. Other potential growth scenarios are analyzed in detail in Section 3.11.2, Foreseeable Future Conditions.

Proposed Build Alternatives

Figure 3-2 shows the total area of upland, wetland/riparian, and combined habitats that would be directly lost as a result of each build alternative. Figure 3-3 shows the total area of each habitat type that would be lost as a result of each build alternative. Habitat losses associated with all build alternatives are listed below.

Alternative A

Alternative A would result in the following direct habitat loss impacts within the right-of-way.

- Loss of 44.4 ha (109.8 ac) of wetland/riparian habitat, comprising:
  - 27.5 ha (68.0 ac) of wet meadow,
  - 8.9 ha (22.0 ac) of emergent marsh,
  - 2.5 ha (6.2 ac) of mudflat/pickleweed,
  - 3.9 ha (9.7 ac) of open water, and
  - 1.6 ha (3.9 ac) of riparian habitat.
- Loss of 201.3 ha (497.4 ac) of upland wildlife habitat, comprising:
  - 85.3 ha (210.7 ac) of pasture,
  - 55.6 ha (137.4 ac) of cropland, and
  - 60.4 ha (149.3 ac) of salt desert scrub habitat.

The total amount of land in the developed habitat category in the Alternative A right-of-way would be 109.9 ha (271.5 ac).

Alternative B

Alternative B would result in the following direct habitat loss impacts within the right-of-way.

- Loss of 79.4 ha (196.2 ac) of wetland/riparian, comprising:
  - 39.2 ha (96.8 ac) of wet meadow,
  - 19.8 ha (48.9 ac) of emergent marsh,
  - 7.5 ha (18.6 ac) of mudflat/pickleweed,
  - 10.7 ha (26.4 ac) of open water, and
  - 2.3 ha (5.6 ac) of riparian habitat.

- Loss of 270.2 ha (667.8 ac) of upland wildlife habitat, comprising:
  - 129.9 ha (321.1 ac) of pasture,
  - 101.1 ha (249.7 ac) of cropland, and
  - 39.3 ha (97.0 ac) of salt desert scrub habitat.

The total amount of land in the developed habitat category in the Alternative B right-of-way would be 100.0 ha (247.1 ac).

Alternative C

Alternative C would result in the following direct habitat loss impacts within the right-of-way.

- Loss of 63.4 ha (156.7 ac) of wetland/riparian habitat, comprising:
  - 36.6 ha (90.4 ac) of wet meadow,
  - 7.8 ha (19.7 ac) of emergent marsh,
  - 12.9 ha (32.0 ac) of mudflat/pickleweed,
  - 3.9 ha (9.7 ac) of open water, and
  - 2.0 ha (4.9 ac) of riparian habitat.
- Loss of 198.1 ha (489.5 ac) of upland wildlife habitat, comprising:
  - 80.5 ha (198.9 ac) of pasture,
  - 48.4 ha (119.5 ac) of cropland, and
  - 69.3 ha (171.2 ac) of salt desert scrub habitat.

The total amount of land in the developed habitat category in the Alternative C right-of-way would be 91.3 ha (225.5 ac).

Alternative E

Alternative E would result in the following direct habitat loss impacts within the right-of-way.

- Loss of 52.3 ha (129.3 ac) of wetland/riparian wildlife habitat, comprising:
  - 26.7 ha (66.1 ac) of wet meadow,
  - 10.2 ha (25.2 ac) of emergent marsh,
  - 6.6 ha (16.3 ac) of mudflat/pickleweed,

- 7.2 ha (17.8 ac) of open water, and
- 1.6 ha (3.9 ac) of riparian habitat.

- Loss of 200.2 ha (494.8 ac) of upland wildlife habitat, comprising:
  - 88.3 ha (218.2 ac) of pasture,
  - 52.9 (130.7 ac) of cropland, and
  - 59.0 ha (145.9 ac) of salt desert scrub.

The total amount of land in the developed habitat category in the Alternative E right-of-way would be 103.8 ha (256.6 ac).

3.1.3 Potential Effects of Direct Habitat Loss on Wildlife Species of Concern

The potential biological effects of direct habitat loss that would result from the build alternatives described above are analyzed for each species of concern in Section 3.10, Effects on Special-Status Wildlife.

3.2 Combined Effects of Changes in Lake Level on Habitat Availability and Habitat Loss from Build Alternatives

As the level of Great Salt Lake rises, existing terrestrial habitats are inundated and converted to saline open water habitat. Figure 2-4 shows annual and long-term (i.e., 1850–2000) fluctuations of the level of Great Salt Lake. The lake reached a historic high of approximately 1,283.7 m (4,211.5 ft) on April 15, 1987, and a low of 1,277.4 m (4,191 ft) on October 15, 1963. As the lake level rises, the total amount of available terrestrial habitat within the project study area decreases. As the lake level recedes, the former ecological communities regenerate slowly. This analysis examines how the total and relative amounts of different wildlife habitats change with the cyclic changes in lake level. The combined effects of natural inundation from changes in lake level and implementation of each build alternative are examined to determine how these factors act in concert to affect the temporal pattern of overall availability of wildlife habitats within the project study area.

3.2.1 Methods

The changes in available habitat within the project study area at different lake levels were analyzed using the wildlife habitat maps (Figures 2-7a–c) and an inundation zone dataset (Figures 3-4a and b; Appendix B). The inundation zones were defined at 1.2-m (4-ft) intervals, starting at 1,280 m (4,200 ft) elevation. These intervals were based on areas where probabilities of lake level occurrence within each inundation zone had previously been estimated by USGS (2003). These estimates were calculated from averaged measurements of lake level on calm days (no wave run-up or seiches) at the following gage locations: 1947–75 traditional data, 1875–77 Black Rock gage, 1877–79 Farmington gage, 1879-81 Lakeshore

gage, 1881–1901 Garfield gages, 1902–03 Midlake gage, 1903–38 Saltair gage, and 1938–present Boat Harbor gage.

A model of the effects of lake level change was developed to evaluate the interaction of increased lake levels with the direct habitat losses that would result from each build alternative. For example, the model simulated a rise in lake level to 1,282.6 m (4,208 ft), converting all terrestrial habitats within the 1,281.4–1,282.6 m (4,204–4,208 ft) inundation zone to open water (saline) habitat (Figures 3-5a and b). The impacts (amount of habitat loss) of each build alternative and the habitat temporarily lost to inundation were calculated for each inundation zone; details of these calculations are provided in Appendix B. The analysis shows the combined habitat loss from natural lake level fluctuation and the proposed alternatives. The historic range of changes in lake level (Figure 2-4) was assumed to be representative of reasonably foreseeable future conditions. However, recent studies of potential future climate change (Baldwin et al. 2003) suggest that regional precipitation could increase more than the levels indicated in the historic record. If such increases were to occur, the lake level could rise above historic high levels. The inundation model was extended to 1,286 m (4,220 ft) to include the potential effects of future climate change in the evaluation of the Proposed Action.

3.2.2 Results

Changes in Habitat Availability with Rising Lake Level

Figures 2-7a–c show the distribution of wildlife habitats within the project study area. Figures 3-4a and b show the inundation zones in the project study area and vicinity; Figures 3-5a and b show the inundation zones in relation to the build alternatives. Figure 3-6 shows the change in availability of each habitat type with inundation. Figures 3-7 to 3-14 show the amount of habitat lost to the combined effects of inundation and the build alternatives. The area under the graph in each of these figures shows the percent of the habitat naturally inundated by the fluctuating lake levels. The contribution of the individual build alternatives is represented by the lines above the line signifying the No-Build Alternative. Figure 3-6 summarizes the modeled changes in habitat availability that would occur within the project study area with rising lake level. The results of this analysis are discussed below.

- Wetland and riparian habitats are distributed largely at the lower elevations of the project study area, and are therefore inundated at initial increases of lake level (Figure 3-6). Upland habitats occur primarily at the higher elevations (Figures 2-7a–c). At the historic high water level (1,283.8 m [4,212 ft]), 97.6 percent of open water habitat (e.g., freshwater ponds), 73.4 percent of mudflat/pickleweed, 74.8 percent of emergent marsh, 69.6 percent of riparian, and 46.6 percent of wet meadow habitats are converted (i.e., lost) to saline open water (Figure 3-6). By contrast, only 20.0 percent of cropland, 21.7 percent of pasture, and 38.7 percent of salt desert scrub habitat are converted by the same rise in lake level. Should the lake level rise to 1,286.3 m (4,220 ft), only 13.8 percent of any wetland/riparian habitat and 33.6 percent of upland habitat would remain within the project study area.

- The rate of change of each existing habitat type associated with inundation (Figure 3-6) varies depending largely on the habitat's distribution within each inundation zone. For example, the extent of available mudflat/pickleweed changes rapidly between 1,281.4 m (4,204 ft) and 1,283.8 m (4,212 ft) (Figure 3-6), the inundation zone in which most of that habitat occurs; this rate surpasses the rates of change of other low-elevation wetland/riparian habitats (emergent marsh, wet meadow, and riparian). Overall, the lower-elevation wetland/riparian habitats become inundated at higher rates than do upland habitats within the same inundation zones (Figure 3-6).

Combined Effects of Lake Level Change and Habitat Loss Associated with Build Alternatives

Figures 3-15 and 3-16 show the areas of available habitats in the project and regional study areas at low and high lake levels. These figures indicate relatively little change in upland habitats (pasture, cropland, scrub) with lake level change, but the availability of wetland habitats (wet meadow, emergent marsh, and mudflat/pickleweed) is markedly reduced at high lake levels. Regionally, there is a 64 percent reduction at high water of both mudflat/pickleweed and emergent marsh habitats, a 30 percent reduction in wet meadow, and a 15 percent reduction in available riparian habitat.

Table 3-2 shows the acreage of each habitat type that would be lost under each build alternative and the percentage of regionally available habitat that the lost area represents at low and high lake levels. Proportionally, the amount of any habitat that would be lost under any build alternative is very small both at low lake level (<0.4 percent) and at high lake level (<0.5 percent). Because of the very large area of habitat available regionally and the comparatively small area of the Proposed Action, the change in lake level does not measurably affect the proportion of habitat lost under the build alternatives, even though the level of the lake can cause up to a 64 percent change in the regional availability of habitat. The largest proportional change in any habitat between low and high lake level—emergent marsh under Alternative B—is only 0.3 percent. This level of change, while calculable, is insignificant with regard to the inherent error of the GIS polygon measurement methodology.

At the project study area level, the change in the areas of habitats that would be lost to the Proposed Action (Figure 3-15, Table 3-3) is proportionally greater at both low and high lake levels than the change at the regional level (Table 3-2) For example, mudflat/pickleweed habitat lost under Alternative C changes from 5 percent of the available habitat in the project study area at low lake level to 27 percent of the habitat in the project study area at high lake level—a difference of 22 percent. Under Alternative B, loss of emergent marsh habitat changes from 9 percent at low lake level to 20 percent at high lake level—a difference of 11 percent. Differences between losses at low and high lake levels in other habitats are all smaller than those described. These project study area changes represent the local effects of lake level change on habitat availability. As in the case of the regional analysis, the greatest changes in wetland habitats are at the lower elevations.

Figures 3-7 through 3-14 show the dynamics of the combined effects of these lake level changes and habitat loss associated with the build alternatives. The principal ecological effects of these dynamic changes are summarized below.

- Except for open water habitat (Figure 3-10), the alignments of the different project alternatives are located such that the highest levels of impact from habitat loss occur mostly in the middle elevation zones (1,281.4–1,282.6 m [4,204–4,208 ft] and 1,282.6–1,283.8 m [4,208–4,212 ft]) (Figures 3-7 through 3-14). This is characteristic of both wetland/riparian and upland habitats. Open water habitat (fresh water) is mostly affected in the lower inundation zones.

- The probability of inundation, as estimated from historic conditions (pre-settlement; before 1847) (Figure 2-4), is highest for the two inundation zones below 1,282.6 m (4,208 ft) (24–33 percent for these zones, contrasted with 1.7–8.3 percent for zones above 1,282.6 m [4,208 ft]; Figures 3-5a and b). This trend indicates that when assessing the relative level of impacts of each alternative, these impacts should be evaluated relative to the probability of inundation, with emphasis on those zones subject to the greatest potential impact but with low probability of inundation (i.e., zones above 1,282.6 m [4,208 ft]).

- The relative impacts of the build alternatives change with changes in lake level (Figures 3-7 through 3-14). These figures show the amount of each habitat type remaining in the project study area at various inundation levels for each of the build alternatives. These changes are directly related to the actual distribution of different habitat types in the project study area and differences in the spatial alignments of each alternative (Figures 3-5a and b).

- Upland and wetland/riparian habitats are more abundant at low lake levels than at high lake levels. With rising lake level, inundation combines with direct habitat loss that would result from the build alternatives to reduce the overall availability of habitat to wildlife. Because the portion of the highway footprint that is inundated would not be available whether or not the alternative were constructed, the direct loss of available habitat caused by the build alternatives is lowest at high lake levels and highest at low lake levels. (It should be noted that the highway itself would not be inundated because it would be raised above ground level.)

- The overall carrying capacity for wildlife species using these habitats could decrease proportionally with the decrease in resource availability as lake level rises.

- As lake level rises, the diminishing available habitat will be located progressively nearer to the alternative rights-of-way. This spatial relationship would likely increase the potential for wildlife impacts associated with the Proposed Action (e.g., noise, disturbance, highway mortality).

- The higher-elevation portions of the project study area provide important refuge habitats for many wetland species when lake levels are high. With increasing lake level, the relative impacts of the build alternatives on these refuge areas will increase. However, large areas of the wildlife habitat that characterize the project study area are found throughout the GSLE. The wider availability of habitats makes the study area less important on a regional scale.

- The above-described effects of lake level change were determined for existing conditions. Projected future build-out within the project study area would result in a marked reduction in the amount of remaining natural habitat in the project study area. The combined effects of a rise in lake level, future build-out, and the proposed Legacy Parkway would leave little habitat available at high water for wildlife within the project study area. The overall habitat loss/fragmentation effects of the Proposed Action on the remaining small amount of natural habitat would be proportionally greater with future build-out.

- If increasing lake level occurs rapidly, some less mobile wildlife (e.g. mice, snakes, frogs, nonflying insects) will perish unless they can move to suitable habitat above the waterline. If the rise is gradual (e.g., over several seasons), local populations will change in size in proportion to the reduced carrying capacity of the remaining habitat.

Lake Level Recession and the Dynamics of Habitat Recovery

When the level of Great Salt Lake naturally recedes, extensive mudflats are exposed in shallow areas, and formerly inundated wetland habitats along the lake edge are again charged with fresh water from both surface and subsurface aquifers. Over time, emergent marshes, freshwater ponds, and seasonal wetlands and playas become reestablished, commonly in the same areas where they occurred before inundation. This natural recovery process occurs over years.

With the natural rise and fall of the lake level, the habitats available to wildlife in the GSLE are likely to follow this general cyclic pattern of inundation and recovery. The dynamics of these processes are very complex and are driven by an intricate interplay of many ecological and physical factors; moreover, the temporal patterns of change associated with inundation and recession differ profoundly. Figure 3-17 presents a general conceptual model of how changes in various habitats within the natural inundation zone of Great Salt Lake respond to fluctuations in lake level and freshwater hydrology. With inundation, upland and freshwater habitats are rapidly converted to saline open water habitats. With receding lake levels, mudflats and saline flats are gradually replaced by drier uplands and/or wetlands as local freshwater supply increases. Vegetation characteristic of these communities becomes reestablished either from existing seedbanks in the soil or through seed dispersal from neighboring communities. Wildlife species characteristic of these habitats return as the communities mature and resources become available.

The general recovery pattern of habitat availability to wildlife that accompanies recession of the lake level would be expected to be the spatial reciprocate of habitat loss caused by inundation; however, as discussed above, the time frame of recovery would far exceed that of inundation. The spatial patterns of habitat change and the acreage of each habitat type that would become available to wildlife would be proportional to the relative position of the lake level, the time the land has been exposed, and the time required for natural recovery of each habitat.

While the natural processes described above can be expected to reestablish natural habitats characteristic of the area, managed habitats (e.g., pasture and croplands) would require human intervention to be reestablished. In the absence of such management, such areas would be expected to revert to conditions that existed prior to human modification. Accordingly, depending on post-recession management actions, the resultant habitat matrix of recovered uplands may or may not match that found in the area before inundation.

3.2.3 Potential Combined Effects of Changes in Lake Level and Habitat Loss from Build Alternatives on Migratory Birds

The GSLE is used by millions of migratory birds each year. Upon arrival at the lake, the birds move to suitable habitat around the lake (Figures 2-8 and 2-9) that provides requisite resources for staging, nesting, roosting, foraging, and other behaviors. The availability of these habitats for most species is greatest at low lake levels, and the birds are likely to find adequate resources for their needs. As the lake level rises, the matrix of habitats around the lake change; lowland habitats—particularly wetlands—become inundated, with resultant losses of wetland resources (Figures 3-4a and b). The migratory species reliant on these wetlands (Tables 2-2 to 2-6) must then concentrate in the remaining, slightly more upland habitats; competition for resources increases accordingly. At high water, Great Salt Lake provides a markedly reduced carrying capacity for these species; in response, these migratory populations are likely either to shorten their stay or bypass the lake altogether.

In the project study area, the rise in lake level reduces the availability of wetland habitats and progressively forces birds to move inland, closer to the proposed highway alignment or elsewhere in the GSLE where suitable habitat is available. This process could potentially increase the risk of project-related impacts on birds (e.g., collisions with vehicles, noise, human disturbance). Such consequences would pertain especially to wetland species that typically use upland areas for refuge during inclement weather and for roosting. The proposed Legacy Parkway project would potentially compound the effects of habitat loss from inundation by reducing the availability of associated upland habitat used by these species. However, these effects would be temporally scaled to the frequency, height, and duration of inundation in the project study area. Inundation at the higher elevations has a much lower probability of

occurrence, but would have an increasingly pronounced effect as habitat availability diminishes. With recession of lake levels, these effects decrease as former habitat regenerates.

It must be emphasized that the rise and fall of the lake level is a natural process to which most of the migratory birds have adapted over time. However, much of the available habitat that formerly existed around the lake has been converted over the last century to other land uses and is unavailable to the birds when the lake level rises. The overall carrying capacity of the GSLE for migratory birds is steadily diminishing. The additive effect of the Proposed Action, while small on a regional scale, contributes to this increasing cumulative effect.

3.3 Habitat Fragmentation

The build alternatives of the Legacy Parkway project would transect the matrix of wildlife habitats in the project study area (Figures 2-7a–c). In addition to direct habitat loss, the Proposed Action would result in fragmentation of existing habitats. Habitat fragmentation can result in a number of biological effects on wildlife, including reduction in habitat patch size, increase in the perimeter-to-area ratio of patches and associated edge effects, reduced connectivity between habitat patches, and introduction of barriers to dispersal for some species (Forman et al. 2003). Reduced habitat patch size can decrease the resources available to wildlife species, in turn reducing the local carrying capacity for those species. Moreover, smaller habitat patches are typically characterized by an increase in the length of the patch edge relative to the patch area, as well as a reduction in the distance from the edge to the center of the patch. These changes can favor a reduction in the ecological buffering capacity of the patch for species sensitive to detrimental factors outside the patch (e.g., microclimate, competition from other species, predation, disturbance). Construction of the Legacy Parkway project would also introduce a physical barrier to movement and dispersal of some species.

Very limited data are available on the specific habitat use patterns of wildlife species within the project study area. It is not possible, therefore, to provide a detailed analysis of how the effects of fragmentation resulting from the Proposed Action would result in specific changes in the population biology of these species. However, current research on the measured effects of fragmentation on the same or similar species or species groups in other areas can provide a reasonable measure of the potential for comparable effects to occur within the project study area. In other words, where adverse or beneficial effects have been correlated with changes in habitat patch dimensions resulting from fragmentation, similar general effects might be expected to occur in comparable species under analogous conditions in the project study area.

3.3.1 Methods

Several empirical and modeling approaches—metapopulation analysis, population viability analysis (PVA), and landscape analysis—have been used to model the response of wildlife populations to fragmentation, and to predict extinction rates within fragmented habitats (Verboom et al. 2001). In the context of the Legacy Parkway project, the detailed species distribution data (i.e., number of individuals; birth rates; survival rates; and temporal, spatial, and genetic variation) necessary for species-specific modeling or PVAs were not available (White 2003). Consequently, prediction of minimum viable population size, population trends, and extinction rates for special-status species was not possible. However, GIS datasets available for the project study area made it possible to evaluate, at the landscape level, the effects that changes in size and distribution of suitable habitats would have on various species.

This approach is a widely accepted procedure for evaluating the effects of fragmentation on wildlife populations (McGarigal and Marks 1994).

Several methods were tested to evaluate fragmentation that would result from each of the build alternatives. Many different habitat fragmentation metrics are used to describe landscapes. Three frequently used metrics are mean patch size, mean perimeter-to-area ratio, and mean nearest neighbor distance. In addition, the distribution of patch sizes can be examined if the size of all the patches is known. Explanations and limitations of the metrics used in this analysis are provided below.

- **Mean patch size.** Mean patch size is the measure of the mean size of habitat patches of a given habitat type. This metric reflects the reduction in habitat patch size that results from fragmentation. In comparing build alternatives, a smaller mean patch size indicates greater fragmentation. Calculation of mean patch size is dependent on the scale of the data and the extent of the study area. This metric provides no indication of the number of patches; for example, one patch and a number of patches can provide the same mean patch size. Accordingly, interpretation of this metric should consider the total habitat area and the variability of patch size. The summary statistics assume a normal distribution of patch sizes.

- **Mean perimeter-to-area ratio.** This metric measures the complexity of patch shape and area. The significance of patch shape is related to the edge effect. Mean perimeter-to-area ratio is dependent on the spatial resolution of the image; comparisons should be made between datasets of the same resolution. The measure reflects the complexity and/or morphology, of patch shape.

- **Mean nearest neighbor distance.** This metric quantifies the edge-to-edge distance of patches of the same habitat type. Patch-to-patch distance is a factor in predicting whether a species or population might be able to disperse to a new habitat patch if fragmentation or degradation makes the occupied patch unsuitable. However, complex distribution of habitat patches may impair the utility of this metric. Mean nearest neighbor distance should be interpreted with the nearest neighbor standard deviation. For useful interpretation, the metric must assume a normal distribution of distances. If the distances are not normally distributed, then actual distribution should be used. This metric is limited by the extent of the data. Only patches within the study area are used for the calculation; patches outside the project study area, even if nearer, are not included in the calculations.

- **Distribution of patch sizes.** This metric quantifies the number of large and small patches; it does not require a normal distribution of patch sizes. In general, an increase in number of patches is accompanied by a decrease in mean patch size, indicating that fragmentation of larger patches could occur under the build alternatives. Calculation of this metric is dependent on the scale and the extent of the study area.

Mean patch size, perimeter-to-area ratio, and nearest neighbor distances were calculated using FRAGSTATS and Patch Analyst software programs. To evaluate habitat fragmentation resulting from the Proposed Action, GIS analysis was used to calculate the following metrics.

- The existing number of habitat patches in five size classes in the project study area.

- The number of habitat patches in each size class that would be fragmented by the Proposed Action.

- The number of habitat patches in each size class after fragmentation caused by each build alternative.

This approach provides information about the distribution of patch size, the comparative fragmentation effects of the build alternatives, and identification of trends in fragmentation. Additionally, the mean and median values were calculated for the existing number of patches in the project study area and the resulting number of patches in the project study area after fragmentation. The metrics and the distributions of patch size illustrate the trend of fragmentation.

For the purposes of this analysis, fragmentation was considered to constitute the following three scenarios.

- A given habitat patch could be divided by a build alternative into two or more smaller patches.
- A given habitat patch could be removed entirely by construction of a build alternative.
- A given habitat patch could be reduced in size by construction of a build alternative without creation of additional patches.

The analytical methods discussed below were used to evaluate habitat fragmentation within the project study area.

- **Measurement of changes in the number of patches of each habitat type.** The proposed Legacy Parkway project would cause division of large- and medium-sized habitat patches, resulting in the creation of smaller patches as well as in the complete or partial loss of smaller patches of different habitat types. For example, a single large patch could be fragmented into two equally sized medium patches or one large and one or more smaller patches. Medium- and small-sized patches could be partially or wholly lost to fragmentation; such reduction could shift given patches to smaller size classes. A reduction in the number of patches generally indicates a loss of available habitat for wildlife species using those habitats. An increase in the number of patches typically reflects fragmentation of larger patches.
- **Analysis of the pattern of change in the number of patches of different sizes.** The trend in the number of patches in each size group is an indicator of the level of fragmentation that would result from each build alternative. In general, fragmentation caused by linear facilities such as highways results in a reduction of the number of large patches and an increase in the number of smaller ones.
- **Analysis of changes in the total habitat area of each habitat type in patches of different size classes.** The change in the total extent of each habitat in conjunction with changes in the number of patches of different size classes provides a valuable indicator of the overall magnitude of the fragmentation impacts on wildlife.
- **Analysis of mean and median patch size.** The summary statistics support the distribution analysis. The summary statistics are of limited utility because the data are not normally distributed and are dominated by small patches, but they can be used as an illustration of trend. All the summary statistics that were calculated are available in Appendix B.
- **Analysis of the distribution of nearest neighbor distance and summary statistics.** The nearest neighbor distance calculations were conducted, but the results were inconclusive and potentially misleading. The results of this analysis have been included in Appendix B.

- **Analysis of the mean perimeter-to-area ratio.** The mean perimeter-to-area ratio calculations were conducted, but the results were inconclusive in the evaluation of the build alternatives. The results are included in Appendix B.

Patch Analyst, an ArcView3.2 extension, was used to calculate mean patch size, median patch size, standard deviation, and the coefficient of variation. FRAGSTATS, a fragmentation analysis software, was used to calculate the nearest neighbor distance metrics. The distribution of patch sizes was calculated from the GIS datasets. Additional details of the GIS analysis methods used in this section are provided in Appendix B.

Because the entire project study area was mapped, all changes in habitat patch size and number associated with each build alternative are quantitative measures of actual effects. Consequently, statistical sampling was not necessary to obtain valid comparisons of differences between build alternatives. Additional details of the GIS analysis methods used in this section are provided in Appendix B.

3.3.2 Results

No-Build Alternative

Existing Conditions

The historic wildlife habitats of the GSLE along the Wasatch Front have been highly fragmented by urban, industrial, and agricultural development and by numerous highways and roads. These land use changes have created a major barrier for many species to movement between the Wasatch foothills and Great Salt Lake. However, under the existing conditions No-Build Alternative, there would be no project-related fragmentation of wildlife habitat in the project study area. Analysis of the number and size of habitat patches within the project study area produced the following conclusions.

- There are 1,062 existing wildlife habitat patches within the project study area. Table 3-4 shows the total number of these patches in each habitat category (upland, wetland, and open water).

- The number of habitat patches in each size class increases with decreasing patch size. The number of large patches (>50 acres) is higher for upland habitats than for wetland habitats. The number of small patches (<10 acres) is much larger for wetland habitats than for upland habitats. There are approximately equal numbers of mid-sized patches (10–50 acres) of wetland and upland habitats.

- The total numbers of habitat patches of each size class vary among habitat types. Figure 2-10 shows the distribution of numbers of patches of each habitat type across all size classes.

Future No-Build Scenario

Future build-out is anticipated to occur throughout the project study area and vicinity even in the absence of the Proposed Action. This build-out would result in additional loss and fragmentation of wildlife habitats from urban/industrial development and construction of associated roads. Under this scenario, most of the habitat changes would result from direct habitat loss as large blocks of existing habitat are converted to developed land. The roads associated with these developments would mostly be contained within these converted blocks, although some peripheral and connector roads would also likely be built.

Many of the existing large habitat patches, as well as medium and small patches, would be lost; however, it is unknown to what extent these existing habitat patches would be fragmented into smaller patches.

Build Alternatives

All the build alternatives would divide the matrix of wildlife habitats in the project study area into eastern and western areas. The area east of the proposed rights-of-way is largely modified by development and is experiencing continued rapid urban growth. Projected future growth in this area is likely to result in complete build-out. This area, however, does not appear to support any ecologically unique habitats that are not still represented west of the proposed alignments. The area west of the project rights-of-way retains a greater proportion of wetlands and wildlife habitats. The primary fragmentation effect of the project is not expected to reduce the diversity of habitat types within the project study area.

In addition to this primary fragmentation effect, all the build alternatives would result in finer-scale fragmentation of many existing wildlife habitat patches within the project study area. Table 3-5 summarizes the distribution of habitat patches, mean patch size, median patch size, and standard deviation for each build alternative and the No-Build Alternative. This analysis suggests the following conclusions.

- Fragmentation is evidenced by a general decrease in the number of large patches and an increase in the number of smaller patches that would result from any of the build alternatives.
- Fragmentation of large patches could result in either a decrease or an increase in the number of patches in the large size classes. For instance, if a 500-acre patch is fragmented, the result could be two or even three patches, all of which could remain in the >100-acre size class.
- Small patches (especially those smaller than 1 acre) would be more readily removed entirely by construction of build alternatives.
- The build alternatives would divide the project study area into two to three large sections.

Although differing levels of fragmentation in different size classes would result from each build alternative, all alternatives would result in a net increase in the total number of habitat patches.

The placement of the proposed build alternatives was also examined. Different alternatives can result in similar mean patch sizes and similar numbers of large and small patches, but nevertheless cause different fragmentation effects on the landscape because of their respective geographic locations. Figures 3-18a–c show the alignments of the four build alternatives. Examination of the geographic locations of the build alternatives suggests the following conclusions.

- The build alternatives can reduce movement between habitat patches for species that cannot fly over the right-of-way or that would not use culverts for movement. The build alternatives would isolate differing amounts of habitat.
- Alternative A, with the easternmost alignment of all the alternatives, would isolate the least amount of habitat from areas adjacent to the lake (i.e., west of the right-of-way).
- Alternative B divides the project study area into three separate portions; the other build alternatives divide the project study area into two portions.

- Alternative C is located closer to Great Salt Lake than Alternative A. Consequently, Alternative C is more likely to divide patches into smaller patches, whereas Alternative A is more likely to reduce patch size by removing the eastern portion of affected patches.

- Alternative E is similar to Alternative A, but some portions of the Alternative E right-of-way are closer to Great Salt Lake. This alignment increases the area isolated on the east of the right-of-way. Like Alternative C, these portions of the Alternative E alignment are likelier to divide patches into smaller patches than to reduce patch size by removing the eastern portions of patches.

Summary of Fragmentation Effects

Table 3-4 summarizes the distribution of habitat patches and contains summary statistics for three generalized categories: upland (cropland, pasture, and scrub habitats); wetland (emergent marsh, mudflat/pickleweed, riparian, and wet meadow); and open water. Open water was placed into its own category for this analysis because it includes both saline and freshwater habitats.

- Alternatives A and E have the least impact on fragmentation across the habitat types. Alternative A is located more to the east and would reduce the amount of habitat isolated between the right-of-way and existing development outside the study area (i.e., to the east).

- The number of upland patches increases with all alternatives. Alternatives A and E cause the smallest increase in the number of upland patches. Alternative B causes the largest increase in the number of upland patches, predominantly in the smaller patch sizes. The changes in mean patch size reflect the same pattern.

- The number of wetland patches increases with all alternatives. Alternative E causes the smallest increase in the number of wetland patches. Alternative A causes the highest increase, but there is very little change in mean patch size.

- There are very few open water habitat patches. All alternatives result in similar numbers of patches and size class distributions. There is very little overall change in open water habitat patch size.

Potential Effects of Habitat Fragmentation on Wildlife in the Project Study Area

The results of this analysis show that all build alternatives would result in a general decrease in the size of habitat patches available to wildlife and a decrease in the number of larger patches, particularly in upland habitats. There would be a declining trend in the total amount of habitat in most size classes in most habitat types, with the exception of wetland habitats in the <1-acre size class. These changes will likely result in some or all of the following effects on wildlife in the project study area and vicinity.

- **Reduced connectivity.** The Proposed Action would result in fragmentation of existing upland and wetland habitat patches, eliminating connectivity between areas of those patches that are currently contiguous. In many areas, the highway would form an impassable barrier to some wildlife movement between currently connected areas, except where culverts would provide passage beneath the highway. The suitability of such artificial passageways for different species is not well understood (Forman et al. 2003), although some species (e.g., amphibians, reptiles, small mammals) are known to use them (Forman et al. 2003). Dispersing or migrating individuals (e.g., western chorus frogs, eastern racers, common garter snakes, gopher snakes, meadow voles, deer mice) in populations

separated by the highway from former habitat in areas without provision of passageways would require extended circuitous travel—possibly through marginal or unsuitable habitat—to reach formerly connected areas. The increased level of exposure resulting from such lengthened routes could elevate risk of predation, disturbance, and adverse intra- or interspecific behavioral interactions. Reduced connectivity between habitat patches could also result in reduced gene flow between populations using them.

- **Reduced carrying capacity.** Reduced habitat patch size would likely result in reduced availability of resources—and hence carrying capacity—to species using those areas. Where large populations are divided into smaller isolated populations by habitat fragmentation, stochastic events (e.g., storms, extended dry periods) could result in fluctuations in the size of these populations. Such impacts would occur to a greater degree in less mobile species (e.g., frogs, snakes, small mammals).

- **Elevated exposure to highway mortality.** Upland habitats in the project study area provide important refuge areas for migratory shorebirds and waterfowl (Appendix A) during periods when the lake level is high (e.g., during storms or periods of high precipitation). These species regularly move between the lower-elevation wetlands and the uplands. While these species are quite mobile and can easily fly between these areas, the highway would likely restrict or eliminate access to some areas currently being used (Forman et al. 2003). It could also increase the risk of highway-related mortality for individuals that commute across the highway. Such risks would likely be elevated during periods of high lake level when available wetlands are located closer to the highway.

- **Elevated exposure to roadside pollution.** Habitat patches fragmented by the Proposed Action would be subject to elevated exposure to various air- and water-borne pollutants. Isolated small wetlands are more likely than larger ones to concentrate these pollutants, resulting in increased degradation of habitat quality (Forman et al. 2003).

- **Elevated exposure to noise disturbance.** Large habitat patches provide more buffering capacity against noise disturbance for core species than do smaller patches. Diminished patch size resulting from fragmentation would result in a reduction of this noise buffering capacity (Forman et al. 2003).

Cumulative Effects of Habitat Fragmentation

Much of the historic (pre-settlement; before 1847) wetland/wildlife habitat (Figure 3-19) in the project study area and vicinity is currently highly fragmented by roads, industrial complexes, housing development, and agriculture (Figure 3-20). The Proposed Action's effects of fragmentation on local wildlife populations would be additive to these existing levels of fragmentation and all reasonably foreseeable future fragmentation that is likely to occur in the area (see Section 3.11, Cumulative Effects). Physical segregation of upland habitats from wetlands in the project study area could have an adverse regional effect on migratory shorebirds and waterfowl that traditionally use both habitats in the area. Examination of projected future build-out in the project study area (Figure 3-21) suggests that much of the upland habitat currently available to wildlife east of the Legacy Parkway project will be converted to other incompatible uses. Loss of this habitat and fragmentation of the existing habitat along the full length of the Legacy Parkway project could disrupt the ecological connectivity between the uplands and adjacent wetlands to a degree that could reduce the attractiveness for continued use of this portion of the GSLE by large numbers of migratory birds.

3.3.3 Potential Effects of Habitat Fragmentation on Special-Status Wildlife Species

Because the existing habitat in the project study area is already highly fragmented by a diversity of human activities (e.g., agriculture, fences, roads, urban development), the additional fragmentation effects that the build alternatives would have on wildlife would likely be less than, but additive to, the effects of direct habitat loss. The fragmentation metrics of the build alternatives (Tables 3-2 and 3-3) display detectable variation, but the differences are small and biologically indistinguishable at the scale of this analysis. The results of the assessment of the effects of direct habitat loss on special-status species, including area lost as a result of fragmentation, indicate that local populations of some species would be affected by loss of individuals and/or habitat. Analysis of the effects of fragmentation relative to those of direct habitat loss show that in landscapes with loss of more than 30 percent of suitable habitats, changes in patch size and isolation will complement the effects of habitat loss, and the loss of species or declines in population size will be greater than that expected to result from habitat loss alone (Andren 1994; Bascompte and Sole 1996). The Ogden hydrologic unit, where the majority of the Proposed Action would be located (See Section 3.11.2 below), has already lost nearly 70 percent of its estimated historic wetland/wildlife habitats. Under these conditions, there is a potential for an substantial increase in isolation of species populations, leading to declines in species numbers. These losses, however, would occur locally. Because extensive areas of suitable wildlife habitat are still present in the region as a whole, the population declines precipitated by the Proposed Action would not result in a notable change in the long-term viability of these species in the GSLE. Section 3.10.3, *Special-Status Species*, describes the potential relative effect of the project actions on special-status bird species known to breed in the project study area or nearby vicinity. A comparison of the generally small number of individuals of each species that would be affected by the Proposed Action with the estimated population size of the same species within the GSLE suggests that overall impacts on individual species would be small. For example, American Avocets regularly nest in emergent marsh, wet meadow, mudflat/pickleweed, and pasture habitats in the project study area (Table 2-1). The loss of potential breeding habitat across all project alternatives (i.e., habitat for 1,841–5,339 pairs Alternatives A and B, respectively) would affect from approximately 3.5 to 10 percent of the estimated 53,000 breeding American Avocets in the regional study area (Paul et al. 1998b in Robinson et al. 1997). The loss of habitat resulting from any of the build alternatives would reduce the local density of breeding birds within the project study area but would not be likely to significantly affect the long-term viability of American Avocets in the GSLE. This local population decline would not notably affect the long-term viability of this species in the GSLE.

3.4 Changes in Habitat Quality

3.4.1 Air Quality

The Final EIS describes the existing (2000) and projected air quality conditions in the project study area. Virtually nothing is known about how changes in air quality affect wildlife. Existing air quality standards established for human health provide a baseline standard for potential effects on wildlife. Temperature inversions and local concentrations of air pollutants would likely effect humans and wildlife comparably, although differences in physiology (e.g., higher metabolism and proportionally larger lung/air sac surface area in birds) may exacerbate some effects in some species. Animals are exposed to air pollutants through the inhalation of gases or small particles and the absorption of gases through the skin. Amphibians and soft-bodied invertebrates (e.g., earthworms) are most susceptible to the effects of absorption of air pollutants. An individual's response to a pollutant varies greatly and depends on the pollutant involved,

the duration and time of exposure, and the amount taken up by the animal. Pollutant fallout onto vegetation and existing water bodies in the project study area could have local effects on plant productivity, ecotoxicity of plants used for food by wildlife, and water quality (see below). Potential effects of criteria air pollutants on humans and, presumably, wildlife are discussed below.

- Nitrogen dioxide: lung damage, illnesses of breathing passages and lungs. Nitrogen dioxide is also an ingredient of acid rain, which can damage vegetation and water quality for amphibians, fish, and other aquatic organisms.

- Volatile organic compounds (VOCs): VOCs include chemicals such as benzene, toluene, methylene chloride, and methyl chloroform. They react with nitrous oxides (NO_x) to form ozone, which can cause breathing problems, reduce lung function, irritate eyes and respiratory passages, reduce resistance to infections, and accelerate aging of lung tissue. VOCs can also cause cancer, and ozone can damage vegetation.

- Carbon monoxide (CO): reduces the ability of blood to bring oxygen to body cells and tissues; CO is particularly hazardous to individuals that have damaged lungs or breathing passages. Can exacerbate problems created by VOCs, NO_x, and ozone.

- Lead: can cause brain and other nervous system damage. Small and young individuals are at special risk. Some lead-containing chemicals cause cancer in animals. Lead also causes digestive problems.

- Particulate matter (PM): can cause respiratory passage irritation, lung damage, and bronchitis.

Analysis of future (2020) air quality conditions indicate that CO and PM will likely be higher along the alignment of the Proposed Action. Ozone is not expected to cause new exceedances of the National Ambient Air Quality Standards (Utah Department of Environmental Quality, Division of Air Quality 1997), but the potential effects on wildlife caused by the Proposed Action are unknown. Similarly, future concentrations of nitrogen dioxide and lead are not expected to change from existing conditions in the project study area, but their effects on wildlife are unknown. Any effect on wildlife and wildlife habitat quality resulting from changes in air quality would be similar for all build alternatives.

3.4.2 Water Quality

All the build alternatives would result in similar increases in highway runoff contaminants. Table 3-6 provides a list of the primary contaminants and their sources.

These are not the only contaminants present in highway runoff, but they are the contaminants of primary concern regarding effects on water quality (Moellmer 2003 cited in HDR Engineering, Inc. 2004). These contaminants reduce water quality and affect wildlife in a variety of ways (Forman et al. 2003). Because of the increased transportability of many of these contaminants in aquatic systems, wetlands adjacent to the highway would most likely be the areas most affected. However, the design of the Legacy Parkway project includes contaminant management BMPs, including appropriately sized grass biofilters in the highway meridian and catchment basins at strategic points of runoff concentration (HDR Engineering, Inc. 2004); these features are designed to minimize exposure to these contaminants in wildlife habitats adjacent to the highway. Any adverse effects of these contaminants would be restricted to such local concentration areas.

3.4.3 Catastrophic Hazardous Materials Spills

Hazardous waste or other chemical spills in wetland habitats could have catastrophic effects on wildlife, particularly when water levels are high. Existing UDOT and FHWA/EPA requirements for safe transport of these materials and emergency spill containment programs minimize these effects under most conditions. Unavoidable accidents do occur, however. Figure 3-22 summarizes the total annual number of highway incidents in the state of Utah for 1994–2003 (10 years). During this period there was an average of 215 highway incidents involving hazardous materials per year, but an average of only 6.7 of these incidents were considered serious each year[1]. Most effects from these incidents are generally localized and would consequently vary under different build alternatives, although they would likely be worse in aquatic habitats. Alternative B, which crosses the most wetland habitat (Figure 3-18) and is closest to the FBWMA, would be most susceptible to adverse effects on wildlife as a result of an accidental hazardous materials spill. Because of their alignment in more upland locations, Alternatives A and E would be less susceptible.

3.5 Habitat Modification

3.5.1 Wetland Hydrology

Newly constructed highways can alter the subsurface and surface flow of water to wetland soils (Stoeckeler 1965; Forman et al. 2003). Soils with limited permeability and low drainage capacity that are compacted by fill can become saturated or nearly saturated. Roads that cross wetlands can often block drainage passages and groundwater flows, effectively altering the upslope water table, shifting species composition to more hydrophytic species, and lowering the downslope water table—thereby creating a more xeric (dry) environment (Stoeckeler 1965; Swanson et al. 1988).

The Final EIS evaluated the potential impact of build alternatives on wetland hydrology using a computer model and available data on embankment width, thickness of the underlying aquifer, hydraulic gradient, and change in permeability due to a simulated embankment. The model showed that a 3-m (9-ft) embankment could cause a 25 percent reduction in soil permeability in the upper 15 m (50 ft) of the aquifer and a 15 percent reduction in the lower 15 m (50 ft). An 8-m (27-ft) embankment could reduce soil permeability by 50 percent and 33 percent respectively for the upper and lower portions of the aquifer. A 2-m (5-ft) embankment could result in a 0.08-m (0.25-ft) rise in the water table on the eastern side of the embankment and a 0.08-m (0.25-ft) drop on the western side. The additional loading associated with 3- to 8-m (9- to 27-ft) embankments would not result in groundwater changes greater than 0.15 m (0.5 ft).

In 2001, 1.5–1.8 m (5–6 ft) of fill was placed along the Alternative E alignment between I-215 and 1500 South, and up to 6 m (20 ft) was placed in the I-215 interchange area. To determine empirically how these activities would affect local wetland hydrology, a network of piezometers (soil water-pressure gauges) were installed parallel to the fill areas in 2001 (Forster and Neff 2002). This study revealed that the

[1] A serious incident is defined as a fatality or major injury caused by the release of a hazardous material, the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire, a release or exposure to fire which results in the closure of a major transportation artery, the alteration of an aircraft flight plan or operation, the release of radioactive materials from Type B packaging, the release of more than 11.9 gallons or 88.2 pounds of a severe marine pollutant, or the release of a bulk quantity (more than119 gallons or 882 pounds) of a hazardous material (http://hazmat.dot.gov/files/hazmat/hmisframe.htm).

groundwater level in the area is very shallow; the groundwater supporting the wetlands is derived largely from vertical flow of water from deeper aquifers rather than from precipitation. The study concluded that the water supply to wetlands in the project study area was not likely to be seriously affected by highway construction, with the exception of the area immediately adjacent to the right-of-way. New drainage features proposed for the Legacy Parkway, including horizontal strip drains to be placed where fill exceeds depths of 3 m (10 ft), would equalize groundwater when the groundwater elevation reaches the drain, effectively mimicking the westward flow of shallow water beneath the right-of-way. The surface loading caused by the Legacy Parkway project would not affect the deeper principal aquifer. Consequently, no adverse impacts on local wetland hydrology are anticipated from implementation of the Legacy Parkway project.

3.5.2 Artificial Landscaping

Artificial landscaping often attracts a diversity of species, particularly birds and small mammals (Forman et al. 2003). Migrating passerine birds frequently rest and forage on insects and fruit in landscaped areas. Fruit- and seed-producing trees and shrubs are especially attractive to these species. Planted trees also attract a variety of raptors, particularly hawks, falcons, and owls, which use them for night/day roosting and nesting sites. Raptors perch in these trees to hunt for rodents, rabbits, and other prey in adjacent fields. Some small mammals may also find suitable food and shelter in landscaped areas associated with highways (Forman et al. 2002).

According to the Landscape Baseline Plan in the Final EIS, the type and design of plantings in the artificial landscaping would be similar under all build alternatives (Federal Highway Administration et al. 2002). The new landscaping would have both beneficial and adverse effects on wildlife species that currently inhabit the project study area. These effects would be similar under all build alternatives (Federal Highway Administration et al. 2002). Beneficial effects would include new trees, shrubs, and herbaceous vegetation that would provide foraging, roosting, and nesting habitats for birds and other wildlife. Adverse effects could result from proximity of the vegetation to the highway (Forman et al. 2002). Wildlife mortality due to collisions with vehicles could increase because a variety of species would be attracted to this roadside vegetation for cover and food (see Section 3.6, Wildlife Mortality). Resident owls, migrating raptors, passerine birds, and some mammals could find landscaped areas especially attractive. The artificial landscaping would also contribute to both the local and regional cumulative effects on wildlife from all new urban landscaping.

3.6 Wildlife Mortality

An estimated one million vertebrates are killed per day on roads in the United States (Forman and Alexander 1998). Ongoing studies show that roads near wetlands and ponds commonly have the highest roadkill rates, particularly of amphibians and reptiles (deMaynadier and Hunter 1995; Fahrig et al. 1995; Ashley and Robinson 1996). Birds and mammals are also susceptible, especially on wide, high-speed highways (Oxley et al. 1974; Buchanan 1987; Evink et al. 1996; Romin and Biossonette 1996). Roadkill is often associated with spilled grain, plants, insects, small mammals, road salt, and dead animals that attract wildlife to roadways (Hodson 1966; Hubbard and Hubbard 1969; Oetting and Cassel 1971; Bennett 1991).

Areas of high kill rates may include natural movement corridors and areas where birds move from patches of habitat on one side of the road to patches on the other. This movement pattern may be particularly

prominent in waterfowl and shorebirds when the lake level is high, forcing these birds to use areas closer to the highway. The upland areas of the project study area are important habitat for many of these species.

UDOT maintains records of wildlife road mortality throughout Utah, including the vicinity of the Proposed Action. These data, however, comprise general records of large animal kills (e.g., deer) along major highways bisecting the movement corridors between the Wasatch Mountains and Great Salt Lake. No records are maintained of road mortality of smaller species (e.g., birds, amphibians, reptiles); such roadkills are typically removed by scavengers soon after impact. The proposed fencing along the highway right-of-way (three parallel fences) and berms are likely to provide substantial barriers to large animal movement across the proposed highway. However, some roadkill—particularly of birds, small mammals, amphibians, and reptiles that could pass through or over the fences—is likely to occur with all build alternatives. Extensive monitoring of roadkill patterns indicates that, while local populations may suffer declines where the roadkill rate exceeds the rates of reproduction and immigration, roadkill in general has minimal effect on population size of most species affected (Hodson 1962, 1966; Forman 1995; Evink et al. 1996; Forman et al. 1997; Forman and Alexander 1998).

3.7 Artificial Light Disturbance

3.7.1 Methods

This analysis focused on new lighting that would be associated with the build alternatives and recognizes that numerous existing sources of residential, commercial, and industrial lighting already affect the project region. The analysis included a literature review of the general and specific effects of artificial lighting on birds, mammals, amphibians, aquatic invertebrates, and terrestrial invertebrates (Appendix D).

3.7.2 Results

New artificial lighting associated with the Proposed Action would be associated primarily with localized street lamps at onramps and offramps. When the lake level is high, many migratory birds are likely to use the wetlands and uplands close to the highway. During periods of low visibility, the lights at intersections could attract migratory birds that become disoriented. Under such conditions, birds could collide with moving vehicles or light poles. While such bird mortality events have been documented in the Great Salt Lake basin and elsewhere (Appendix D), they are apparently very rare, at least for large numbers of birds. Low-visibility weather in the Salt Lake City area is generally highly seasonal, occurring mostly during winter. Over a 30-year survey period at Salt Lake City International Airport, dense fog was recorded on average only 0.2–3.5 percent of the time each year, occurring only during November through March (University of Utah 2004). Similarly, moderate or heavy snow was recorded on average only 0.1–0.8 percent of the time from October through April. Bird population surveys in state wildlife management areas and the Bear River Migratory Bird Refuge on Great Salt Lake indicate that waterfowl begin arriving from northern breeding areas in June (0% fog, 0% snow); peak in September (0% fog, 0% snow); and taper off through November (0.2 % fog, 0.3% snow) (Aldrich and Paul 2002). Populations begin returning from southern wintering areas in February (1.8% fog; 0.7% snow), peak in March (0.1% fog; 0.6% snow) and taper off through April (0% fog; 0.4% snow). These data reflect some seasonal overlap of poor-visibility weather events and bird migratory periods in the Great Salt Lake basin, indicating some potential for light-related mortality of these species. However, the Proposed Action would add a minimal amount of light to overall existing conditions (See Section 2.4.10 Existing Sources of Artificial Light in Project Vicinity). Consequently, the project-related effects of light on birds, amphibians, mammals, fish,

aquatic invertebrates, and terrestrial invertebrates would likely be low (Appendix D), and would not affect the long-term viability of any species in the GSLE. Such effects would be the same for all four build alternatives.

All build alternatives would contribute minimally to the cumulative effects on wildlife from increased artificial lighting within the project study area and regionally.

3.8 Highway Noise Disturbance

Noise can adversely affect wildlife in two ways: by inducing stress and by masking communication and other natural sounds. Stress can result from sudden loud noises or prolonged exposure to high-level noise. Highway noise is typically neither loud nor startling enough to cause marked stress effects on wildlife (Saigul-Klin et al. 1977). However, noise can mask important vocal communication and natural sounds important for mate attraction, social cohesion, predator avoidance, prey detection, navigation, and other basic behaviors. Highway noise can markedly interfere with communication in many species (Bowles 1995; Bradbury and Vehrencamp 1998). Such interference can result in the reduced ability of individuals to successfully acquire mates, reproduce, raise young, and avoid predation (Saigul-Klin et al. 1997).

Research on the ecological effects of highway noise on wildlife shows that grassland bird diversity and abundance in habitat similar to that in the project study area declined in direct relation to proximity to existing highways (Reijnen et al. 1996; Forman and Deblinger 2000; Forman et al. 2002). According to these studies, detectable noise-related effects were measurable to 3,530 m (2.2 mi) from highways with traffic volumes of 50,000 vehicles per day. These effects distances represented an average noise level of approximately 48 decibels (dB) (Figure 3-23).

3.8.1 Methods

To determine whether highway noise could affect wildlife within and adjacent to the project study area, a two-level analytical approach was used. First, to estimate the distance at which project highway noise could potentially affect wildlife communication, an analysis was conducted of the bioacoustics requirements of representative birds and the masking potential of highway noise on those species. Species analyzed were selected to represent the range of frequencies in the songs and calls of bird species known to occur in the project study area (Appendix E) and the special-status species that are known to breed in the project study area or close vicinity. Second, to assess the area of each habitat type within and adjacent to the project study area that could be affected by highway noise, noise contours were modeled for each project alternative and delineated on a map of the habitats in the project study area and vicinity (Figures 3-24a and b). From this map, the approximate area of effect for each project alternative could be calculated. Detailed descriptions of these methods are presented below and in Appendix E.

Bioacoustics Analysis of Potential Masking Effects of Highway Noise

A detailed description of the methods used in this analysis is presented in Appendix E.

Effects Distance and Area of Potential Noise Impacts Analysis

Projected future traffic noise levels for the different build alternatives were estimated using the Federal Highway Administration Traffic Noise Model (TNM)[2] (Figure 3-25). A traffic volume of 1,800 vehicles per hour per lane, or 7,200 vehicles per hour for four lanes (72,000 veh/d), was used in this analysis. The TNM used this traffic volume to generate noise level contours for existing conditions and each build alternative. These noise contours were then integrated onto the GIS wildlife habitat map, and the areas of each habitat type within each contour were calculated for each modeled alternative.

As mentioned above, Reijnen et al. (1995) found that the threshold noise level at which the population density of affected grassland birds began to decline averaged 48 dB, and the most sensitive species in that study responded to road noise at 43 dB. For this analysis, as in the Final EIS, the intermediate level of 45 dB was used to determine the geographical extent of potential impacts (effects distance). This distance was estimated by measuring representative distances between the center of the proposed rights-of-way and the modeled 45-dB noise level contour line.

3.8.2 Results

Potential for Legacy Highway Noise to Mask Bird Vocal Communication

Birds use vocal signals to communicate information on many aspects of their status and behavior important for survival, social cohesion, and reproductive success. Songs and calls function to identify the caller's species, sex, age (experienced adult vs. juvenile), territorial status, and motivational state (e.g., aggressive, submissive); to attract mates and repel rivals; to stimulate egg laying and synchronize hatching; to strengthen pair bonds; to signal change in domestic duties; to entice young to eat; and to warn of predators, maintain flock cohesion, and incite group mobbing action against intruders. Many species have complex vocal repertoires of songs and calls that can vary subtly in many ways, including frequency and timing of use, intensity (amplitude variation), and syntax (order of signal presentation). Clear transmission and reception of these signals and the subtleties of their variation are critical for maintaining the normal biological and ecological function of each species. Masking occurs when highway noise interferes with signal transmission by swamping out the signal or parts of a signal (e.g., low-amplitude elements of a song) or degrading the signal to a point at which it is no longer recognizable. When such masking or degradation occurs, the normal communication and associated biological functions of the species are impaired. Depending on the degree of masking, and the particular species' capacity to adapt (e.g., to sing louder), masking can result in abandonment of an area or reduced productivity and survival. Signal masking may result in males' inability to effectively attract mates and/or repel territorial rivals. Excess energy may be required to physically maintain a territory and to sing louder. Predator warning and parent-offspring signals can be impaired. All these factors can potentially result in reduced viability of affected populations adjacent to the highway.

The results of the bioacoustics analysis of sound masking detailed in Appendix E indicate that the effects of highway noise on birds are highly variable and species specific. The nature and extent of noise disturbance depends largely on the acoustic characteristics of the noise (e.g., frequency, duration, loudness, periodicity); the sound attenuation properties of the adjacent habitat; the hearing capacity and sound requirements of the species affected; and the distance between the animal and the highway.

[2] The TNM model assumes neutral meteorological conditions and therefore does not take into account the effects of wind, temperature, or other meteorological factors on the noise level. Analysis of these factors is included in the bioacoustics report in Appendix E.

For some species—such as American Bitterns, which use low-frequency calls (i.e., in a frequency range similar to that of highway noise)—masking effects could extend as far as 5 km (3 mi) from the project right-of-way. For other species with higher-frequency calls and more gregarious social arrangements (i.e., individuals gather in groups, requiring only close-range communication), the effects of highway noise would be minimal, allowing normal communication close to the highway. Territorial bird species such as Brewer's Sparrows, which use singing to maintain their territories, could potentially experience communication masking from highway noise to an intermediate distance of between 300 m (1,000 ft) and >600 m (>2,000 ft). Natural air turbulence would likely reduce these effects distances during windy/warm periods by disrupting the long-range transmission of highway noise.

Potential Impacts of Highway Noise on Bird Species of Concern

The masking potential of highway noise from the Proposed Action would be similar for all build alternatives.

Figures 3-26a–e show the sonograms of the principal vocalizations (e.g., song or call) of nine special-status bird species (Bald Eagle, Swainson's Hawk, Peregrine Falcon, Prairie Falcon, Burrowing Owl, Short-eared Owl, Wilson's Phalarope, Boblink, and American Avocet) known to breed in or near the project study area. These figures show the frequency range and temporal pattern of the sound elements in each vocalization. Figures 3-27a–d show the acoustic relationship between these vocalizations and highway noise. A series of highway noise masking thresholds are given for increasing distances from the highway (from 38 m to 4,877 m [125 ft to 16,000 ft]). Each line shows that the higher frequencies of noise attenuate (decrease in amplitude) more rapidly than lower frequencies. The preponderance of highway noise falls within the lower frequencies (50–250 Hz), decreasing proportionally as frequency increases. Plotting of the bird vocal signal profiles over these threshold curves can identify what frequencies of the signals (i.e., elements) would be masked by the highway noise at each distance from the highway. If the vocal signal profile line lies below a highway noise threshold line, that signal, or the portion of the signal defined by the frequency range below the threshold line, would be masked by the highway noise. For example, the vocal signal profile for Bald eagle lies below the 38-m (125-ft) highway masking threshold for signal frequencies below 1600 Hz. All signal elements with frequencies below this threshold would be masked by the highway noise at 38 m (125 ft) from the highway. All signal elements above this frequency would not be masked. As discussed below, the principal long-range vocal signals of Bald Eagles lie between 4 and 10 kHz, well above the masking threshold for highway noise at 38 m (25 ft). Accordingly, these signals would not be masked by highway noise at that distance for birds communicating at close range.

For birds communicating across greater distances, the vocal signal of the sender attenuates with distance. Depending on how close the birds are to the highway, highway noise may begin to interfere with communication as the birds move apart (for ease of conceptualization, this discussion assumes that the birds move apart parallel to the highway). With increasing distance between the two birds, the amplitude of the signal the receiver hears decreases and the relative impact of the highway noise increases (Figures 3-28a–i). These figures show the attenuation rate of the vocal signal of each special-status bird species plotted against the highway noise level at specific distances from the highway. The intersection of the attenuation curve for each species with the highway noise level signifies the distance two birds can be apart and still communicate clearly. For example, as shown in Figure 3-28f, at 15 m (50 ft) from the highway, a Short-eared Owl could communicate with another owl using a peak-amplitude signal at slightly less than 30 m (100 ft) away without undue interference from the highway. If the birds were 38 m (125 ft) from the highway, they could communicate clearly to a range of 122 m (400 ft), primarily

because the highway noise attenuates from approximately 69 dB at 15 m (50 ft) from the highway to 55 dB at 38 m (125 feet) from the highway.

An analysis of how highway noise could affect vocal communication in each of the special-status species is provided below. It should be noted that these analyses are based on general, representative conditions for general assessment purposes only. Both highway noise levels and the vocal signals of the birds can vary from the examples modeled here in a variety of ways. The vocal signal profiles of each species are based on a peak-hold amplitude spectrum analysis, which scans the frequency-amplitude pattern of the entire sampled vocalization and produces a profile based on the peak amplitudes recorded for each frequency for the entire sample. However, as described in Appendix E, signals within bird vocalizations can vary markedly in amplitude. These variations can affect actual effective transmission distance of individual signals and the potential for highway noise to interfere with these signals. The results presented here are based on both peak-hold and minimum amplitude values to provide a range of transmission distances that would be effective for birds using different amplitude signals.

An additional factor that could affect the impacts of highway noise is the ability of species to adapt to noise. Some birds adapt to tolerable noise levels by habituation and by increasing the amplitude of their vocal signals. While this adaptation is generally associated with increased energy demands on the individual, it can provide short-term solutions to overcoming road noise interference. Such an adaptive response can effectively increase the masking distance. In contrast, wind and air turbulence can often disrupt both highway noise and vocal signals (see Appendix E). If highway noise is so affected, the distance from the highway at which it would interfere with communication would decrease with increasing level of disturbance. Similarly, birds naturally have to adapt to local background noise, including wind. If natural background noise levels exceed highway noise levels, the latter would have no impact.

Bald Eagle

Bald Eagle vocalizations include a *wail*, a high-pitched, prolonged gull-like *peal*, and a chatter call. The wail is seldom given; the peal is often used as a defensive response to territorial intrusion or as a threat vocalization to fend off attack at communal feeding sites (Buehler 2000). The chatter call is often used when an adult approaches the nest or at communal roosts. Bald Eagle territories are typically 1–2 km^2 in size (Buehler 2000). Assuming the territories to be circular and that defense vocalizations would need to be transmitted at least from the center of the territory to the perimeter, a typical required communication distance would be 0.6–0.8 km (0.4–0.5 mi). Figure 3-26a shows a representative vocalization that could be used by Bald Eagles during such communication. The frequency range of this calls extends from approximately 2.9 kHz (fundamental harmonic) to 10.4 k Hz (fourth harmonic). Figure 3-27a shows the vocal signal profile for this call. Note that for this peak-hold measurement, the signal exceeds the 38-m (125-ft) traffic noise threshold for all frequencies above 1.6 kHz. Figure 3-28a shows that minimum amplitude signals could also be effectively transmitted 305 m (1,000 ft) under calm conditions without interference from highway noise if the birds were 38 m (125 ft) from the highway. The outer effect distance for highway noise masking of long-range communication for this species would therefore be approximately 38 m (125 ft) from the highway near ground level. Table 3-7 shows the amount of different habitats potentially used by Bald Eagles within the project study area that would be affected by highway noise at 38 m (125 ft) for each build alternative. The existing nest location of the Bald Eagle pair in the project study area is far enough from the highway (1.6 km [1 mi]) that this masking effect would not be a factor. For birds that call from high elevations (e.g., more than 38 m [125 ft]) above the ground, their linear proximity to the highway may not be a factor.

During mating, female Bald Eagles frequently emit soft, high-pitched notes important in communicating reproductive readiness to the male (Gerrard et al. 1979 in Buehler 2000). Because of their low amplitude, some level of masking could occur close to the highway; however, these calls are likely to be given only in close proximity to the male and would therefore not likely be significantly affected by highway noise.

Swainson's Hawk

The principal call of Swainson's Hawk is the adult scream (Figure 3-26a), a shrill plaintive *kreeee* given either in flight or from a perch (England et al. 1997). The call is given by both sexes in response to nest area intruders, , and by the female in response to a male at the nest or a male delivering prey (Porton 1977 in England et al. 1997; Fitzner 1978 in England et al. 1997). The , broad-band (1.7–10.6 kHz), high-frequency character of this call suggests it would not likely be affected by highway noise, which is comprised mostly of lower frequencies. Figure 3-27a shows that, like Bald Eagles, if calling Swainson's Hawks are more than 38 m (125 ft) from the highway, highway noise would not affect peak-amplitude signals of the species. Figure 3-28b shows that minimum amplitude signals could also be effectively transmitted at least 500 feet under calm conditions without interference from highway noise if the birds were 38 m (125 ft) from the highway. The outer impact effect distance for this species would thus be approximately 125 feet from the highway at low elevations. Table 3-7 shows the amount of different habitats potentially used by Swainson's Hawks within the project study area that would be affected by highway noise at this distance (125 ft) for each project alternative. Birds that call while soaring high (e.g., more than 38 m [125 ft]) above the ground would not likely be affected by highway noise.

Other calls used by this species include an agonistic pursuit call given during territorial boundary disputes and a soft one-syllable solicitation call given by the female during copulation (Fitzner 1978 in England 1997). Both these calls are most commonly given in close proximity to the receiver and would therefore not likely be unduly affected by highway noise unless the birds were immediately adjacent to the highway. This species commonly nests close to major highways (Estep pers. comm.) and does not appear to be affected by traffic noise.

Peregrine Falcon

Peregrine Falcon vocalizations comprise four main call types: *cack*, Chitter, *eechip*, and Wail (White et al. 2002). The *cack* is a short, broad-band (1–9 kHz) harmonic call that is often repeated incessantly. It is given in alarm and in conjunction with nest defense. The Chitter is a short, repeated broad-band call given primarily by the male prior to or during mating. The *eechip* consists of three elements: *ku*, *ee*, and *chip*. The *ku* covers the lowest frequency range (0–4 kHz) and contains the least energy of the elements. The *ee* is a high-frequency (4.5 kHz) call. The *chip* is the highest-energy element that covers the broadest range of frequencies (1–6 kHz). The *eechip* is commonly used by both sexes during courtship behavior and aerial encounters. Finally, the Wail is a continual or repeated broad-band (1.2–7.3 kHz) call used in a variety of behavioral contexts, including food begging, agonistic encounters, copulation, and mate advertisement. All these vocalizations except the Wail are commonly used in close proximity to mates, rivals, and/or offspring. Accordingly, they would not likely be affected in any significant way by highway noise.

The Wail vocalization (Figure 3-26b), however, is commonly quite loud when given by nestlings or fledglings begging for food (Cade 1960 in White et al. 2002; Hustler 1983 in White et al. 2002). Under calm conditions it can carry up to 2 km (1.2 mi.) (White et al. 2002). Because of this long communication distance, the clarity of this call could be reduced by highway noise if either the sender or receiver were close to the highway, or if the highway was between the birds. Figure 3-27b shows the signal profile for this call. Calls given at or beyond 38m (125 ft) from the highway would not theoretically be noticeably

affected by highway noise. Figure 3-28c shows that low-amplitude Wail calls could potentially be masked at this distance from the highway if the birds were 183 m (600 ft) or more apart, and at 76 m (250 ft) from the highway if the birds were 305 m (1,000 ft) apart. The operative outer effects distance for highway noise impacts on this species appears to be approximately 76–152 m (250–500 ft) from the highway. Table 3-7 shows the amount of different habitats potentially used by Peregrine Falcons within the project study area that would be affected by highway noise at 152 m [500 ft] for each build alternative. Birds that call high (e.g., more than 76 m [250 ft]) above the ground would not likely be affected by the highway noise.

Prairie Falcon

Prairie Falcon vocalizations are not well studied (Steenhof 1998). The general patterns of calls, however, appear similar to those of other falcons, including the Peregrine Falcon as described above. The most common vocalization is the alarm or territorial Cacking call (Steenhoff 1998), a shrill *kik-kik-kik* (Figure 3-26b). It is given when one or both members of a pair aggressively confront an intruder on the breeding territory. Territories commonly encompass a 300–400-m (984–1,312 ft) radius semicircle extending in front of the nest and along the cliff face and 100 m (328 ft) above the nest (Steenhoff 1998).

The signal profile for the Cacking call (Figure 3-27b) is similar to that of Peregrine Falcon, with frequencies above 1.6 k Hz exceeding the masking threshold of highway noise at 38 m (125 ft) from the highway. Figure 3-28d shows that the operative outer effects distance for highway noise impacts on minimum amplitude Cacking calls of this species is more than 305 m (1,000 ft) (the verification limit of the TNM model) from the highway. Pairs with territories within this zone could potentially experience masking affects from highway noise during use of the Cacking call. Table 3-7 shows the amount of different habitats potentially used by Prairie Falcons within the project study area that would be affected by highway noise at 305 m (1,000 ft) for each build alternative.

During courtship, Prairie Falcons use a characteristic *Eechup* call, commonly used when pairs are investigating potential nest sites, but also given during food transfers, aggressive interactions, and copulation. Females can emit a distinctive whine or wail when soliciting food or copulation from the male. Each of these calls is given over relatively short distances between the individuals and would therefore not be unduly affected by highway noise unless used very close to the highway.

Burrowing Owl

Martin (1973 in Haug 1993) identified 13 vocalizations of adult Burrowing Owls (cited in Haug et al. 1993). These include a primary song, five calls associated with copulation, and seven calls associated with nest defense and/or food begging. Of these calls, all except the song are given at relatively short distances and would not likely be affected by highway noise except very close to the highway. The song is a low-frequency (0.7–1.3 kHz), narrow-band, two-note *coo cooo* call (Figure 3-26d). It is given exclusively by the male and is commonly used in maintenance of territorial boundaries. The distances between Burrowing Owl burrows in the project study area have not been determined, but Burrowing Owls are semicolonial, with distances between nest burrows ranging from less than 14 m (46 ft) to 900 m (0.56 mi) (Rose 1974; Gleason 1978). In areas where Burrowing Owl colonies are close to the highway and inter-territory distances are high, highway noise could mask song communication between neighboring males. Figure 3-27c shows the vocal signal profile for Burrowing Owl *coo cooo* call. Figure 3-28e indicates that under calm conditions the masking effect of highway noise extends out to 305 m (1,000 feet) or more from the highway and could affect the communication between two Burrowing Owls 152–305 m (500–1,000 ft) or more apart. Table 3-7 shows the amount of different habitats potentially used by Burrowing Owls within the project study area that would be affected by highway noise at 305 m (1,000 ft) for each build alternative.

Short-Eared Owl

Adult and first-year birds are generally silent, except for an intraspecific *Kee-ow* call heard during the winter (Holt and Leasure 1993). This call (Figure 3-26c) and variations of it (including a bark-like call) are also directed at territorial intruders any time of the year. It may also function as a male/female contact and/or solicitation call. Territories of Short-eared Owls are highly variable in size, varying with available local density of prey (mostly voles). Field studies indicate that territory sizes range from a mean of 20–82 ha (49–203 ac) to maximum of 137 ha (383 ac) (Holt and Leasure 1993). Assuming circular territories, the radii of these territories would vary from 244 to 488 m (800 to 1,600 ft). To be effective, the territorial exclusion vocalization should be transmissible across at least this distance. Figure 3-26c shows the sonogram for this call. The signal ranges in frequency from approximately 1.1 to 5.5 kHz. Figure 3-27c shows that this signal largely exceeds the masking threshold for highway noise at 38 m (125 ft) from the highway. However, Figure 3-28f shows that low-amplitude signals could potentially be affected by highway noise beyond 305 m (1,000 ft) from the highway if the caller and receiver were 122 m (400 ft) or more apart. Communication between Short-eared Owls with territories in this zone could thus be affected by highway noise. Table 3-7 shows the amount of different habitats potentially used by Short-eared Owls within the project study area that would be affected by highway noise at 305 m (1,000 ft) for each build alternative.

Male Short-eared Owls use a distinctive *Voo-hoo-hoo-hoo-hoo* (Figure 3-26c) mating call during courtship flights 30–150 m (98–492 ft) high over females on the ground. The frequency of this call at peak amplitude is low (approximately 315 Hz) (Figure 3-27c). Accordingly, its frequency is near that of highway noise (Figure 3-25c). Because of the extended distance between individuals using this call, highway noise could potentially interfere with communication if the birds are less than 305 m (1,000 ft) from the highway (Figure 3-28g; minimum amplitude signal).

Wilson's Phalarope

Vocal communication in Wilson's Phalarope has been little studied. Howe (1975 in Colwell and Jehl 1994) described four calls associated with courtship. The *ernt* call is a short, nasal vocalization possibly used as a contact call and during agonistic encounters between males. A low-frequency, hollow *wa* call given by females is similar to the *ernt* but may function in longer-range communication. The *purr* call is a low-frequency guttural vocalization given at close range that may function to reduce aggression between competing females and between males following pair formation (Cowell and Jehl 1994). Finally, a low-amplitude, frog-like vocalization is emitted by females in close proximity to males. Jehl (1988) described one additional call—a soft gurgling call given at migratory staging areas that are audible within 50 m (164 ft); its function is unknown.

The general low frequency (fundamental frequency = 462 Hz; dominant harmonic = 924 Hz) and low amplitude of the *wa* calls (Figures 3-26d and 3-27 d) makes them acoustically susceptible to masking by highway noise close to the highway. Figure 3-28h shows that birds using peak-amplitude signals 15 m (50 ft) from the highway would need to be closer than 3 m (10 ft) to one another to communicate to avoid masking from highway noise. At 38 m (125 ft) from the highway, they could communicate clearly over distances of approximately 8 m (25 ft) or less. For lower-amplitude signals, this minimum inter-bird communication distance would be less than 10 ft (3 m) for birds 125 ft (38 m) from the highway. Because Wilson's Phalaropes are highly gregarious and nonterritorial throughout the year, and most vocal communication occurs at short distances, it is likely these short-range communication distances can be maintained fairly close to the highway. However, during the breeding season the average distance between nests can range between 57 and 69 m (187 and 226 ft). Under calm conditions, communication across such distances would require that the nests be approximately 305 m (1,000 ft) from the highway for peak-amplitude calls to transmit, and much more than 610 m (2,000 ft) from the highway for minimum-amplitude calls to transmit. Table 3-7

shows the amount of different habitats potentially used by Wilson's Phalaropes within the project study area that would be affected by highway noise at 610 m (2,000 ft) for each build alternative.

Bobolink

Male Bobolinks sing long, complex, territorial songs (Figure 3-26e) with many notes varying in frequency from 1.2 to 7.5 kHz. Mean territory size for this species in Oregon is 0.74 ha (1.83 ac) in good habitat and 1.45 ha (3.5 8 ac) in drier habitat (Wittenberger 1978 in Martin and Gavin 1995). The approximate distance between two males at the centers of territories of this size range would be 97–136 m (318–446 ft). Figure 3-28i shows that to transmit peak-amplitude signals over 97 m (318 ft), Bobolinks would have to be 38–76 m (125–250 ft) from the highway. To transmit minimum amplitude signals, they would have to be more than 305 m (1,000 ft) from the highway. To transmit peak-amplitude signals over 136 m (446 ft), they would have to be nearly 76 m (250 ft) from the highway; to transmit minimum amplitude signals across the same distance, they would have to be more than 305 m (1,000 ft) from the highway. Table 3-7 shows the amount of different habitats potentially used by Bobolinks within the project study area that would be affected by highway noise at 915 m (3,000 ft) for each build alternative.

American Avocet

The vocal array of American Avocets includes alarm calls, flight calls, and contact calls (Robinson et al. 1997). These calls range in frequency from approximately 2 kHz to 7 kHz. American Avocets form close aggregate flocks during the non-breeding season. When flocking, the birds are generally close enough to one another that highway noise would not greatly affect communication unless the birds were very close to the highway. During the breeding season, territories of 20–39 m (66–128 ft) diameter are vigorously defended. Using peak-amplitude calls, American Avocets could communicate over these distances less than 15 m (50 ft) from the highway without masking from highway noise (Figure 2-28j). However, to transmit lower-amplitude signals across distances of 20 m (66 ft), the birds would have to be more than 15 m (50 ft) from the highway; they would have to be nearly 76 m (250 ft) from the highway for inter-territorial communication distances of 39 m (128 ft). Table 3-7 shows the amount of different habitats potentially used by American Avocets within the project study area that would be affected by highway noise at 76 m (250 ft) for each build alternative.

Summary of Potential Highway Noise Impacts on Special-Status Bird Species

In summary, highway noise could affect vocal communication in a number of special-status bird species that breed in the project study area; the magnitude of this effect varies with the proximity of the birds to the highway and the required transmission distance of the species' vocal signals. Based on the analysis of minimum-amplitude signals, the outer effects distance of highway noise masking could extend to more than 914 m (3,000 ft) for territorial Bobolinks; more than 610 m (2,000 ft) for nesting Wilson's Phalaropes; more than 305 m (1,000 ft) for territorial Short-eared Owls, Burrowing Owls, and Prairie Falcons; 76 m (250 ft) for American Avocets; and 38 m (125 ft) for Bald Eagles, Swainson's Hawks, and Peregrine Falcons. However, that these results are based on estimated source amplitudes for each species and a standard 6 dB per doubling of distance attenuation rate under quiet, stable atmospheric conditions. Wind, atmospheric turbulence, thermal layering, variation in substrate absorption, and background noise can all affect the distance that both highway noise and species vocal signals can be transmitted. Moreover, this analysis does not account for behavioral adaptations species may use to minimize the effects of highway noise masking (See Appendix E). Until these variables can be measured and tested, caution should be exercised in interpreting the biological meaning of these values.

Impact Area Determination and Comparison of Alternatives

Figures 3-24a and b show the TNM-modeled noise impact area for the No-Build Alternative and the proposed build alternatives. The distance between the build alternative rights-of-way and the 45-dB contour line (potential effects distance) varies between 5.1 km (3.2 mi) and 7.8 km (4.8 mi); the average distance is 6.3 km (3.9 mi). This distance is close to the effects distance (5 km [3 mi]) determined for American Bittern in the bioacoustics analysis (Appendix E) , but is higher than the calculated effects distances for special-status bird species known to breed in the project study area (>0.6 mi [1 km]; see above). This latter result is more consistent with documented highway noise impacts on grassland bird species in Europe (Forman et al. 2003). Reijnen et al. (1995) found that the average threshold disturbance distance for grassland birds experiencing noise from 50,000 veh/d was 930 m (3,051 ft). However, the disturbance distances ranged from 75 to 3,530 m (250 to 11,581 ft), depending on the species surveyed. Shorebirds (Oystercatcher, Black-tailed Godwit, Lapwing) had the greatest disturbance distances (560–3,530 m [1,837–11,581 ft]); waterbirds (Coot, Shoveler) and passerines (Meadow Pipit and Skylark) had lower effects distances (75–490 m [250–1,608 ft]).

The analysis presented here includes very different species that those studied by Reijnen et al. (1995): six raptors (Bald Eagle, Swainson's Hawk, Peregrine Falcon, Prairie Falcon, Burrowing Owl, and Short-eared Owl), two shorebirds (Wilson's Phalarope, American Avocet), and one passerine (Bobolink). These species, while associated to varying degrees with the open grassland/pasture habitat of the project study area, were selected on the basis of regulatory designation, not specific guild association. Accordingly, the results for the effects distance calculations reflect marked differences in bioacoustics requirements. The diurnal raptors have very large territories and use important long-range vocalizations while soaring high above the ground; Short-eared Owls also use high-elevation aerial mating calls. The calls of American Avocet, Wilson's Phalarope, and Bobolink are more similar to those of the grasslands species analyzed in the Reijnen study. However, because the projected traffic load for the Legacy Parkway project is somewhat larger (72,000 veh/d), the threshold distance for highway noise impacts would be expected to be slightly greater (i.e. > 1 km [0.6 mi]) for these species under the Proposed Action than the distances identified in the Reijnen et al. study. Other non-special-species, including many migratory species, could be affected by highway noise to the 45 dB contour line as is indicated by the impact analysis results for American Bittern (Appendix E) and the results of the Reijnen study.

Figures 3-24a and b also show the following.

- The total area potentially affected by existing noise (i.e., from I-15 and other existing noise sources to the 45-dB contour line) extends beyond the boundaries of the project study area. It includes a portion of the Farmington Bay Waterfowl Management Area (FBWMA). The figures also show that some of the FBWMA, along the eastern shore of the lake closest to the highway, is also subject to disturbances from I-15 highway noise at the 50–55 dB level.

- Implementation of the Proposed Action would extend the noise contours both eastward and westward, resulting in larger areas of the FBWMA and project study area being subjected to higher noise levels, as shown in Figures 3-24a and b.

Analysis of the total area of wildlife habitat that would be affected by highway noise in each noise contour interval showed an increase of 42–61 percent in the 60+ dB impact area, depending on alternative; an increase of 19–58 percent in the 55–60 dB area; and an increase of 27–47 percent in the 50–55 dB area (Figure 3-25). The noise level interval of 45–50 dB showed slight decreases in the area affected within the analysis area.

Potential Impacts on Wildlife

This analysis shows the potential areal extent of noise impact on birds in the project study area and surrounding habitats, including the FBWMA. The highest impacts would occur in the areas with the highest noise levels. As the distance from the highway increases, the potential for highway noise to mask communication decreases logarithmically (Figures 3-27 and 3-28). This means that birds farther from the highway could potentially experience some level of masking on calm days, but the probability of these effects having a detectable biological impacts on these birds would be low. Natural air turbulence during windy and/or warm weather would commonly degrade the highway noise, therein reducing the effects distance of the noise. Also, where masking effects are intermittent, individual birds can often adapt by communicating during quiet periods or predictable lulls in the noise.

Along the eastern shore of Great Salt Lake, the open water, emergent marsh, wet meadow, and mudflat/pickleweed habitats in the FBWMA are currently subject to noise levels of 45–55 dB from I-15 (Figure 3-24a). These areas are commonly used by numerous Wilson's Phalaropes, American Avocets, Black-necked Stilts, California Gulls, Ring-billed Gulls, Eared Grebes, Franklin's Gulls, and Northern Shovelers (Figure 2-9) (Paul and Manning 2002). The Proposed Action would potentially produce an increase in noise levels to 55–60+ dB (Figure 3-24a). Such noise levels could result in high levels of communication masking for breeding birds.

Future No-Action Build-Out Scenario

With future planned build-out of the project study area, existing noise levels will rise. Typical noise levels for progressive phases of development are summarized below (Cowan 1994).

- Rural 40–48 dB
- Small Town and Quiet Suburban 45–55 dB
- Suburban and Low-Density Urban 52–60 dB
- Urban Area 58–67 dB
- Dense Urban Area with Heavy Traffic 65–74 dB
- Downtown in Large City 72–80 dB

These noise sources would contribute to the future noise environment of the project study area in proportion to the temporal phasing and geographic extent of each type of development.

3.9 Human Disturbance

Human and domestic pet access (especially cats) to wildlife habitats adjacent to the highway could result in some level of habitat degradation and wildlife mortality. However, the existing design for the Legacy Parkway project includes three fences that would restrict access to sensitive wildlife areas and should minimize these effects. Localized disturbance from human use of the proposed trail corridor is also possible, but such adverse effects would likely be secondary to traffic noise effects. Alternative B, which crosses the largest extent of wetland habitats (Figure 3-18), would probably cause the greatest wildlife

disturbance, particularly when the lake level is high. Because Alternatives A and E are located in more upland alignments than Alternatives B and C, they would probably disturb wildlife to a lesser extent. However, many wildlife species, particularly shorebirds, use these upland areas. Fencing of the highway right-of-way and protection of the Nature Preserve would reduce human impacts under all build alternatives.

3.10 Effects on Special-Status Wildlife

Some wildlife species that occur or could potentially use habitats within the project study area are federally listed or have been identified as federal or state species of conservation concern. Table 2-1 summarizes the regulatory designation, seasonal occurrence and abundance, migratory and breeding status, and habitat use patterns of these species within the GSLE and the project study area. This information is presented in greater detail in Appendix A. Potential effects on each of these species resulting from direct habitat loss and road mortality are described below. Potential impacts resulting from other indirect effects of the Proposed Action (e.g., noise, light, pollution) on these species are described in each appropriate subsection of this chapter.

3.10.1 Agency Consultation and Coordination History

On August 10, 1998, FHWA submitted a Biological Assessment (BA) to USFWS for impacts on Bald Eagles (federally listed as threatened) and Peregrine Falcons (formerly federally listed as threatened) that could occur as a result of the Legacy Parkway project. USFWS issued a Biological Opinion (BO) for the Final EIS Preferred Alternative (D) on February 11, 1999 (U.S. Fish and Wildlife Service 1999a). The BO concluded that the Legacy Parkway "…may affect and is likely to adversely affect…" both Bald Eagles and Peregrine Falcons, but that it was not likely to jeopardize the continued existence of either species. In addition, the BO concluded that, because no critical habitat is designated for either Bald Eagles or Peregrine Falcons in Utah, none would be affected by the Proposed Action.

On September 17, 1999, FHWA received a letter from USFWS stating that Peregrine Falcons had been removed from the federal list of endangered and threatened wildlife, pursuant to the ESA (U.S. Fish and Wildlife Service 1999b) (Appendix F). As a result, the terms and conditions in the BO are no longer considered nondiscretionary with respect to Peregrine Falcons. USFWS did recommend, however, that all strategies outlined in the BO to minimize impacts on Peregrine Falcons be implemented to ensure compliance with the MBTA.

3.10.2 Agency Coordination since Publication of the Final EIS

Subsequent to the remand of the Legacy Parkway Final EIS by the court, FHWA published a Notice of Intent (NOI) to prepare a Supplemental EIS for the Legacy Parkway project in the April 1, 2003, Federal Register. In response to an invitation from FHWA and the Corps to be a cooperating agency for the Proposed Action, USFWS sent a letter to FHWA on May 2, 2003, agreeing to act as a cooperating agency under NEPA, and providing suggestions on direct, indirect, and cumulative effects on wildlife that should be addressed in the Supplemental EIS (U.S. Fish and Wildlife Service 2003a) (Appendix F).

To ensure that the effects identified by USFWS were adequately addressed, a wildlife technical team (WTT) was assembled consisting of ecologists and biologists from UDOT, FHWA, the Corps, and their representative technical consultants. Recommendations on the technical analysis approach developed by

this team were provided to a science technical team (STT) for focused review and recommendations on data sources, methodology, and results. The STT team consisted of the WTT members and wildlife biologists and technical experts from USFWS, EPA, and UDWR.

3.10.3 Special-Status Species

The following impact discussion provides information on how the Proposed Action could affect special-status species, based on the approach described above and input received from USFWS, EPA, and UDWR. The information presented below and correspondence from USFWS on December 3, 2003 (Appendix F), reaffirms the terms and conditions in the original BO. Table 3-8 provides a comparison of impacts on habitat types in the context of both regional and project study areas. It should be noted that the calculations represented in this table were derived from a regional dataset; consequently, they are of limited utility for analyzing impacts on a quantitative basis, but provide adequate basis for comparison of trends.

Federally Listed Species

Bald Eagle (Status: Threatened)

Potential impacts of the Legacy Parkway Project on breeding and wintering Bald Eagles are discussed separately.

Breeding. One active nest exists in an artificial nesting structure on state-owned land within about 1.6 km (1 mi) of the project study area. This is the only known nesting location in northern Utah, and one of only four known in the state (Utah Division of Wildlife Resources 2002). This nest is within about 1 km (0.6 mi) of a regularly traveled country road, and the nesting pair is accustomed to some degree of human noise and disturbance (U.S. Fish and Wildlife Service 1999a). If this nest is active in the future, the pair could experience some noise disturbance from construction and operation of the Legacy Parkway project. Such disturbance could result in temporary or permanent abandonment of the site by the nesting eagles, resulting in a loss of productivity of up to two eggs or young per year during the construction period, and possibly during operation (if the nest site is abandoned permanently) (U.S. Fish and Wildlife Service 1999a). However, many raptor species nest in close proximity to highways, and they appear to habituate to highway noise. The actual effects of highway noise on this nesting pair cannot be determined without onsite analysis, but the effects are expected to be similar for all build alternatives.

Raptors are often killed as a result of collisions with moving vehicles. Bald Eagles often forage on carrion, and they may be attracted to highway corridors to forage on carcasses of mule deer and other large mammals and birds. The Legacy Parkway project could provide an additional source of carrion and could increase the potential for Bald Eagle collisions with vehicles, especially for inexperienced juvenile birds. Raptor mortality along roadways in Utah is not well documented, but 15 eagles were reported killed in Carbon and Emery Counties in 1996 and 1997, probably due to collisions with coal trucks (U.S. Fish and Wildlife Service 1999a). Direct mortality effects on Bald Eagles would likely be the same for all build alternatives.

Wintering. Bald Eagles are common winter visitors to the project study area. Four active roost sites exist near the project study area at distances of 2.3 km (1.4 mi), 2.1 km (1.3 mi), 1.6 km (1.0 mi), and 0.2 km (0.1 mi). Some of these roost sites could be disturbed or abandoned during construction of any of the build alternatives. The roost site nearest the project study area would be the most likely to be adversely affected (U.S. Fish and Wildlife Service 1999a).

In the project study area, Bald Eagles primarily forage in the following habitats: emergent marsh, wet meadow, mudflat/pickleweed, pasture, and salt desert scrub. All the build alternatives would result in direct loss and fragmentation of suitable Bald Eagle foraging habitat. Alternative A would result in 184.6 ha (456.2 ac) of habitat loss; Alternative B in 235.7 ha (582.4 ac); Alternative C in 207.1 ha (512.2 ac); and Alternative E in 190.8 ha (471.7 ac). These direct habitat losses would contribute to the marked cumulative reduction of foraging habitat for this species in the project study area; however, according to the regional land use dataset analysis (Table 3-8), these losses would affect less than 0.11 percent of the overall extent of these habitats in the regional study area. As described above, wintering Bald Eagles scavenging road-killed wildlife along the highway would also be subject to increased road mortality from collisions with vehicles.

Federally Delisted Species

Peregrine Falcon

Potential impacts of the Legacy Parkway Project on breeding and wintering Peregrine Falcons are discussed separately.

Breeding. Two nesting eyries exist in the project study area in abandoned Common Raven nests on 340 kV electric power transmission support towers; the same nesting pair uses both nests (U.S. Fish and Wildlife Service 1999a). This nesting pair is accustomed to some disturbance because their eyries are within 1.6 km (1 mi) of I-15 and within 0.2 km (0.1 mi) of a dike that supports a well-traveled, unsurfaced road in the FBWMA (U.S. Fish and Wildlife Service 1999).

Raptors may be killed by collisions with moving vehicles. Peregrine Falcons may forage for bird prey along highway corridors. The overall proximity of the Legacy Parkway project to the existing eyries increases the potential for Peregrine Falcon collisions with vehicles, especially for inexperienced juvenile birds (U.S. Fish and Wildlife Service 1999a). Direct mortality effects on Peregrine Falcons would probably be the same for all build alternatives.

Wintering. In winter, Peregrine Falcons from northern breeding populations are rare transients in the GSLE (U.S. Fish and Wildlife Service 1999a). They primarily forage in the following habitats in the project study area: emergent marsh, wet meadow, mudflat/pickleweed, pasture, salt desert scrub, and developed areas. All build alternatives would result in direct loss and fragmentation of suitable wetland and upland Peregrine Falcon foraging habitat at the same levels as those described above for Bald Eagle.

Wintering Peregrine Falcons forage over large areas and are not dependent on individual habitat patches that may be lost during highway construction. Other cumulative impacts associated with the Legacy Parkway project are primarily related to induced growth that could follow highway construction. Such growth could lead to further loss and fragmentation of existing Peregrine Falcon foraging areas. Direct impacts of the Legacy Parkway project would affect less than 0.11 percent of the overall extent of these habitats in the regional study area (Table 3-8). These losses would contribute to the overall cumulative reduction of suitable foraging habitat for this species in this area.

Federal Candidate Species

Yellow-Billed Cuckoo

Yellow-billed Cuckoos are rare migrants in the GSLE; they have low potential to occur in the project study area because of limited suitable riparian breeding habitat (Table 2-1). Recent surveys of riparian habitats in the project region recorded only three Yellow-billed Cuckoos during 7,000 survey hours (E. Owens, cited in U.S. Fish and Wildlife Service 2002). Recent documentation of a Yellow-billed Cuckoo in a Peregrine Falcon nest in Salt Lake City, however, suggests that this species still migrates through the GSLE and all remnant riparian habitats, including those available in the project study area, could provide suitable roosting and foraging habitat for Yellow-billed Cuckoos. All build alternatives would result in direct loss of less than 2.3 ha (5.7 ac) of riparian habitat (Figure 3-3). Howe (1986 in Hughes 1999) reported densities of Yellow-billed Cuckoo in appropriate habitat in New Mexico ranging from 1 to 15 pairs per ha (0.4–6.1 pairs per acre). In suitable habitat, the area lost to construction of the Proposed Action could potentially support one to several pairs of Yellow-billed Cuckoos. However, the riparian habitats in the project study area, which include areas of sparsely distributed Russian olive trees, are generally degraded and of low suitability for this species. As indicated by the low numbers of birds detected in regional surveys mentioned above, the affected area is not likely to provide good habitat for this species. The habitat losses caused by the Proposed Action are unlikely to have any adverse effects on this rare transient species.

Conservation Agreement Species

Northern Goshawk

Northern Goshawks have not been observed in the project study area. However, some studies on seasonal movement and habitat use patterns suggest that goshawks could use this area during the winter. Moreover, the project study area supports prey species that could sustain wintering individuals that move through the GSLE. The few wintering individuals that may occur in this region probably range over a large area with a variety of grassland and shrubland habitats. Direct habitat loss under any of the build alternatives would not likely affect this species.

U.S. Fish and Wildlife Service Birds of Conservation Concern

Swainson's Hawk

Swainson's Hawks are considered rare summer breeders in the project study area, where they have been known to nest in riparian habitat. They have been observed in the proposed build alternative rights-of-way. Favorable foraging conditions are common in the agricultural areas (primarily alfalfa) in and adjacent to the project study area; other crops, such as sod, corn, and wheat, also provide foraging habitat. Alternatives A and E would result in direct loss of 1.6 ha (3.9 ac) of riparian habitat, Alternative B in the loss of 2.3 ha (5.6 ac), and Alternative C in the loss of 2.0 ha (4.9 ac) (Figure 3-3).

Reported nesting densities for Swainson's Hawks in areas with either a mixture of native habitat and agriculture or a high diversity of irrigated crops include 30.23 pairs/100 km^2 (0.001 pair/ac) in central California (England et al. 1995 in England et al. 1997); 23.1 pairs/100 km^2 (0.0009 pairs/ac) in Hanna, Alberta (Schmutz 1987); 18.0 pairs/100 km^2 (0.0007 pairs/ac) in Kindersley, Saskatchewan (Houston in England et al. 1997); and 9.5 pairs/100 km^2 (0.0003 pairs/ac) in Los Medanos, New Mexico (Bednarz et al 1990). In northeastern California, the overall density of Swainson's Hawk territories was 20 pairs/100

km^2 (0.0008 pairs/acre), but varied from 5.7 pairs/100 km^2 (0.0002 pairs/ac) in irrigated pasture to 36.8 pairs/100 km^2 (0.0014 pairs/ac) in areas dominated by alfalfa (Woodbridge et al 1995a in England et al. 1997). These data indicate that the riparian area that would be lost under any of the build alternatives would support at most a single pair of Swainson's Hawks. Site-specific surveys would be necessary prior to construction to determine if any active Swainson's Hawk nest is present within the project study area and whether any of the build alternatives would disturb that nest.

All the build alternatives would also result in a direct loss of foraging habitat for this species. Alternative A would result in 55.6 ha (137.4 ac) of cropland habitat loss; Alternative B in 101.1 ha (249.7 ac]); Alternative C in 48.4 ha (119.5 ac); and Alternative E in 52.9 ha (130.7 ac). Based on radiotelemetry survey data in central California, Swainson's Hawks forage over areas ranging between 325 ha (800 ac) and 8,500 ha (21,000 ac) (approx. average = 2,750 ha (6,800 ac) (Estep pers. comm. 2004). The foraging area that would be lost under each build alternative would comprise approximately 0.6–31 percent of the foraging range of a single pair, depending on the available habitat in the project study area. Loss of this habitat could result in that pair shifting to new foraging areas in the GSLE. The Legacy Parkway project would affect less than 0.1 percent of the overall extent of cropland habitat in the regional study area (Table 3-8).

Ferruginous Hawk

Ferruginous Hawks have not been observed within the project study area (Appendix A), but could potentially occur there while moving within or through the GSLE. Suitable habitats within the project study area include wet meadow, mudflat/pickleweed, pasture cropland, and salt desert scrub. Ferruginous Hawks could possibly occur in the same habitats as Swainson's Hawks, and would experience similar loss of foraging habitat under all the build alternatives. Although the direct impacts of the Legacy Parkway project would affect less than 0.1 percent of the overall extent of these habitats in the regional study area (Table 3-8), they would contribute to the local and regional cumulative reduction of suitable foraging habitat for this species.

Golden Eagle

Golden Eagles are rare permanent residents of the GSLE and rare transients in the project study area. Their preferred foraging habitats in the GSLE could include wet meadow, pasture, cropland, and salt desert scrub habitats. All the build alternatives would result in the direct loss of foraging habitat. Alternative A would result in 228.8 ha (565.4 ac) of habitat loss; Alternative B in 309.4 ha (764.6 ac); Alternative C in 234.7 ha (580.0 ac); and Alternative (E) in 227.0 ha (560.9 ac). In the western United States, Golden Eagles forage over home ranges that average 20–33 km^2 (2,000–3,300 ha [4,942–8,154 ac]) (Kochert et al. 2002). Resident pairs tend to maintain home ranges year-round, with shifts in intensity of use from breeding season to winter (Dunstan et al. 1978 in Kochert et al. 2002; Marzluff et al. 1997 in Kochert et al. 2002). Individuals do not use all areas within their home range equally, but concentrate activity within core areas (Platt 1984 in Kochert et al. 2002; Marzluff et al. 1997 in Kochert et al. 2002). In southwest Idaho, core areas contained 95 percent of locations of radio-tagged eagles, but only 14.4 percent of the breeding-season range and 25.3 percent of the non-breeding range (Marzluff et al. 1997 in Kochert et al. 2002). The low frequency of Golden Eagle occurrences in the project study area suggests that the birds that use this area are either residents with core territory areas elsewhere in the GSLE or are migrants moving through the area. The direct impacts of the Legacy Parkway project would affect 6.8–15.4 percent of one Golden Eagle home range, depending on its actual size, or small portions of several territories if they overlap. These impacts would affect less than 0.1 percent of the overall extent of these

habitats in the regional study area (Table 3-8). The Proposed Action would not affect the long-term viability of this species within the GSLE but would contribute to the ongoing local and regional cumulative reduction of suitable foraging habitat for this species.

Prairie Falcon

Prairie Falcons are rare permanent residents and breeders in the GSLE. They are occasionally seen foraging in the project study area, but they do not breed there (Table 2-1). Habitats most likely to be used by this species in the project study area are emergent marsh, wet meadow, mudflat/pickleweed, pasture, cropland, and salt desert scrub. All the build alternatives would result in the direct loss of foraging habitat for this species. Alternative A would result in 240.2 ha (593.6 ac) of habitat loss; Alternative B in 336.7 ha (832.1 ac) Alternative C in 255.6 ha (631.7 ac); and Alternative E in 243.7 ha (602.4 ac). The estimated home range of this species in southwestern Idaho is 108–315 km^2 (10,800– 31,500 ha [26,690–77,840 ac]) (Dunstan et al. 1978 in Kochert et al. 2002; Marzluff et al. 1997 in Kochert et al. 2002). The direct impacts of the Legacy Parkway project would affect 0.7–3.1 percent of one Prairie Falcon home range, depending on its actual size and overlap with the project study area. The build alternatives would affect less than 0.1 percent of the overall extent of these habitats in the regional study area (Table 3-8). The Proposed Action would not affect the long-term viability of this species within the GSLE, but would contribute to the ongoing local and regional cumulative reduction of suitable foraging habitat for this species.

American Golden-Plover

American Golden-Plovers are rare migrants through the GSLE and have not been observed in the project study area (Table 2-1); however, they could potentially occur within the project study area during migration, where they may occasionally forage in pasture, cropland, mudflat/pickleweed, and wet meadow habitats. All the build alternatives would result in direct loss of foraging habitats for this species. Alternative A would result in 170.9 ha (422.3 ac) of habitat loss; Alternative B in 277.7 ha (686.2 ac); Alternative C in 178.3 ha (440.7 ac); and Alternative E in 174.5 ha (431.3 ac). The direct impacts of the Legacy Parkway project would affect less than 0.1 percent of the overall extent of these habitats in the regional study area (Table 3-8), but they would contribute to the local and regional cumulative reduction of suitable foraging habitat for this species.

Snowy Plover

Snowy Plovers are common breeders in the GSLE, but they have not been observed in the project study area (Table 2-1). Their preferred breeding and foraging habitats (salt flats and mudflat/pickleweed habitats) are minor components of the project study area. Because salt flats are relatively abundant in the GSLE, the local Snowy Plover population is unlikely to be adversely affected by the loss of 2.5–12.9 ha (6.2–32.0 ac) of mudflat/pickleweed habitat. The direct impacts of the Legacy Parkway project would affect less than 0.1 percent of the overall extent of these habitats in the regional study area (Table 3-8), but they would contribute to the local and regional cumulative reduction of suitable foraging habitat for this species.

American Avocet

American Avocets occur regularly in the project study area (Table 2-1), where they nest in emergent marsh, wet meadow, mudflat/pickleweed, and pasture habitats. Avocets forage in these habitats as well as

in open water. All the build alternatives would result in the direct loss of suitable habitats for this species. Alternative A would result in 128.1 ha (316.6 ac) of habitat loss; Alternative B in 207.1 ha (511.8 ac); Alternative C in 141.9 ha (350.7 ac); and Alternative E in 139.1 ha (343.6 ac). The breeding density of American Avocets in northern Utah has been estimated to be 16–28 pairs/ha (6–11 pairs/ac). If all the habitat area (excluding open water) lost from construction of the Proposed Action were suitable for nesting, Alternative A would result in the direct loss of nesting habitat for 1,841–3,376 pairs; Alternative B in the loss of habitat for 2,912–5,339 pairs, Alternative C in the loss of habitat for 2,046–3,751 pairs, and Alternative E in the loss of habitat for 1,955–3,584 pairs. However, because of the extensive distribution of suitable breeding habitat throughout the GSLE, the direct impacts of the Legacy Parkway project would affect less than 0.1 percent of the overall extent of these habitats (Table 3-8). Accordingly, the loss of potential breeding habitat across all project alternatives (i.e., habitat for 1,841–5,339 pairs Alternatives A and B, respectively) would affect from approximately 3.5 to 10 percent of the estimated 53,000 breeding American Avocets in the regional study area (Paul et al. 1998b in Robinson et al. 1997). The loss of habitat resulting from any of the build alternatives would reduce the local density of breeding birds within the project study area but would not be likely to significantly affect the long-term viability of American Avocets in the GSLE. The project would, however, contribute to the ongoing marked cumulative loss of breeding habitat for this species throughout the region.

Solitary Sandpiper

Solitary Sandpipers have not been observed in the project study area (Table 2-1). Patton et al. (1992 in Moskoff 1995) reported only 19 records of this species visiting the GSL; Point Reyes Bird Observatory (1995 in Moskoff 1995) recorded only three occurrences during fall migration in 1994 and 1995. Although they are unlikely to occur in the project study area in any given year, individuals may occasionally forage in emergent wetlands, shallow streams, and pools within riparian corridors, mudflat/pickleweed, and wet meadow habitats. All the build alternatives would result in the direct loss of foraging habitat for this species. Alternative A would result in 40.5 ha (100.1 ac) of habitat loss; Alternative B in 68.8 ha (169.9 ac); Alternative C in 59.4 ha (147.0 ac); and Alternative (E) in 45.1 ha (111.5 ac). The direct impacts of the Legacy Parkway project would affect less than 0.1 percent of the overall extent of these habitats in the regional study area (Table 3-8). Because of the low frequency of use of the project study area by Solitary Sandpipers, it is unlikely that loss of foraging habitat resulting from any build alternative would affect the long-term viability of this species in the GSLE, but such loss would contribute to the ongoing local and regional cumulative reduction of suitable foraging habitat for this species.

Whimbrel

Whimbrels are rare transients in the GSLE and have not been observed in the project study area (Table 2-1). Although they are unlikely to occur in the project area in any given year, individuals may occasionally forage in pasture, cropland, mudflat/pickleweed, and wet meadow habitats. All the build alternatives would result in the direct loss of foraging habitats for this species. Alternative A would result in 170.9 ha (422.3 ac) of habitat loss; Alternative B in 277.7 ha (686.2 ac); Alternative C in 178.4 ha (440.8 ac); and Alternative E in 174.5 ha (431.3 ac). The direct impacts of the Legacy Parkway project would affect less than 0.1 percent of the overall extent of these habitats in the regional study area (Table 3-8). Because of the low frequency of use of the project study area by Whimbrels, it is unlikely that loss of foraging habitat resulting from any build alternative would affect the long-term viability of this species in the GSLE, but such loss would contribute to the ongoing local and regional cumulative reduction of foraging habitat for this species.

Long-Billed Curlew

Although breeding Long-billed Curlews have not been observed in the project study area, occurrences of migrants have documented (Table 2-1). They may forage in wet meadows, mudflat/pickleweed, and areas within salt desert scrub habitat. All the build alternatives would result in the direct loss of breeding and foraging habitats for this species. Alternative A would result in 90.4 ha (223.5 ac) of habitat loss; Alternative B in 86.0 ha (212.4 ac); and Alternative C in 118.8 ha (293.6 ac); and Alternative E in 92.4 ha (228.3 ac). The direct impacts of the Legacy Parkway project would affect less than 0.1 percent of the overall extent of these habitats in the regional study area (Table 3-8). As with other transient shorebirds that use the project study area, it is unlikely that loss of foraging habitat resulting from any build alternative would affect the long-term viability of Long-billed Curlews in the GSLE, but such loss would contribute to the ongoing local and regional cumulative reduction of foraging habitat for this species.

Marbled Godwit

Marbled Godwits are rare migrants in the project study area (Table 2-1). They forage in mudflat/pickleweed, shallow open water, cropland, pasture, and wet meadow habitats. All the build alternatives would result in the direct loss of foraging habitats for this species. Alternative A would result in 174.8 ha (432.0 ac) of habitat loss; Alternative B in 288.4 ha (712.6 ac); Alternative C in 182.3 ha (450.5 ac); and Alternative E in 181.7 ha (449.1 ac). The habitat losses associated with all alternatives, however, would affect less than 0.1 percent of the overall extent of these habitats in the regional study area (Table 3-8). While this change would result in local loss of foraging habitat for this species in the project study area, it would not affect the long-term viability of this species in the GSLE, but it would contribute to the ongoing regional cumulative reduction of suitable foraging habitat for this species.

Sanderling

Sanderlings have not been observed in the project study area (Table 2-1), but could occasionally use the area. Because their foraging habitat (mudflat/pickleweed) is a minor component of the project study area and this habitat is relatively abundant in the regional study area, Sanderlings are unlikely to be adversely affected by the loss of 2.5–12.9 ha (6.2–32.0 ac) of habitat. The direct impacts of the Legacy Parkway project would affect less than 0.1 percent of the overall extent of these habitats in the regional study area (Table 3-8), but they would contribute to the local and regional cumulative reduction of suitable foraging habitat for this species.

Wilson's Phalarope

Wilson's Phalaropes are rare breeders and uncommon migrants in the project study area (Table 2-1). They nest in wet meadow habitat and forage there and in open water, emergent marsh, and mudflat/pickleweed habitats. All the build alternatives would result in the direct loss of breeding and foraging habitats for this species. Alternative A would result in loss of 27.5 ha (68 ac) of breeding habitat loss; Alternative B in 39.1 ha (96.8 ac); Alternative C in 35.6 ha (90.4 ac); and Alternative E in 26.7 ha (66.1 ac). Very little information is available on nesting densities of this species. Estimated nest densities in an ephemeral wetland in Saskatchewan varied between 0 and 1.1 breeding pairs/ha (0.445 pairs/ac), and between 0.55 and 1.1 pairs/ha (0.22 and 0.44 pairs/ac) in a permanent wetland (Colwell and Jehl 1994). Assuming that wet meadow habitat in the project study area is wet during the breeding season, Alternative A would result in a potential loss of habitat for 15.1–30.2 pairs, Alternative B in the loss of habitat for 53.2–106.5 pairs, Alternative C in the loss of habitat for 49.7–99.4 pairs, and Alternative E in the loss of habitat for

14.6–29.4 pairs. The impact of the Proposed Action on the regional population of Wilson's Phalaropes within the GSLE, however, would be very small. In July, the Wilson's Phalarope staging population at Great Salt Lake frequently represents more than a third of the world's population, varying between 54,000 (1984) and 603, 333 (1991) (Aldrich and Paul 2002). A large portion of these birds breed in the regional study area. The wet meadow habitat in the project study area comprises only 0.052–0.88 percent of the potential breeding habitat available to Wilson's Phalaropes within the regional study area (Table 3-8).

Alternative A would result in 42.8 ha (105.9 ac) of foraging habitat loss; Alternative B in 77.2 ha (190.7 ac); Alternative C in 61.4 ha (151.8 ac); and Alternative E in 50.7 ha (125.4 ac). Because Wilson's Phalaropes are highly gregarious and social throughout the year, they often concentrate in large numbers while foraging. Although, these foraging habitat losses would likely result in notable shifts of foraging areas for local populations of birds using the project study area, the direct impacts of the Legacy Parkway project would affect less than 0.1 percent of the overall extent of Wilson Phalarope foraging habitats in the regional study area (Table 3-8). However, these losses would contribute to the marked cumulative reduction of suitable foraging habitat.

Burrowing Owl

Burrowing Owls have been observed in the project study area (Table 2-1), where suitable habitats include dry mudflat/pickleweed, pasture, cropland, salt desert scrub, urban fields, and freeway right-of-way. They nest in crevices and burrows, especially those excavated by red fox and badgers. They breed and forage primarily in pasture, salt desert scrub, and cropland (along edges) habitats as well as on dikes and islands in water impoundments. All the build alternatives would result in the direct loss of breeding and foraging habitats for this species. Alternative A would result in 203.8 ha (503.6 ac) of habitat loss; Alternative B in 277.8 ha (686.4 ac); Alternative C in 211.1 ha (521.6 ac); and Alternative E in 206.8 ha (511.1 ac). Radiotelemetry studies of Burrowing Owl movement patterns in central Saskatchewan showed that home range size varied from 0.14 to 4.81 km^2 (14.0 to 48.1 ha [34.6 to 118.9 ac]). Assuming similar spatial requirements for Burrowing Owls in the regional study area, Alternative A would remove habitat sufficient to support 10.5–36 pairs, Alternative B would remove habitat for 14.3–49 pairs, Alternative C would remove habitat for 4.4–15 pairs, and Alternative E would remove habitat 4.3–14 pairs. The population size of Burrowing Owls in the regional study area is unknown, but the direct impacts of the Legacy Parkway project would affect less than 0.1 percent of the overall extent of suitable habitats in the regional study area (Table 3-8). Such losses would contribute to a marked cumulative reduction of suitable foraging habitat for this species in the region.

This species is generally declining in many areas throughout the western United States (Haug et al. 1993). Vehicle collision is a major source of mortality. If the Proposed Action were to traverse existing Burrowing Owl habitat, road mortality would likely increase. Moreover, highway alignments can provide travel corridors for a variety of native and nonnative predators, including introduced foxes, which can have severe local effects on Burrowing Owl populations.

Loggerhead Shrike

Loggerhead Shrikes are uncommon year-round residents in the GSLE and have not been observed in the project study area (Table 2-1). Suitable habitats in the project study area include riparian corridors, pasture, salt desert scrub, and developed areas (urban landscaping). All the build alternatives would result in the direct loss of breeding and foraging habitats for this species. Alternative A would result in 147.3 ha (363.9 ac) of habitat loss; Alternative B in 171.5 ha (423.7 ac); Alternative C in 151.8 ha (375.0 ac); and

Alternative E in 148.9 ha (368.0 ac). Reported territory sizes of Loggerhead Shrikes vary from 4.6 to 25 ha (10.4 to 62 ac) (Yosef 1996). Assuming comparable territory sizes in the regional study area, Alternative A would remove habitat sufficient to support 6–32 territories; Alternative B would remove habitat for 6.9–37.3 territories, Alternative C would remove habitat for 6–33 territories, and Alternative E would remove habitat for 6–32 territories. The direct impacts of the Legacy Parkway project would affect less than 0.1 percent of the overall extent of these habitats in the regional study area (Table 3-8) and would not affect the long-term viability of this species in the GSLE. However, such impacts would contribute to the marked ongoing cumulative reduction of suitable foraging habitat for this species in the region.

Virginia's Warbler

Virginia's Warblers have not been observed in the project study area (Table 2-1). They are found during migration in riparian and some scrub (with large, tall shrubs) habitats that have high densities of insects. Potential habitat in the project study area includes riparian corridors, salt desert scrub, and urban shrub (developed). Virginia's Warblers have low potential to occur in the project study area because of the limited extent of riparian habitat and the low stature of the shrubs in the salt desert scrub habitat (Table 2-1). All the build alternatives would result in direct losses of less than 2.3 ha (5.6 ac) of suitable habitat; these losses are unlikely to have any adverse effects on this species.

Brewer's Sparrow

Brewer's Sparrows are rare summer visitants in the project study area (Table 2-1). They breed in shrub steppe habitats and are found during migration in riparian and scrub habitats. Suitable habitats within the project study area include riparian, wet meadow, mudflat/pickleweed, pasture, cropland, salt desert scrub, and urban shrub (developed). All the build alternatives would result in the direct loss of breeding and foraging habitats for this species. Alternative A would result in 232.9 ha (575.5 ac) of habitat loss; Alternative B in 319.2 ha (788.8 ac); Alternative C in 249.7 ha (616.9 ac); and Alternative E in 235.2 ha (581.1 ac). Breeding season densities of Brewer's Sparrows can be highly variable between years, ranging from 50 to 350 individuals/km^2 (0.5 to 3.5 individuals/ha [0.2 to 1.4 individuals/ac]) (Weins and Rottenberry 1985 in Rottenberry et al. 1999) in southeast Oregon. In southeast Idaho, densities ranged from 116 to 192 individuals/ km^2 (1.16 to 1.92/ha [0.47 to 0.78/ac]) (Oetersin and Best 1897 in Rottenberry et al. 1999); and in central Oregon, densities ranged from 111 to 277 individuals/km^2 (1.11 to 2.77/ha [0.45 to 1.12/ac]) (Rottenberry et al. 1999). Assuming an approximate density of 2.47 individuals/ha [1 individual/ac] for populations in the project study area, the habitat losses listed above could theoretically result in loss of habitat sufficient to support 580–789 Brewer's Sparrows. However, the existing habitat in the project study area is not sufficient to support such a density of birds. Moreover, because this species has been documented only as a rare summer visitant, these estimates are clearly extreme. Accordingly, the Proposed Action would likely have only a small effect on this species.

The direct impacts of the Legacy Parkway project would affect less than 0.1 percent of the overall extent of these habitats in the regional study area (Table 3-8). The Proposed Action would therefore not affect the long-term viability of this species in the GSLE. It would, however, contribute to the local and regional cumulative reduction of suitable foraging habitat for this species.

Utah Division of Wildlife Resources Wildlife Species of Concern

American White Pelican

American White Pelicans are rare summer visitants to the project study area (Table 2-1). All the build alternatives would result in the direct loss of small areas of potential foraging habitat (i.e., open water) for this species. Alternative A would result in 3.9 ha (9.7 ac) of habitat loss; Alternative B in 10.7 ha (26.4 ac); Alternative C in 3.9 ha (9.7 ac); and Alternative E in 7.2 ha (17.8 ac). The direct impacts of the Legacy Parkway project would be minimal on this species, affecting less than 0.1 percent of the overall extent of these habitats in the regional study area (Table 3-8). However, these changes would contribute to the local and regional cumulative reduction of suitable foraging habitat for this species.

Short-Eared Owl

Short-eared Owls are uncommon breeders in the project study area (Table 2-1). In the project study area, they are likely to be found in emergent marsh, wet meadow, mudflat/pickleweed, pasture, cropland, and salt desert scrub habitats. All the build alternatives would result in the direct loss of breeding and foraging habitats for this species. Alternative A would result in 240.2 ha (593.6 ac) of habitat loss; Alternative B in 336.7 ha (832.1 ac); Alternative C in 255.6 ha (631.7 ac), and Alternative E in 243.8 ha (602.4 ac). This species exhibits considerable variation in the size of breeding territories (Holt and Leasure 1993); territories range from 20 to 121 ha/pair (49 to 299 ac/pair) in North American populations (Holt and Leasure 1993). If Short-eared Owls in the GSLE exhibit the same range, the Proposed Action would potentially result in loss of habitat sufficient to support 2–16 breeding pairs. Sighting records in the project area suggest that the number of owls that would be affected by the Proposed Action would fall near the lower end of this range. The direct impacts of the Legacy Parkway project would affect less than 0.1 percent of the overall extent of these habitats in the regional study area (Table 3-8). The Proposed Action is not likely to affect the long-term viability of this species within the GSLE, but it would contribute to the local and regional cumulative reduction of suitable foraging habitat for this species.

Bobolink

Bobolinks have occasionally been observed in agricultural fields at the northern end of the project study area near the FBWMA (Table 2-1). All the build alternatives could result in the direct loss of some breeding and foraging habitats for this species, but the amount of habitat is unknown. Site-specific preconstruction surveys would be necessary to determine whether any of the build alternatives could disturb active Bobolink nests (Federal Highway Administration et al. 2000).

Grasshopper Sparrow

Grasshopper Sparrows have not been documented in the project study area, but could potentially occur there. Consequently, the impact of the Proposed Action on this species would be small or nonexistent. Site-specific preconstruction surveys would be necessary to determine whether any of the build alternatives could disturb active Grasshopper Sparrow nests (Federal Highway Administration et al. 2000).

Preble's Shrew

Because habitats similar to those supporting Preble's shrews are present, the species may occur in wet meadow habitat in the project study area. All the build alternatives would affect such habitat. Alternative A would result in 27.5 ha (68.0 ac) of habitat loss; Alternative B in 39.2 ha (96.8 ac); Alternative C in 36.6 ha (90.4 ac); and Alternative (E) in 26.7 ha (66.1 ac). Because no information is currently available on the density of this species in different habitats, it was impossible to estimate the number of shrews that could be affected by the Proposed Action. However, the direct impacts of the Legacy Parkway project would affect less than 0.1 percent of the overall extent of habitats suitable for Preble's shrew in the regional study area (Table 3-8). Consequently, the regional impact of the Proposed Action would be very small, unless surveys indicated that the remaining populations in the regional study area were restricted to the project study area. Site-specific preconstruction surveys would be necessary to determine whether any of the build alternatives could disturb local populations of this species (Federal Highway Administration et al. 2000).

Spotted Bat

Like many species of arid-land bats, spotted bats take their insect prey on the wing. For this reason, these aerial foragers are not tied to any specific habitats in the project study area, and direct habitat losses would probably not have any adverse effects on this species. Spotted bats could benefit from the artificial lighting that is proposed under all the build alternatives, because the lighting would attract and concentrate aerial insects, potentially reducing the energetic costs of foraging for some individuals.

Townsend's Big-Eared Bat

While no studies have been conducted, it is likely that this species frequents suitable foraging habitat around the lake, including the project study area. Like many species of arid-land bats, Townsend's big-eared bats take their insect prey on the wing. For this reason, these aerial foragers are not tied to any specific habitats in the project study area, and direct habitat losses would probably not have any adverse effects on this species. Townsend's big-eared bats could benefit from the artificial lighting that is proposed under all the build alternatives, because the lighting would attract and concentrate aerial insects, potentially reducing the energetic costs of foraging for some individuals.

Kit Fox

Great Salt Lake is located on the northeastern edge of the known distribution of kit fox (Zevellof and Collett 1988). Kit foxes are found throughout Utah in desert and semiarid regions with flat shrub or shrub-grass communities with little ground cover. Where these foxes occur in the Great Basin, shadscale, greasewood, and sagebrush communities are common. Major prey items include desert rodents, jackrabbits, cottontail rabbits, groundnesting birds, reptiles, and insects.

Due to limited suitable habitat along the Wasatch Mountains in the vicinity of the project study area, kit foxes are considered extremely rare and have a low probability of occurring there. If they do occur in the project study area, they are most likely to frequent salt desert scrub habitats. All the build alternatives could result in the direct loss of suitable habitat for this species. Alternative A would result in 60.4 ha (149.3 ac) of habitat loss; Alternative B in 39.3 ha (97.0 ac); Alternative C in 69.3 ha (171.2 ac); and Alternative E in 59.0 ha (145.9 ac). The direct impacts of the Legacy Parkway project would affect less than 0.1 percent of the overall extent of these habitats in the regional study area (Table 3-8), but the

Proposed Action would contribute to the local and regional cumulative reduction of suitable foraging habitat for this species.

3.11 Cumulative Effects

Multiple analyses were conducted to evaluate the cumulative effects on wildlife habitats in the project and regional study areas. The analyses illustrate a regional trend in wildlife habitat availability under historic, current, and estimated future conditions, and estimate the proportion of the cumulative effects that the Proposed Action would contribute. The detailed descriptions of the datasets used in these analyses are in Appendix B. A brief summary of the analyses appears below, followed by more detailed discussions.

- **Historic Conditions: Cumulative Habitat Loss/Degradation in the GLSE from Past Activities.** The change from historic (pre-settlement; before 1847) to current habitat availability was calculated using estimated historic wetlands and current regional-scale land-cover data.

- **Recent Trends in Permitted Losses of Wetland Habitat.** Using Corps records of wetland removal, the relative effects of the Proposed Action were compared to recent cumulative historic losses in wetland habitat availability in Salt Lake and Davis Counties.

- **Foreseeable Future Conditions.** Four categories of analysis were performed.

  - **Current Ownership Status as an Indicator of Future Potential Cumulative Habitat Loss.** The ownership status of habitat was determined to evaluate the level of protection of existing wildlife habitat and the future potential for habitat loss. The elevational dynamics of Great Salt Lake were included in this analysis.

  - **Estimated Future Development and Population Growth in the Region as an Indicator of Future Potential Cumulative Habitat Loss.** Population densities for 2001, 2010, 2020, and 2030 were used to identify areas of wildlife habitat that would be converted from low population density to high population density. This analysis was conducted for a subset of the regional study area for which a dataset was available, as well as for the Ogden and Jordan River hydrological units individually.

  - **Estimated Future Development in the Project Study Area.** The project-level wildlife habitat map was used in concert with projected development data to evaluate the Proposed Action's contribution to habitat loss in the project study area.

  - **Contribution of Project Impacts to Cumulative Effects.** The direct impact analysis was repeated using the regional-scale land-cover data. The results should be used to evaluate trends, rather than as an absolute measure of impacts. The regional-scale data are more general than the project study area data; regional-scale data are not typically appropriate for project-scale analysis to determine an individual project's contribution to cumulate effects on wildlife habitat loss.

3.11.1 Historic Conditions: Cumulative Habitat Loss/Degradation from Past Activities

Methods

To estimate cumulative effects on wildlife from past activities, a regional-scale GIS analysis was conducted to evaluate the change in available habitat in the regional study area from estimated historic (pre-settlement; before 1847) habitat extent to current habitat extent. The GIS analysis used data describing the extent of *wetland/wildlife habitat*[3] from the available Natural Resource Conservation Service Soil Survey Geographic (SSURGO) database and the USFWS National Wetlands Inventory (NWI) dataset (Figure 3-19). The SSURGO dataset contains soils data mapped in each county at a scale of 1:24,000. For this analysis, soils that were identified as potentially supporting wetland plants and habitats as well as soils associated with mudflats were included in the estimated historic extent of wetland/wildlife habitat in the regional study area (Figure 3-19; see Appendix B). Because the soils data for the region as a whole are incomplete, only the areas that were mapped for soils or as part of the NWI mapping were used in the comparison between current habitat conditions and estimated historic availability of habitat (see Appendix B). The area of estimated historic available habitat and current available habitat were calculated for each hydrologic unit.

Results and Conclusions

There has been a 58 percent reduction in wetland/wildlife habitats from estimated historic conditions to current conditions. The amount of loss varies by hydrologic unit. For example, the Ogden hydrologic unit, where the majority of the Proposed Action would be located, has already lost nearly 70 percent of its estimated historic wetland/wildlife habitats. Furthermore, the Ogden hydrologic unit has the second highest historic wetland/wildlife extent in the regional study area. The comparison of estimated historic conditions to current conditions illustrates the downward trend in the extent of wetland/wildlife habitats in the regional study area.

Although it is not possible to directly compare the extent of estimated historic wetland/wildlife habitat with the potential future loss of wildlife habitat, it is possible to demonstrate the continued trend of high loss of wildlife habitat in the GSLE. The loss trend varies by hydrologic unit and by habitat type.

The extent of estimated historic wetland/wildlife habitats and current conditions are compared below.

- 42 percent of the estimated historic wetland/wildlife habitats are still available in the regional study area (Table 3-9).
- The remaining habitat varies by hydrologic unit (Table 3-9). Some examples are listed below.
  - Tooele Valley hydrologic unit – 80 percent (22,652.7 ha [56,370 ac]).
  - Utah Lake hydrologic unit – 17 percent (3,870 ha [11,018 ac]).

[3] The term *wetland/wildlife habitat* refers to a mapping category comprising polygons that include soils suitable for wetland vegetation, as well as associated upland areas, as defined by the SSURGO database and the NWI dataset. These datasets were used to establish a baseline of historic wetland and associated upland habitat distribution for use in evaluating temporal changes in habitat distribution and availability. Accordingly, this term pertains only to quantitative analysis involving historic conditions.

- Ogden hydrologic unit – 30 percent (14,898 ha [35,043 ac]).
- Jordan River hydrologic unit – 38 percent (12,477 ha [37,333 ac]).

3.11.2 Recent Trends in Permitted Loss of Wetlands

Methods

To assess the relative effects of the Proposed Action compared to other recent land use changes in the project area, Corps records of permitted wetland loss in Salt Lake and Davis Counties were analyzed.

Results and Conclusions

Figure 3-29 shows the total amount of wetland habitat loss permitted in Salt Lake and Davis Counties between 1992 and 2003. It also shows the average annual project-specific acreage permitted for take during this period. These data show that there has been a decreasing trend in the total and project-specific area of wetlands that have been permitted for conversion in the two counties in which the Proposed Action is located. The largest annual total acreage permitted for this period was 25 ha (62 ac) in 1992. The lowest annual total acreage was 2.6 ha (6.5 ac) in 2001. The annual average total wetland acreage permitted for individual projects ranged between 0.08 and 2.83 ha (0.2 and 7 ac) (range = 0.0004–23.6 ha [0.001–58.2 ac]) during the 12-year period.

By comparison, the proposed Legacy Parkway project (Alternative D [Final EIS Preferred Alternative]) would result in the loss of approximately 46 ha (114 ac) of wetlands. This is approximately 100 times the average annual project-specific permitted conversion (0.45 ha [1.1 acres]). It is approximately twice the amount of wetland loss from the largest project permitted in Salt Lake or Davis Counties during the entire study period (23.6 ha [58.2 ac] in 1992 – Project #199250147 Kennecott); equals the sum total of all projects permitted from 1998 to 2002; and equals approximately 30 percent of all wetland losses permitted during the entire 12-year study period.

3.11.3 Foreseeable Future Conditions

To evaluate the trend of available habitat through time, it is important to analyze potential future habitat availability. The vulnerability of wildlife habitat to continued development was evaluated on the basis of ownership status and potential population density to describe some of the potential future conditions on a regional scale. The future condition was evaluated using a dataset of potential development in the project study area. It is rarely possible to predict exactly where development will occur in the future, but the analyses described below were used to help illustrate some of the reasonably foreseeable future trends in habitat availability.

Current Ownership Status as an Indicator of Future Potential Habitat Loss

Methods

This analysis examined the ownership status of different habitats throughout the regional study area (Figure 3-30). The analysis used a dataset of land cover in the regional study area and an administrative ownership dataset. The land-cover dataset was based on a combination of data from the USGS Land

Cover Dataset (NLCD) and the NWI dataset (Appendix B). The administrative ownership dataset was created by Utah State University as part of the Utah GAP Analysis. In addition, recent data on State Trust Lands (May 2003) from the Utah School and Institutional Trust Lands Administration (SITLA) were included in the dataset. The ownership data were combined with the land-cover data to classify the areas of wildlife habitat by ownership status in the following categories.

- Publicly owned.
- Privately owned.
- Under combined public/private ownership (i.e., The Nature Conservancy lands or private in-holding on public lands).
- Public trust lands[4] (Appendix B).

The analysis was conducted for two different lake levels: low water and high water. The high lake-level data were from the 1984 lake-level dataset from the University of Utah Mapping and Monitoring Great Salt Lake Dynamics (1972–1996) project. The low lake-level data were defined using the land cover dataset.

The analysis was used to evaluate the ownership status for the region and for each watershed at the two different lake levels. It was assumed that the lands that are privately owned have a higher potential for development than land under public ownership.

Results and Conclusions

Table 3-10 summarizes the ownership status of lands within the regional study area. In addition, it summarizes the distribution of wetland/riparian habitats within each of the ownership status categories. The data show that 12 percent of the hydrologic units and 41 percent of the wetland/riparian habitats are under public ownership. The implications of this ownership pattern are summarized below.

- 41 percent of the wetland/riparian habitat in the regional study area is under public ownership.
- 47 percent of the wetland/riparian habitat in the regional study area is under private ownership and has the potential to be converted to other developed land uses.
- The dynamics of Great Salt Lake change the percentage of protected habitat.
- Conversion of all the wetland/riparian and other wildlife habitats on privately owned lands would greatly reduce the amount of remaining such habitats in the regional study area.

The level of protection from development varies by hydrologic unit. Table 3-11 summarizes the results of the analysis of habitat type by ownership status and hydrologic unit. The project study area is located in the Ogden and Jordan River hydrologic units. The analysis of the Ogden hydrologic unit provides an

[4] The SITLA dataset includes a water classification that was not included as a category in the final analysis. However, the area of wetland habitats in the water category was included in the total available habitat when percentages were calculated. This was done so the percentages would be calculated for the entire available area, not just the areas with known ownership.

example of the changes in habitat ownership and level of protection at the different lake levels; a compilation of these results by habitat category (upland and wetland) is provided below.

- At low water, 40 percent of the wetland habitat in the Ogden hydrologic unit is privately owned; 36 percent is privately owned at high water.
- At both low and high water, 96 percent of the nonwetland (cropland, pasture, desert salt scrub) habitat in the Ogden hydrologic unit is privately owned.
- At low water, 53 percent of the wetland habitat in the Ogden hydrologic unit is publicly owned; 4 percent is publicly owned at high water.
- At both low and high water, 3 percent of the nonwetland habitat in the Ogden hydrologic unit is publicly owned.

This analysis of the Ogden hydrologic unit suggests that the areas of wildlife habitat at higher elevations are more susceptible to development because they are generally privately owned, whereas wildlife habitat at lower elevations are more protected because they are generally publicly owned. The assumption in this analysis that private lands are more likely to be developed in the future suggests that many of the habitats will continue a trend of decline. However, some private lands in the project study area that are managed as duck clubs will probably continue to provide high-quality habitat values for waterfowl, shorebirds, and other wildlife species in the future. In addition, because of the distribution of public lands, habitat areas at higher elevations do not have the same level of protection as lower-elevation areas. Further, the availability of habitat on public lands depends on lake levels.

Cumulative Habitat Loss/Degradation from Estimated Future Development and Population Growth in the Region and in the Ogden and Jordan Hydrologic Units

Methods

The cumulative habitat loss/degradation from potential future population growth was based on projected population densities for Weber, Davis, Salt Lake, and Utah Counties. Future population density data were obtained from the Wasatch Front Regional Council (WFRC). The data indicate the area potentially available for development and estimate the population for 2001, 2010, 2020, and 2030. Because data were not available for the entire regional study area (as defined for the wildlife analysis), in this particular analysis the area covered by the WFRC dataset is referred to as the region, with the understanding that the region is not congruent with the regional study area. Accordingly, the available data were used to illustrate future trends in the region and in portions of the Ogden and Jordan hydrologic units.

Population density values were assigned a value of high, moderate, or low potential for habitat loss.[5]

[5] The divisions were based on a visual inspection of the densities and available 2002 aerial photographs of the local study site. Areas of >2 people/acre were generally areas of residential housing. The area of population density between 0 and 2 people/acre had only a few houses or a small development. Areas of 0 people/acre were open natural areas, cropland, or pasture with little or no development.

- Low = 0 people/acre.
- Moderate = > 0 and < 2 people/acre.
- High = > 2 people/acre.

The population density analysis provides information on the trends and potential impacts that may be associated with changing land use. For the years represented in the dataset, it is possible to track how much of the currently available habitat already is or will be located in high, moderate, and low population density areas.

Results and Conclusions

An analysis of potential future wildlife habitat loss was conducted using estimated population densities for the area evaluated for growth by the WFRC. Table 3-12 summarizes the distribution of available wildlife habitat in the region by area of population density for the years 2001, 2010, 2020, and 2030. The table also illustrates habitat in areas progressing in population density from low to moderate to high. For example, the area of emergent marsh habitat occurring in high-density areas will increase from less than 1 percent (28.3 ha [70 ac]) in 2001 to 10 percent (579.9 ha [1,433 ac]) in 2030. The area of wet meadow in the high-density category will increase from 5 percent (559.7 ha [1,383 ac]) to 20 percent (2,355.2 ha [5,820 ac]) over the 29-year time period. Because this analysis reflects temporal changes in the distribution of areas of population density, it is important to remember that the occurrence of individual habitat types is the baseline, or existing, condition. Thus, the change of habitat occurrence in population density categories is a function of the dynamic expansion of developed areas.

Accordingly, the results should be used as an indicator of potential future impacts and to identify areas of high or moderate potential development. The results reflect the potential trends and indicate that not all habitat types located in high- or moderate-density areas would be lost, although the potential for loss in these areas is greater than in low-density areas. The evaluation of the project study area considered only the Jordan River and Ogden hydrologic units. Tables 3-13 and 3-14 summarize the variation in potential habitat loss among the different habitats in the two hydrologic units. While the magnitude of change varies by hydrologic unit, there is a trend of increasing areas of habitat occurring in the moderate or high-density categories over time. For example, in the Jordan River unit, the proportion of emergent marsh in the high-density category increases from 1 percent to 6 percent over the 29-year period, and wet meadow habitat in the high-density category increases from 16 percent to 23 percent. Other habitats show analogous trends. It is estimated that 90 percent of cropland and <1 percent of mudflat/pickleweed habitat will be in the high-density category by 2030. In the Ogden hydrologic unit, mudflat/pickleweed in the high-density category would increase from <1 percent to 9 percent over the 29-year period. The other habitats in the high-density category exhibit increases ranging from 25 percent to 39 percent over the 29-year period. In 2030, the percentage of habitat in the high-density category ranges from 9 percent (mudflat/pickleweed) to 62 percent (pasture). The implications of these trends are summarized below.

- Based on projected estimates of population density, there will be a continued trend of conversion of wildlife habitat to increasingly dense levels of development.
- The magnitude of the conversion trend varies between the hydrologic units and among the habitat types.

Estimated Future Growth in the Project Study Area

Methods

The potential future build-out in the project study area was evaluated using the wildlife habitat dataset and a projected land development build-out dataset. The land development build-out dataset was developed from sources used in the Final EIS as well as additional data provided by UDOT (Appendix B). This dataset was used to illustrate a reasonably foreseeable future build-out scenario. Two categories of development were identified in the dataset: areas developed since 1997 (developed), and areas potentially developable in the future (developable). The impact of future build-out was evaluated by overlaying the future build-out data on the wildlife habitats map and calculating the area of habitat that is within the potential future development area. In addition, each build alternative was incorporated into the future development area to calculate the proportion of habitat that would be affected by the alternative. The area affected by the build alternative was included in the totals for the developed category. Wetlands in the developed or developable categories may not be completely lost, but they would likely be degraded by developing the surrounding land use.

Results and Conclusions

The Legacy Parkway project is not the only potential source of loss of wetland and upland habitats in the future. For example, the developed lands scenario would result in the loss or degradation of 15.1 ha (37.4 ac) of emergent marsh, 4.7 ha (11.6 ac) of mudflat/pickleweed, and 27.8 ha (68.7 ac) of the wet meadow habitats in the project study area (Figure 3-21, Table 3-15). In contrast, Alternative E—considered in isolation from full build-out—would result in the direct loss of 10.2 ha (25.2 ac) of emergent marsh, 6.6 ha (16.3 ac) of mudflat/pickleweed, and 26.7 ha (66.1 ac) of wet meadow habitats (Figure 3-3). When the developed lands scenario and Alternative E are combined, 22.3 ha (55.0 ac) of emergent marsh, 10.7 ha (26.4 ac) of mudflat/pickleweed and 51.7 ha (127.7 ac) of wet meadow would be lost or degraded. As development occurs in the project study area, the loss or degradation of habitat will continue. As much as 65.2 ha (161.1 ac) of emergent marsh, 68.4 ha (168.9 ac) or mudflat/pickleweed, and 229.4 ha (566.8 ac) of wet meadow could be lost or degraded within the project study area.

Table 3-15 summarizes the direct losses or degradation of wildlife habitat of the two build-out scenarios in association with each of the build alternatives and the no-build scenario, and illustrates the continued trend of habitat loss in the project study area. It is possible that areas designated as developable could be set aside as protected in the future. Areas west of the Critical Protection Areas line (Figure 3-21) have been designated as priority lands for conservation in the *Wetlands Preservation Plan: a Plan for Protection of the Great Salt Lake Wetlands Ecosystem in Davis County* (Wetland Protection Plan Steering Committee 1996). Currently available data do not facilitate quantification of specific acreage to be protected.

Proportion of Project Impacts to Regional Habitat Availability

Methods

The contribution of the Legacy Parkway project to habitat loss in the region was evaluated using regional-scale data. To provide a regional context for the project study area and the project alternatives, GIS was used to calculate the percentage of habitat types that each alternative would affect in the regional study area and adjacent hydrologic units. In addition, the area of wetland (emergent marsh, mudflat/pickleweed,

wet meadow) and upland (cropland, pasture, scrub) habitats in the project study area under each project alternative was compared to the habitat in the region and the adjacent hydrologic units.

The regional land-cover dataset was used for the analysis because the scale used for the regional study area mapping is a smaller geographic scale than that used for the project-level study area. The smaller scale is appropriate for a regional analysis but results in a variation in the extent of wetland habitat calculated from the project-scale data. Because of this variation in scale and the corresponding variation in area calculations between the two study areas, representative comparisons between the two acreages cannot be made.

The analysis of the contribution of each alternative to the regional change in wildlife habitat using the regional-scale data has been used to indicate a trend. An unknown level of error associated with changes in scale should be assumed when evaluating the results.

Results

The effects of the Legacy Parkway project compared to the total available habitat in the regional study area are summarized in Table 3-8. These results are based on the regional study area land-cover dataset that was used to compare the acreage of habitat available in the regional study area to the impacts from the project alternatives. The project study area represents 0.1 percent of the available habitat in the regional study area (Table 3-8). Specific habitat types range between 0.07 percent (cropland) to 3.2 percent (cropland) of the regional land area for these habitats (see Table 3-8). Alternatives A, B, C, and E would affect 0.077, 0.096, 0.077, and 0.079 percent of the regionally available habitat respectively. Between 8.9 and 10.5 ha (22 and 26 ac) of the alternatives were unclassified.

Project Study Area

The project study area is split between three hydrologic units: Salt Lake, Ogden, and Jordan River. Less than 1 percent of the project study area is in the Salt Lake hydrologic unit, and none of the project alternatives' rights-of-way are in the Salt Lake hydrologic unit. The following summarizes the percentage of the hydrologic unit that the project study area represents and the percentage of the project study area that is located in each hydrologic unit.

- 76 percent of the project study area is located in the Ogden hydrologic unit, which equates to 4.5 percent of the entire hydrologic unit.
- 22 percent of the project study area is located in the Jordan River hydrologic unit, which equates to 4.3 percent of the entire hydrologic unit.

No-Build Alternative

There would be no project-related loss of wildlife habitat under the No-Build Alternative.

Alternative A

The following list quantifies habitat loss by region and hydrologic unit for this alternative.

- 0.024 percent wetland habitat in the regional study area.
- 0.096 percent nonwetland habitat in the regional study area.

- 0.18 percent wetland habitat in the Jordan River hydrologic unit.
- 0.89 percent nonwetland habitat in the Jordan River hydrologic unit.
- 0.17 percent wetland habitat in the Ogden hydrologic unit.
- 0.52 percent nonwetland habitat in the Ogden hydrologic unit.

Alternative B

The following list quantifies habitat loss by region and hydrologic unit for this alternative.

- 0.06 percent wetland habitat in the regional study area.
- 0.11 percent nonwetland habitat in the regional study area.
- 0.48 percent wetland habitat in the Jordan River hydrologic unit.
- 0.97 percent nonwetland habitat in the Jordan River hydrologic unit.
- 0.45 percent wetland habitat in the Ogden hydrologic unit.
- 0.57 percent nonwetland habitat in the Ogden hydrologic unit.

Alternative C

The following list quantifies habitat loss by region and hydrologic unit for this alternative.

- 0.05 percent wetland habitat in the regional study area.
- 0.08 percent nonwetland habitat in the regional study area.
- 0.39 percent wetland habitat in the Jordan River hydrologic unit.
- 0.77 percent nonwetland habitat in the Jordan River hydrologic unit.
- 0.38 percent wetland habitat in the Ogden hydrologic unit.
- 0.45 percent nonwetland habitat in the Ogden hydrologic unit.

Alternative E

The following list quantifies habitat loss by region and hydrologic unit for this alternative.

- 0.035 percent wetland habitat in the regional study area.
- 0.093 percent nonwetland habitat in the regional study area.
- 0.26 percent wetland habitat in the Jordan River hydrologic unit.

- 0.86 percent nonwetland habitat in the Jordan River hydrologic unit.
- 0.26 percent wetland habitat in the Ogden hydrologic unit.
- 0.5 percent nonwetland habitat in the Ogden hydrologic unit.

3.11.4 Cumulative Effects Analysis Summary

Historical wetland/wildlife habitat has been reduced by 58 percent in the regional study area as a result of past activities; 42 percent of the estimated historic wetland/wildlife habitat remains (Table 3-9). A continued trend of loss of wildlife habitats in the regional study area can be reasonably expected to occur, with or without the Legacy Parkway project, as a result of planned development in the region. If all the private lands in the region were developed or had a change in land use that was incompatible with wildlife habitat, 50 percent of the remaining wildlife habitats (constituting 38 percent of estimated historic wetland/wildlife habitat) could be lost or degraded. The percentages of remaining habitat under private and public ownership are provided below.

- 47 percent of existing wildlife habitats is in private ownership (Table 3-10).
- 41 percent of existing wildlife habitats is in public ownership (Table 3-10).
- 6 percent of existing wildlife habitats is in mixed public/private and Public Trust ownership

The project study area represents 0.88 percent of the regional study area geographically; 0.84 percent of the wetland/riparian habitat in the region is located in the project study area. Of the upland wildlife habitats in the region, 0.98 percent are in the project study area.

- The project study area is 0.88 percent of the regional study area.
- Of the wetland/riparian habitats in the region, 0.8 percent is in the project study area.

The build alternatives would contribute to the trend of loss of wildlife habitats in the region (Table 3-8).

- Alternative E would affect 0.035 percent of the wetland/riparian habitat in the regional study area.
- Alternative E would affect 0.093 percent of the upland wildlife habitat in the regional study area (Table 3-8).

Ogden Hydrologic Unit

Seventy-six percent of the project study area is located in the Ogden hydrologic unit. The Ogden hydrologic unit historically supported the second largest area of wetland/wildlife habitats (46,618 ha [115,196 ac]) in the regional study area, and currently represents the fourth largest area (14,899 ha [36,815 ac]). This trend of loss is predicted to continue.

- Of the estimated historic wetlands in the Ogden hydrologic unit, 30 percent are still available.
- Of the wetland habitats in the region, 14 percent are in the Ogden hydrologic unit.

- Of the nonwetland wildlife habitats in the region, 19 percent are in the Ogden hydrologic unit.

The watershed is split between public and private ownership, but the distribution of these lands differs markedly. The area of wildlife habitats on private lands decreases from 40 percent at low water to 36 percent at high water. This suggests that much of the privately owned wildlife habitat is not affected by changes in lake level. The area of wildlife habitats on public lands decreases from 53 percent at low water to 4 percent at high water. This suggests that much of the publicly owned wildlife habitat is located at lower elevations. The distribution of public and private lands in the Ogden hydrologic unit suggests that much of the higher-elevation wetland habitat that is available to wildlife during both low- and high-water conditions is privately owned and has the potential to be degraded or lost to changes in land use. The following list shows the percentage of wildlife habitat in the Ogden hydrologic unit publicly and privately owned.

- 40 percent of the wetland habitat is privately owned at low water; 30 percent is privately owned at high water.
- 96 percent of nonwetland habitat at both low and high water in the Ogden hydrologic unit is privately owned.
- 53 percent of the wetland habitat is publicly owned at low water; 4 percent is publicly owned at high water.
- Of the nonwetland habitat in the Ogden hydrologic unit, 3 percent is publicly owned at low and high water.

The continuing trend of wetlands loss and degradation is also illustrated by the analysis of future growth potential in the Ogden hydrologic unit. By 2030 the majority of wetland, nonwetland, and wildlife habitats will be in a high or moderate population density area. The Proposed Action would contribute to this continued decline of available habitat in the Ogden hydrologic unit.

- 36 percent of the wildlife habitats analyzed[6] will potentially be in a high population density area, 63 percent in a moderate population density area, and 8 percent in a low population density area by 2030.
- 58 percent of the nonwetland wildlife habitat analyzed will potentially be in a high population density area, 41 percent in a moderate population density area, and 1 percent in a low population density area by 2030.
- Alternative E would contribute to a 0.25 percent loss of wetland habitat in the Ogden hydrologic unit.
- Alternative E would contribute to a 0.86 percent loss of nonwetland wildlife habitat in the Ogden hydrologic unit.

Jordan River Hydrologic Unit

Twenty-two percent of the project study area is located in the Jordan River hydrologic unit. The Jordan River hydrologic unit historically supported the third largest area of wetland/wildlife habitat in the

[6] The potential future habitat loss based on projected population density covered only a portion of the Ogden and Jordan River hydrologic units.

regional study area (40,526.5 ha [98,954 ac]) and currently represents the third largest area (12,477.3 ha [37,333 ac]). This trend of loss of loss is predicted to continue.

- Of the estimated historic wetlands in the Jordan River hydrologic unit, 38 percent are still available.
- Of the wetland habitats in the region, 13 percent are in the Jordan River hydrologic unit.
- Of the nonwetland wildlife habitats in the region, 11 percent are in the Jordan River hydrologic unit.

The majority of remaining wildlife habitats in the Jordan River hydrologic unit are privately owned. The distribution of private and public lands in the Jordan River hydrologic unit is similar to that in the Ogden hydrologic unit. Of the remaining 38 percent of the estimated historic wetland/wildlife habitat in the Jordan River hydrologic unit, 68 percent could be lost or degraded by land use changes on private property at low water; 40 percent could be lost at high water. The publicly owned wildlife habitat decreases from 27 percent at low water to 1 percent at high water, indicating that much of the publicly owned wetland habitat is at low elevations.

- 68 percent of the wetland habitat at low water and 40 percent of the wetland habitat at high water in the Jordan River hydrologic unit are privately owned.
- 79 percent of the nonwetland habitat at both low and high water in the Jordan River hydrologic unit is privately owned.
- 27 percent of the wetland habitat at low water and 1 percent of the wetland habitat at high water in the Jordan River hydrologic unit are publicly owned.
- 2 percent of the nonwetland habitat at low and 1 percent of the nonwetland habitat at high water in the Jordan River hydrologic unit are publicly owned.

The trend of population change in the Jordan River hydrologic unit is different than in the Ogden unit. Of the wildlife habitat in the unit, 7–27 percent will be in a high or moderate population density area by 2030. The remaining 66 percent will be in a low population density area. Of the nonwetland wildlife habitat in the unit, 24–72 percent will be located in a high or moderate population density area by 2030. This suggests that the nonwetland wildlife habitats in the hydrologic unit have a higher potential for loss or degradation from changes in land use than the wetland habitats. The Proposed Action would contribute to this trend of decline in available habitat in the Jordan River hydrologic unit.

- 7 percent of the wildlife habitat analyzed would be in a high population density area, 27 percent in a moderate population density area, and 66 percent in a low population density area by 2030.
- 72 percent of the nonwetland wildlife habitat analyzed would be in a high population density area, 18 percent in a moderate population density area, and 9 percent in a low population density area by 2030.
- Alternative E would contribute to a 0.26 percent loss of wetland habitat in the Jordan River hydrologic unit.
- Alternative E would contribute to a 0.86 percent loss of nonwetland wildlife habitat in the Jordan River hydrologic unit.

Conclusion

The regional study area has lost much of its estimated historic wetland areas for wildlife habitat. Future growth projections suggest that this trend will continue. The Proposed Action would contribute proportionally (less than 1 percent) to this overall decrease in wildlife habitat. The location of the Legacy Parkway project in the Ogden and Jordan River hydrologic units would continue a trend of habitat loss in two of the largest wildlife habitat areas in the regional study area.

Chapter 3

Tables

Table 3-1. Summary of Direct Habitat Loss of Wetland/Riparian and Upland Wildlife Habitats by Alternative

Alternative	Wetland/Riparian Habitats	Upland Habitats
No Build	0 ha (0 ac)	0 ha (0 ac)
Alternative A	44.4 ha (109.8 ac)	201.3 ha (497.4 ac)
Alternative B	79.4 ha (196.2 ac)	270.2 ha (667.8 ac)
Alternative C	63.4 ha (156.7 ac)	198.1 ha (489.5 ac)
Alternative E	52.3 ha (129.3 ac)	200.2 ha (494.8 ac)

Table 3-2. Wildlife Habitat Availability within the Regional Study Area at Low and High Lake Levels

	Alternative A				Alternative B			
Habitat	Area* (acres)	% of Regional Habitat at Low Lake Level	% of Regional Habitat at High Lake Level	Change in % Between High and Low Lake Level	Area* (acres)	% of Regional Habitat at Low Lake Level	% of Regional Habitat at High Lake Level	Change in % Between High and Low Lake Level
Pasture	315	0.11	0.11	0.00	351	0.12	0.12	0.00
Cropland	1	0.00	0.00	0.00	3	0.00	0.00	0.00
Scrub	267	0.13	0.13	0.00	283	0.14	0.14	0.00
Wet Meadow	52	0.05	0.08	0.02	87	0.09	0.09	0.00
Emergent Marsh	24	0.06	0.16	0.10	110	0.26	0.56	0.31
Mudflat/Pickleweed	2	0.00	0.00	0.00	12	0.01	0.00	0.00
Riparian	0	0.00	0.00	0.00	1	0.02	0.03	0.00

	Alternative C				Alternative E			
Habitat	Area* (acres)	% of Regional Habitat at Low Lake Level	% of Regional Habitat at High Lake Level	Change in % Between High and Low Lake Level	Area* (acres)	% of Regional Habitat at Low Lake Level	% of Regional Habitat at High Lake Level	Change in % Between High and Low Lake Level
Pasture	213	0.07	0.08	0.00	274	0.10	0.10	0.00
Cropland	1	0.00	0.00	0.00	0	0.00	0.00	0.00
Scrub	293	0.14	0.14	0.00	286	0.14	0.14	0.00
Wet Meadow	71	0.07	0.08	0.01	67	0.07	0.09	0.03
Emergent Marsh	86	0.20	0.39	0.19	44	0.10	0.29	0.18
Mudflat/Pickleweed	17	0.01	0.01	0.00	3	0.00	0.00	0.00
Riparian	0	0.01	0.00	-0.01	0	0.00	0.00	0.00

*Area represents acreage of each habitat that lies within the build alternative right-of-way. These acreages are based upon the regional dataset to facilitate regional-scale analysis.

Table 3-3. Wildlife Habitat Availability within the Project Study Area at Low and High Lake Levels

	Project Study Area			Alternative A				Alternative B			
Habitat	At Low Lake Level (acres)*	At High Lake Level (acres)	Change in Available Habitat (acres) Between Low and High Lake Level	Area (acres)	% of Project Study Area Habitat at Low Lake Level	% of Project Study Area Habitat at High Lake Level	Change in % Between High and Low Lake Level	Area (acres)	% of Project Study Area Habitat at Low Lake Level	% of Project Study Area Habitat at High Lake Level	Change in % Between High and Low Lake Level
Pasture	3,372	3,371	1	315	9.333	9.336	0.004	351	10.401	10.405	0.004
Cropland	83	81	1	1	0.809	0.820	0.011	3	3.774	3.825	0.052
Scrub	2,469	2,416	53	267	10.808	11.045	0.237	283	11.465	11.717	0.251
Wet Meadow	1,203	888	315	52	4.326	5.860	1.534	87	7.266	9.842	2.577
Emergent Marsh	1,212	541	671	24	1.982	4.443	2.461	110	9.064	20.321	11.257
Mudflat/Pickleweed	341	62	279	2	0.717	3.915	3.198	12	3.453	18.861	15.408
Riparian	8	6	2	0	0.000	0.000	0.000	1	11.765	15.385	3.620

	Alternative C				Alternative E			
	Area (acres)	% of Project Study Area Habitat at Low Lake Level	% of Project Study Area Habitat at High Lake Level	Change in % Between High and Low Lake Level	Area (acres)	% of Project Study Area Habitat at Low Lake Level	% of Project Study Area Habitat at High Lake Level	Change in % Between High and Low Lake Level
Pasture	213	6.305	6.308	0.002	274	8.126	8.129	0.003
Cropland	1	0.809	0.820	0.011	0	0.539	0.546	0.007
Scrub	293	11.862	12.121	0.260	286	11.591	11.845	0.254
Wet Meadow	71	5.879	7.964	2.085	67	5.546	7.513	1.967
Emergent Marsh	86	7.101	15.919	8.818	44	3.651	8.186	4.535
Mudflat/Pickleweed	17	4.951	27.046	22.095	3	0.782	4.270	3.489
Riparian	0	2.941	3.846	0.905	0	0.000	0.000	0.000

* Acreages in this table are derived from the regional GIS dataset, which is a low-resolution dataset. Consequently, the acreages differ from those presented in project-level analyses.

Table 3-4. Summary of Habitat Fragmentation by Habitat Category Resulting from Build Alternatives

Habitat Category	Alternative		Number of Patches in Each Size Class					**Total Number of Patches**	Summary Statistics (acres)	
			<1	1–10	10–50	50–100	>100		Mean Patch Size	Median Patch Size
Upland	No Action		147	70	40	13	12	**282**	21.20	0.79
	Alternative A	Patches Fragmented	10	9	15	7	10			
		Total Patches	175	97	46	13	13	**344**	15.93	0.90
	Alternative B	Patches Fragmented	6	16	22	10	11			
		Total Patches	196	97	59	14	12	**378**	14.05	0.84
	Alternative C	Patches Fragmented	9	14	17	8	10			
		Total Patches	181	100	50	11	13	**355**	15.46	0.94
	Alternative E	Patches Fragmented	7	8	12	7	10			
		Total Patches	182	91	47	17	11	**348**	15.76	0.79
Wetland	No Action		464	227	39	5	2	**737**	3.17	0.60
	Alternative A	Patches Fragmented	38	57	9	1	1			
		Total Patches	494	218	36	5	2	**755**	2.96	0.48
	Alternative B	Patches Fragmented	78	78	15	3	2			
		Total Patches	500	206	39	6	1	**752**	2.88	0.48
	Alternative C	Patches Fragmented	70	74	13	2	1			
		Total Patches	498	206	36	7	1	**748**	2.93	0.45
	Alternative E	Patches Fragmented	55	65	7	1	1			
		Total Patches	486	208	39	5	2	**740**	3.01	0.45
Open Water	No Action		25	12	4	1	1	**43**	7.27	0.69
	Alternative A	Patches Fragmented	2		2	1	0			
		Total Patches	28	15	3	1	1	**48**	6.31	0.61
	Alternative B	Patches Fragmented	1	1	2	1	0			
		Total Patches	28	14	4	0	1	**47**	6.09	0.74
	Alternative C	Patches Fragmented	2	0	2	0	0			
		Total Patches	28	14	4	1	1	**48**	6.31	0.64
	Alternative E	Patches Fragmented	2	0	2	1	0			
		Total Patches	26	14	4	1	1	**46**	6.41	0.69

Table 3-5. Summary of Habitat Fragmentation Statistics by Habitat Type Resulting from Build Alternatives

Habitat Type	Alternative		Number of Patches in Each Size Class					Summary Statistics (Acres)				
			<1	1–10	10–50	50–100	>100	Number of Patches	Mean Patch Size	Median Patch Size	Patch Size Coefficient of Variance	Standard Deviation
Cropland	No Action		25	18	18	5	4	70	24.76	4.49	0.06	56.43
	Alternative A	Patches Fragmented	2	2	7	3	3					
		Total Patches	30	22	19	8	3	82	19.46	4.33	0.04	34.94
	Alternative B	Patches Fragmented	3	6	11	5	4					
		Total Patches	33	25	28	7	2	95	15.61	4.33	0.04	26.27
	Alternative C	Patches Fragmented	2	2	7	3	3					
		Total Patches	32	26	21	4	5	88	18.34	3.35	0.05	37.84
	Alternative E	Patches Fragmented	2	1	6	1	3					
		Total Patches	31	21	20	8	3	83	19.31	4.33	0.04	34.68
Emergent Marsh	No Action		68	41	9	2	1	121	5.84	0.73	0.08	17.80
	Alternative A	Patches Fragmented	4	8	3							
		Total Patches	77	45	7	2	1	132	5.19	0.62	0.08	16.99
	Alternative B	Patches Fragmented	18	9	4	1	1					
		Total Patches	71	41	8	2	1	123	5.35	0.72	0.08	17.29
	Alternative C	Patches Fragmented	9	9	5	1						
		Total Patches	70	41	9	2	1	123	5.59	0.72	0.08	17.41
	Alternative E	Patches Fragmented	6	9	2							
		Total Patches	76	40	9	2	1	128	5.33	0.60	0.08	17.26
Mudflat/Pickleweed	No Action		211	61	6	1		279	1.58	0.26	0.10	6.23
	Alternative A	Patches Fragmented	7	4								
		Total Patches	208	60	6	1		275	1.58	0.25	0.10	6.26

Table 3-5. Continued

Habitat Type	Alternative		Number of Patches in Each Size Class					Summary Statistics (Acres)				
			<1	1–10	10–50	50–100	>100	Number of Patches	Mean Patch Size	Median Patch Size	Patch Size Coefficient of Variance	Standard Deviation
	Alternative B	Patches Fragmented	20	16	1							
		Total Patches	224	56	5	1		286	1.47	0.24	0.10	6.13
	Alternative C	Patches Fragmented	26	18	1							
		Total Patches	221	54	6	1		282	1.45	0.22	0.11	6.17
	Alternative E	Patches Fragmented	17	9								
		Total Patches	212	57	6	1		276	1.53	0.24	0.10	6.25
Open Water	No Action		25	12	4	1	1	43	7.27	0.69	0.07	20.92
	Alternative A	Patches Fragmented	2		2	1						
		Total Patches	28	15	3	1	1	48	6.31	0.61	0.08	19.36
	Alternative B	Patches Fragmented	1	1	2	1						
		Total Patches	28	14	4		1	47	6.09	0.74	0.08	18.97
	Alternative C	Patches Fragmented	2		2							
		Total Patches	28	14	4	1	1	48	6.31	0.64	0.08	19.40
	Alternative E	Patches Fragmented	2		2	1						
		Total Patches	26	14	4	1	1	46	6.41	0.69	0.07	19.41
Pasture	No Action		65	23	16	7	7	118	25.11	0.45	0.10	97.38
	Alternative A	Patches Fragmented	5	5	8	4	6					
		Total Patches	84	45	19	3	7	158	17.42	0.79	0.12	81.73
	Alternative B	Patches Fragmented	2	6	8	5	6					
		Total Patches	95	37	26	6	6	170	15.54	0.45	0.10	64.41
	Alternative C	Patches Fragmented	5	8	5	5	6					
		Total Patches	79	35	25	4	6	149	18.55	0.83	0.11	83.92
	Alternative E	Patches Fragmented	4	5	6	6	6					

Table 3-5. Continued

Habitat Type	Alternative		Number of Patches in Each Size Class					Summary Statistics (Acres)				
			<1	1–10	10–50	50–100	>100	Number of Patches	Mean Patch Size	Median Patch Size	Patch Size Coefficient of Variance	Standard Deviation
		Total Patches	85	39	19	7	5	155	17.71	0.72	0.11	82.02
Riparian	No Action		9	16	1			26	2.73	1.61	0.03	3.62
	Alternative A	Patches Fragmented	5	6								
		Total Patches	9	16	1			26	2.58	1.61	0.03	3.57
	Alternative B	Patches Fragmented	5	10								
		Total Patches	15	13	1			29	2.25	0.92	0.04	3.50
	Alternative C	Patches Fragmented	5	9								
		Total Patches	9	15	1			25	2.64	1.61	0.03	3.61
	Alternative E	Patches Fragmented	5	7								
		Total Patches	5	16	1			22	3.04	2.04	0.03	3.71
Scrub	No Action		57	29	6	1	1	94	13.64	0.49	0.19	104.57
	Alternative A	Patches Fragmented	3	2			1					
		Total Patches	61	30	8	2	3	104	10.89	0.56	0.12	52.38
	Alternative B	Patches Fragmented	1	4	3		1					
		Total Patches	68	35	5	1	4	113	10.49	0.49	0.11	47.56
	Alternative C	Patches Fragmented	2	4	5		1					
		Total Patches	70	39	4	3	2	118	9.42	0.57	0.13	48.37
	Alternative E	Patches Fragmented	1	2			1					
		Total Patches	66	31	8	2	3	110	10.33	0.49	0.12	50.08

Table 3-5. Continued

Habitat Type	Alternative		Number of Patches in Each Size Class					Summary Statistics (Acres)				
			<1	1–10	10–50	50–100	>100	Number of Patches	Mean Patch Size	Median Patch Size	Patch Size Coefficient of Variance	Standard Deviation
Wet Meadow	No Action		176	109	23	2	1	311	3.60	0.85	0.08	10.93
	Alternative A	Patches Fragmented	22	39	6	1	1					
		Total Patches	200	97	22	2	1	322	3.26	0.71	0.08	10.50
	Alternative B	Patches Fragmented	35	43	10	2	1					
		Total Patches	190	96	25	3		314	3.26	0.72	0.06	8.26
	Alternative C	Patches Fragmented	30	38	7	1	1					
		Total Patches	198	96	20	4		318	3.23	0.71	0.07	8.75
	Alternative E	Patches Fragmented	27	40	5	1	1					
		Total Patches	193	95	23	2	1	314	3.35	0.72	0.08	10.65

Table 3-6. Typical Highway Runoff Contaminants

Contaminant	Source
Total dissolved solids (TDS)	De-icing salts, vehicle deposits, pavement wear
Heavy metals (copper, lead, zinc)	Vehicle deposits
Chlorides, sodium, calcium	De-icing salts
Cyanide	Anticake compound used to keep de-icing salts granular
Petroleum	Vehicle spills and leaks from lubricants, antifreeze, hydraulic fluids
Pathogenic bacteria	Soil, litter, trucks hauling livestock
Rubber	Tire wear
Sediments (TSS)	Construction activities, vehicle deposits, pavement wear
Organic Compounds	Crankcase oil and vehicle emissions*

Source: Federal Highway Administration 1987a
* Source: U.S Geological Survey 2003 as presented in HDR Engineering, Inc. 2004

Table 3-7. Wildlife Habitat (by Special-Status Bird Species) That Would Potentially Be Affected by Highway Noise

Habitat	Type[1]	Area (acres)			
		Alt A	Alt B	Alt C	Alt E
Bald Eagle					
Riparian	FB	3	4	3	3
Emergent Marsh	F	19	38	33	16
Wet Meadow	F	53	80	62	47
Mudflat Pickleweed	F	2	17	20	7
Pasture	F	161	218	150	148
Salt Desert Scrub	F	56	57	73	58
Total		295	416	340	279
Swainson's Hawk					
Riparian	B	3	4	3	3
Emergent Marsh	F	19	38	33	16
Wet Meadpw	F	53	80	62	47
Mudflat Pickleweed	F	2	17	20	7
Pasture	F	161	218	150	148
Cropland	F	97	174	102	91
Salt Desert Scrub	F	56	57	73	58
Total		392	590	442	369
Peregrine Falcon					
Riparian	F	11	21	97	10
Emergent Marsh	F	72	129	251	64
Wet Meadow	F	180	331	119	185
Mudflat/Pickleweed	F	24	77	457	39
Pasture	F	546	904	432	562
Cropland	F	377	662	279	368
Scrub	F	219	230	410	211
Total		1,430	2,354	2,045	1,439
Prairie Falcon					
Emergent Marsh	F	123	255	482	103
Wet Meadow	F	321	593	196	360
Mudflat/Pickleweed	F	62	145	954	71
Pasture	F	1,019	1,608	713	1,051
Cropland	F	641	1,061	449	629
Scrub	F	396	447	699	366
Total		2,563	4,111	3,493	2,580

Habitat	Type[1]	Area (acres)			
		Alt A	Alt B	Alt C	Alt E
Burrowing Owl					
Mudflat/Pickleweed	F	62	145	954	71
Pasture	F	1,019	1,608	713	1,051
Scrub	FB	396	447	699	366
Total		1,477	2,201	2,366	1,488
Short-eared Owl					
Emergent Marsh	F	123	255	482	103
Wet Meadow	F	321	593	196	360
Mudflat/Pickleweed	F	62	145	954	71
Pasture	F	1,019	1,608	713	1,051
Cropland	F	641	1,061	449	629
Scrub	FB	396	447	699	366
Total		2,563	4,111	3,493	2,580
Wilson's Phalarope					
Open Water	F	121	181	42	132
Emergent Marsh	F	264	436	689	305
Wet Meadow	FB	581	892	292	567
Mudflat/Pickleweed	F	183	276	1,447	201
Pasture	F	1,634	2,287	1,126	1,531
Total		2,662	3,891	3,554	2,603
Bobolink					
Wet Meadow	F	763	939	369	733
Pasture	F	1,998	2,523	1,343	1,875
Cropland	F	1,309	1,456	893	1,318
Scrub	F	891	1,003	1,259	871
Total		4,961	5,921	3,864	4,797
American Avocet					
Open Water	F	18	27	10	21
Emergent Marsh	F	39	67	101	35
Wet Meadow	F	99	171	81	92
Mudflat/Pickleweed	F	8	35	166	16
Pasture	F	291	436	242	288
Total		456	735	600	452

[1] Type signifies species use of habitat.

F = Foraging

B = Breeding Habitat

FB = Foraging and Breeding Habitat

Table 3-8. Areal Comparison of the Build Alternatives with the Regional Study Area*

	Regional Land Cover	Project Study Area		Alternative A		Alternative B		Alternative C		Alternative E	
Habitat	acres	acres	%	acres	%	acres	%	acres	%	acres	%
Cropland	113,742	83	0.07	1	0.001	3	0.003	1	0.001	0	0.000
Developed	159,416	467	0.29	108	0.068	111	0.069	105	0.066	111	0.069
Emergent Marsh	42,817	1,212	2.83	24	0.056	110	0.257	86	0.201	44	0.103
Mudflat/Pickleweed	184,915	341	0.18	2	0.001	12	0.006	17	0.009	3	0.001
Pasture	285,165	3,372	1.18	315	0.110	351	0.123	213	0.075	274	0.096
Riparian	3,728	8	0.20	0	0.000	1	0.024	0	0.006	0	0.000
Scrub	206,017	2,469	1.20	267	0.130	283	0.137	293	0.142	286	0.139
Unclassified	11,283	67	0.60	23	0.205	24	0.217	26	0.227	22	0.195
Upland	22,084	707	3.20	79	0.356	101	0.458	64	0.290	79	0.357
Wet Meadow	99,139	1,203	1.21	52	0.052	87	0.088	71	0.071	67	0.067
Total Wetland[1]	326,871	2,756	0.84	79	0.024	209	0.064	174	0.053	114	0.035
Total Upland[2]	604,923	5,924	0.98	582	0.096	637	0.105	506	0.084	561	0.093
Total[3]	1,128,305	9,929	0.88	870	0.077	1,083	0.096	874	0.077	886	0.079

* Areal calculations are based on regional-scale data. Please refer to the cumulative impacts analysis and Appendix B for a discussion of data limitations.
[1] Total Wetland comprises emergent marsh, wet meadow, and mudflat/pickleweed.
[2] Total Upland comprises desert salt scrub, cropland, and pasture.
[3] Total is the sum of all habitat types

Table 3-9. Comparison of Estimated Historic Wetland/Wildlife Habitat and Current Habitat Availability by Hydrologic Unit (acres)

	Bear River	Jordan River	Utah Lake	Ogden	Promontory Point West	Salt Lake	Tooele Valley	Total
Estimated Historic Wetland Habitat [1]	297,827	98,954	66,147	115,196	10,249	19,473	70,784	678,630
NWI Wetland Habitat [1]	134,539	37,333	11,018	35,043	3,290	7,880	56,370	284,650
Percent Remaining Wetland Habitats	45%	38%	17%	30%	32%	36%	80%	42%

[1] Area reported is the geographic extent of the area common to both datasets as of May 2003 within the regional study area. Area is reported in acres.

Table 3-10. Ownership Status of Regional Study Area and Ownership Status of Wetland / Riparian Habitats

Ownership Status	Acres	% of Area under Each Ownership Type for the Watersheds	Available Wetland/ Riparian (Acres)	Percent of Available Wetland/Riparian Habitats
Private	1,044,266	51	164,041	47
Public	240,532	12	143,644	41
Public/Private	12,175	1	5,977	2
Public Trust	18,616	1	13,283	4
Unclassified Ownership (Water)	748,006	36	19,428	6
Total Area Analyzed	2,063,595	100	346,374	100

Table 3-11. Distribution of Available Habitat at Low and High Water by Ownership Status and Watershed

Habitat	Private				Public				Public / Private				Public Trust				Total Low Water (acres)[1]
	Low Water (acres)	Low Water (%)	High Water (acres)	High Water (%)	Low Water (acres)	Low Water (%)	High Water (acres)	High Water (%)	Low Water (acres)	Low Water (%)	High Water (acres)	High Water (%)	Low Water (acres)	Low Water (%)	High Water (acres)	High Water (%)	
Bear River Hydrologic Unit																	
Cropland	83,870	99	83,352	99	394	0	378	0	197	0	197	0	0	0	0	0	84,507
Developed	4,495	87	4,491	87	53	1	50	1	626	12	626	12	0	0	0	0	5,180
Emergent Marsh	4,133	50	2,455	30	2,659	32	742	9	3	0	2	0	256	3	229	3	8,283
Mudflat/Pickleweed	28,346	33	17,445	21	46,867	55	10,945	13	4,352	5	2,645	3	796	1	703	1	84,797
Pasture	81,021	96	79,661	94	2,112	3	1,957	2	1,079	1	1,078	1	32	0	27	0	84,362
Riparian	1,165	74	1,090	70	365	23	28	2	0	0	0	0	0	0	0	0	1,566
Scrub	32,548	86	31,541	84	3,269	9	3,004	8	1,667	4	1,667	4	89	0	79	0	37,659
Upland	356	82	353	81	16	4	14	3	61	14	61	14	0	0	0	0	433
Wet Meadow	24,356	55	17,445	39	15,953	36	5,476	12	174	0	172	0	201	0	114	0	44,377
Jordan River Hydrologic Unit																	
Cropland	627	100	627	100	0	0	0	0	0	0	0	0	0	0	0	0	627
Developed	87,285	100	87,181	100	279	0	263	0	0	0	0	0	6	0	6	0	87,588
Emergent Marsh	7,186	64	2,332	21	2,836	25	12	0	0	0	0	0	0	0	0	0	11,261
Mudflat/Pickleweed	14,693	61	9,026	38	8,519	35	232	1	0	0	0	0	0	0	0	0	24,065
Pasture	32,512	99	32,445	99	375	1	374	1	4	0	4	0	0	0	0	0	32,903
Riparian	182	97	175	93	6	3	1	1	0	0	0	0	0	0	0	0	188
Scrub	31,160	98	30,687	96	614	2	602	2	71	0	71	0	0	0	0	0	31,923
Upland	7,810	97	7,755	96	226	3	226	3	3	0	3	0	0	0	0	0	8,053
Wet Meadow	8,009	93	6,328	74	396	5	126	1	0	0	0	0	0	0	0	0	8,601
Ogden Hydrologic Unit																	
Cropland	22,932	100	22,925	100	51	0	50	0	1	0	0	0	1	0	1	0	22,987
Developed	39,220	96	39,216	96	1,377	3	1,335	3	18	0	18	0	6	0	6	0	40,650
Emergent Marsh	3,752	24	2,654	17	10,860	71	559	4	274	2	37	0	9	0	1	0	15,363
Mudflat/Pickleweed	2,653	20	1,716	13	9,891	76	302	2	137	1	16	0	7	0	0	0	13,045
Pasture	60,092	97	60,046	97	1,643	3	1,601	3	176	0	176	0	2	0	2	0	61,931
Riparian	1,421	95	1,415	95	62	4	25	2	5	0	5	0	0	0		0	1,490
Scrub	24,626	91	24,484	90	2,039	7	1,801	7	490	2	488	2	3	0	3	0	27,201
Upland	4,727	96	4,723	96	143	3	142	3	33	1	33	1	0	0	0	0	4,905
Wet Meadow	12,319	72	10,994	64	3,993	23	845	5	680	4	295	2	2	0		0	17,201

Table 3-11. Continued

Habitat	Private				Public				Public / Private				Public Trust				Total Low Water (acres)[1]
	Low Water (acres)	Low Water (%)	High Water (acres)	High Water (%)	Low Water (acres)	Low Water (%)	High Water (acres)	High Water (%)	Low Water (acres)	Low Water (%)	High Water (acres)	High Water (%)	Low Water (acres)	Low Water (%)	High Water (acres)	High Water (%)	
Promontory Point West Hydrologic Unit																	
Cropland	1,047	100	1,047	100	0	0	0	0	0	0	0	0	0	0	0	0	1,047
Developed	4	46	3	32	0	0	0	0	0	0	0	0	0	0	0	0	8
Emergent Marsh	89	100	89	100	0	0	0	0	0	0	0	0	0	0	0	0	89
Mudflat/Pickleweed	1,257	34	1,243	33	2,381	64	547	15	0	0	0	0	42	1	42	1	3,747
Pasture	7,985	100	7,978	99	20	0	18	0	0	0	0	0	0	0	0	0	8,025
Riparian	28	89	28	89	3	11	3	11	0	0	0	0	0	0	0	0	32
Scrub	14,734	99	14,720	99	101	1	87	1	0	0	0	0	0	0	0	0	14,917
Upland	0	33	0	33	0	33	0	33	0	0	0	0	0	0	0	0	1
Wet Meadow	646	79	636	78	42	5	41	5	0	0	0	0	0	0	0	0	819
Salt Lake Hydrologic Unit																	
Cropland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Developed	0	0	0	0	70	91	35	46	0	0	0	0	0	0	0	0	77
Emergent Marsh	113	7	7	0	1,521	87	89	5	0	0	0	0	0	0	0	0	1,740
Mudflat/Pickleweed	186	1	21	0	12,947	89	208	1	3	0	0	0	0	0	0	0	14,608
Pasture	400	5	381	5	7,384	95	7,244	93	0	0	0	0	0	0	0	0	7,796
Riparian	0	0		0	48	81	8	14	0	0	0	0	0	0	0	0	59
Scrub	2,714	22	2,548	21	9,434	77	9,092	74	0	0	0	0	0	0	0	0	12,258
Upland	115	19	115	19	481	80	457	76	0	0	0	0	0	0	0	0	598
Wet Meadow	43	5	6	1	756	85	168	19	1	0	1	0	0	0	0	0	887
Tooele Valley Hydrologic Unit																	
Cropland	589	100	588	100	0	0	0	0	0	0	0	0	0	0	0	0	589
Developed	2,871	91	2,774	88	220	7	180	6	0	0	0	0	56	2	51	2	3,163
Emergent Marsh	327	77	292	69	73	17	29	7	0	0	0	0	6	1	5	1	425
Mudflat/Pickleweed	12,663	29	8,649	20	19,480	45	1,338	3	0	0	0	0	10,576	25	8,807	20	43,120
Pasture	24,471	89	24,392	89	2,748	10	2,684	10	0	0	0	0	314	1	314	1	27,557
Riparian	153	82	117	63	28	15	22	12	0	0	0	0	7	4	7	4	188
Scrub	31,479	66	31,168	66	13,739	29	13,518	28	0	0	0	0	2,276	5	2,276	5	47,565
Upland	1,722	77	1,705	76	470	21	453	20	0	0	0	0	32	1	32	1	2,231
Wet Meadow	11,324	85	10,280	77	516	4	70	1	0	0	0	0	1,371	10	1,356	10	13,265

Table 3-11. Continued

Habitat	Private				Public				Public / Private				Public Trust				Total Low Water (acres)[1]
	Low Water (acres)	Low Water (%)	High Water (acres)	High Water (%)	Low Water (acres)	Low Water (%)	High Water (acres)	High Water (%)	Low Water (acres)	Low Water (%)	High Water (acres)	High Water (%)	Low Water (acres)	Low Water (%)	High Water (acres)	High Water (%)	
Utah Lake Hydrologic Unit																	
Cropland	3,909	98	3,909	98	61	2	61	2	5	0	5	0	1	0	1	0	3,985
Developed	22,197	98	22,197	98	95	0	95	0	69	0	69	0	2	0	2	0	22,750
Emergent Marsh	1,657	29	1,657	29	451	8	451	8	80	1	80	1	11	0	11	0	5,657
Mudflat/Pickleweed	749	49	749	49	763	50	763	50	12	1	12	1	0	0	0	0	1,533
Pasture	60,935	97	60,935	97	1,055	2	1,055	2	286	0	286	0	182	0	182	0	62,591
Riparian	152	74	152	74	40	19	40	19	0	0	0	0	0	0	0	0	205
Scrub	30,873	90	30,873	90	1,468	4	1,468	4	920	3	920	3	742	2	742	2	34,495
Upland	5,545	95	5,545	95	214	4	214	4	83	1	83	1	10	0	10	0	5,864
Wet Meadow	11,083	79	11,083	79	2,083	15	2,083	15	254	2	254	2	0	0	0	0	13,989

[1] The acreages shown in Total Low Water includes areas for which the available dataset did not provide ownership information.

Table 3-12. Distribution of Existing Habitat in the Region by Potential Population Density Category (2001–2030)

Potential Loss/Degradation of Wildlife Habitat (2001)						
Population Density:	High		Moderate		Low	
Habitat	Acres	%	Acres	%	Acres	%
Cropland	3,329	13	17,861	68	5,041	19
Emergent Marsh	70	0	6,470	44	8,141	55
Mudflat/Pickleweed	15	0	3,400	24	11,029	76
Pasture	43,134	15	66,662	24	173,408	61
Riparian	326	18	1,079	61	359	20
Scrub	25,300	5	49,258	10	403,572	84
Upland	16,132	4	25,284	6	350,289	89
Wet Meadow	1,383	5	12,322	42	15,442	53

Potential Loss/Degradation of Wildlife Habitat (2010)						
Population Density:	High		Moderate		Low	
Habitat	Acres	%	Acres	%	Acres	%
Cropland	4,380	17	16,810	64	5,041	19
Emergent Marsh	379	3	6,171	42	8,131	55
Mudflat/Pickleweed	35	<1	3,394	23	11,014	76
Pasture	59,612	21	51,325	18	172,268	61
Riparian	423	24	982	56	359	20
Scrub	36,286	8	39,455	8	402,389	84
Upland	19,052	5	22,535	6	350,117	89
Wet Meadow	1,973	7	11,757	40	15,418	53

Potential Loss/Degradation of Wildlife Habitat (2020)						
Population Density:	High		Moderate		Low	
Habitat	Acres	%	Acres	%	Acres	%
Cropland	6,087	23	15,102	58	5,041	19
Emergent Marsh	1,014	7	5,537	38	8,130	55
Mudflat/Pickleweed	247	2	3,183	22	11,014	76
Pasture	73,744	26	40,419	14	169,042	60
Riparian	515	29	891	50	359	20
Scrub	49,926	10	33,928	7	394,277	82
Upland	23,791	6	20,004	5	347,910	89
Wet Meadow	5,275	18	8,455	29	15,418	53

Potential Loss/Degradation of Wildlife Habitat (2030)

Population Density:	High		Moderate		Low	
Habitat	Acres	%	Acres	%	Acres	%
Cropland	8,672	33	12,518	48	5,041	19
Emergent Marsh	1,433	10	5,118	35	8,130	55
Mudflat/Pickleweed	288	2	3,142	22	11,014	76
Pasture	82,735	29	32,118	11	168,351	59
Riparian	799	45	606	34	359	20
Scrub	60,322	13	24,835	5	392,974	82
Upland	31,636	8	12,824	3	347,243	89
Wet Meadow	5,820	20	7,910	27	15,418	53

Table 3-13. Distribution of Existing Habitat in the Jordan River Hydrologic Unit by Potential Population Density Category (2001–2030)

Potential Loss/Degradation of Wildlife Habitat (2001)							
Population Density:	High		Moderate		Low		
Habitat	Acres	%	Acres	%	Acres	%	Total
Cropland	461	54	390	46	1	<1	852
Emergent Marsh	26	1	1,917	59	1,293	40	3,235
Mudflat/Pickleweed	8	<1	826	8	9,361	92	10,196
Pasture	21,858	41	24,058	45	7,383	14	53,299
Riparian	86	52	74	45	5	3	165
Scrub	14,532	24	28,173	46	19,003	31	61,709
Upland	12,838	40	13,052	41	5,919	19	31,809
Wet Meadow	646	16	2,519	61	998	24	4,163

Potential Loss/Degradation of Wildlife Habitat (2010)							
Population Density:	High		Moderate		Low		
Habitat	Acres	%	Acres	%	Acres	%	Total
Cropland	685	80	165	19	1	<1	852
Emergent Marsh	71	2	1,881	58	1,283	40	3,235
Mudflat/Pickleweed	17	<1	831	8	9,347	92	10,196
Pasture	31,867	60	15,190	28	6,242	12	53,299
Riparian	93	57	66	40	5	3	165
Scrub	21,616	35	22,273	36	17,820	29	61,709
Upland	14,833	47	11,229	35	5,747	18	31,809
Wet Meadow	819	20	2,370	57	974	23	4,163

Potential Loss/Degradation of Wildlife Habitat (2020)							
Population Density:	High		Moderate		Low		
Habitat	Acres	%	*Acres*	%	Acres	%	Total
Cropland	686	81	164	19	1	<1	852
Emergent Marsh	193	6	1,760	54	1,282	40	3,235
Mudflat/Pickleweed	34	<1	815	8	9,347	92	10,196
Pasture	38,699	73	11,583	22	3,017	6	53,299
Riparian	122	74	38	23	5	3	165
Scrub	33,248	54	18,754	30	9,708	16	61,709
Upland	18,852	59	9,417	30	3,540	11	31,809
Wet/Meadow	942	23	2,247	54	974	23	4,163

Table 3-13. Continued

Potential Loss/Degradation of Wildlife Habitat (2030)

Population Density:	High		Moderate		Low		
Habitat	Acres	%	Acres	%	Acres	%	Total
Cropland	768	90	83	10	1	<1	852
Emergent Marsh	193	6	1,760	54	1,282	40	3,235
Mudflat/Pickleweed	36	<1	813	8	9,347	92	10,196
Pasture	42,904	80	8,069	15	2,326	4	53,299
Riparian	150	91	10	6	5	3	165
Scrub	40,193	65	13,112	21	8,405	14	61,709
Upland	22,144	70	6,791	21	2,874	9	31,809
Wet Meadow	943	23	2,246	54	974	23	4,163

Table 3-14. Distribution of Existing Habitat in the Ogden Hydrologic Unit by Potential Population Density Category (2001–2030)

Potential Loss/Degradation of Wildlife Habitat (2001)							
Population Density:	High		Moderate		Low		
Habitat	Acres	%	Acres	%	Acres	%	Total
Cropland	2,868	14	17,471	86	3	<1	20,342
Emergent Marsh	45	1	4,458	98	31	1	4,534
Mudflat/Pickleweed	7	<1	2,218	100	3	<1	2,228
Pasture	21,274	33	42,574	66	847	1	64,695
Riparian	240	18	1,006	76	77	6	1,322
Scrub	10,739	33	21,036	65	754	2	32,529
Upland	3,281	21	12,190	78	168	1	15,639
Wet Meadow	737	7	9,764	93	14	<1	10,515

Potential Loss/Degradation of Wildlife Habitat (2010)							
Population Density:	High		Moderate		Low		
Habitat	Acres	%	Acres	%	Acres	%	Total
Cropland	3,695	18	16,644	82	3	<1	20,342
Emergent Marsh	278	6	4,225	93	31	1	4,534
Mudflat/Pickleweed	18	1	2,207	99	3	<1	2,228
Pasture	27,716	43	36,133	56	847	1	64,695
Riparian	330	25	915	69	77	6	1,322
Scrub	14,604	45	17,171	53	754	2	32,529
Upland	4,168	27	11,303	72	168	1	15,639
Wet Meadow	1,154	11	9,347	89	14	<1	10,515

Potential Loss/Degradation of Wildlife Habitat (2020)							
Population Density:	High		Moderate		Low		
Habitat	Acres	%	Acres	%	Acres	%	Total
Cropland	5,401	27	14,938	73	3	<1	20,342
Emergent Marsh	770	17	3,733	82	31	1	4,534
Mudflat/Pickleweed	169	8	2,057	92	3	<1	2,228
Pasture	35,015	54	28,834	45	847	1	64,695
Riparian	392	30	853	65	77	6	1,322
Scrub	16,608	51	15,168	47	754	2	32,529
Upland	4,888	31	10,583	68	168	1	15,639
Wet Meadow	4,329	41	6,172	59	14	<1	10,515

Table 3-14. Continued

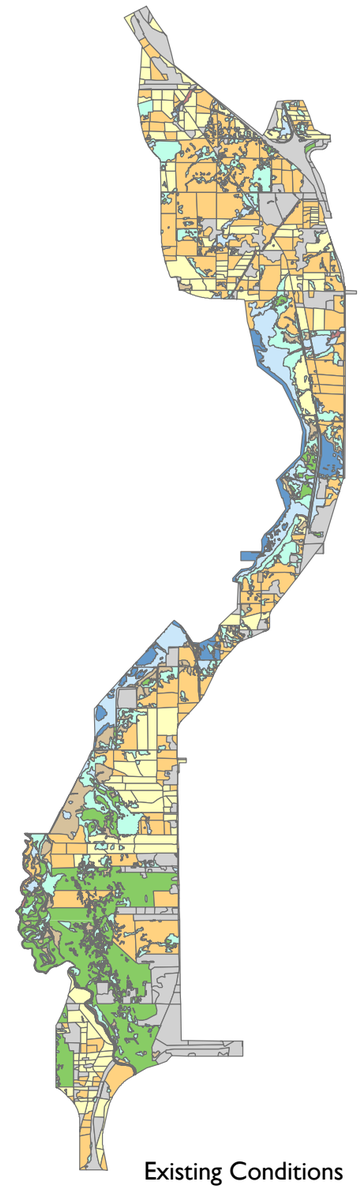
Potential Loss/Degradation of Wildlife Habitat (2030)							
Population Density:	High		Moderate		Low		
Habitat	Acres	%	Acres	%	Acres	%	Total
Cropland	7,904	39	12,435	61	3	<1	20,342
Emergent Marsh	1,188	26	3,315	73	31	1	4,534
Mudflat/Pickleweed	208	9	2,017	91	3	<1	2,228
Pasture	39,800	62	24,049	37	847	1	64,695
Riparian	649	49	596	45	77	6	1,322
Scrub	20,056	62	11,720	36	754	2	32,529
Upland	9,438	60	6,033	39	168	1	15,639
Wet Meadow	4,873	46	5,628	54	14	<1	10,515

Table 3-15. Potential Impact (acres) of Future Development and the Build Alternatives in the Project Study Area

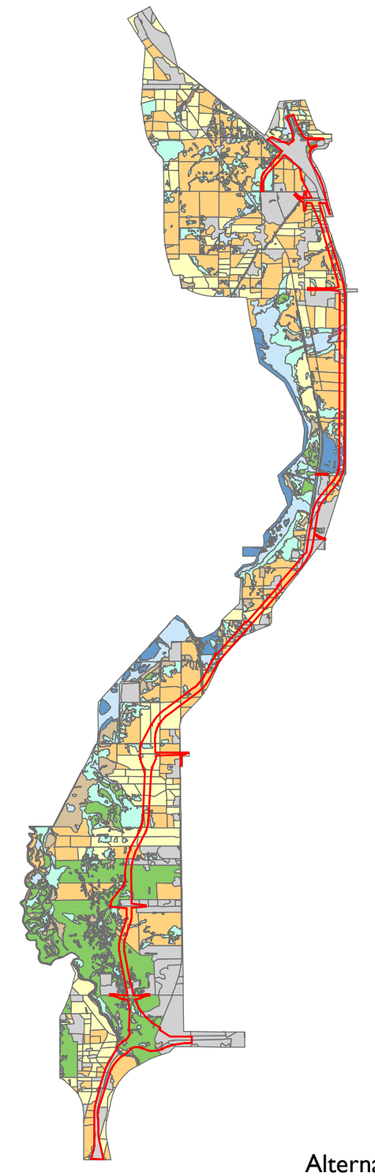
Habitat	Total Project Study Area	Build Out		Alternative A and Build Out		Alternative B and Build Out		Alternative C and Build Out		Alternative E and Build Out	
		Developed	Developable	Developed	Developable	Developed	Developable	Developed	Developable	Developed	Developable
Cropland	1733.1	264.3	1103.2	379.9	988.2	482.9	938.6	264.3	1011.6	374.3	994.4
Developed	1715.9	990.3	294.4	1049.5	271.2	1052.9	275.7	990.3	273.0	1053.5	270.5
Emergent Marsh	707.2	37.4	161.1	52.0	155.6	74.3	139.1	37.4	151.5	55.0	152.6
Mudflat/Pickleweed	439.8	11.6	168.9	17.3	167.4	26.3	156.5	11.6	152.1	26.4	159.7
Open Water	312.8	8.1	27.1	16.6	24.7	30.5	20.4	8.1	21.3	21.9	19.3
Pasture	2963.3	588.5	1706.5	754.2	1545.3	849.3	1544.0	588.5	1547.5	787.8	1522.9
Riparian	70.9	12.2	21.8	14.2	19.7	15.2	19.6	12.2	18.6	14.9	19.0
Scrub	1282.2	167.4	799.9	283.7	688.1	232.7	748.7	167.4	673.8	282.6	690.2
Wet Meadow	1118.9	68.7	566.8	130.2	511.6	147.0	506.3	68.7	499.6	127.7	515.8
Wetland	2649.7	138.1	945.6	230.4	878.9	293.5	841.8	138.1	843.1	246.0	866.4
Upland	5978.6	1020.2	3609.6	1417.8	3221.7	1564.9	3231.2	1020.2	3233.0	1444.8	3207.4

Chapter 3

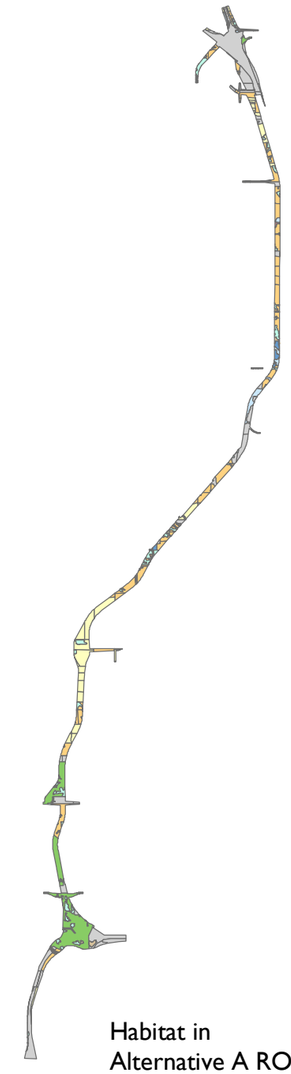
Figures



1 Existing Conditions



2 Alternative A*



3 Habitat in Alternative A ROW*

Legend

- Cropland
- Developed
- Emergent Marsh
- Mudflat/Pickleweed
- Open Water
- Pasture
- Riparian
- Scrub
- Wet Meadow
- Alternative Alignments

N

2.5 1.25 0 2.5 5

Kilometers

Map Production: 12/15/03

Data Sources: UDOT Project Alternatives and Wetland / Wildlife Habitat Data

*Supplemental EIS 312 Foot ROWs used for the Alternatives

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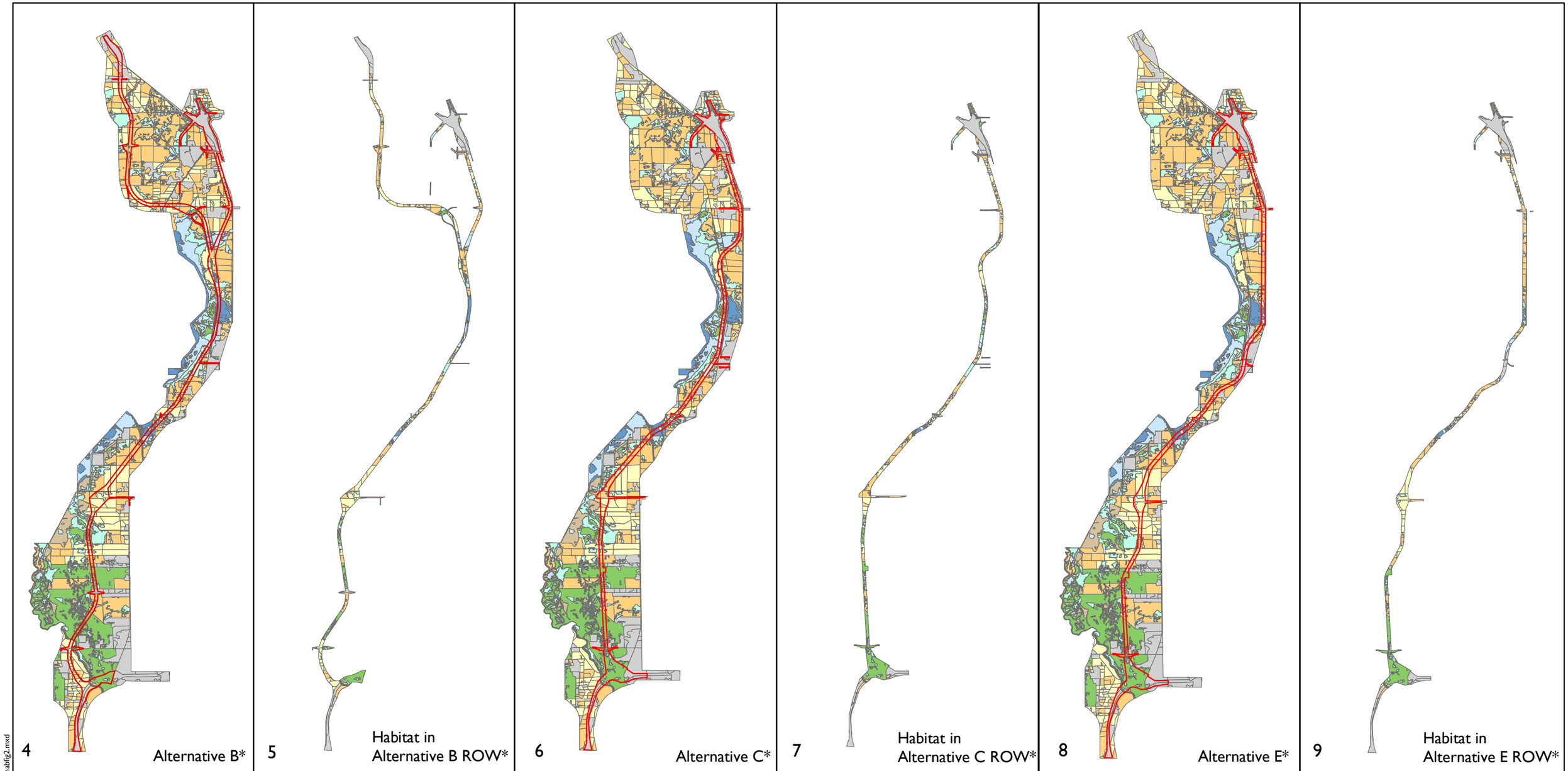
Jones & Stokes

Figure 3-1a

Legacy Parkway Study Area: Potential Direct Habitat Loss



Legend

- Cropland
- Developed
- Emergent Marsh
- Mudflat/Pickleweed
- Open Water
- Pasture
- Riparian
- Scrub
- Wet Meadow
- Alternative Alignment

N

2.5 1.25 0 2.5 5

Kilometers

Map Production: 1/15/04
Data Sources: UDOT Project Alternatives and Wetland / Wildlife Habitat Data
*Supplemental EIS 312 foot ROWs used for the Alternatives

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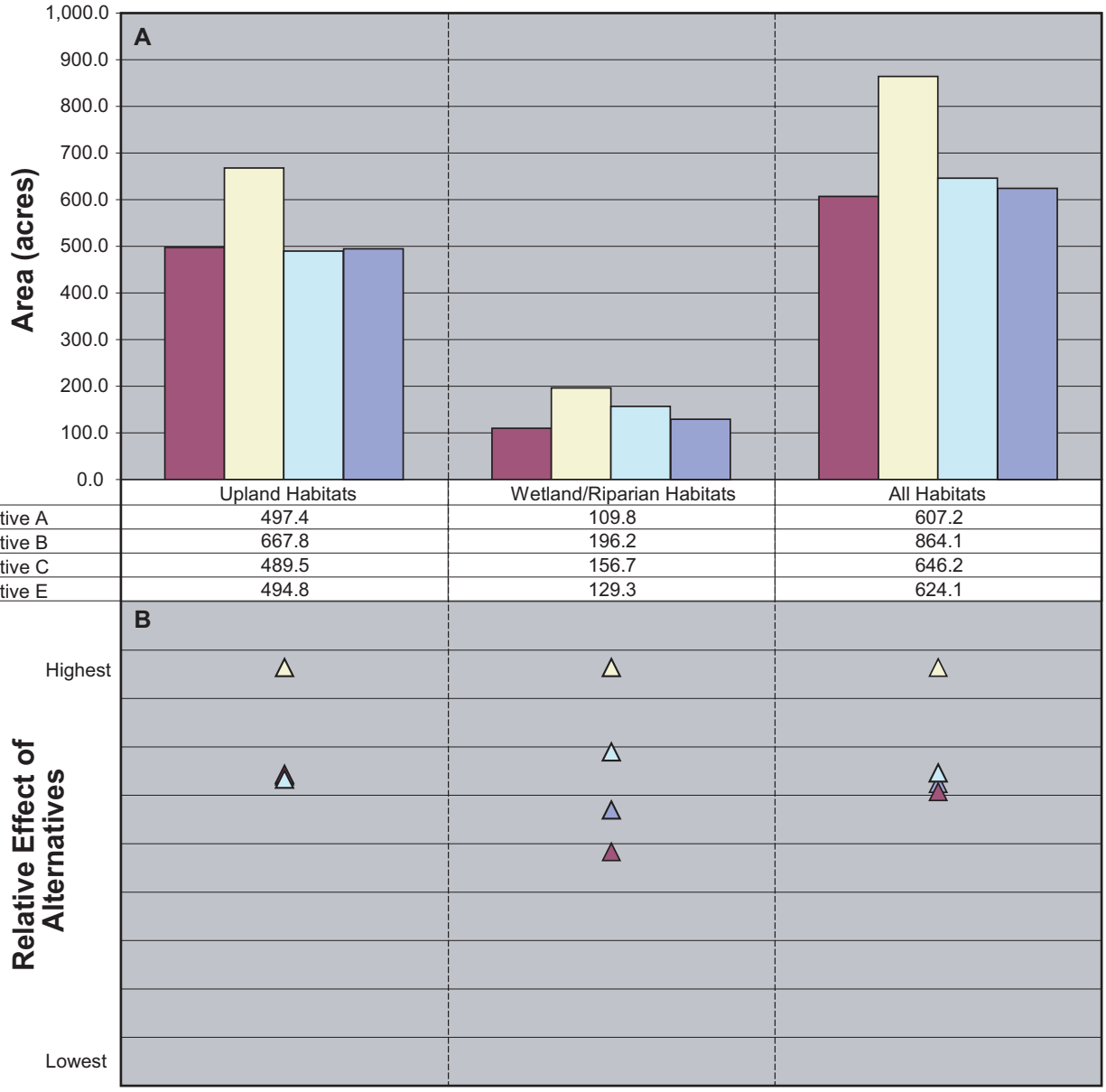
Figure 3-1b
Legacy Parkway Study Area: Potential Direct Habitat Loss



	Upland Habitats	Wetland/Riparian Habitats	All Habitats
Alternative A	497.4	109.8	607.2
Alternative B	667.8	196.2	864.1
Alternative C	489.5	156.7	646.2
Alternative E	494.8	129.3	624.1

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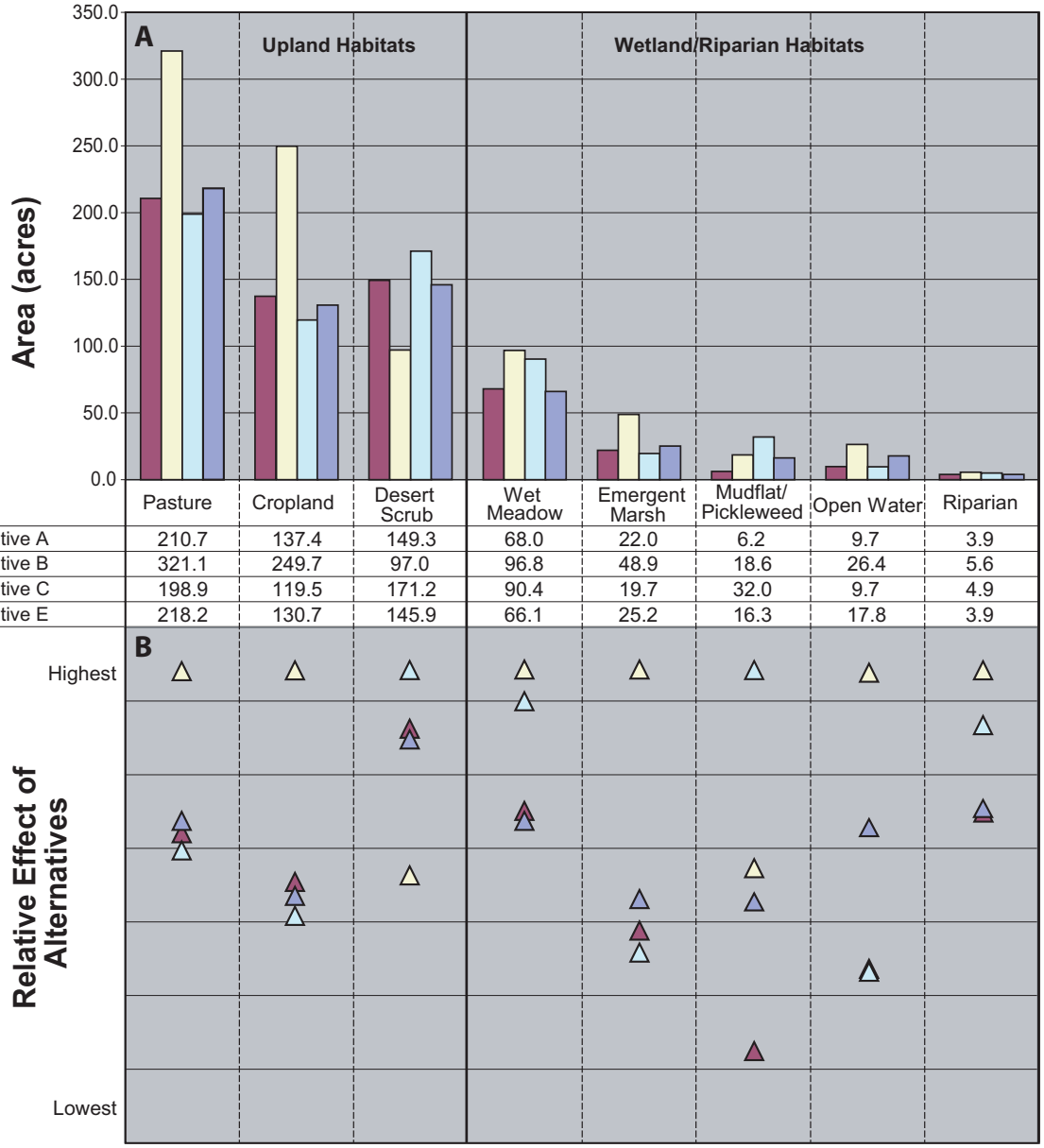
Figure 3-2
Total Direct Habitat Loss in Project Study Area



	Pasture	Cropland	Desert Scrub	Wet Meadow	Emergent Marsh	Mudflat/ Pickleweed	Open Water	Riparian
Alternative A	210.7	137.4	149.3	68.0	22.0	6.2	9.7	3.9
Alternative B	321.1	249.7	97.0	96.8	48.9	18.6	26.4	5.6
Alternative C	198.9	119.5	171.2	90.4	19.7	32.0	9.7	4.9
Alternative E	218.2	130.7	145.9	66.1	25.2	16.3	17.8	3.9

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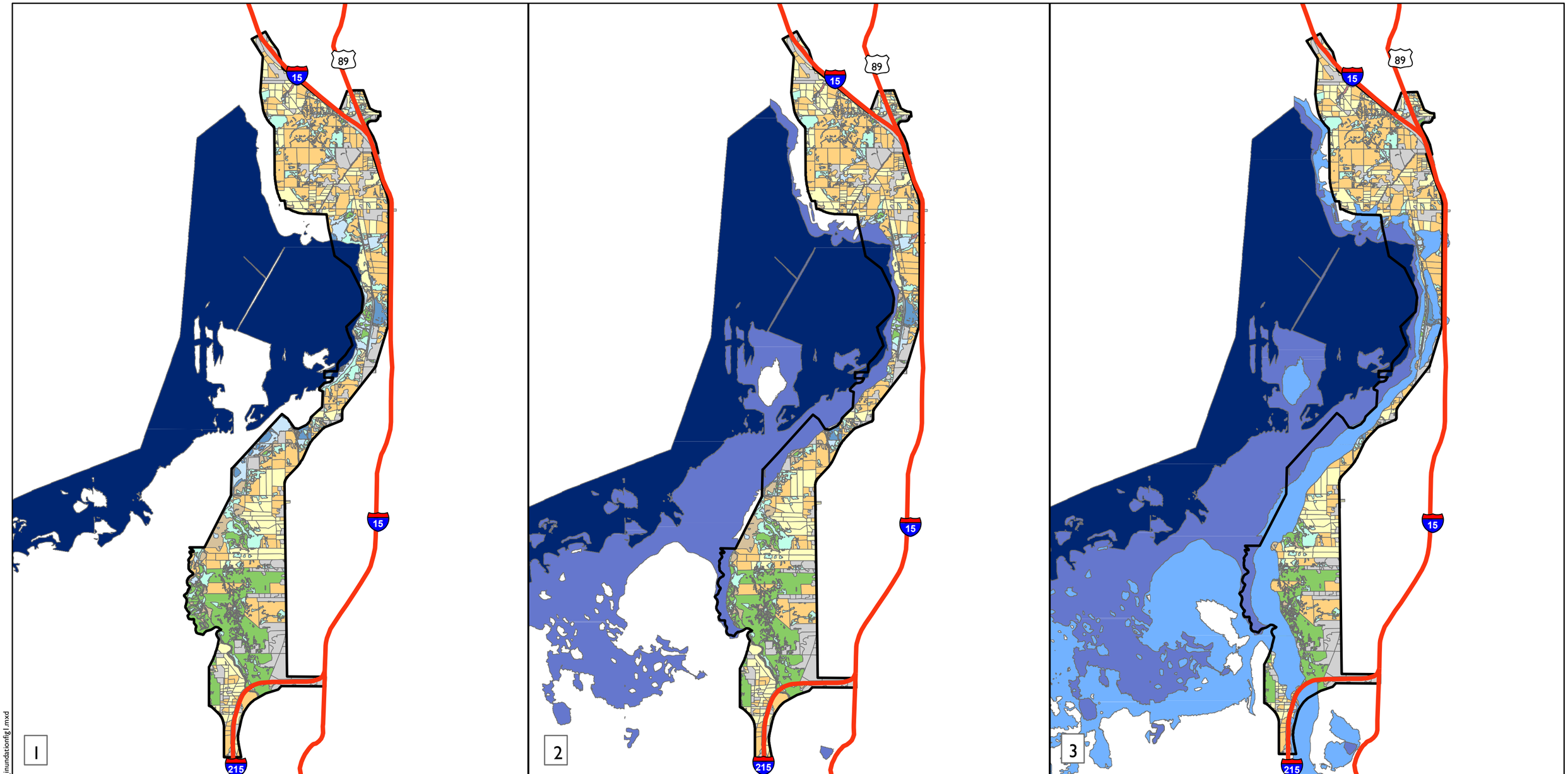
Figure 3-3
Direct Habitat Loss in Project Study Area
By Habitat Type



Legend

- Major Existing Roads
- Project Study Area Boundary

Inundation Zones

1 (4200 - 4204)
2 (4204-4208)
3 (4208-4212)
4 (4212-4216)
5 (4216-4220)
6 (>4220)

Wetland / Wildlife Habitats

- Cropland
- Developed
- Emergent Marsh
- Mudflat/Pickleweed
- Open Water
- Pasture
- Riparian
- Scrub
- Wet Meadow

2.5 1.25 0 2.5 5
Kilometers

Map Production: 12/15/03
Data Sources: UDOT Project Study Area Boundary, Exsiting Roads. Contours Generated USGS 10 Meter Digital Elevation Model (DEM)

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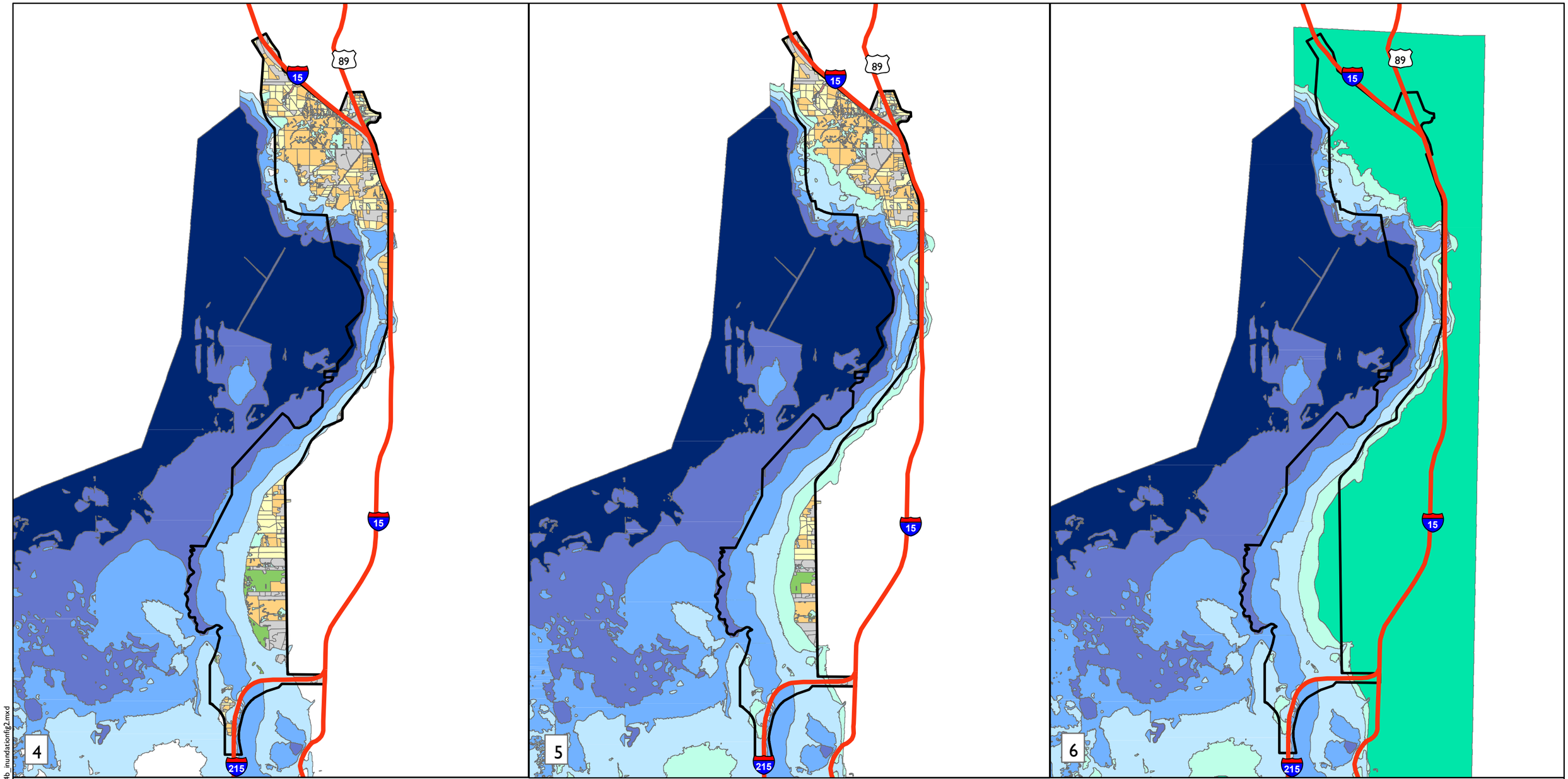
Figure 3-4a
Great Salt Lake Inundation Zones



Legend

- Major Existing Roads
- Project Study Area Boundary

Inundation Zones

1 (4200 - 4204)
2 (4204-4208)
3 (4208-4212)
4 (4212-4216)
5 (4216-4220)
6 (>4220)

Wetland / Wildlife Habitats

- Cropland
- Developed
- Emergent Marsh
- Mudflat/Pickleweed
- Open Water
- Pasture
- Riparian
- Scrub
- Wet Meadow

2.5 1.25 0 2.5 5
Kilometers

Map Production: 12/15/03
Data Sources: UDOT Project Study Area Boundary, Exsiting Roads. Contours Generated USGS 10 Meter Digital Elevation Model (DEM)

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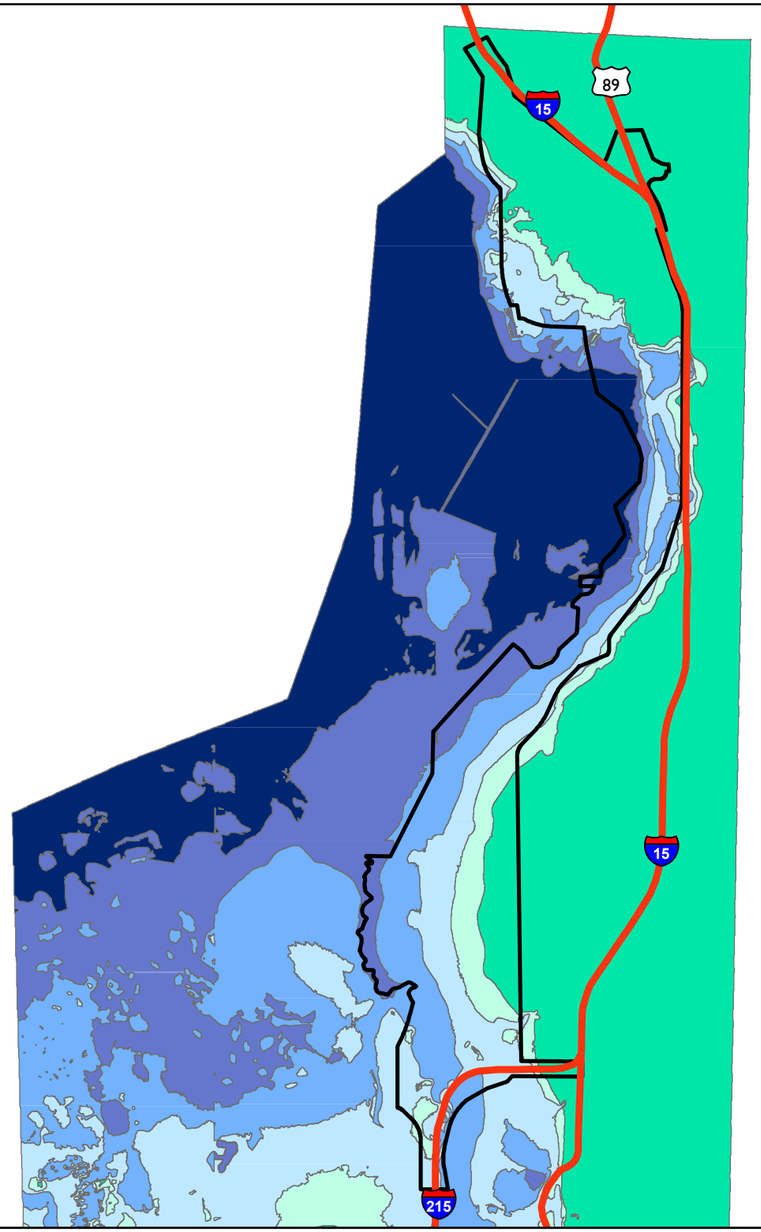
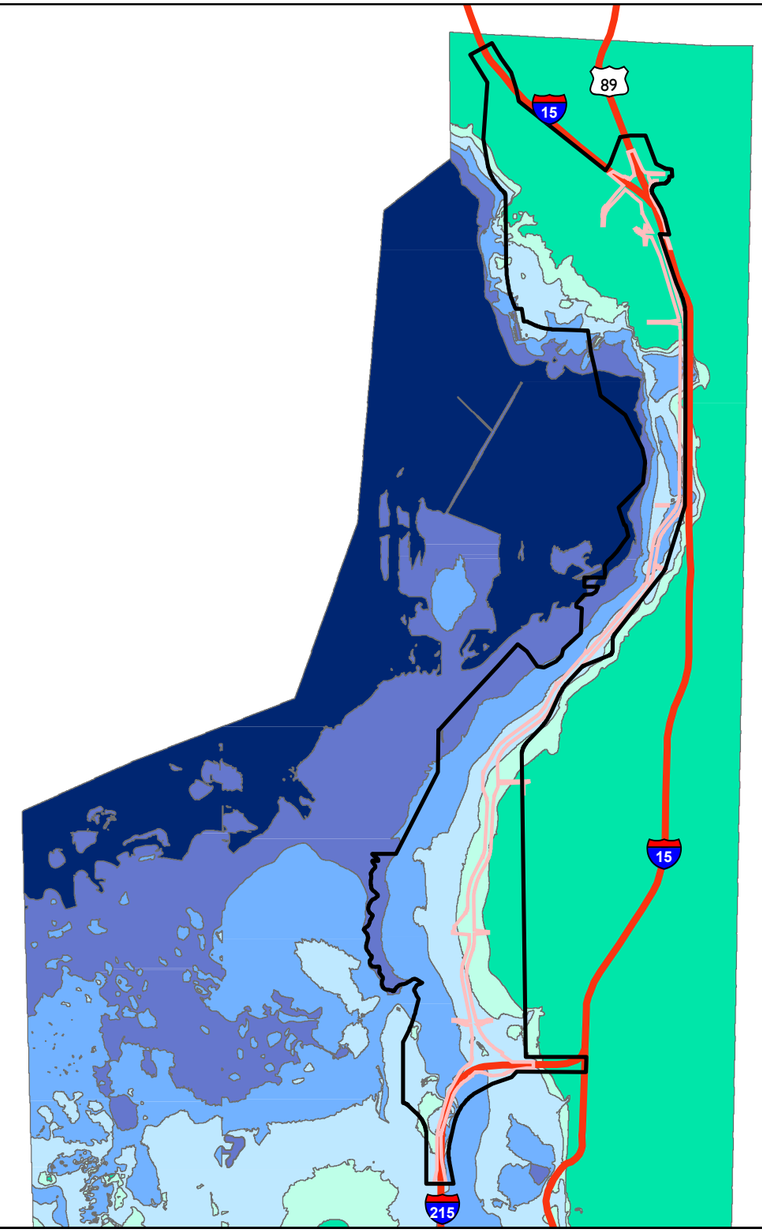
Figure 3-4b
Great Salt Lake Inundation Zones



Existing Conditions



Alternative A*

Legend

- Project Study Area Boundary
- Proposed Right of Way
- Major Existing Roads

Inundation Zones and
Probability That Lake Level Will Occur Within Each Inundation Zone

- (4200 - 4204) 33.0%
- (4204 - 4208) 24.0 %
- (4208 - 4212) 8.3. %
- (4212 - 4216) 1.7 %
- (42126- 4220) 1.7%
- (> 4220) 1.7%

2.5 1.25 0 2.5 5
Kilometers

Map Production: 12/15/03
Data Sources: UDOT Project Study Area Boundary, Project Alternatives and Exsiting Roads. Contours Generated USGS 10 Meter Digital Elevation Model (DEM)
*Supplemental EIS 312 foot ROWs used for the Alternatives

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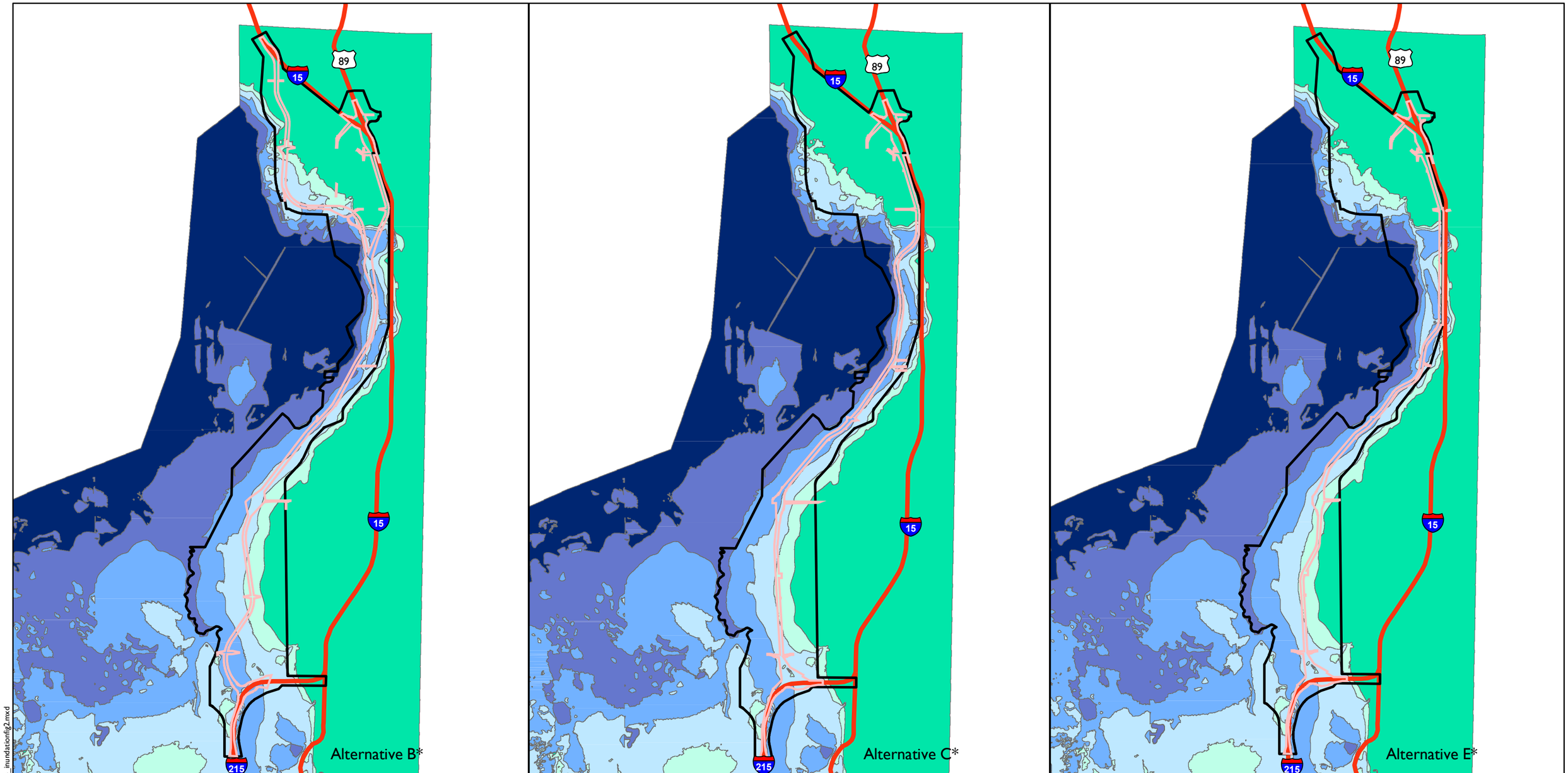
Figure 3-5a
Great Salt Lake Inundation Zones Relative to Build Alternatives



Legend

- Project Study Area Boundary
- Proposed Right of Way
- Major Existing Roads

Inundation Zones and
Probability That Lake Level Will Occur Within Each Inundation Zone

- (4200 - 4204) 33.0%
- (4204 - 4208) 24.0 %
- (4208 - 4212) 8.3. %
- (4212 - 4216) 1.7 %
- (4216- 4220) 1.7%
- (> 4220) 1.7%

2.5 1.25 0 2.5 5
Kilometers

Map Production: 12/15/03
Data Sources: UDOT Project Study Area Boundary, Project Alternatives and Exsiting Roads. Contours Generated USGS 10 Meter Digital Elevation Model (DEM)
*Supplemental EIS 312 foot ROWs used for the Alternatives

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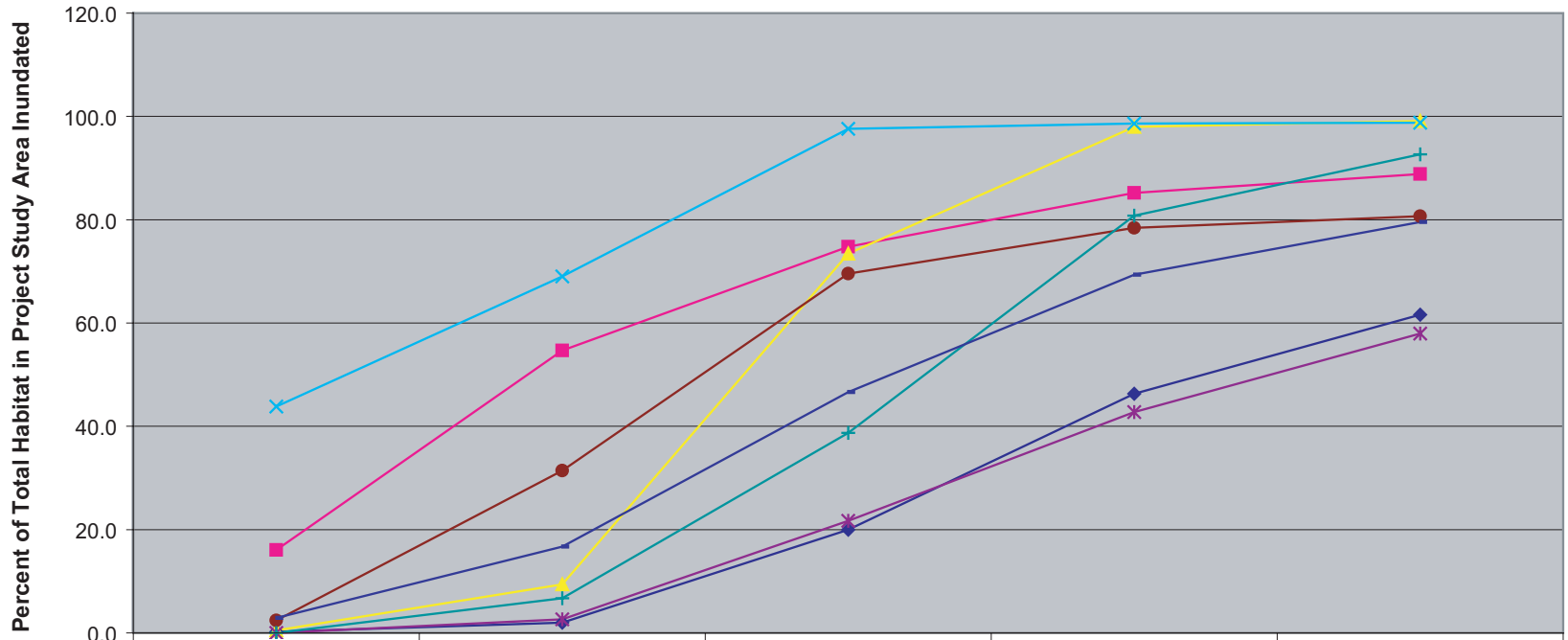
Figure 3-5b
Great Salt Lake Inundation Zones Relative to Build Alternatives



	4,204 ft (elevation)	4,204-4,208 ft	4,208-4,212 ft	4,212-4,216 ft	4,216-4,220 ft
Cropland	0.2	2.0	20.0	46.3	61.6
Emergent Marsh	16.0	54.7	74.8	85.2	88.8
Mudflat/Pickleweed	0.5	9.4	73.4	98.0	99.1
Open Water	43.8	69.0	97.6	98.6	98.8
Pasture	0.0	2.7	21.7	42.7	57.9
Riparian	2.4	31.4	69.6	78.4	80.7
Desert Salt Scrub	0.0	6.7	38.7	80.8	92.7
Wet Meadow	2.9	16.7	46.6	69.3	79.5

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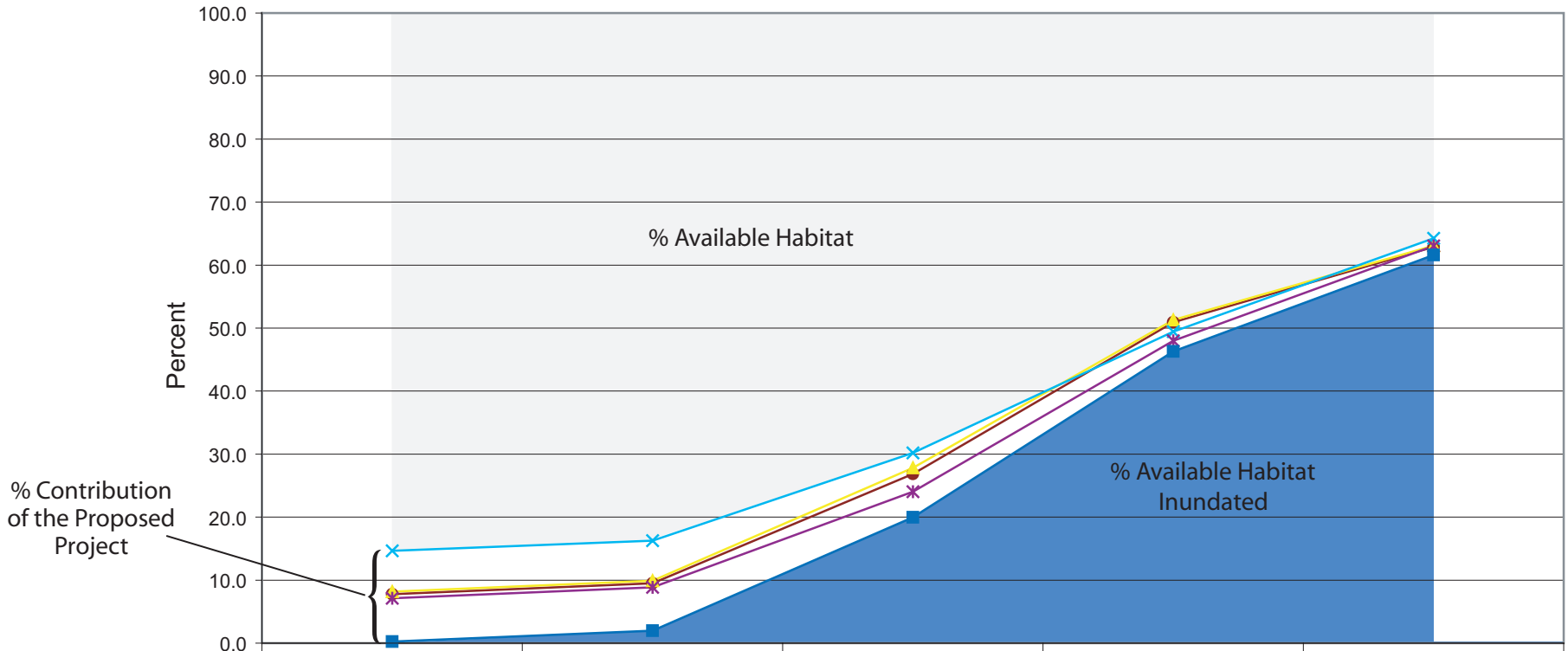
Figure 3-6
Percent Habitat Inundation with Changing Lake Levels



	4,204 ft (elevation)		4,204-4,208 ft		4,208-4,212 ft		4,212-4,216 ft		4,216-4,220 ft	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
No Action	4.2	0.2	34.1	2.0	346.1	20.0	802.4	46.3	1,067.5	61.6
Alternative A	141.6	8.2	171.6	9.9	482.1	27.8	888.9	51.3	1,093.5	63.1
Alternative B	253.9	14.7	281.7	16.3	523.0	30.2	857.0	49.4	1,113.5	64.2
Alternative C	123.7	7.1	153.5	8.9	416.3	24.0	831.5	48.0	1,092.3	63.0
Alternative E	134.9	7.8	164.9	9.5	465.6	26.9	882.6	50.9	1,090.1	62.9

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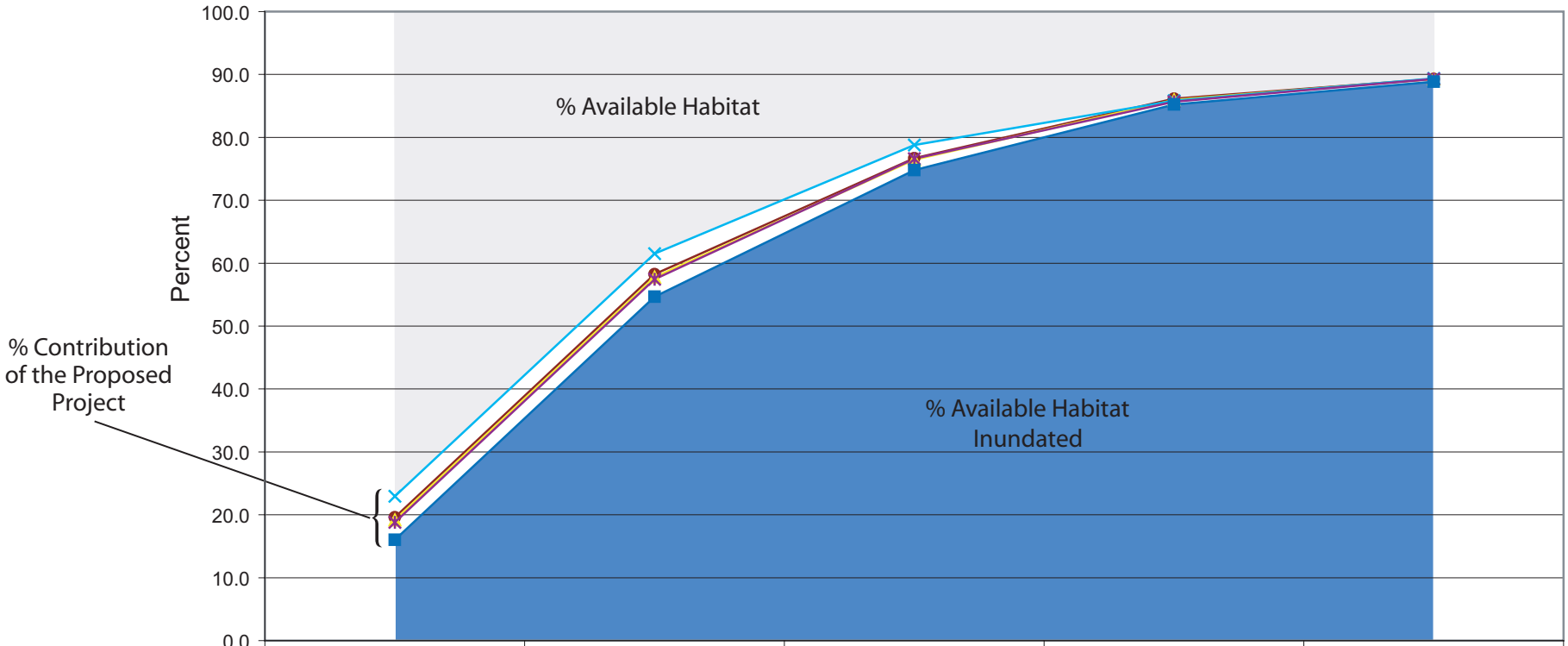
Figure 3-7
Percent Cropland Habitat Loss from Project Alternatives and Varying Lake Lake Levels



	4,204 ft (elevation)		4,204-4,208 ft		4,208-4,212 ft		4,212-4,216 ft		4,216-4,220 ft	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
No Action	113.4	16.0	386.7	54.7	528.9	74.8	602.6	85.2	628.3	88.8
Alternative A	135.4	19.1	408.7	57.8	540.8	76.5	607.8	85.9	631.6	89.3
Alternative B	162.3	22.9	435.1	61.5	557.2	78.8	606.9	85.8	632.1	89.4
Alternative C	133.1	18.8	406.4	57.5	541.8	76.6	605.9	85.7	631.4	89.3
Alternative E	138.7	19.6	412.0	58.3	542.3	76.7	609.2	86.1	631.6	89.3

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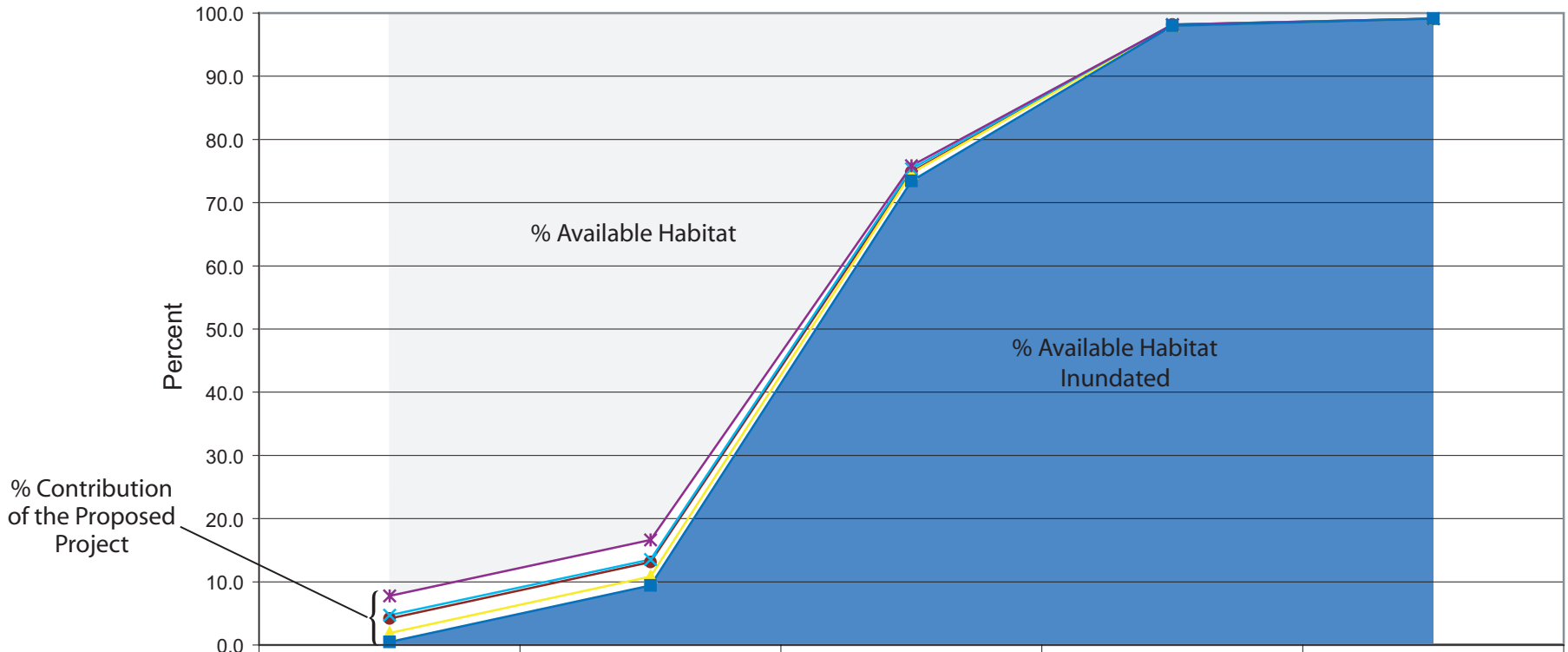
Figure 3-8
Percent Emergent Marshland Habitat Loss from Project Alternatives and Varying Lake Lake Levels



	4,204 ft (elevation)		4,204-4,208 ft		4,208-4,212 ft		4,212-4,216 ft		4,216-4,220 ft	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
No Action	2.2	0.5	41.4	9.4	323.0	73.4	431.0	98.0	435.9	99.1
Alternative A	8.4	1.9	47.6	10.8	328.4	74.7	431.2	98.1	435.9	99.1
Alternative B	20.8	4.7	59.4	13.5	331.5	75.4	431.8	98.2	435.9	99.1
Alternative C	34.1	7.8	73.1	16.6	333.6	75.9	431.7	98.1	435.9	99.1
Alternative E	18.5	4.2	57.7	13.1	329.3	74.9	431.8	98.2	435.9	99.1

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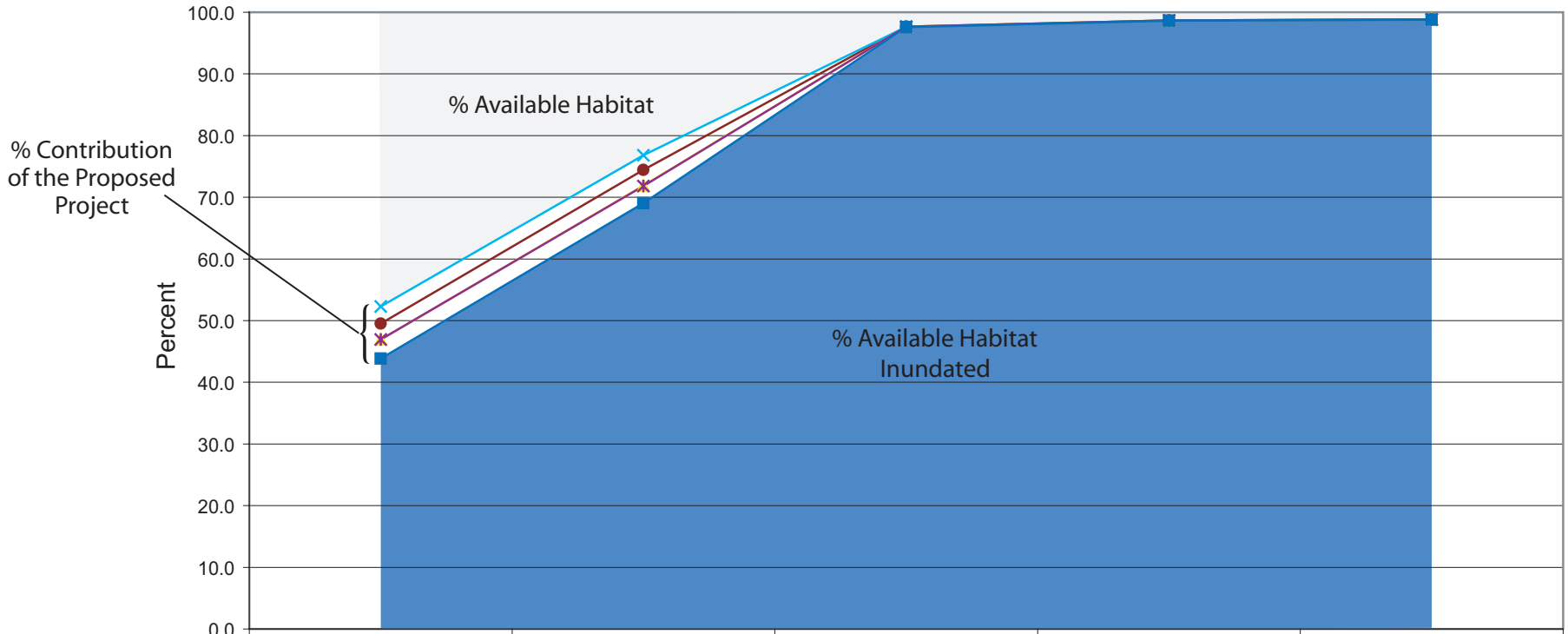
Figure 3-9
Percent Mudflat Pickleweed Habitat Loss from Project Alternatives and Varying Lake Lake Levels



	4,204 ft (elevation)		4,204-4,208 ft		4,208-4,212 ft		4,212-4,216 ft		4,216-4,220 ft	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
No Action	137.1	43.8	215.9	69.0	305.3	97.6	308.5	98.6	309.0	98.8
Alternative A	146.8	46.9	224.9	71.9	305.5	97.7	308.7	98.7	309.1	98.8
Alternative B	163.5	52.3	240.2	76.8	305.4	97.6	308.7	98.7	309.1	98.8
Alternative C	146.8	46.9	224.7	71.8	305.4	97.6	308.7	98.7	309.1	98.8
Alternative E	154.9	49.5	232.8	74.4	305.4	97.6	308.7	98.7	309.1	98.8

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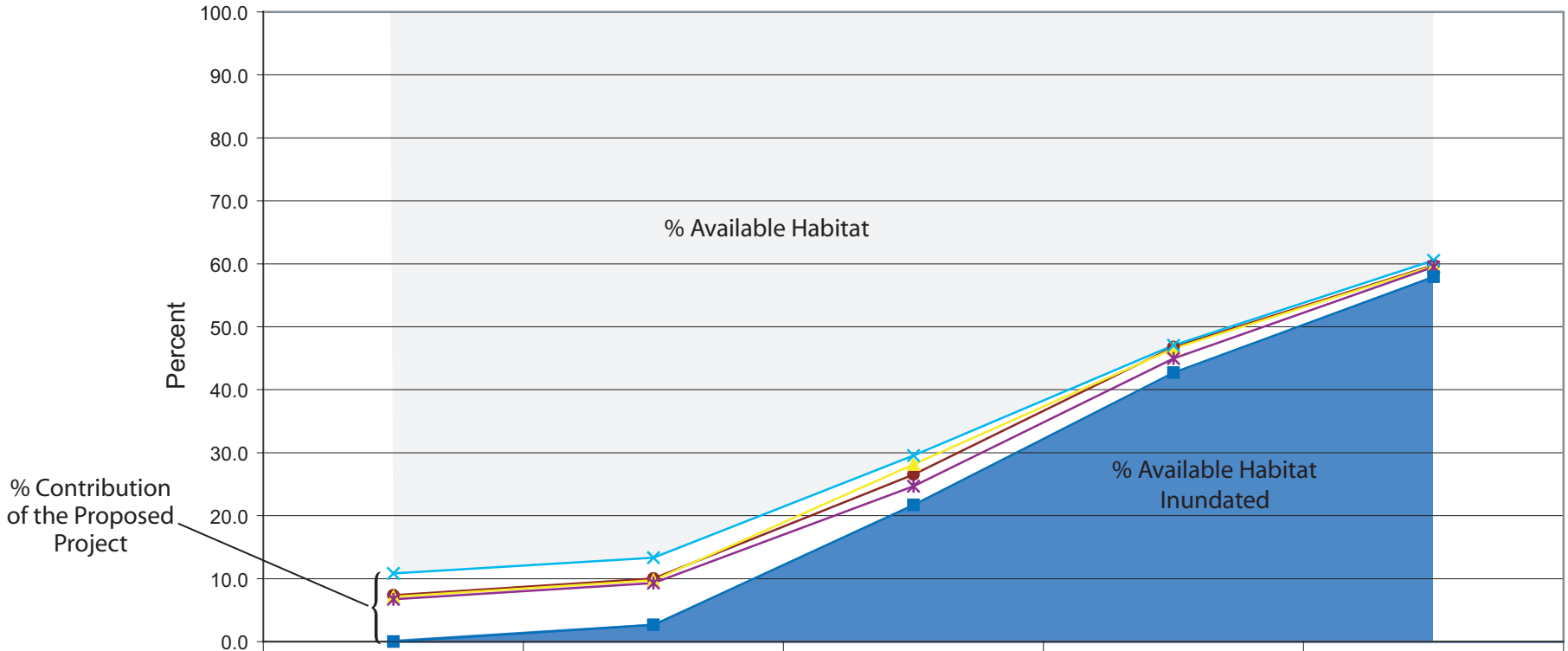
Figure 3-10
Percent Open Water Habitat Loss from Project Alternatives and Varying Lake Lake Levels



	4,204 ft (elevation)		4,204-4,208 ft		4,208-4,212 ft		4,212-4,216 ft		4,216-4,220 ft	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
No Action	0.0	0.0	78.6	2.7	634.0	21.7	1,266.3	42.7	1,717.0	57.9
Alternative A	210.7	7.1	289.2	9.8	834.1	28.1	1,378.6	46.5	1,768.4	59.7
Alternative B	321.1	10.8	394.8	13.3	875.0	29.5	1,394.4	47.1	1,794.7	60.6
Alternative C	198.9	6.7	276.1	9.3	731.1	24.7	1,332.8	45.0	1,762.7	59.5
Alternative E	218.2	7.4	296.8	10.0	786.5	26.5	1,386.8	46.8	1,771.1	59.8

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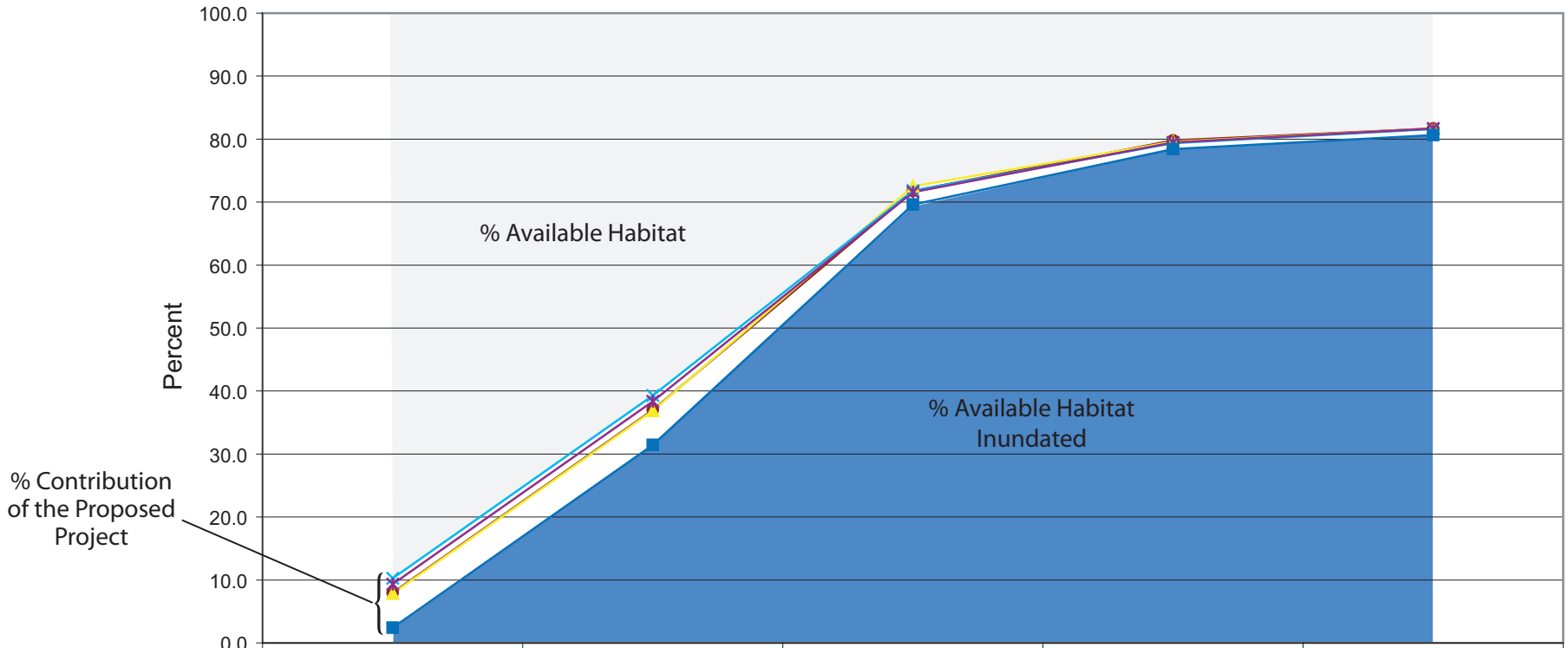
Figure 3-11
Percent Pasture Habitat Loss from Project Alternatives and Varying Lake Lake Levels



	4,204 ft (elevation)		4,204-4,208 ft		4,208-4,212 ft		4,212-4,216 ft		4,216-4,220 ft	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
No Action	1.7	2.4	22.3	31.4	49.3	69.6	55.6	78.4	57.2	80.7
Alternative A	5.6	7.9	26.1	36.9	51.4	72.5	56.4	79.6	57.9	81.7
Alternative B	7.3	10.3	27.8	39.3	50.9	71.8	56.3	79.4	57.9	81.6
Alternative C	6.6	9.3	27.2	38.4	50.7	71.6	56.3	79.4	57.9	81.7
Alternative E	5.7	8.0	26.2	37.0	50.9	71.8	56.6	79.8	57.9	81.7

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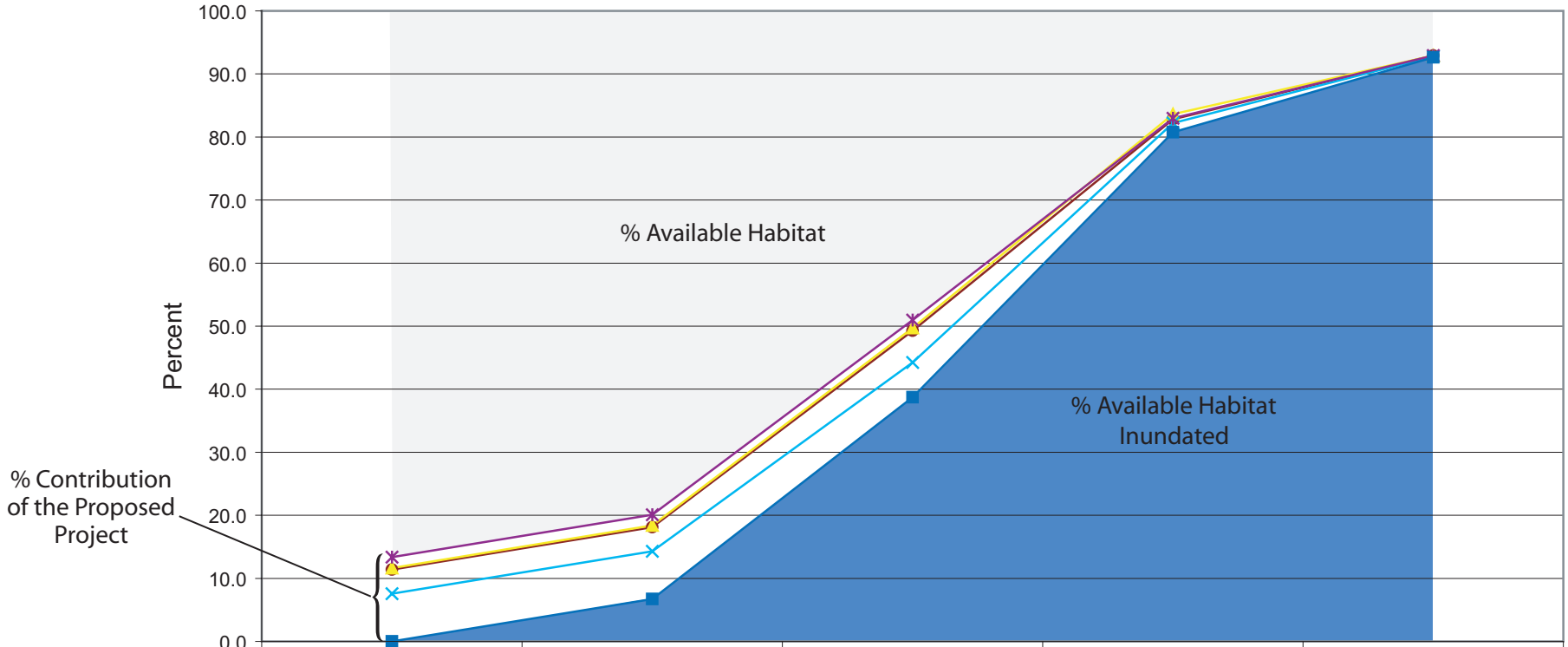
Figure 3-12
Percent Riparian Habitat Loss from Project Alternatives and Varying Lake Lake Levels



	4,204 ft (elevation)		4,204-4,208 ft		4,208-4,212 ft		4,212-4,216 ft		4,216-4,220 ft	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
No Action	0.0	0.0	86.4	6.7	496.7	38.7	1,035.7	80.8	1,187.9	92.7
Alternative A	149.3	11.6	235.7	18.4	637.2	49.7	1,071.9	83.6	1,191.4	92.9
Alternative B	97.0	7.6	183.4	14.3	567.2	44.2	1,053.8	82.2	1,190.0	92.8
Alternative C	171.2	13.3	257.6	20.1	653.2	50.9	1,063.6	83.0	1,191.5	92.9
Alternative E	145.9	11.4	232.2	18.1	631.6	49.3	1,061.9	82.8	1,191.4	92.9

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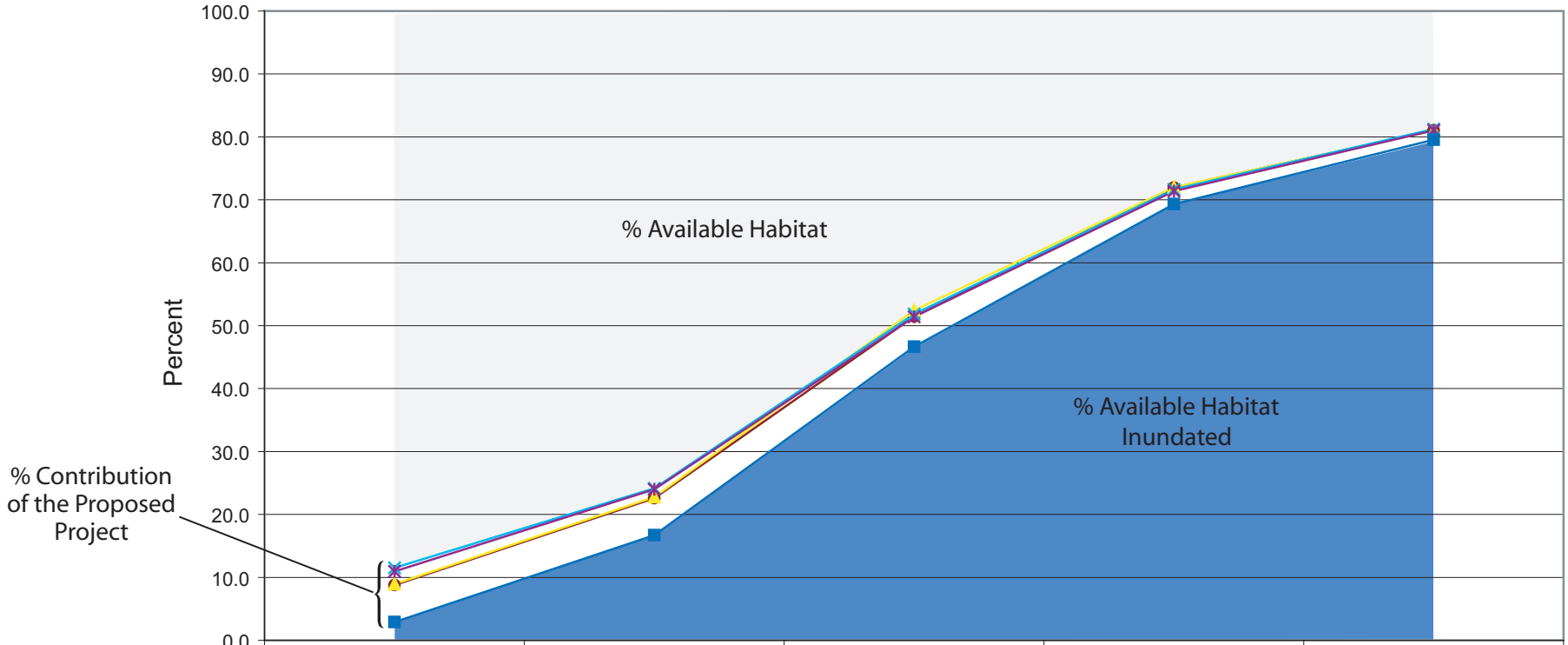
Figure 3-13
Percent Scrub Habitat Loss from Project Alternatives and Varying Lake Lake Levels



	4,204 ft (elevation)		4,204-4,208 ft		4,208-4,212 ft		4,212-4,216 ft		4,216-4,220 ft	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
No Action	32.2	2.9	186.8	16.7	522.0	46.6	775.8	69.3	890.1	79.5
Alternative A	100.2	9.0	254.8	22.8	586.5	52.4	805.6	72.0	906.7	81.0
Alternative B	129.0	11.5	270.4	24.2	580.2	51.8	801.6	71.6	909.1	81.3
Alternative C	122.6	11.0	268.5	24.0	575.1	51.4	798.6	71.4	906.7	81.0
Alternative E	98.3	8.8	252.9	22.6	575.8	51.5	805.0	71.9	906.7	81.0

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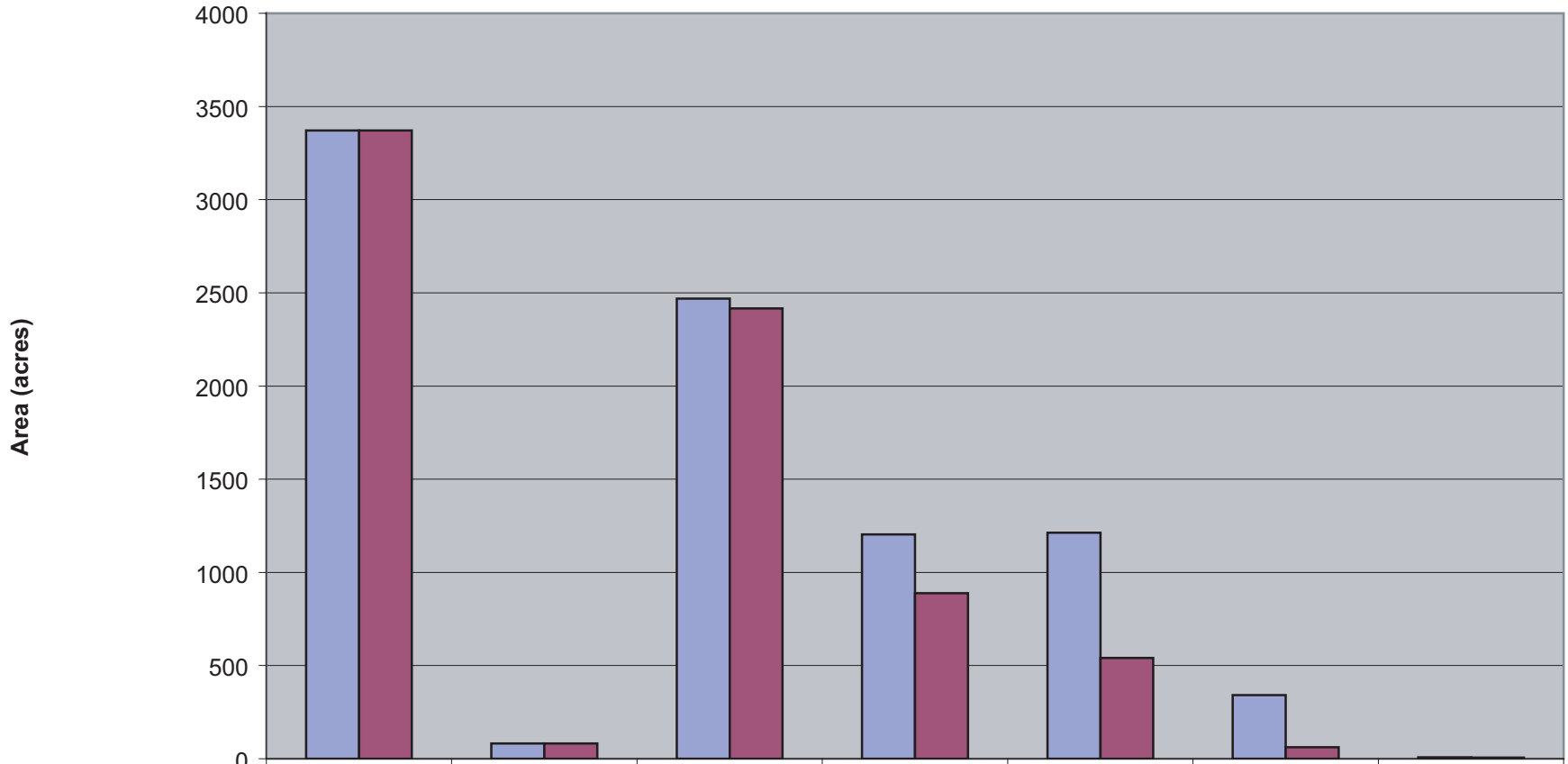
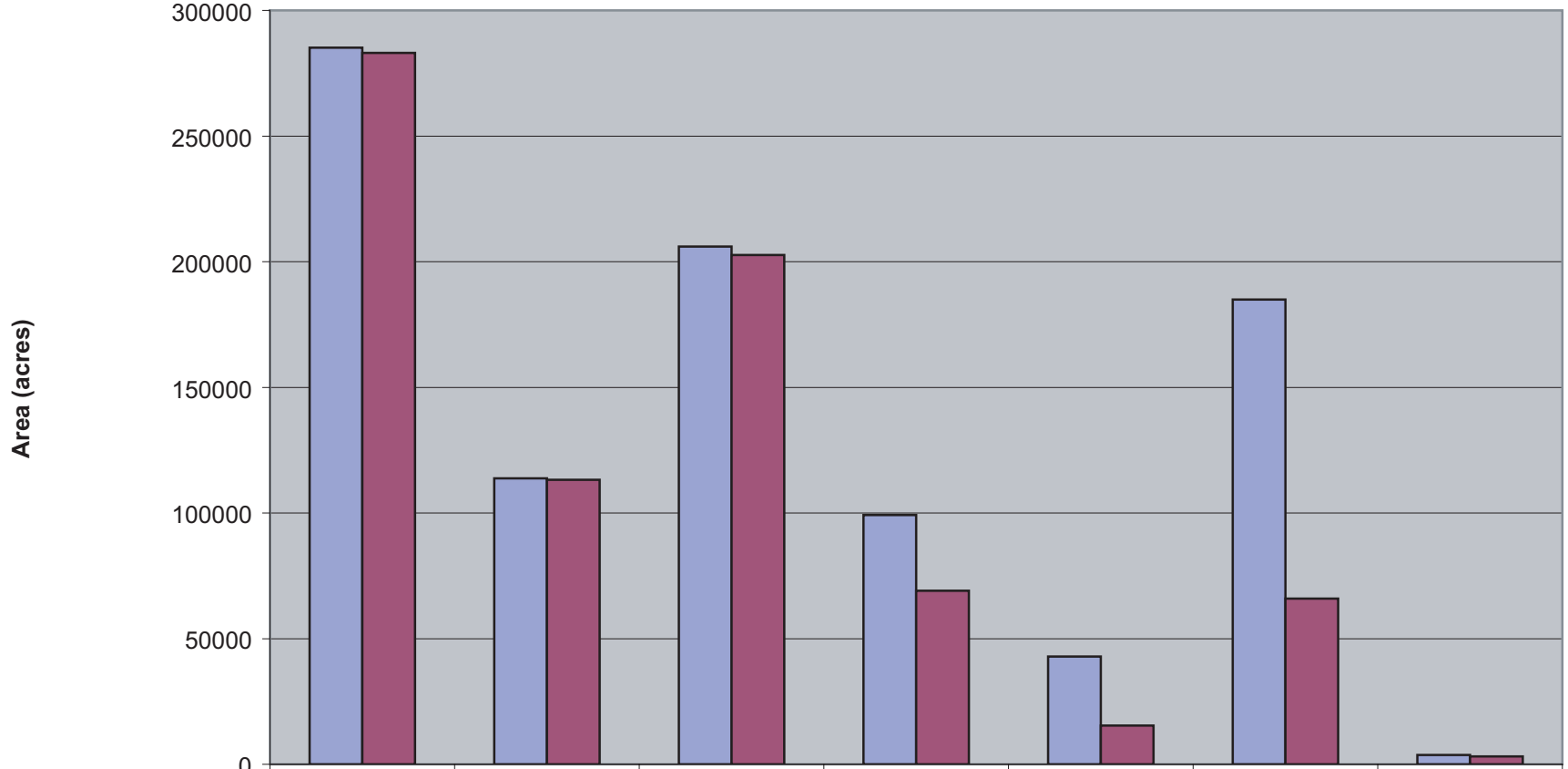
Figure 3-14
Percent Wet Meadow Habitat Loss from Project Alternatives and Varying Lake Lake Levels



	Pasture	Cropland	Scrub	Wet Meadow	Emergent Marsh	Mudflat/ Pickleweed	Riparian
Total Habitat at Low Water (acres)	3,372	83	2,469	1,203	1,212	341	8
Total Habitat at High Water (acres)	3,371	81	2,416	888	541	62	6

03076.03 (11/04)

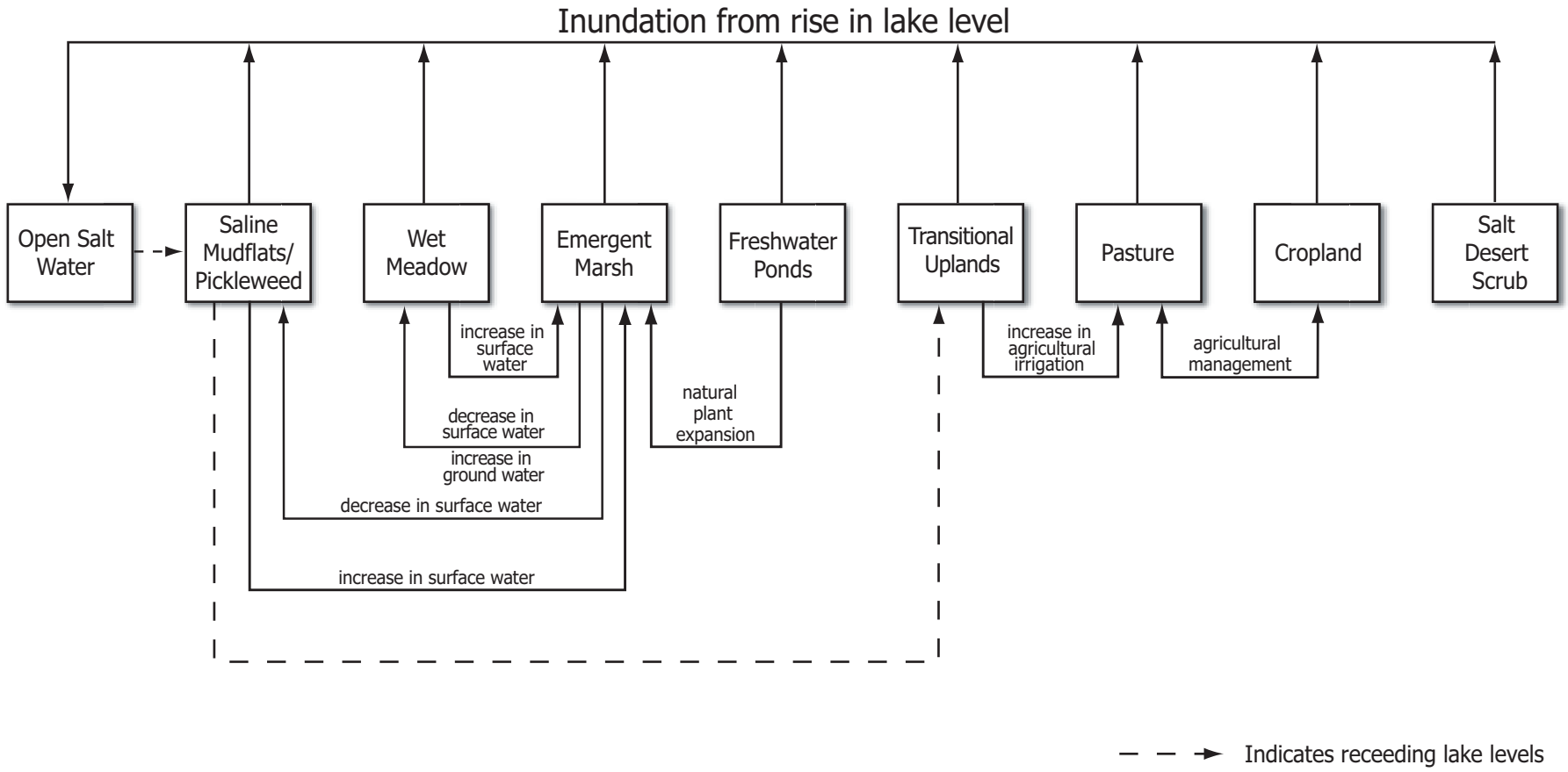
Figure 3-15
Wildlife Habitat Availability in Project Study Area at Low and High Lake Levels



	Pasture	Cropland	Scrub	Wet Meadow	Emergent Marsh	Mudflat/ Pickleweed	Riparian
Total Habitat at Low Water (acres)	285,165	113,742	206,017	99,139	42,817	184,915	3,728
Total Habitat at High Water (acres)	283,104	113,195	202,614	69,005	15,431	65,938	3,139

03076.03 (11/04)

Figure 3-16
Wildlife Habitat Availability in Regional Study Area at Low and High Lake Levels



Source: modified from - Bellagamba/Dolling/Peterson

03076.03 002 Wildlife Tech Memo

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Figure 3-17
Conceptual Ecological Model:
Dynamics of Great Salt Lake Shoreline Habitats

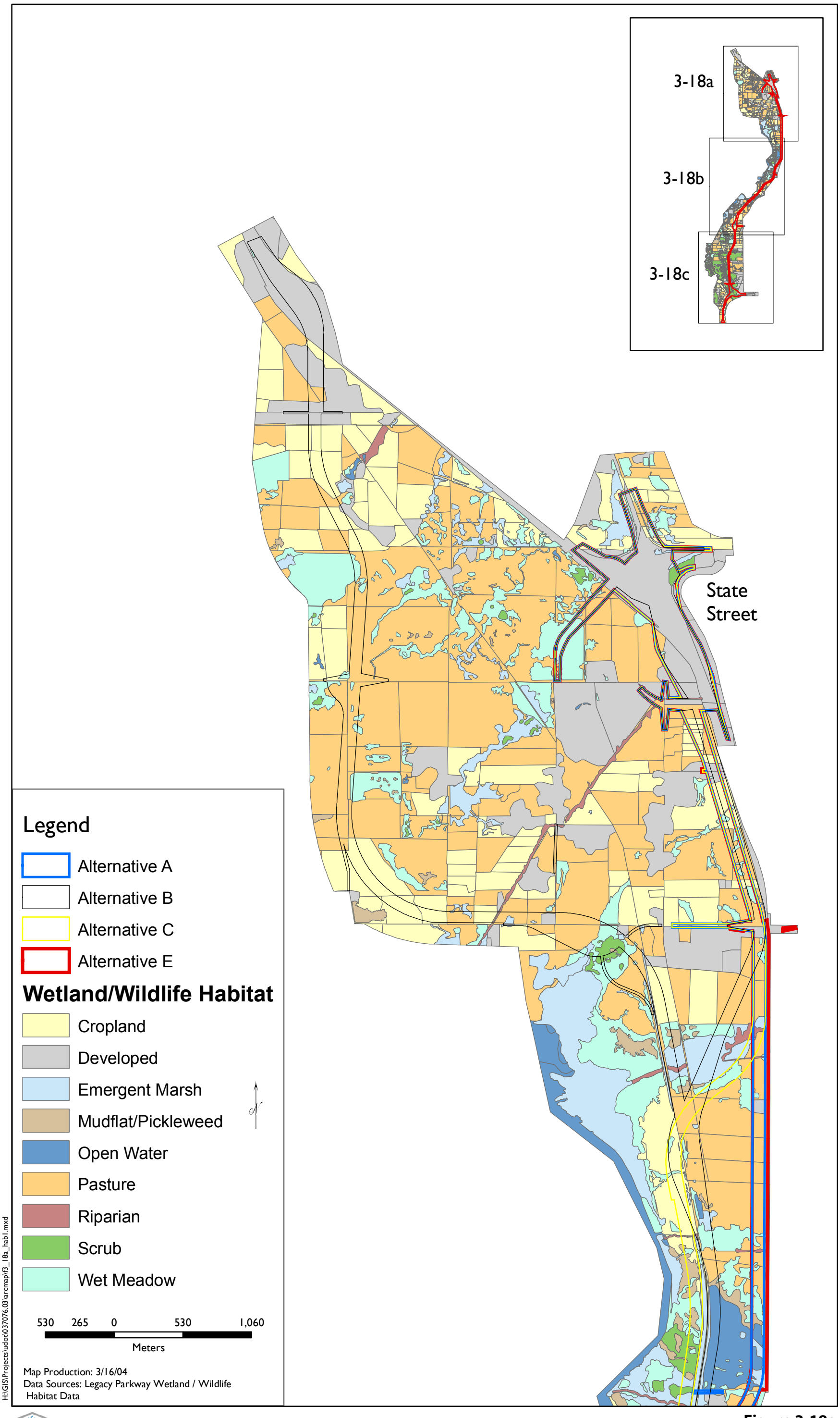

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Figure 3-18a
Wildlife Habitats and Build Alternatives in the Legacy Parkway Project Study Area

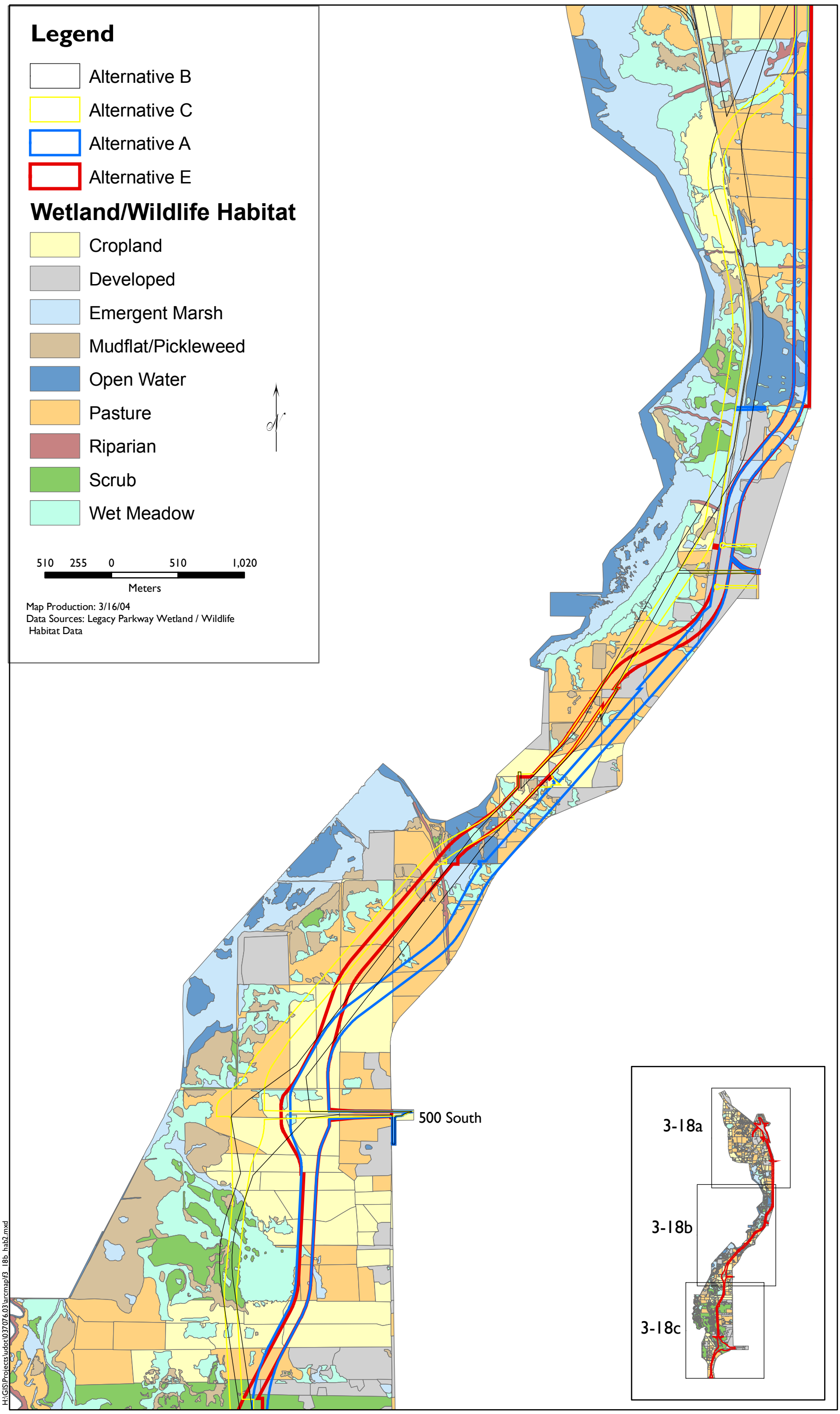

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Figure 3-18b
Wildlife Habitats and Build Alternatives in the Legacy Parkway Project Study Area

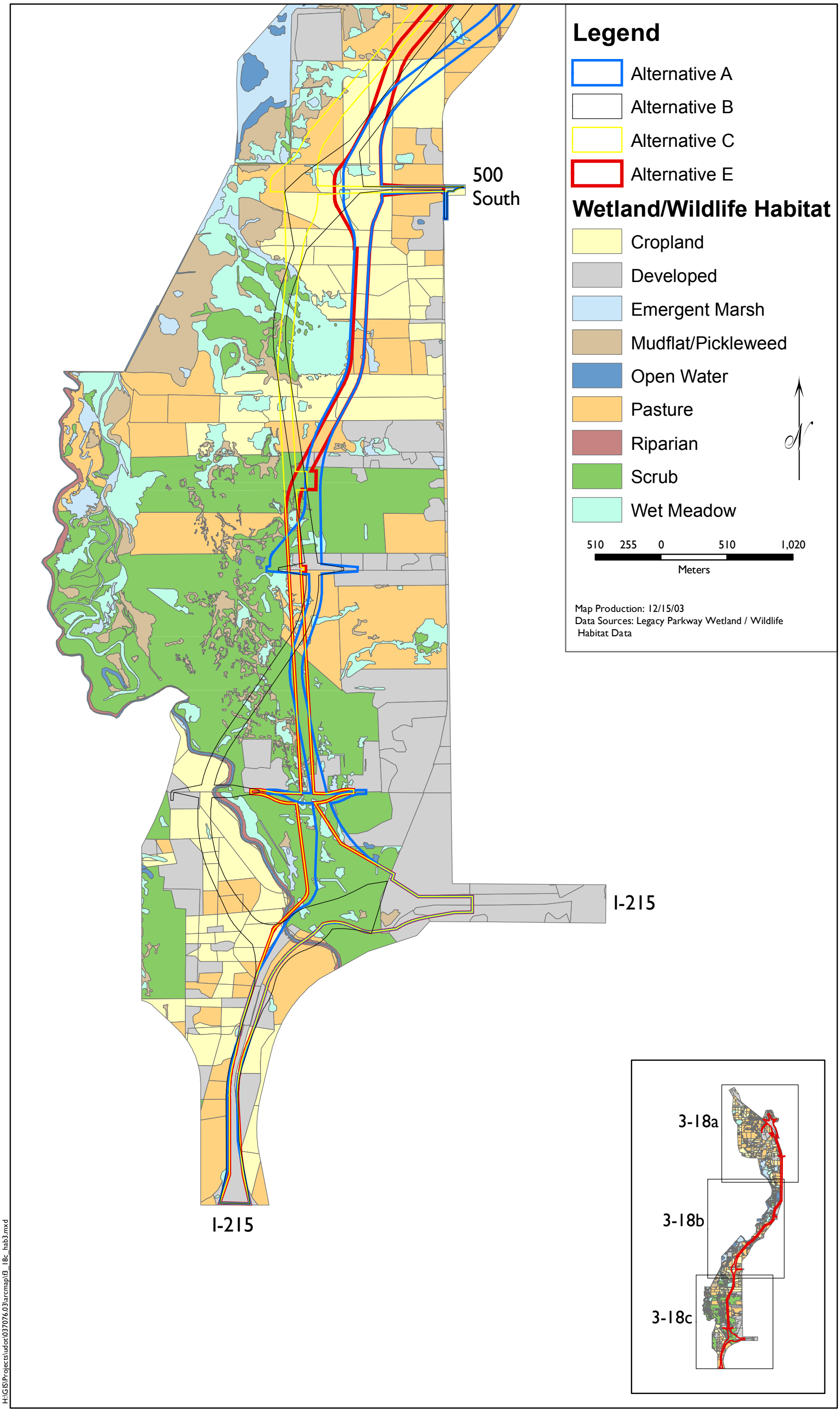

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Figure 3-18c
Wildlife Habitats and Build Alternatives in the Legacy Parkway Project Study Area

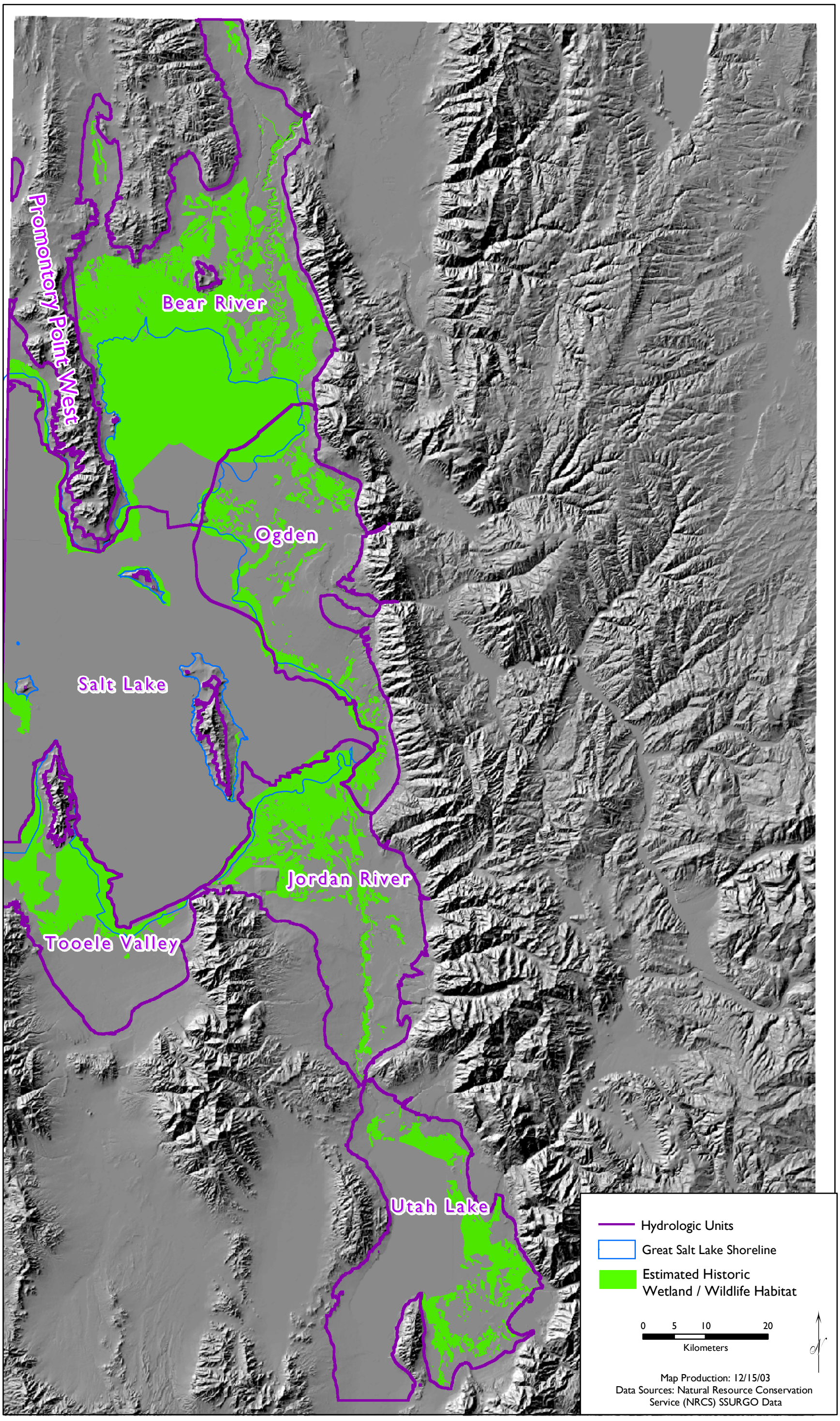

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Figure 3-19
Regional Study Area Estimated Historic Extent of Wetland/Wildlife Habitat

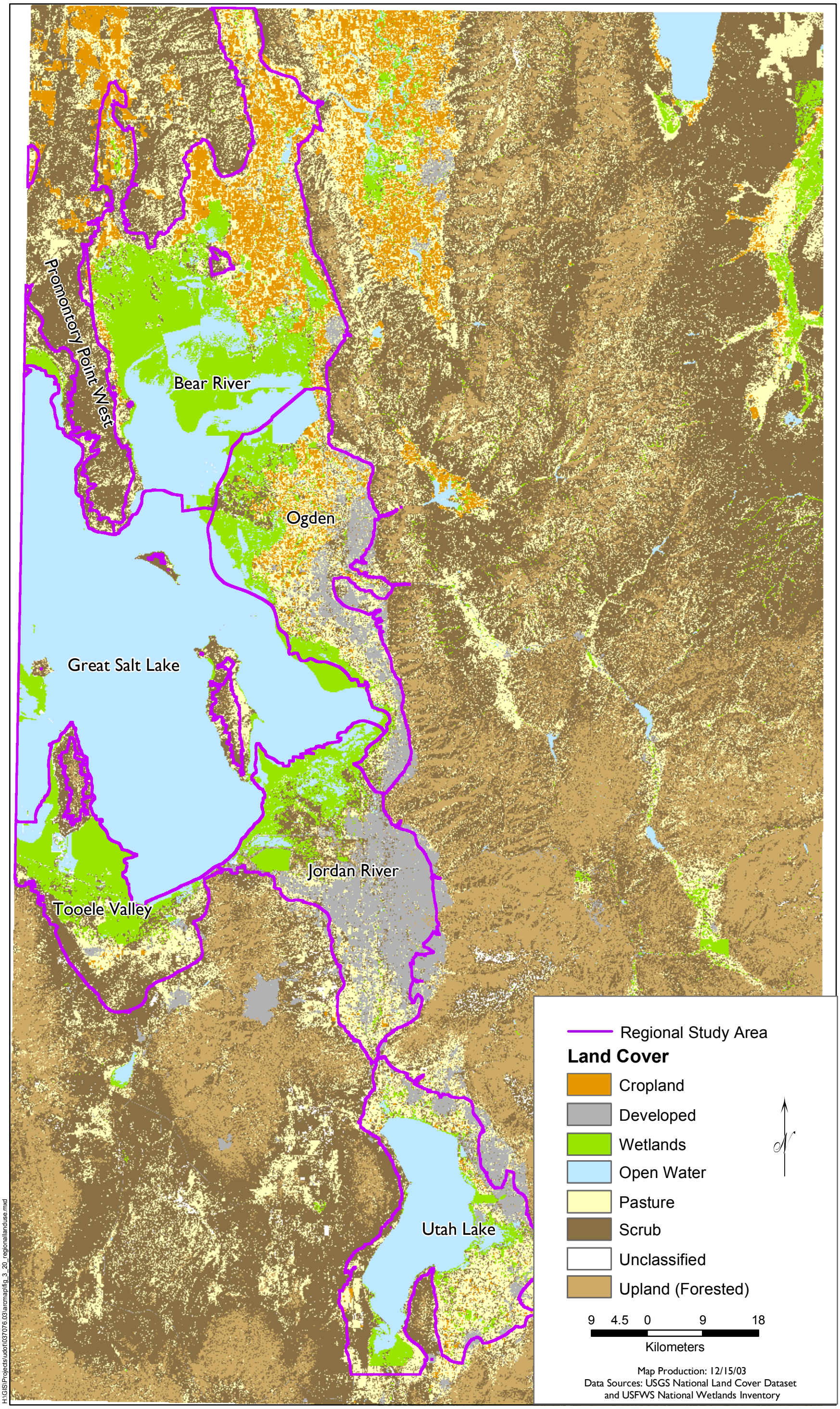

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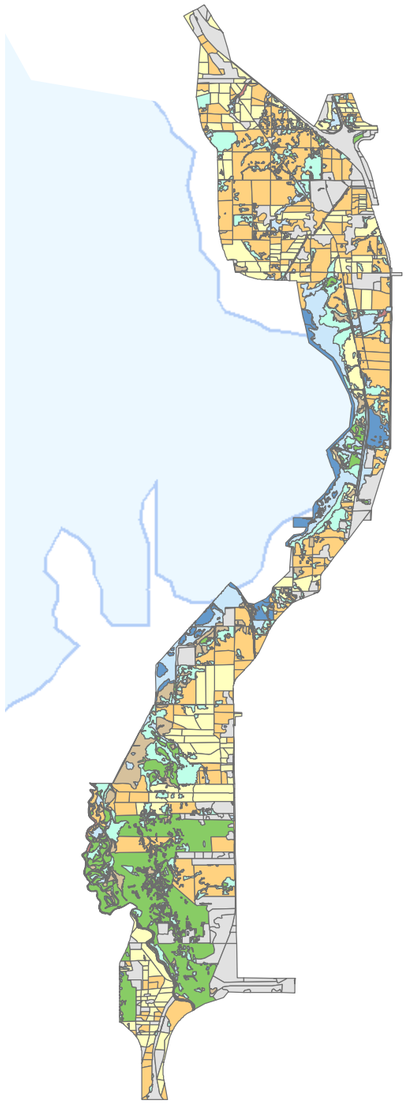
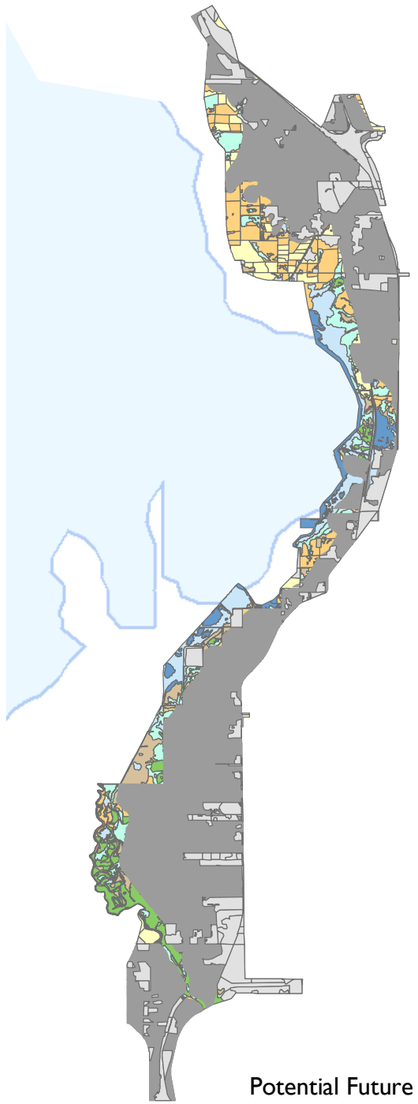
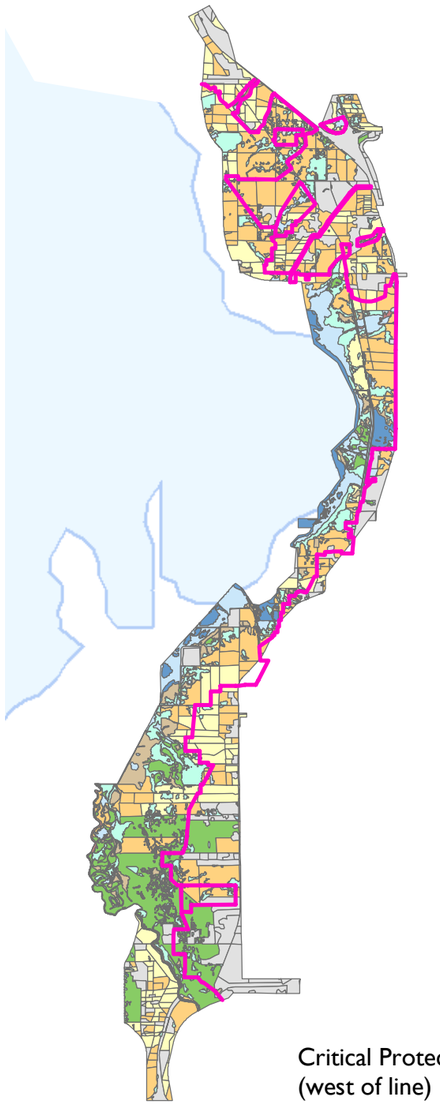
Figure 3-20
Regional Study Area Land Cover





Potential Future Development



Critical Protection Areas*
(west of line)

3

Legend

Critical Protection Areas (west of line)*

Potential Future Development

- Developed
- Developable

Wetland / Wildlife Habitat

- Cropland
- Developed
- Emergent Marsh
- Mudflat/Pickleweed
- Open Water
- Pasture
- Riparian
- Scrub
- Wet Meadow

1 0.5 0 1 2
Kilometers

Jones & Stokes

Map Production: 12/15/03
Data Sources: UDOT Project Alternatives and Wetland / Wildlife Habitat Data, Potential Future Development modified from the Final EIS
*Davis County Critical Protection Area from the Wetlands Conservation Plan -- A Plan for Protection of the Great Salt Lake Wetlands Ecosystem in Davis County (December 1996).

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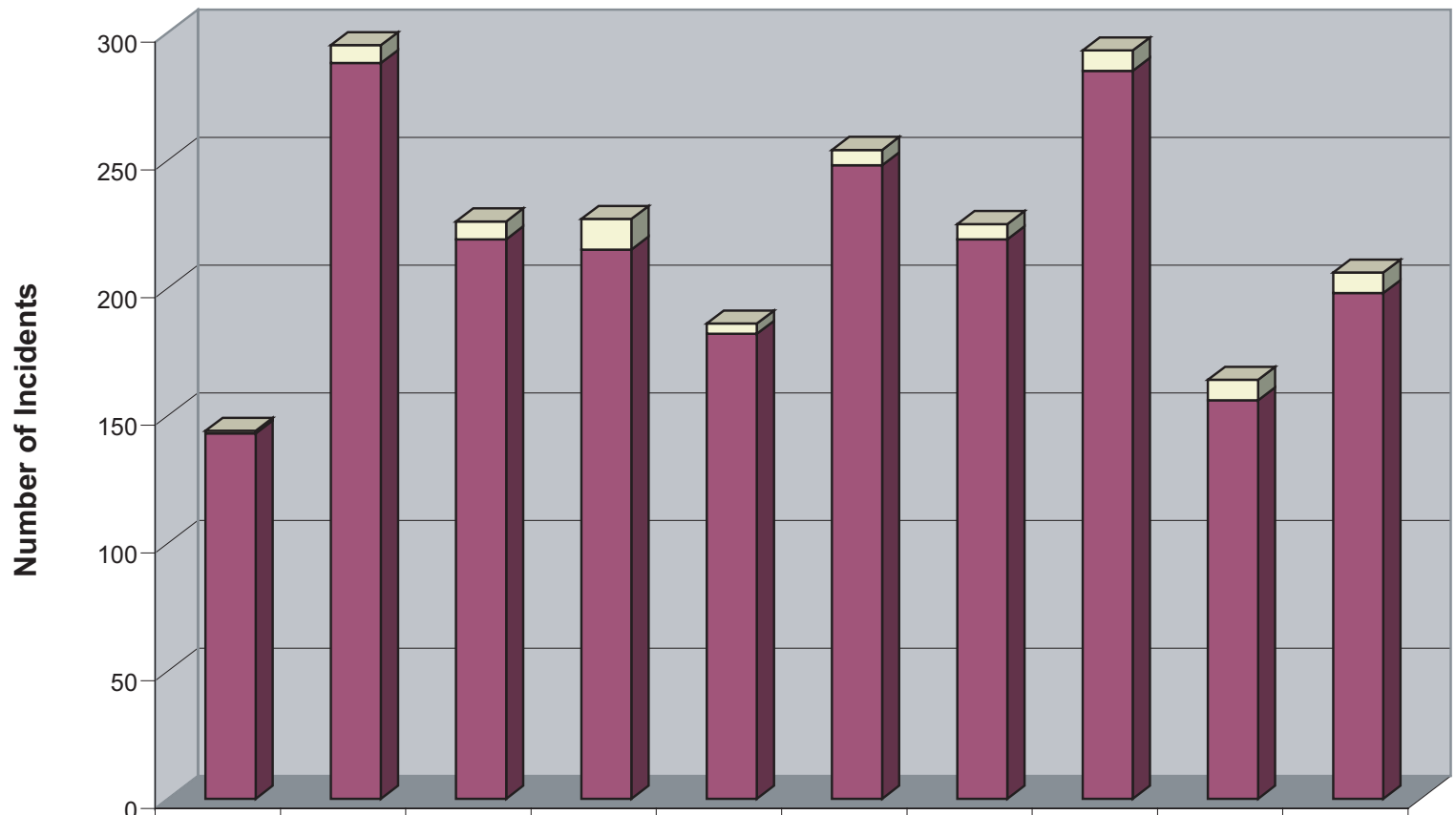
Figure 3-21
Legacy Parkway Study Area Potential Future Development



	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Serious Incidents	1	7	7	12	4	6	6	8	8	8
Highway Incidents	143	288	219	215	182	248	219	285	156	198

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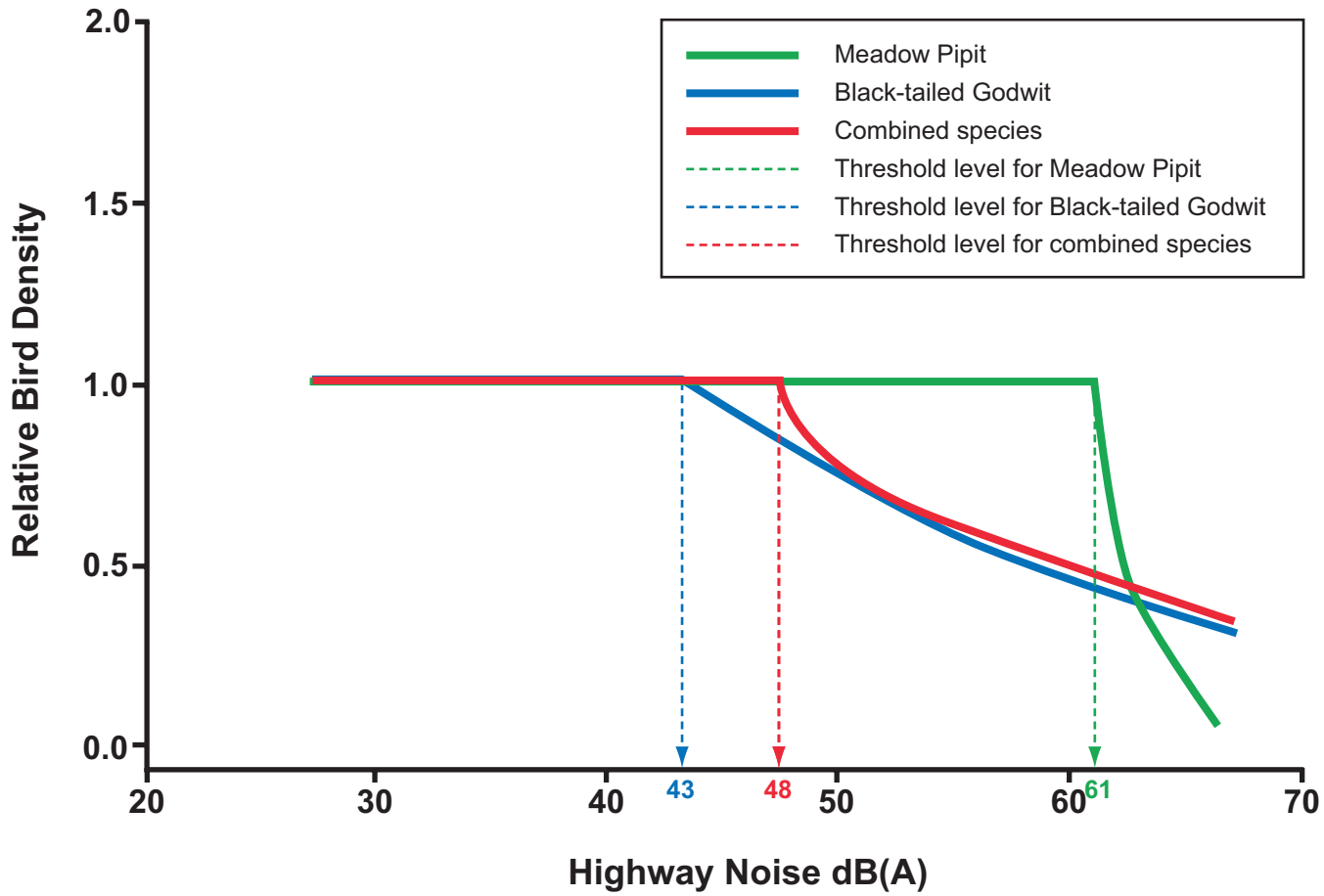
Figure 3-22
Highway Incidents Involving Hazardous Materials in Utah



Source: Modified from Reijnen, Foppen, Meeuwsen (1995)

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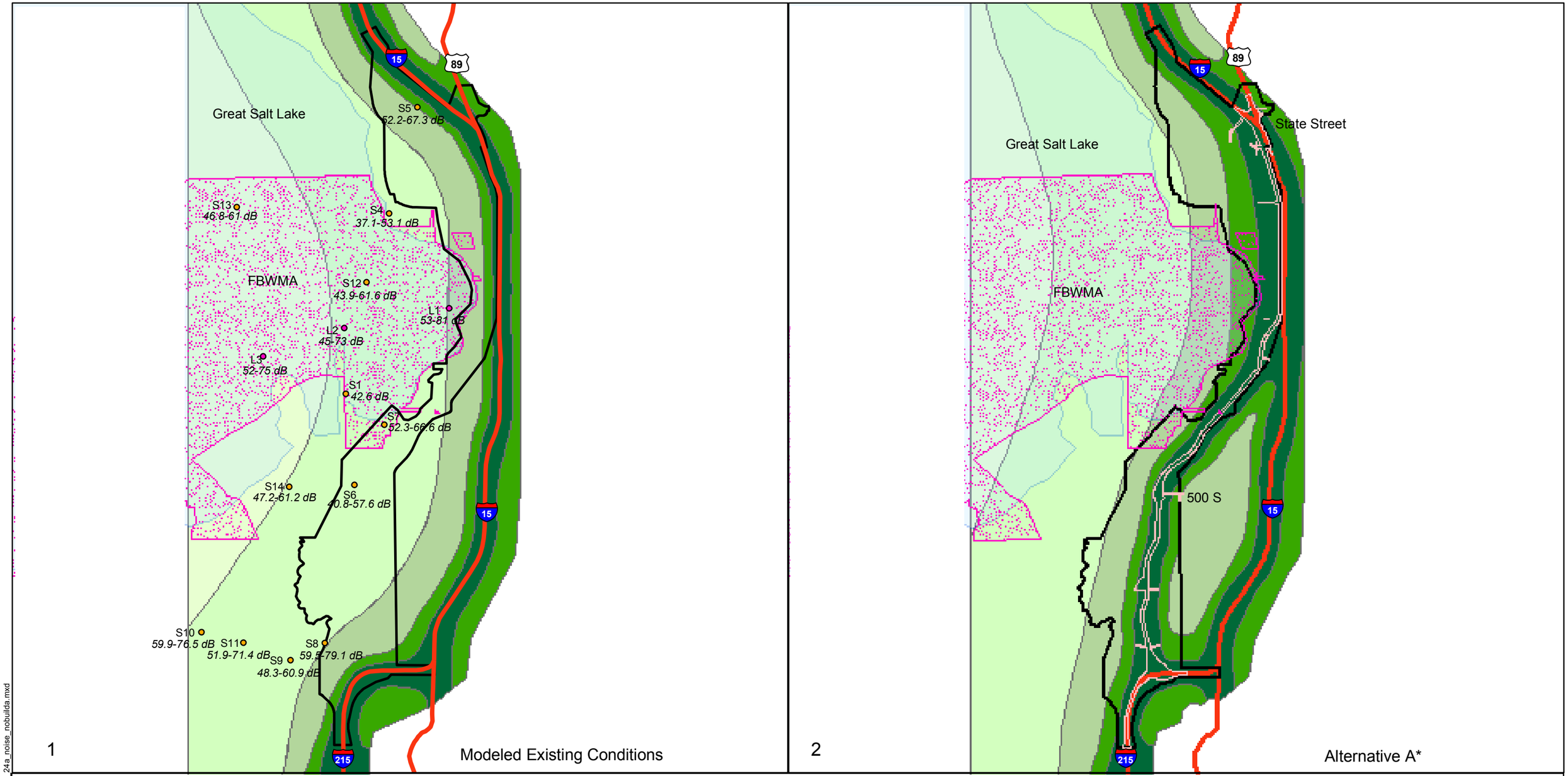
Figure 3-23
Threshold Noise Level Determination for Representative Grassland Birds



Legend

- Local Study Area Boundary
- Proposed Right of Way
- Major Existing Roads
- Great Salt Lake
- Farmington Bay Wildlife Management Area (FBWMA)

TNM Modeled Noise Levels (Decibels dBA)[1]

- <45
- > = 45 < 50
- > = 50 < 55
- > = 55 < 60
- > = 60

Monitoring Type

- Short-term Noise Measurements (Leq-Lmax): Table F-3
- Long-term Noise Measurements (Leq-Lmax); Table F-4

2.5 1.25 0 2.5 5
Kilometers

Map Production: 12/15/03
Data Sources: UDOT Project Study Area Boundary, Project Alternatives and Exsiting Roads. Contours Generated from Field Data
*Supplemental EIS 312-ft ROWs used for the Alternatives

[1] The noise level contours generated by the traffic noise model have not yet been verified beyond 305m (1000ft). The locations of contours beyond this distance are projected estimates only and could vary significantly depending on existing background noise, atmospheric conditions, and substrate type.

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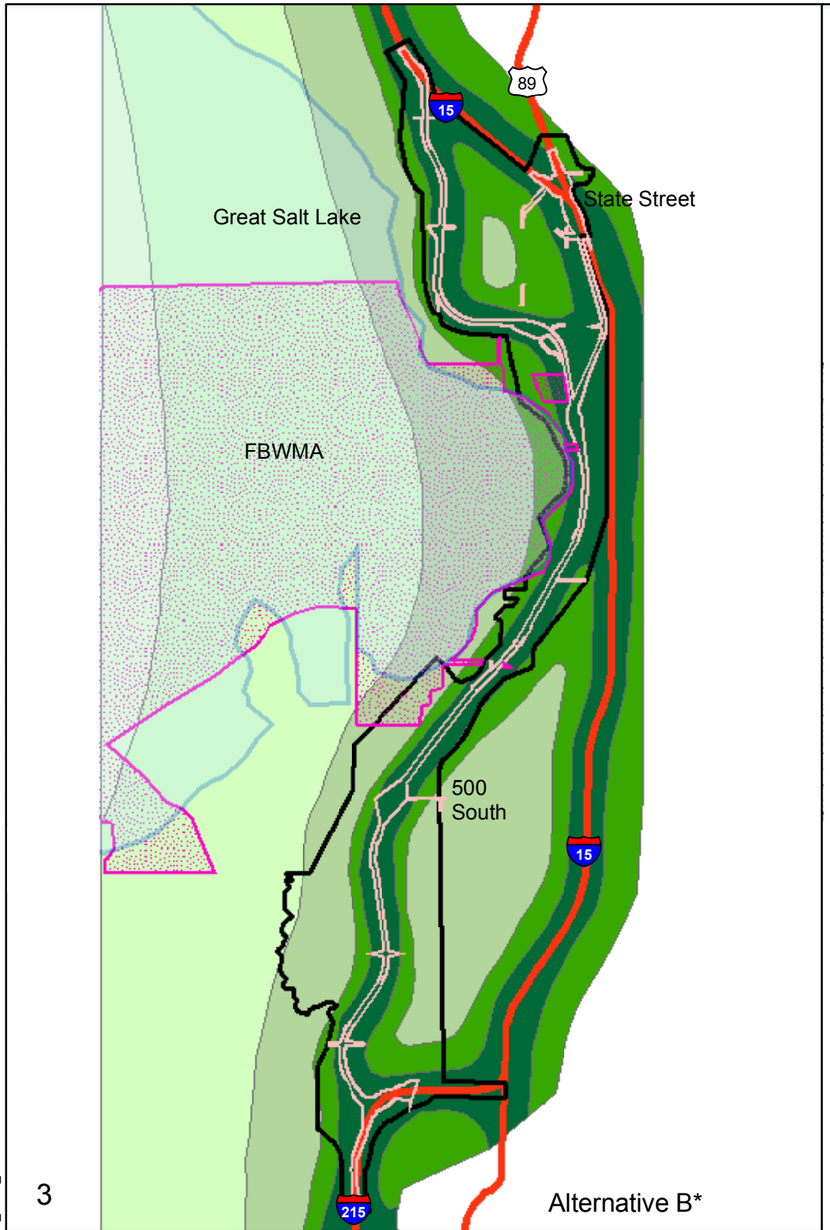
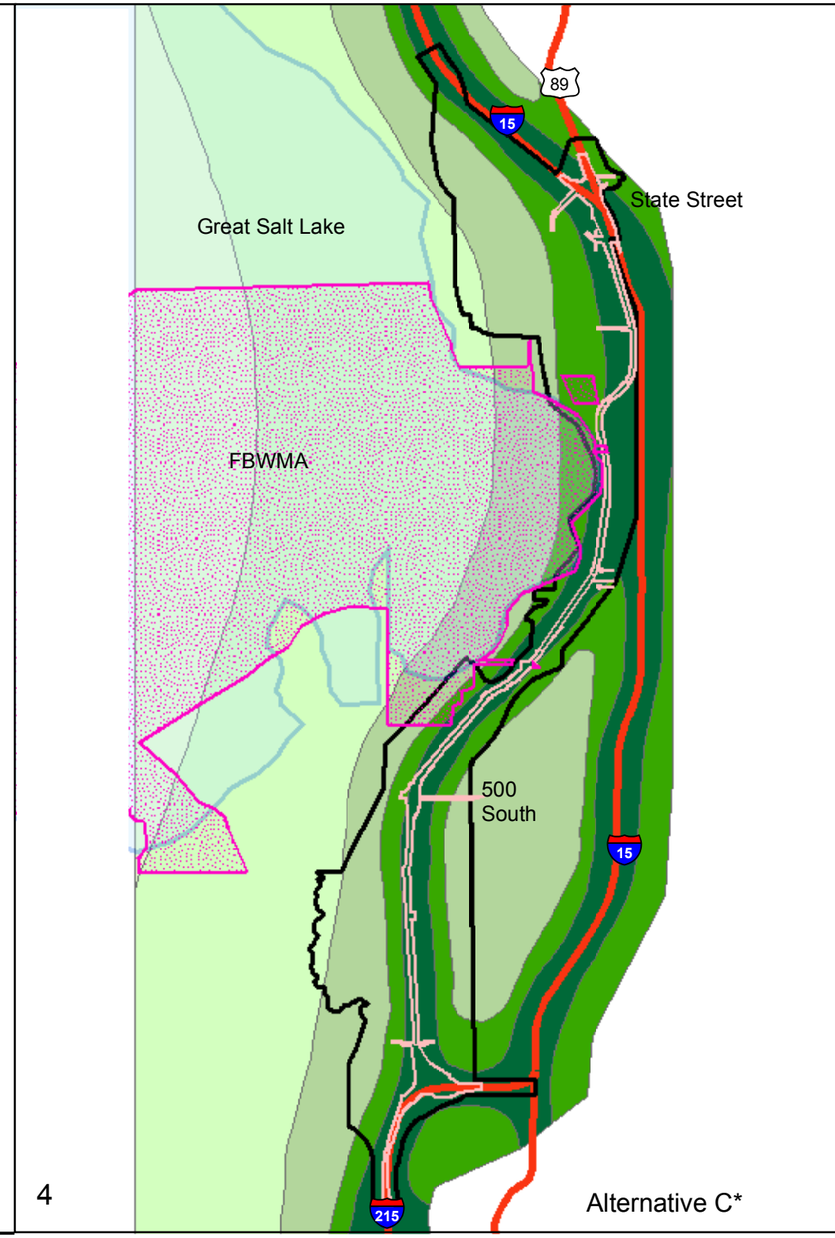
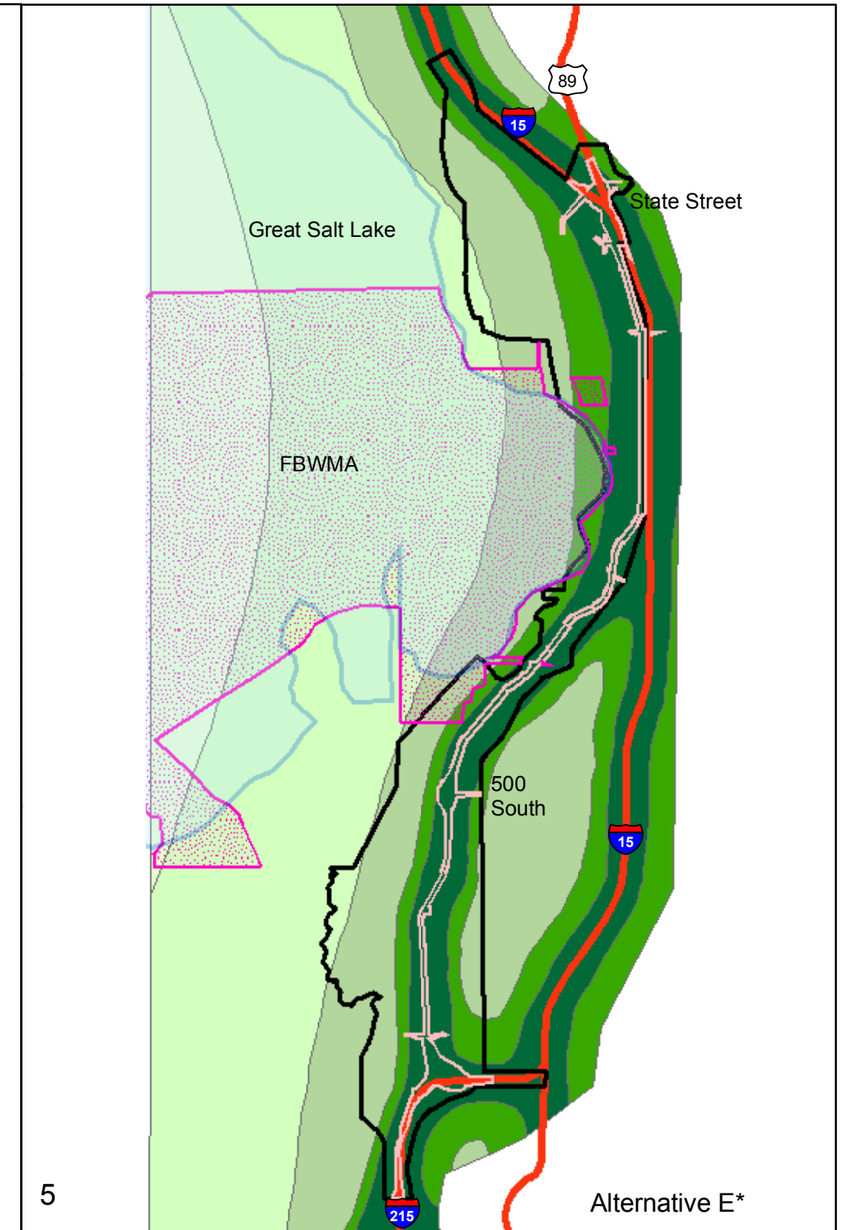
Figure 3-24a
Highway Noise Level for the Legacy Parkway







Legend

- Local Study Area Boundary
- Proposed Right of Way
- Major Existing Roads
- Great Salt Lake
- Farmington Bay Wildlife Management Area (FBWMA)

TNM Modelled Noise Levels (Decibels)[1]

- <45
- > = 45 < 50
- > = 50 < 55
- > = 55 < 60
- > = 60

N

2.5 1.25 0 2.5 5
Kilometers

Map Production: 12/15/03
Data Sources: UDOT Project Study Area Boundary, Project Alternatives and Exsiting Roads. Contours Generated from Field Data
*Supplemental EIS 312 foot ROWs used for the Alternatives
[1] The noise level contours generated by the traffic noise model have not yet been verified beyond 305m (1000ft). The locations of contours beyond this distance are projected estimates only and could vary significantly depending on existing background noise, atmospheric conditions, and substrate type.

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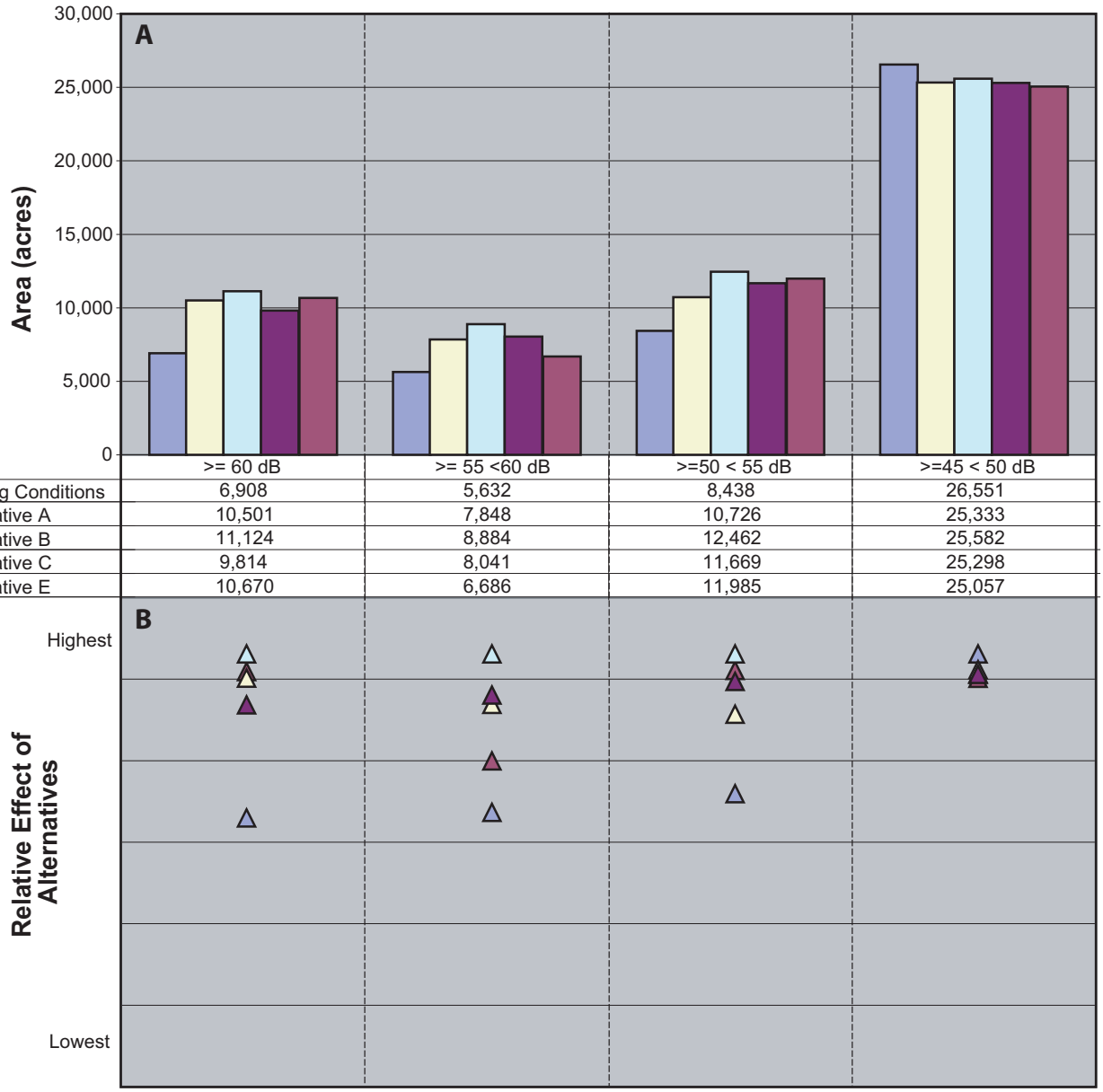
Jones & Stokes

Figure 3-24b
Highway Noise Level for the Legacy Parkway



	>= 60 dB	>= 55 <60 dB	>=50 < 55 dB	>=45 < 50 dB
Existing Conditions	6,908	5,632	8,438	26,551
Alternative A	10,501	7,848	10,726	25,333
Alternative B	11,124	8,884	12,462	25,582
Alternative C	9,814	8,041	11,669	25,298
Alternative E	10,670	6,686	11,985	25,057

Note: The noise level contours generated by the traffic noise model (Fig 3-22) have not been verified beyond 305 m (1,000 ft). The locations of contours beyond this distance are projected estimates only and could vary significantly depending on existing background noise, atmospheric conditions, and substrate type.

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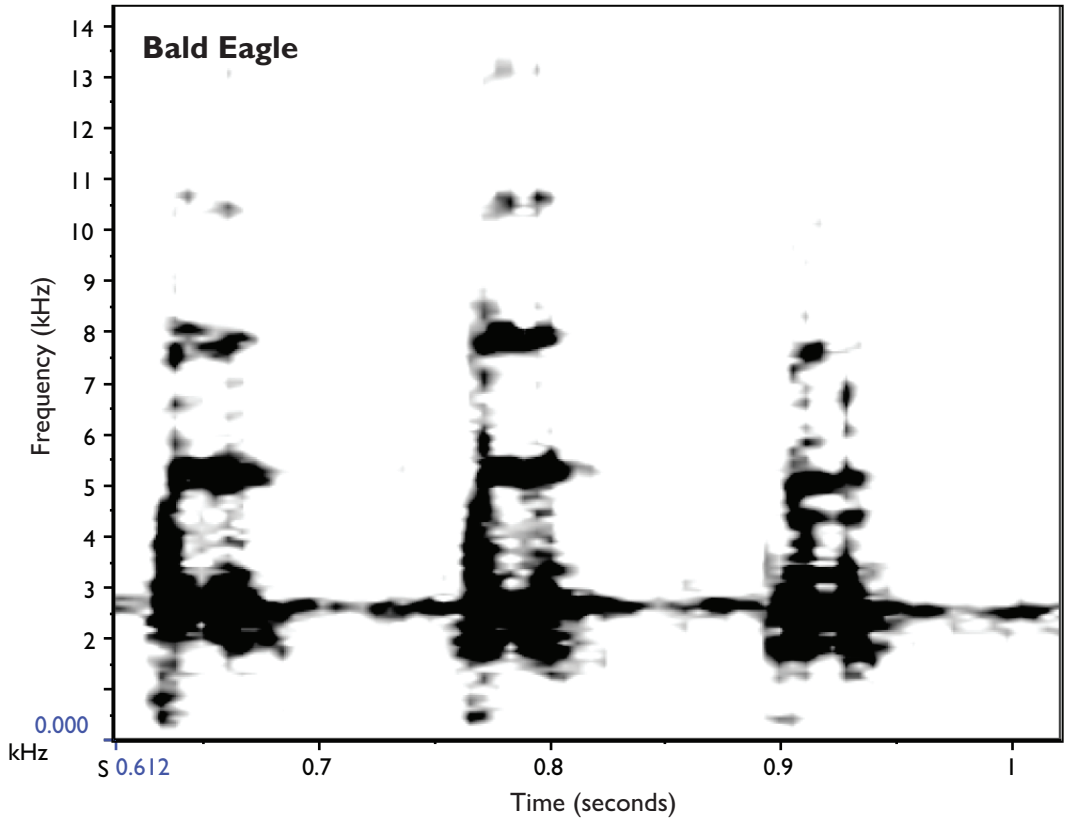
Figure 3-25
TNM Predicted Total Habitat Area Affected by Highway Noise



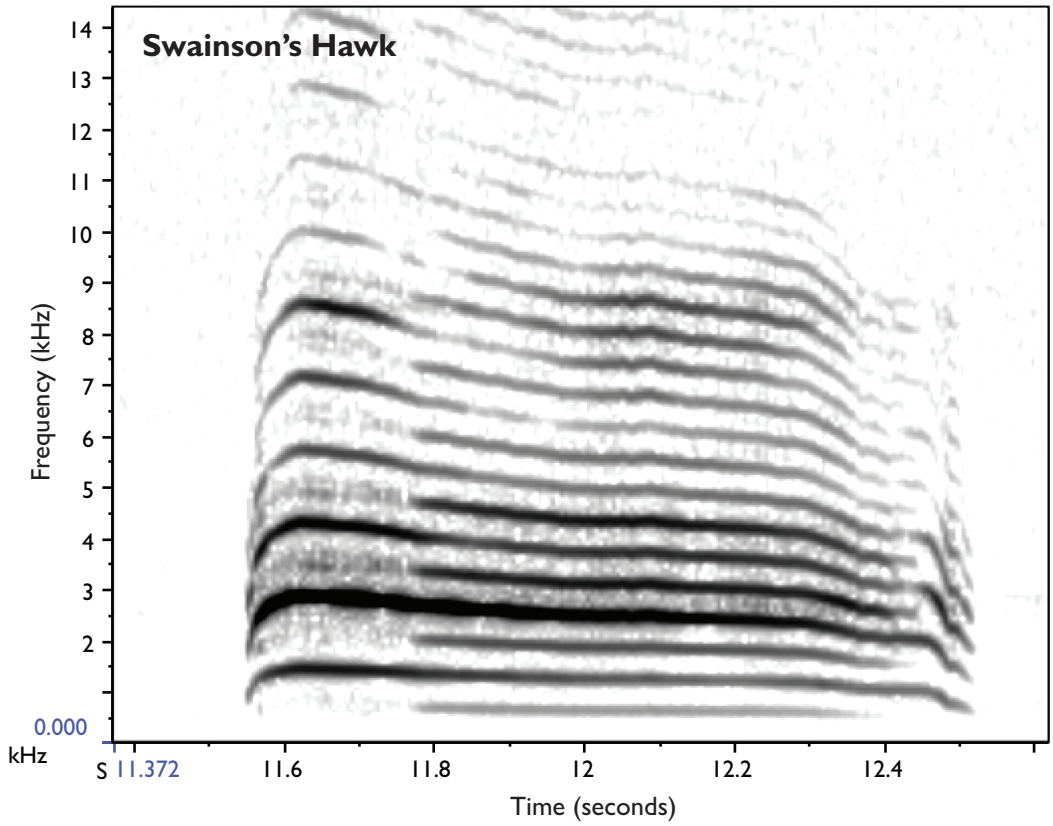


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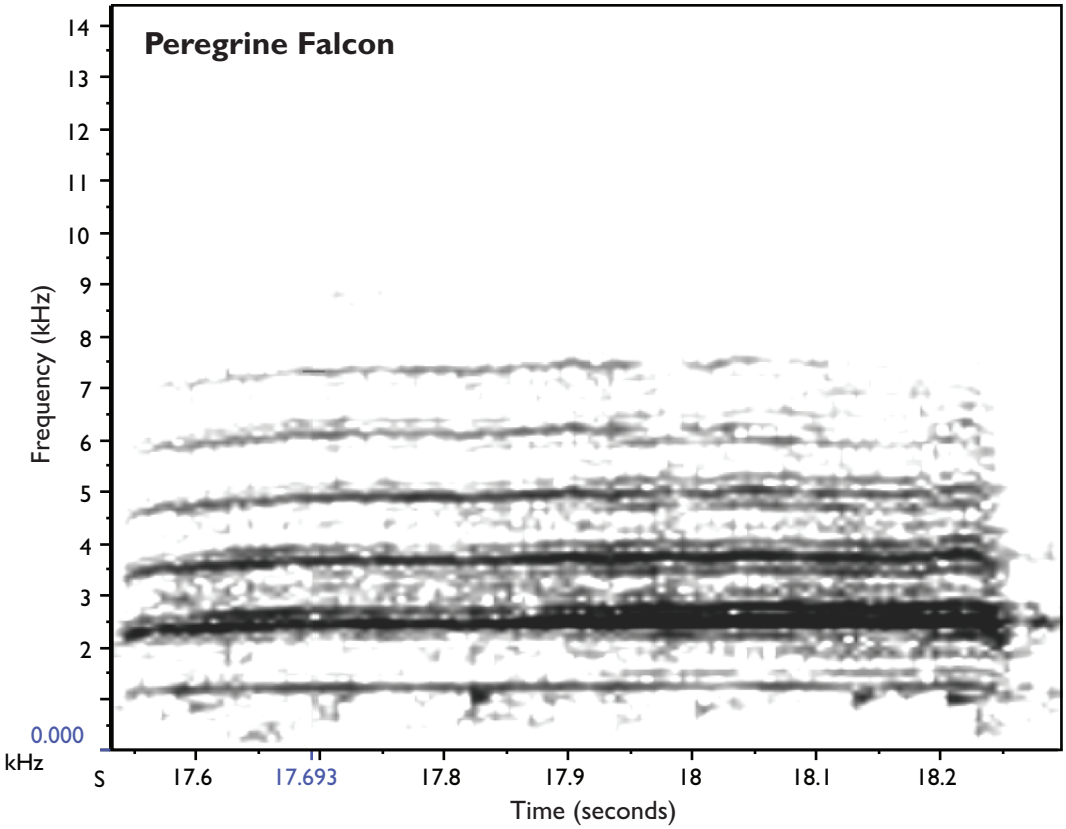
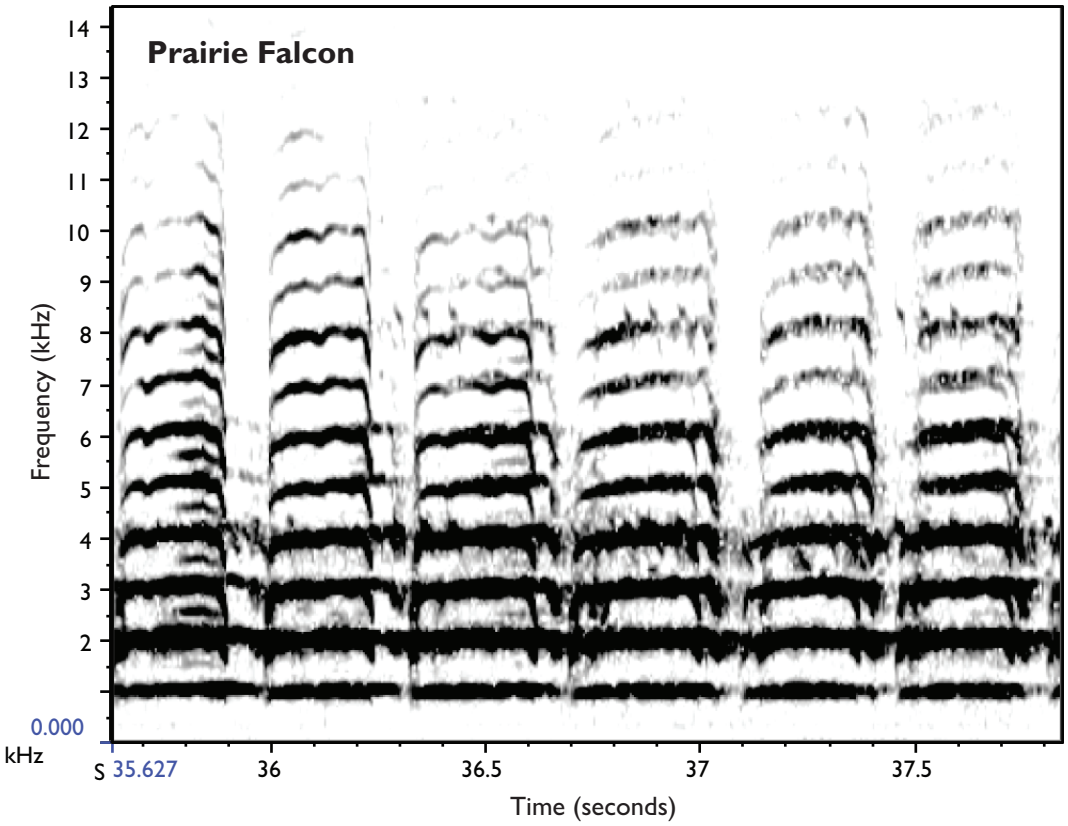
Figure 3-26a
Bird Vocalization Sonograms
Bald Eagle and Swainson's Hawk





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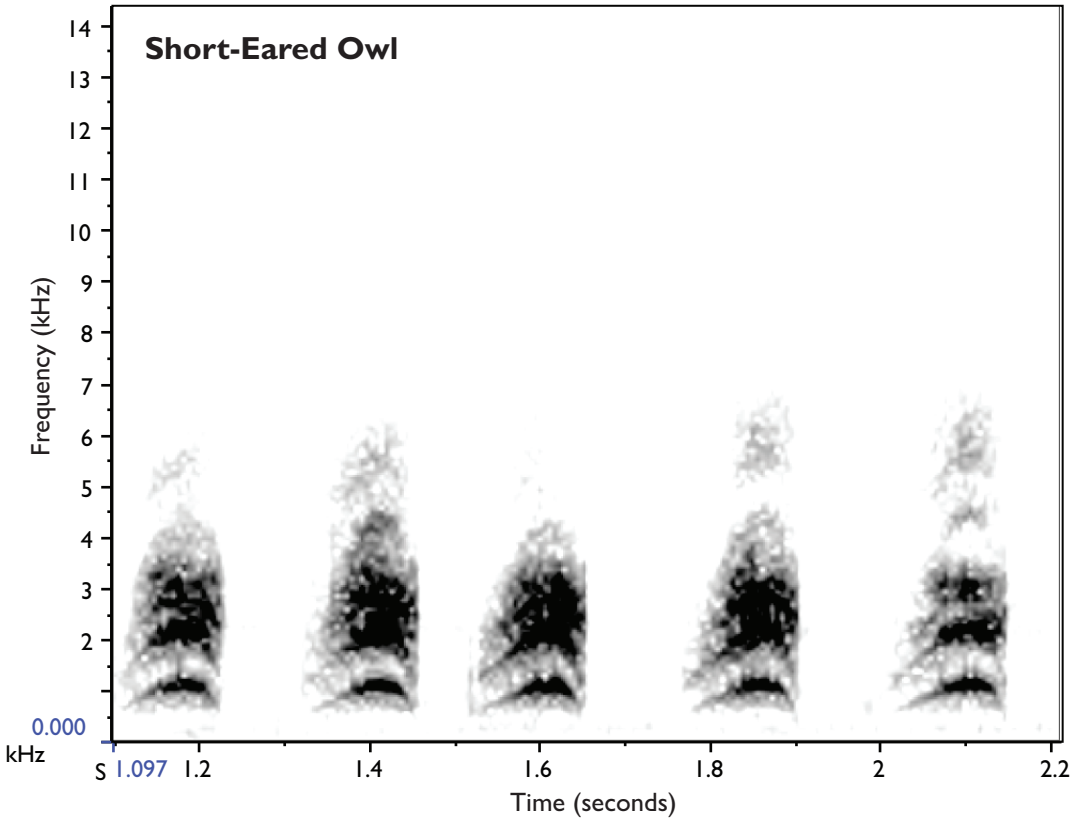
Jones & Stokes

Figure 3-26b
Bird Vocalization Sonograms
Peregrine Falcon and Prairie Falcon



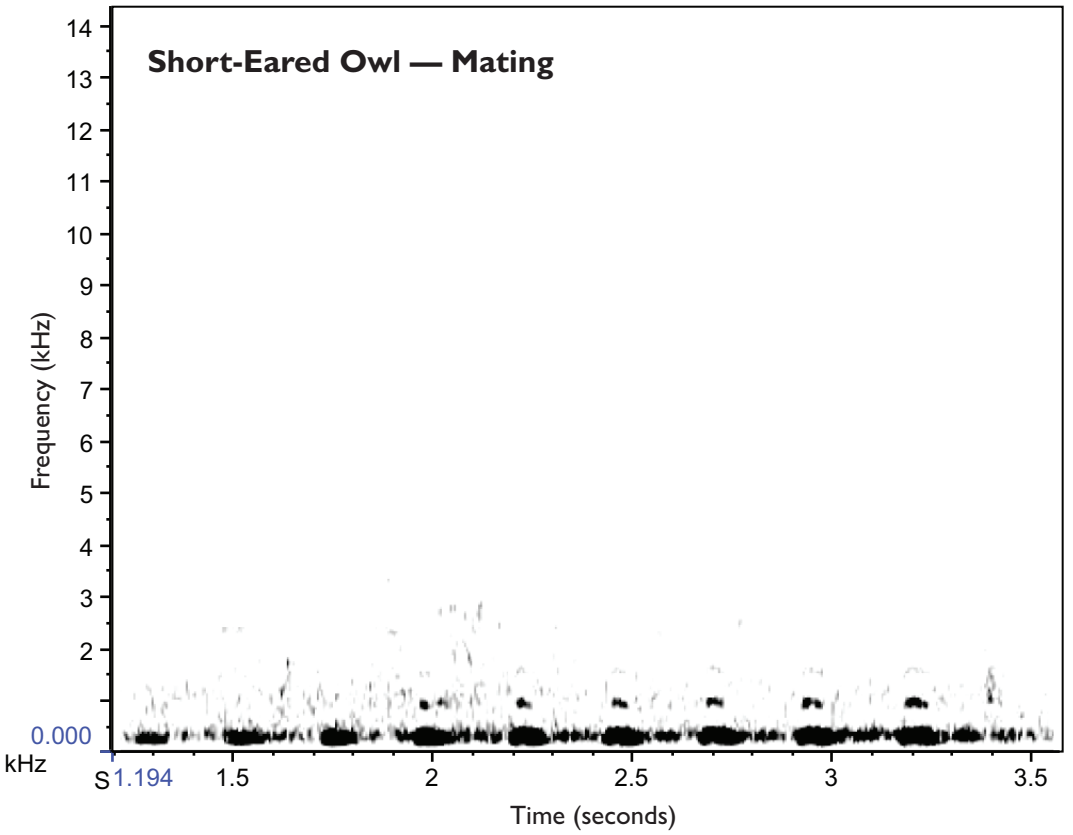


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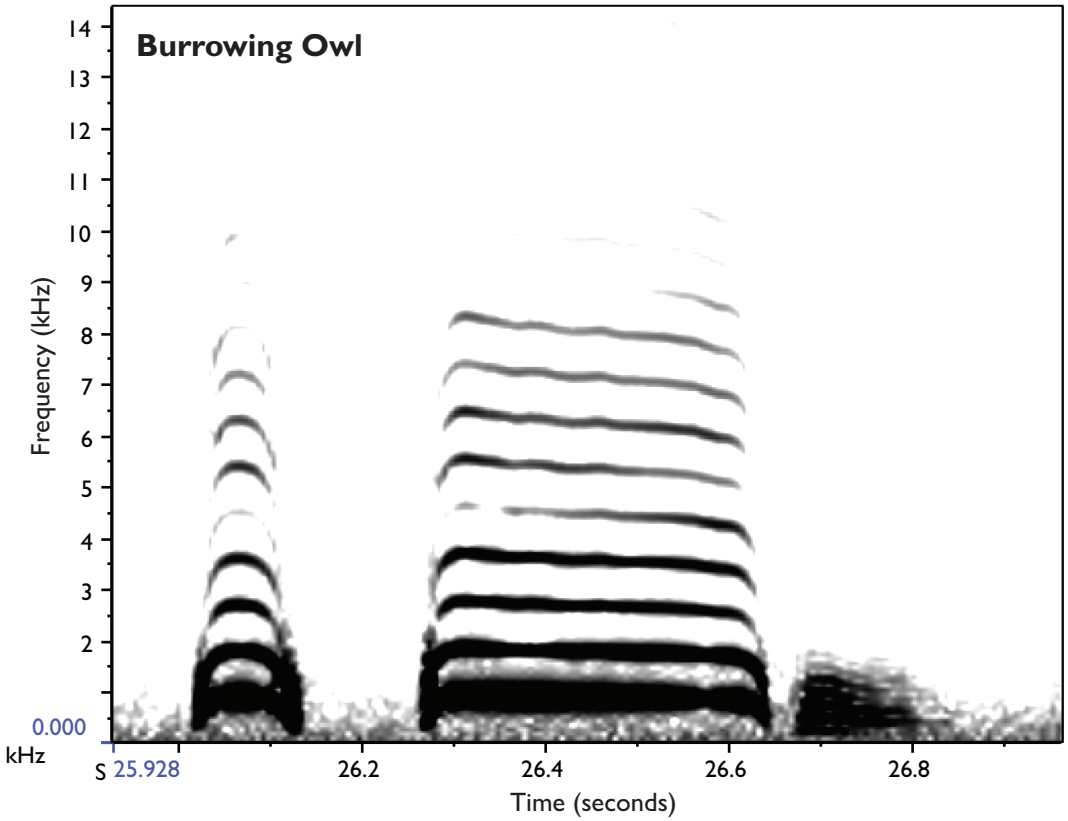
Figure 3-26c
Bird Vocalization Sonograms
Short-Eared Owl



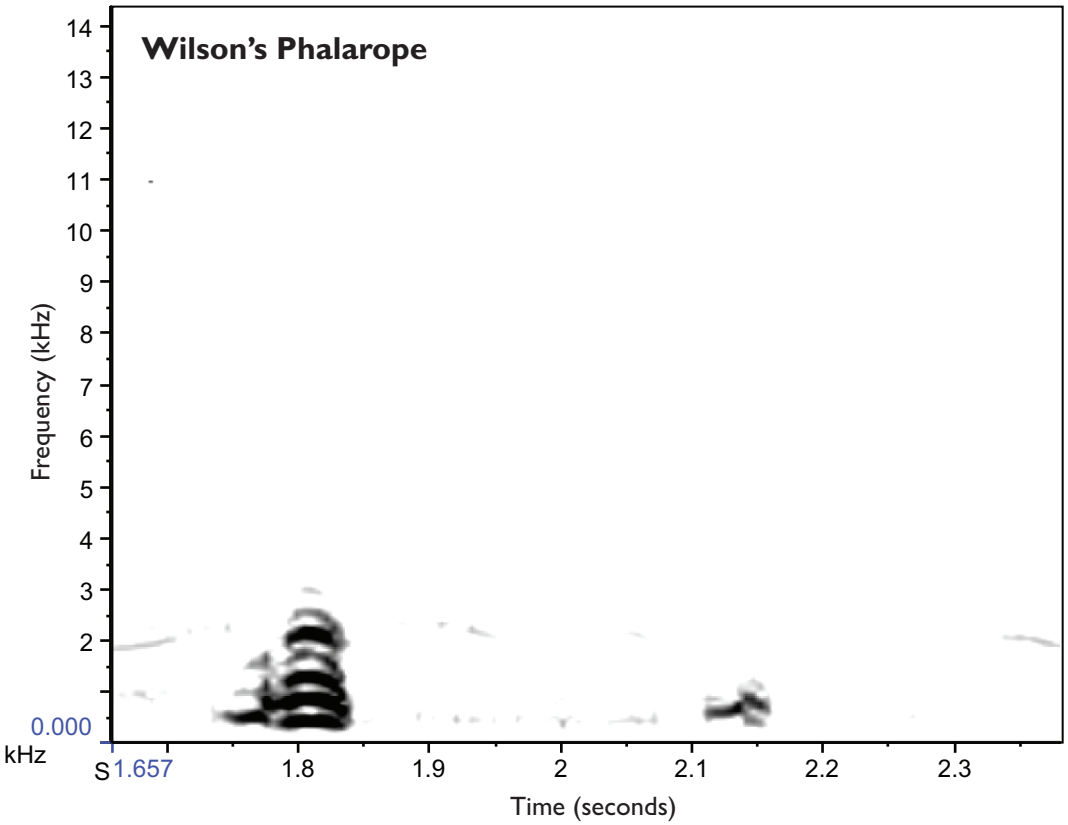


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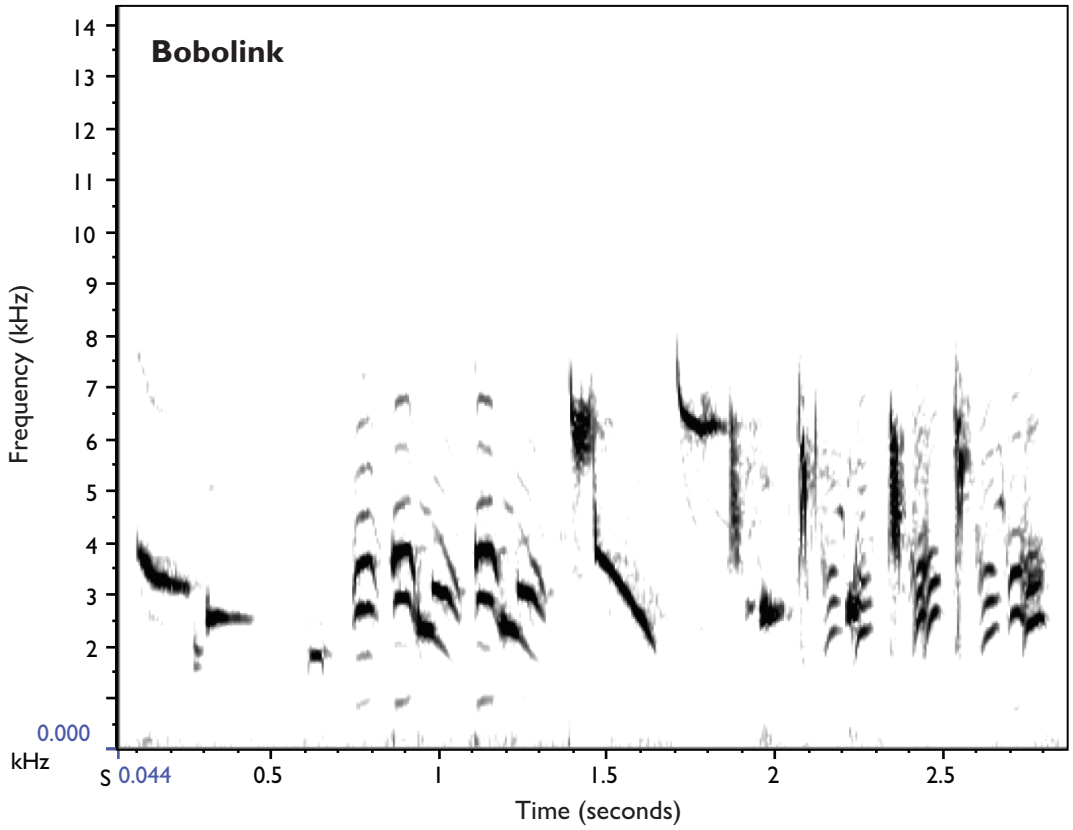
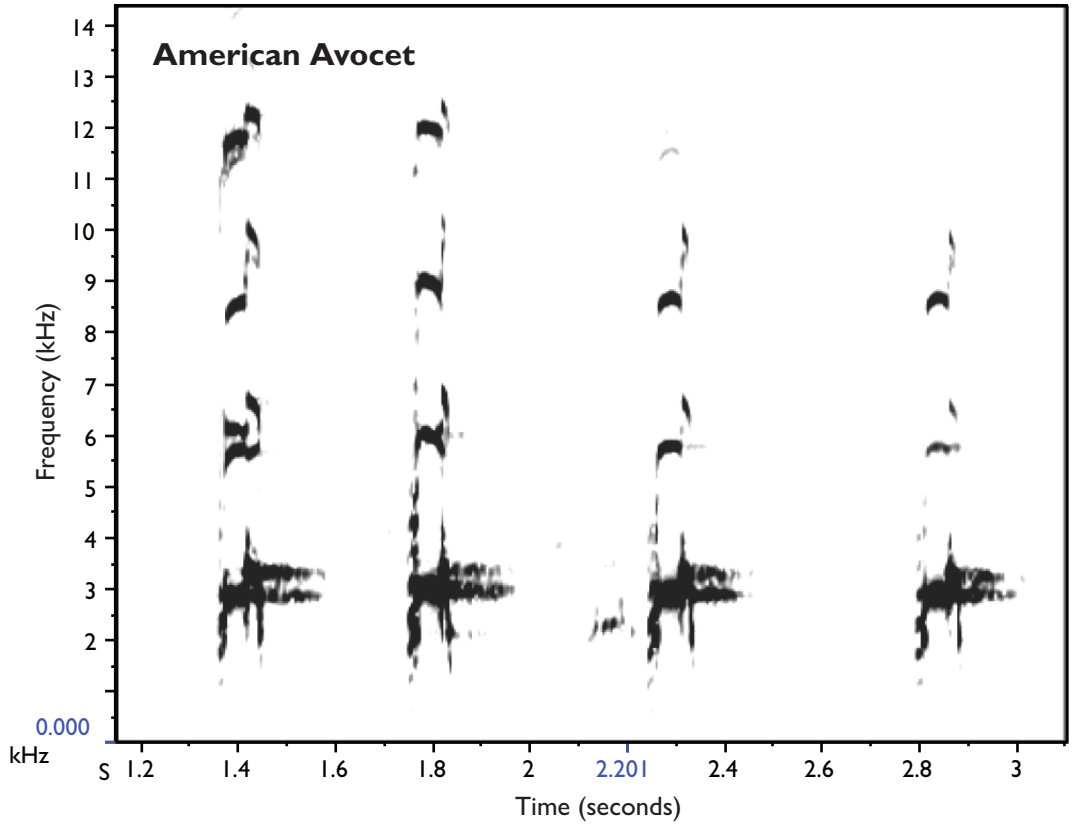
Figure 3-26d
Bird Vocalization Sonograms
Burrowing Owl and Wilson's Phalarope





03076.02 Wildlife Tech Memo

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Figure 3-26e
Bird Vocalization Sonograms
Bobolink and American Avocet

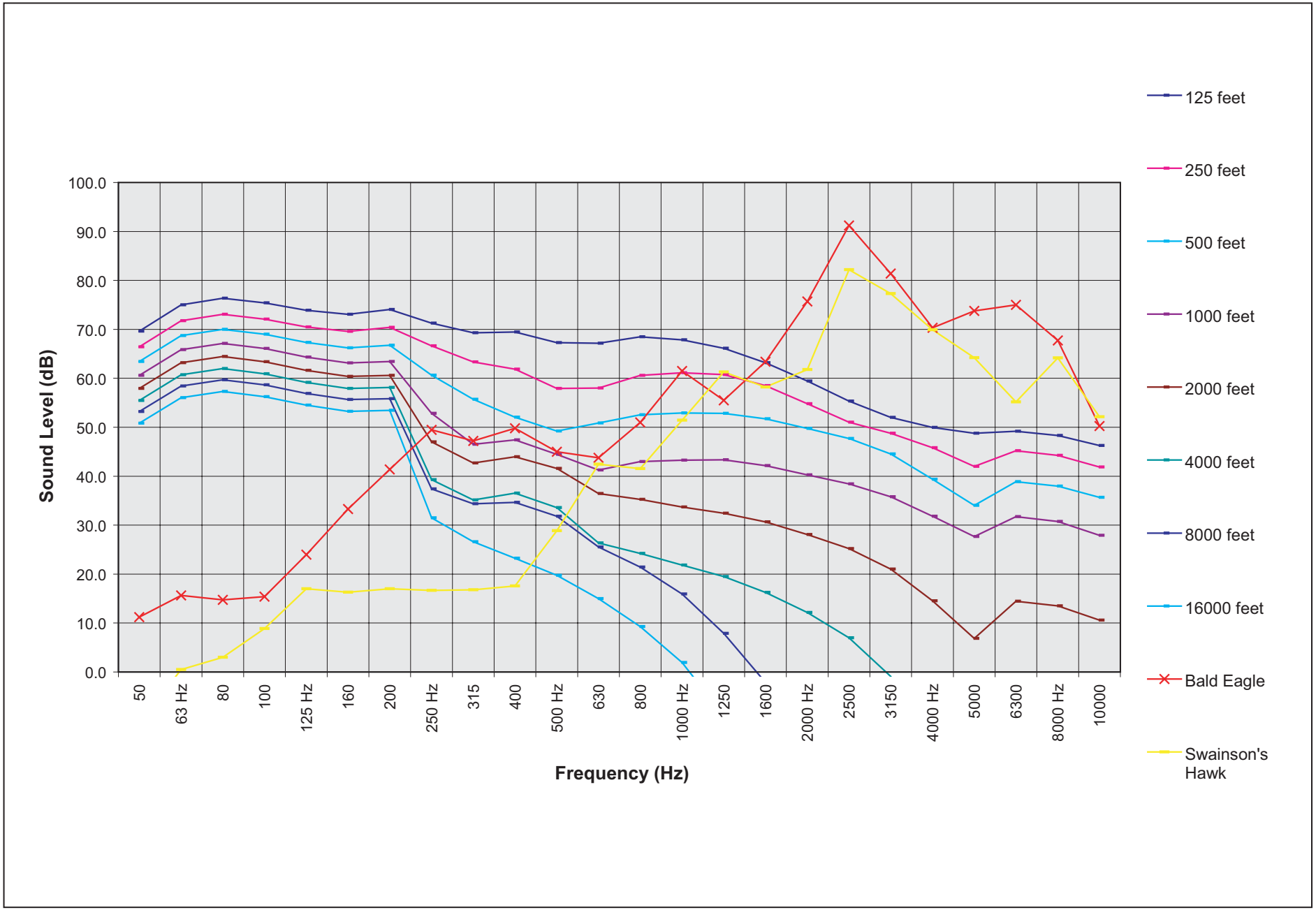

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Figure 3-27a
Traffic Noise Masking Thresholds and Vocal Signal Profiles at 50 Feet
Bald Eagle and Swainson's Hawk

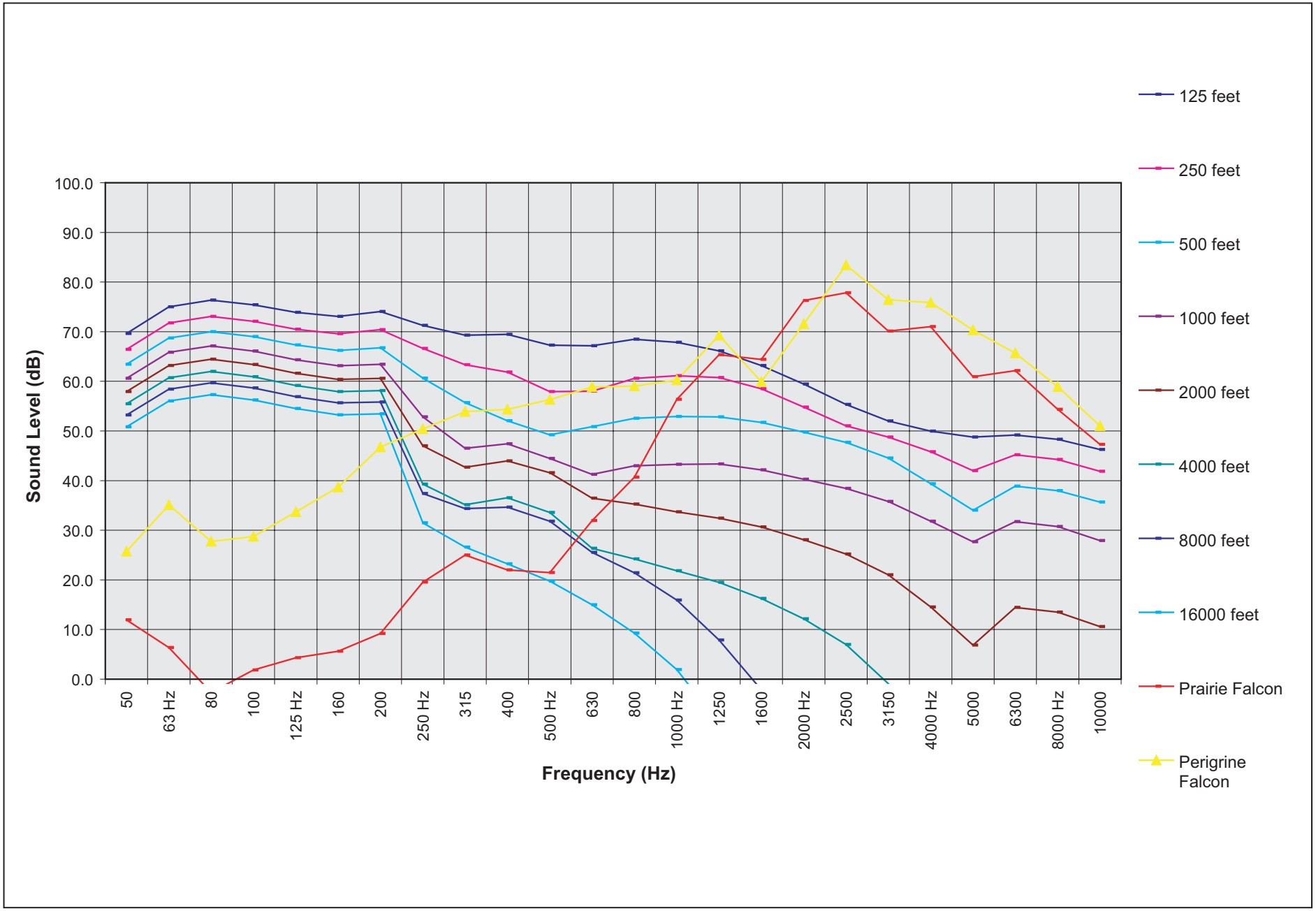

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Figure 3-27b
Traffic Noise Masking Thresholds and Vocal Signal Profiles at 50 Feet
Peregrine Falcon and Prairie Falcon

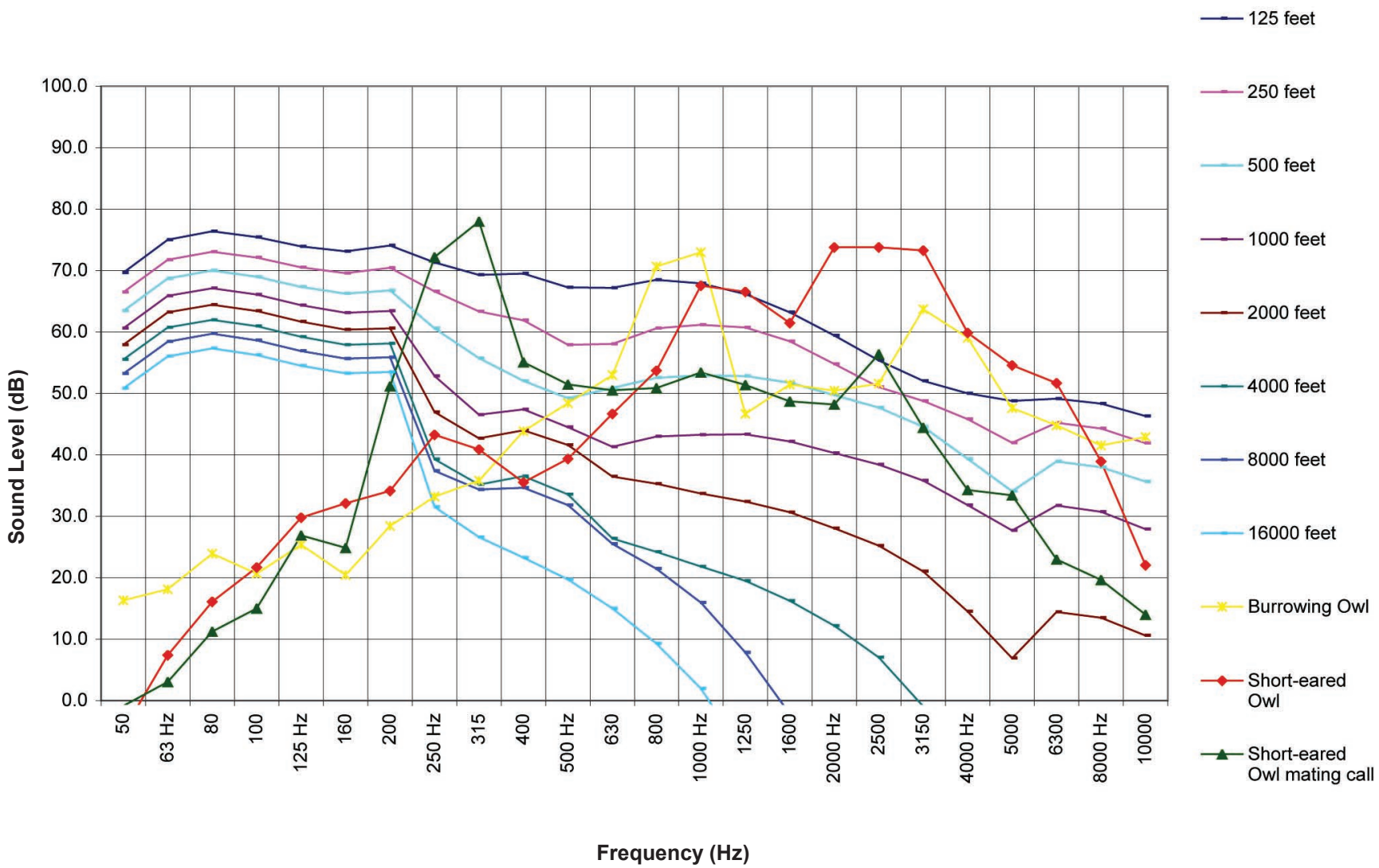

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Figure 3-27c
Traffic Noise Masking Thresholds and Vocal Signal Profiles at 50 Feet
Burrowing Owl and Short-Eared Owl

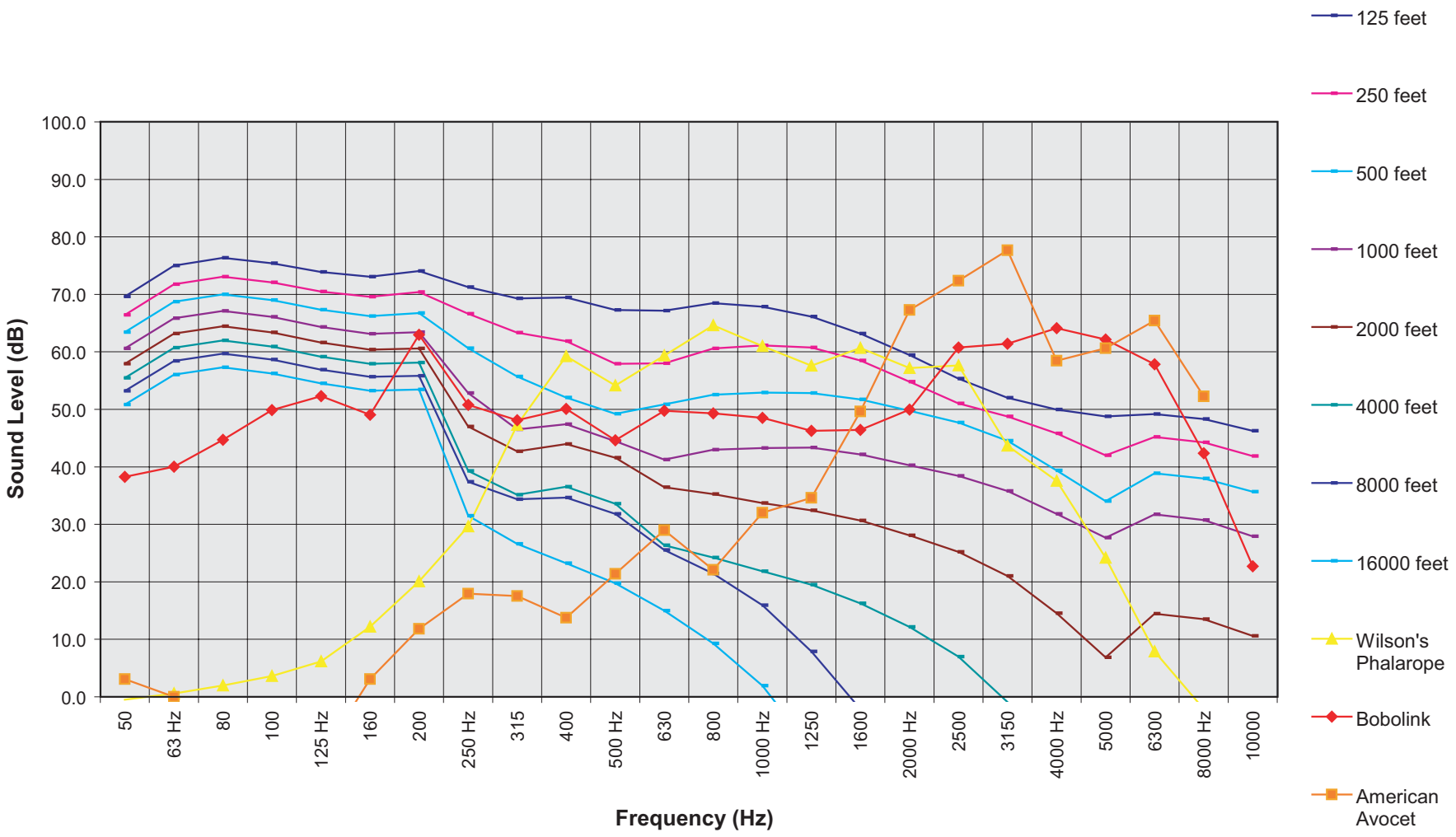

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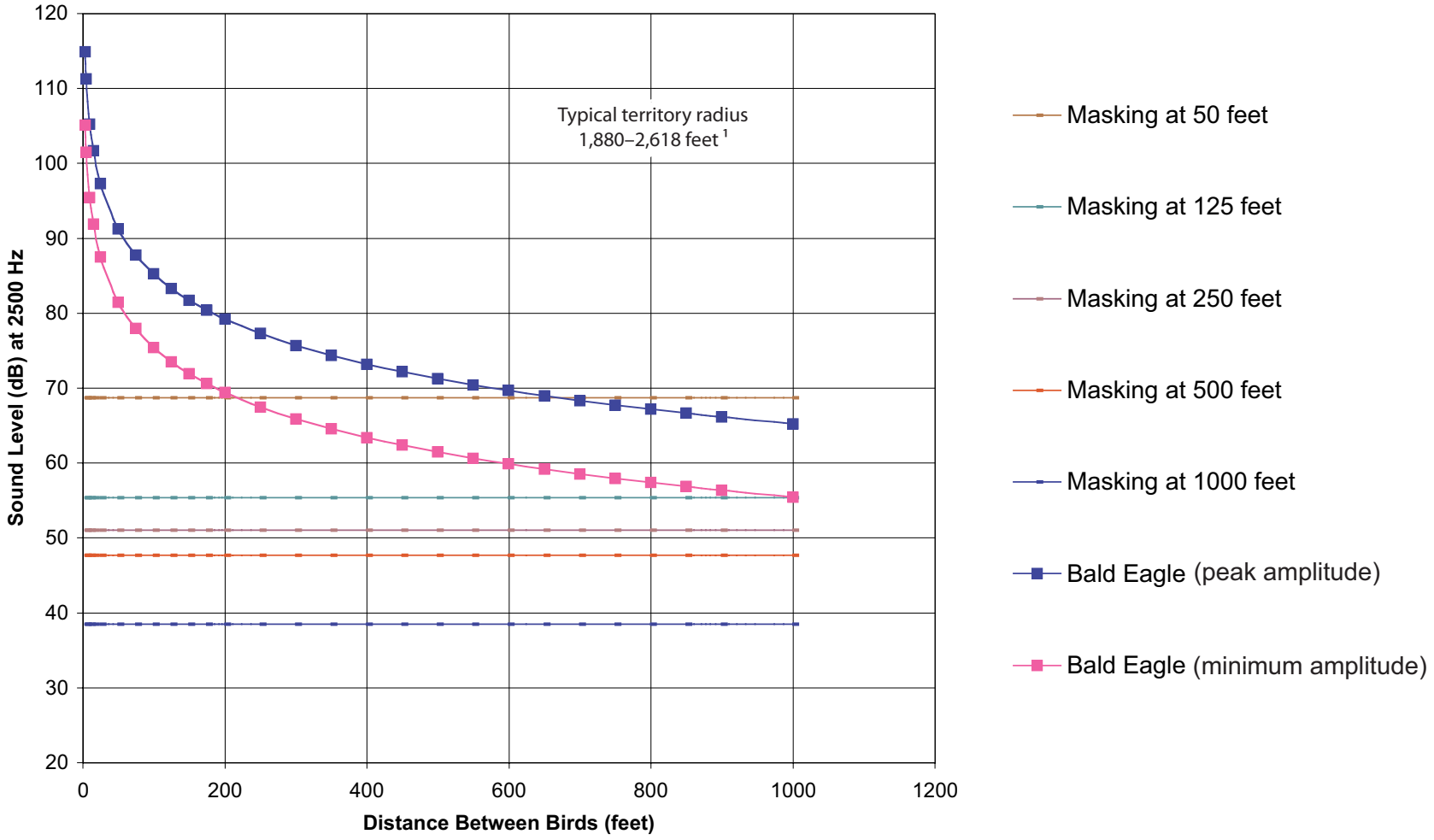
Figure 3-27d
Traffic Noise Masking Thresholds and Vocal Signal Profiles at 50 Feet
Wilson's Phalarope, Bobolink and American Avocet



[1] Buehler 2000

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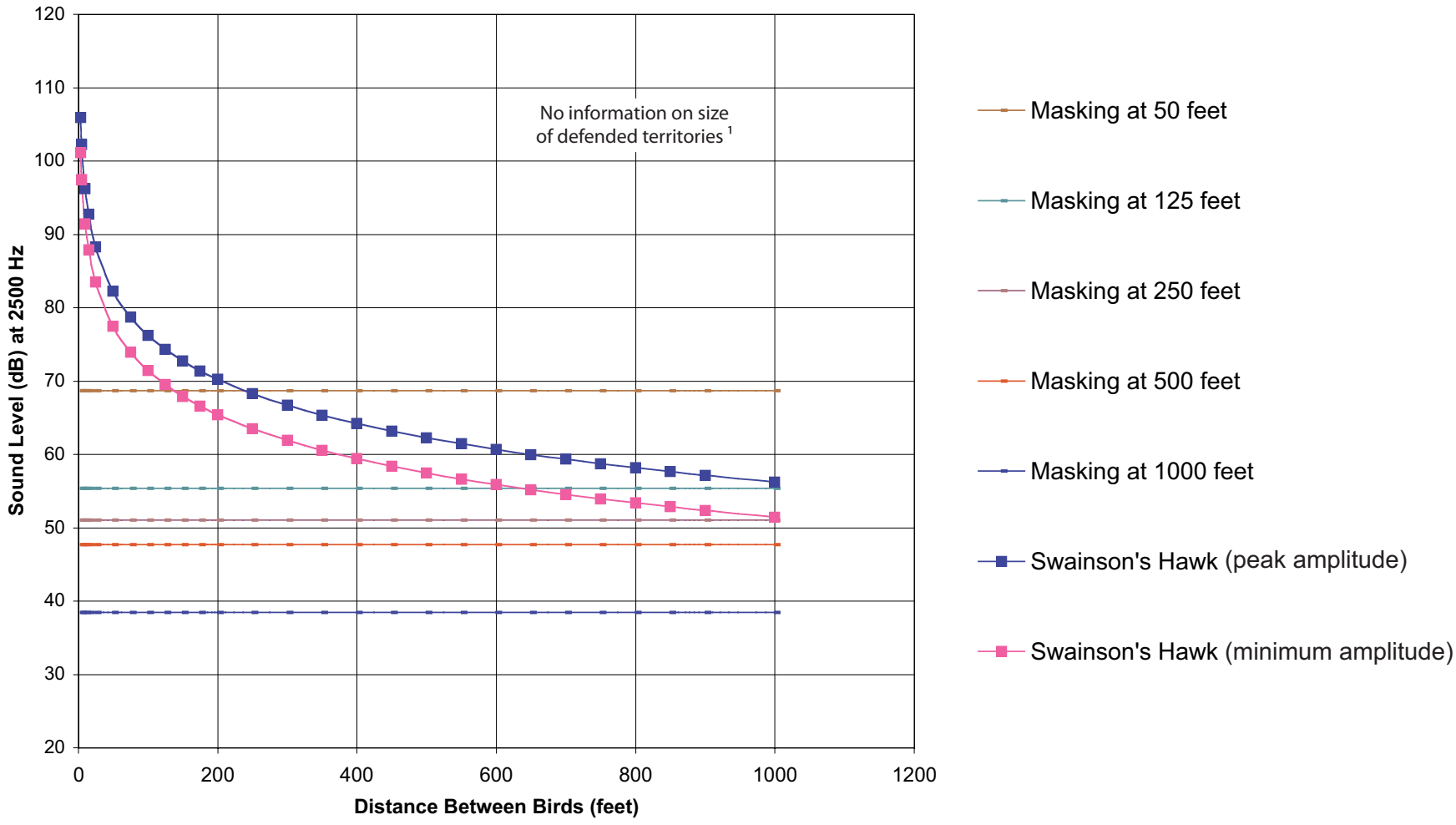
Figure 3-28a
Bald Eagle Masking Distance



[1] England et al. 1997

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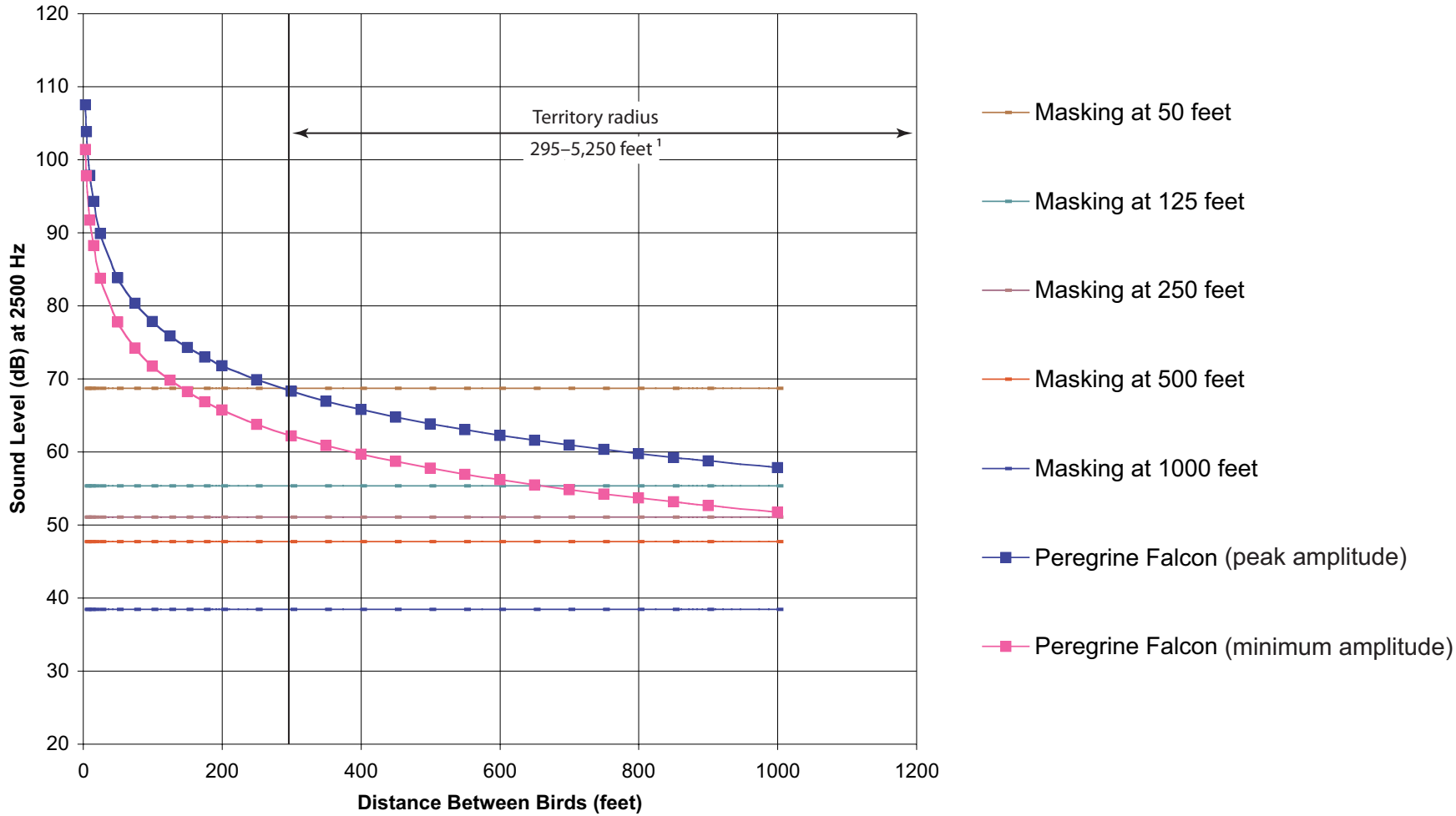
Figure 3-28b
Swainson's Hawk Masking Distance



[1] Johnsgard 1990

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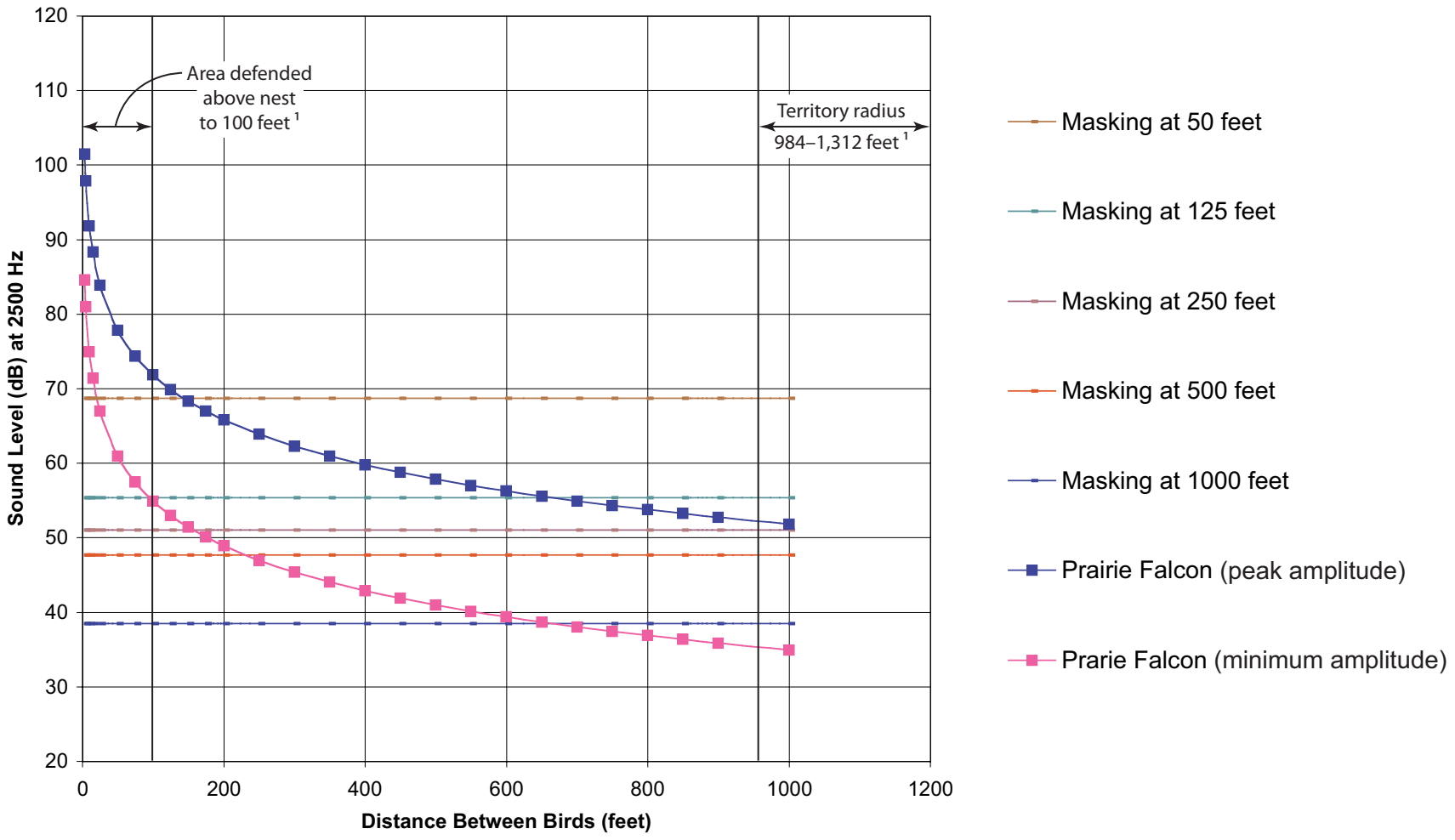
Figure 3-28c
Peregrine Falcon Masking Distance



[1] Steenhof 1998

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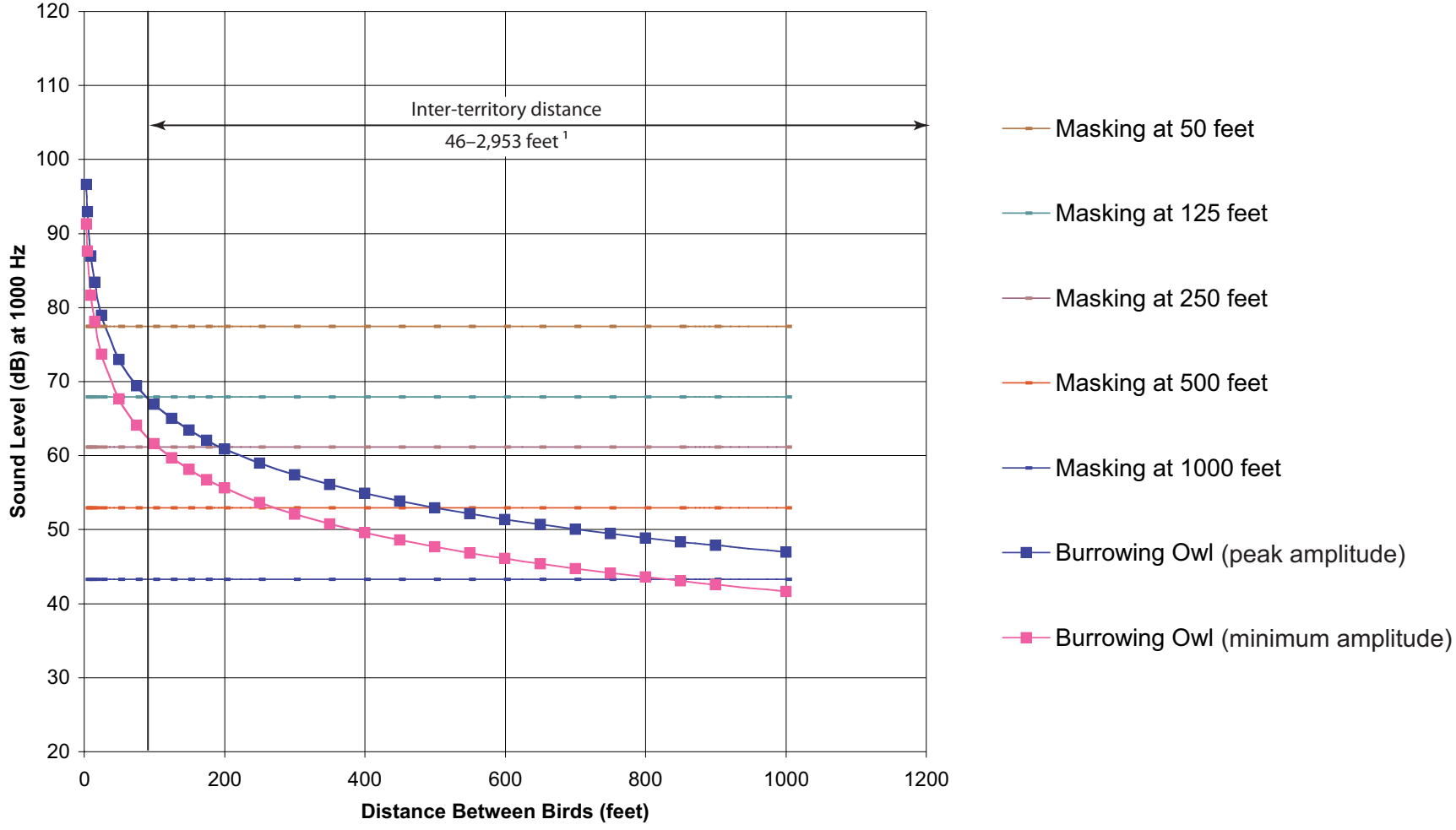
Figure 3-28d
Prairie Falcon Masking Distance



[1] Haug et al. 1993

03076.03 Wildlife Tech Memo

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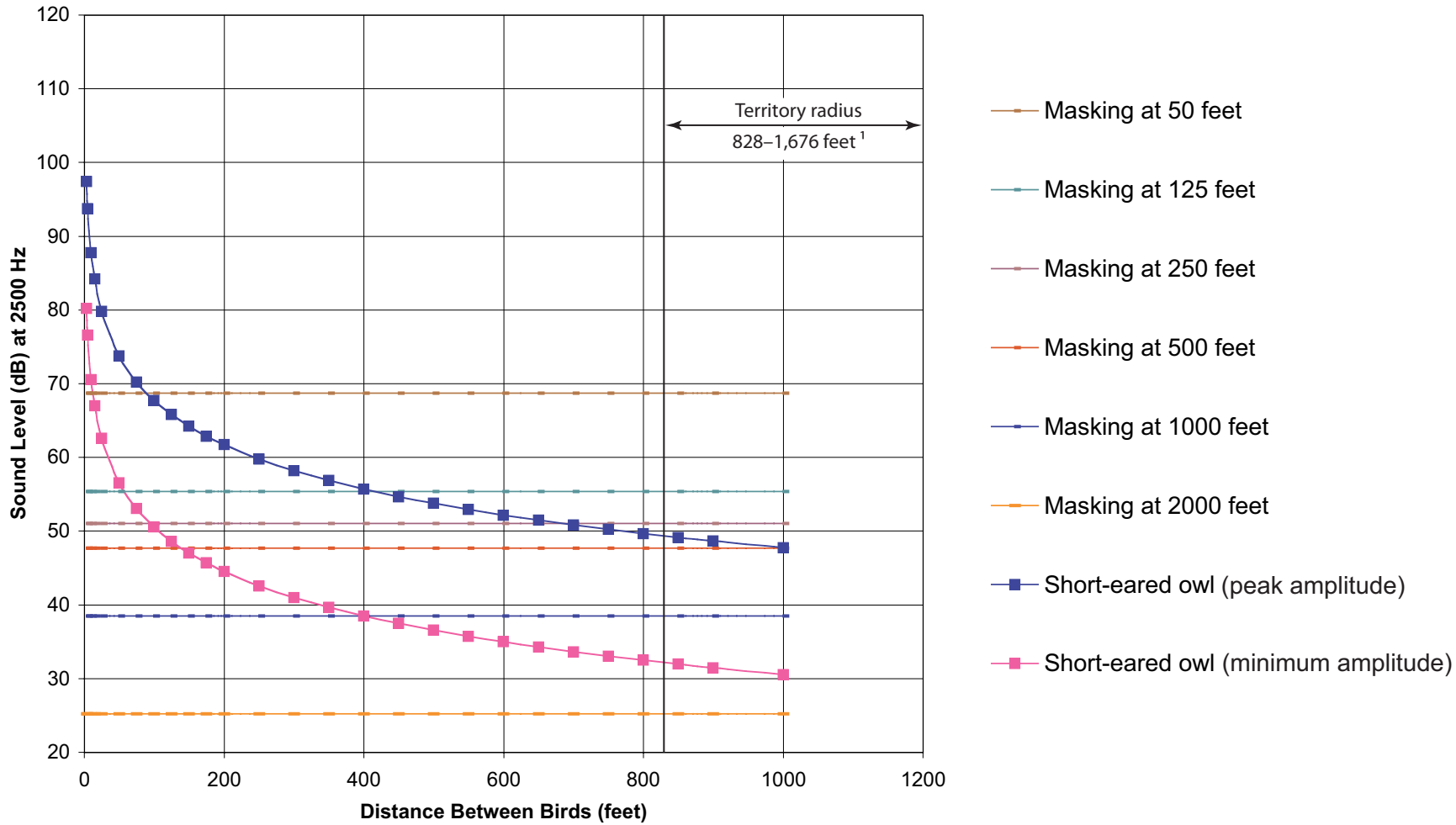
Figure 3-28e
Burrowing Owl Masking Distance



[1] Holt and Leasure 1993

03076.03 Wildlife Tech Memo

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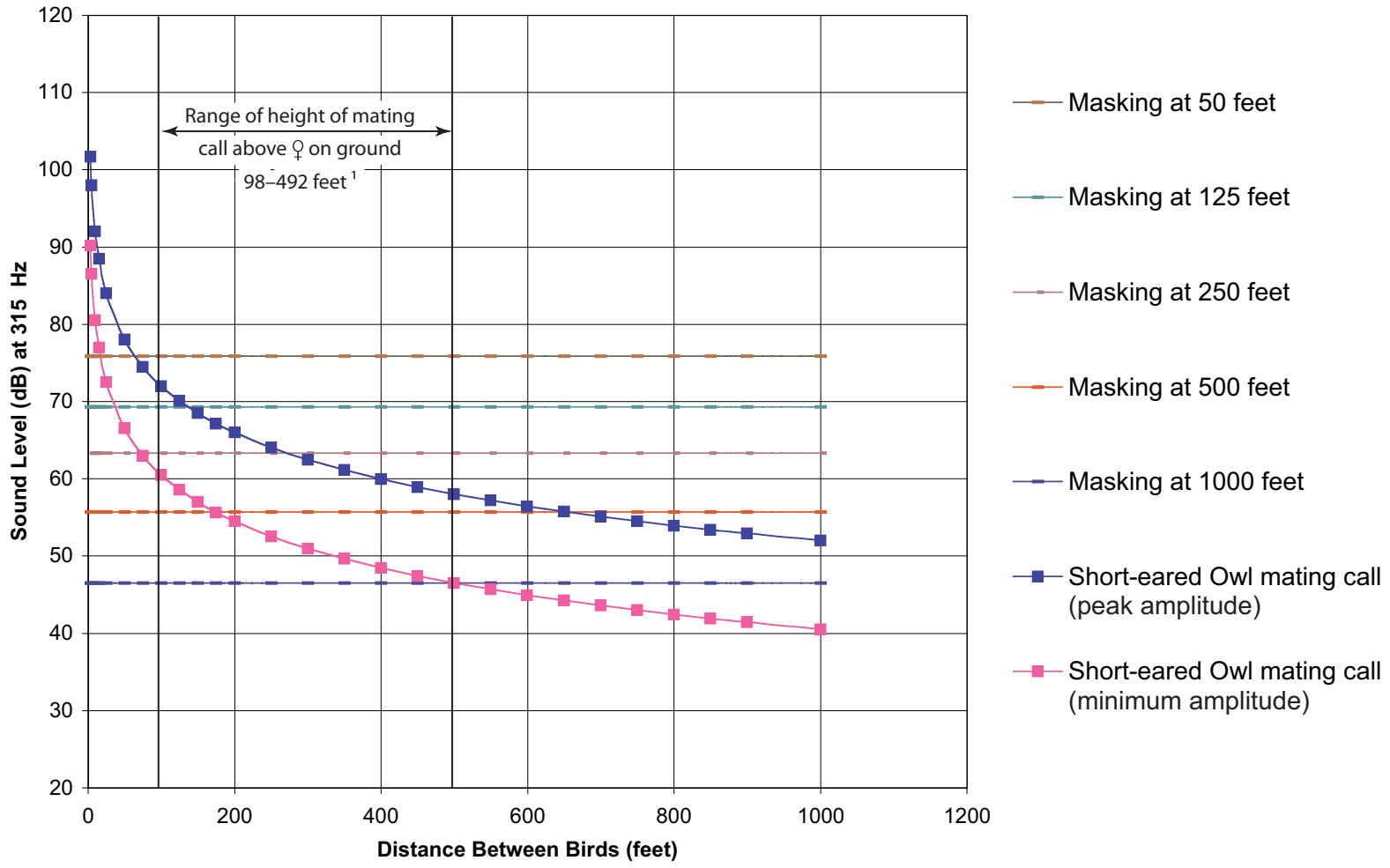
Figure 3-28f
Short-Eared Owl Masking Distance



[1] Holt and Leasure 1993

03076.03 Wildlife Tech Memo

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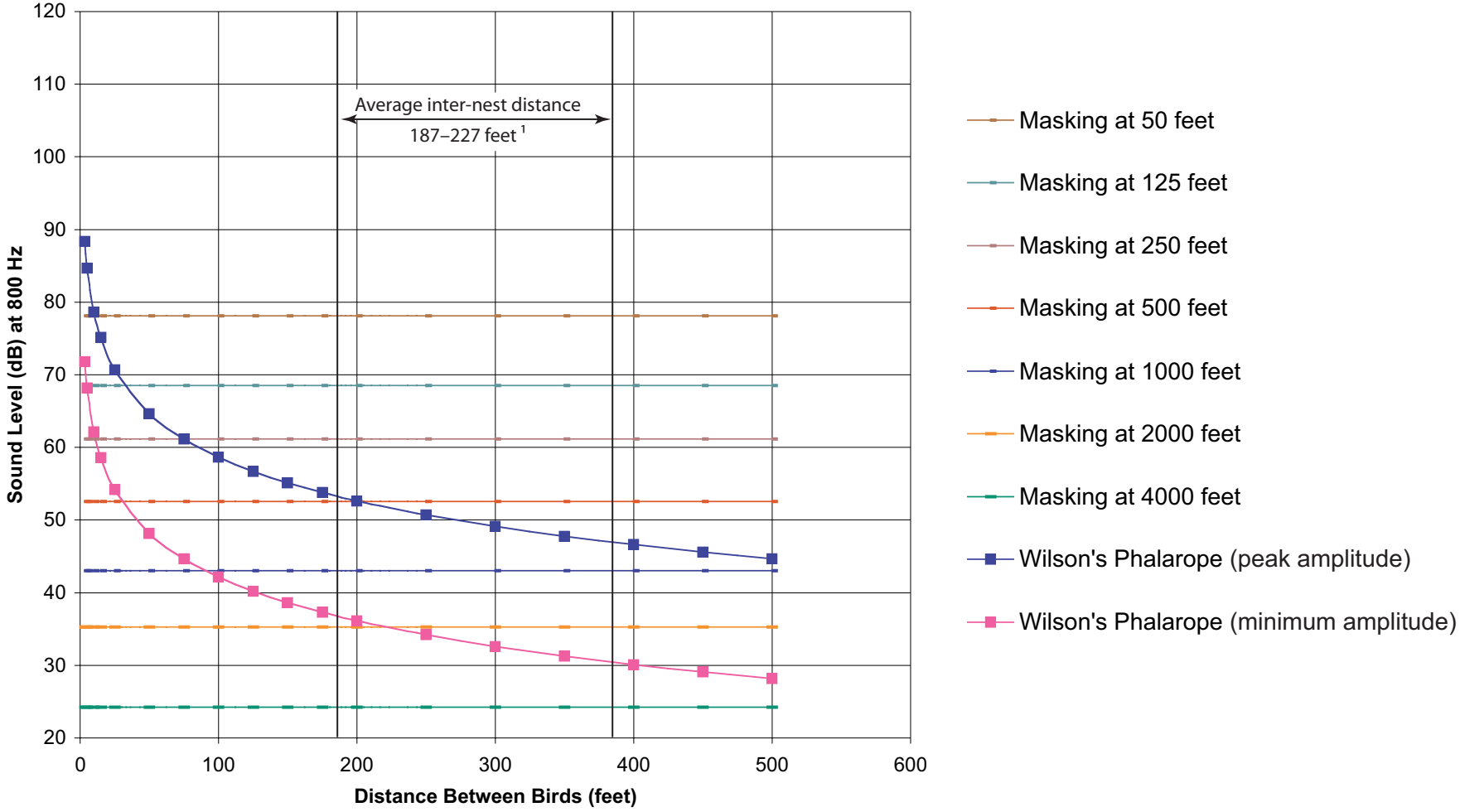
Figure 3-28g
Short-Eared Owl (Mating Call) Masking Distance



[1] Colwell and Jehl 1994

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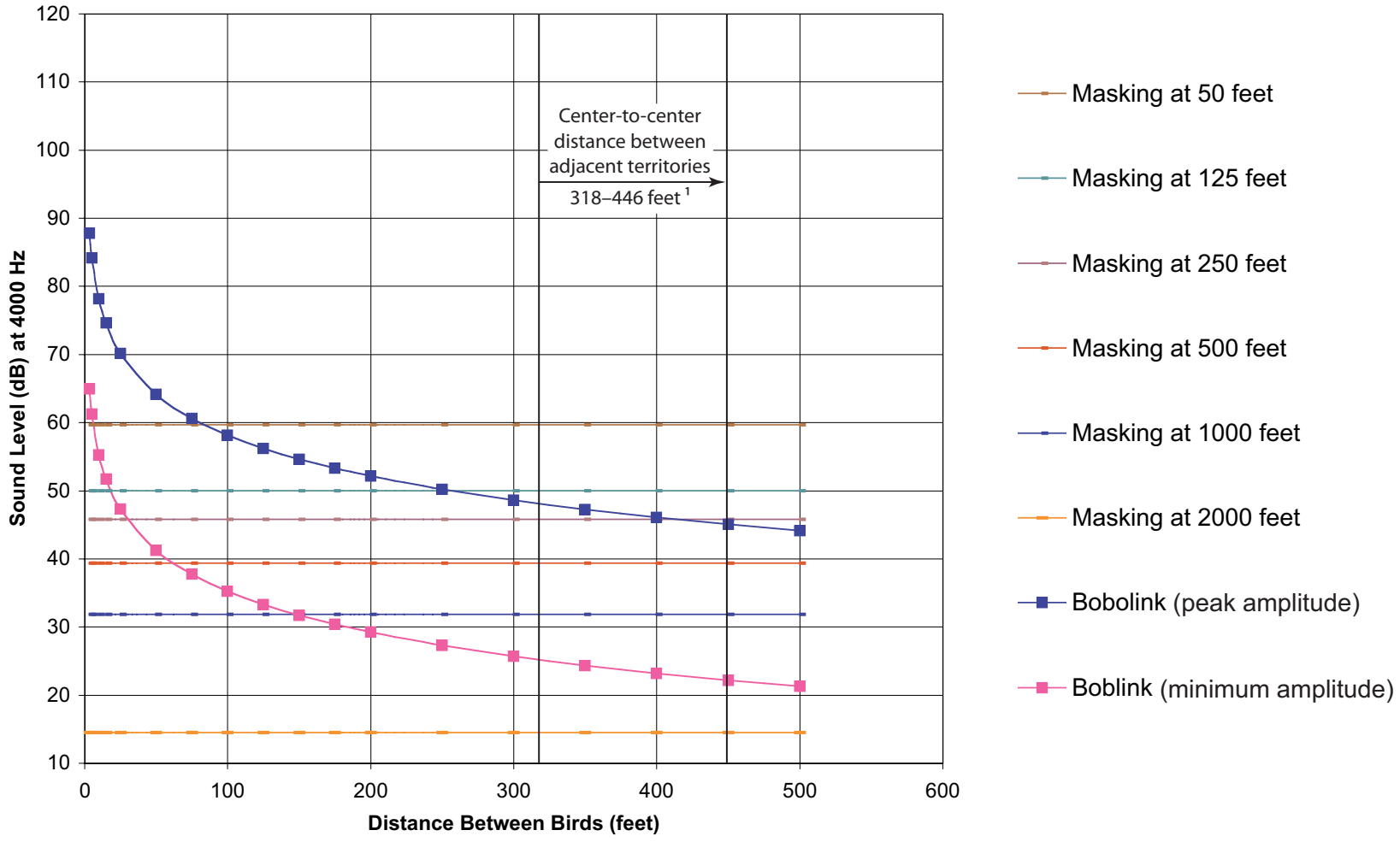
Figure 3-28h
Wilson's Phalarope Masking Distance



[1] Martin and Gavin 1995

03076.03 Wildlife Tech Memo

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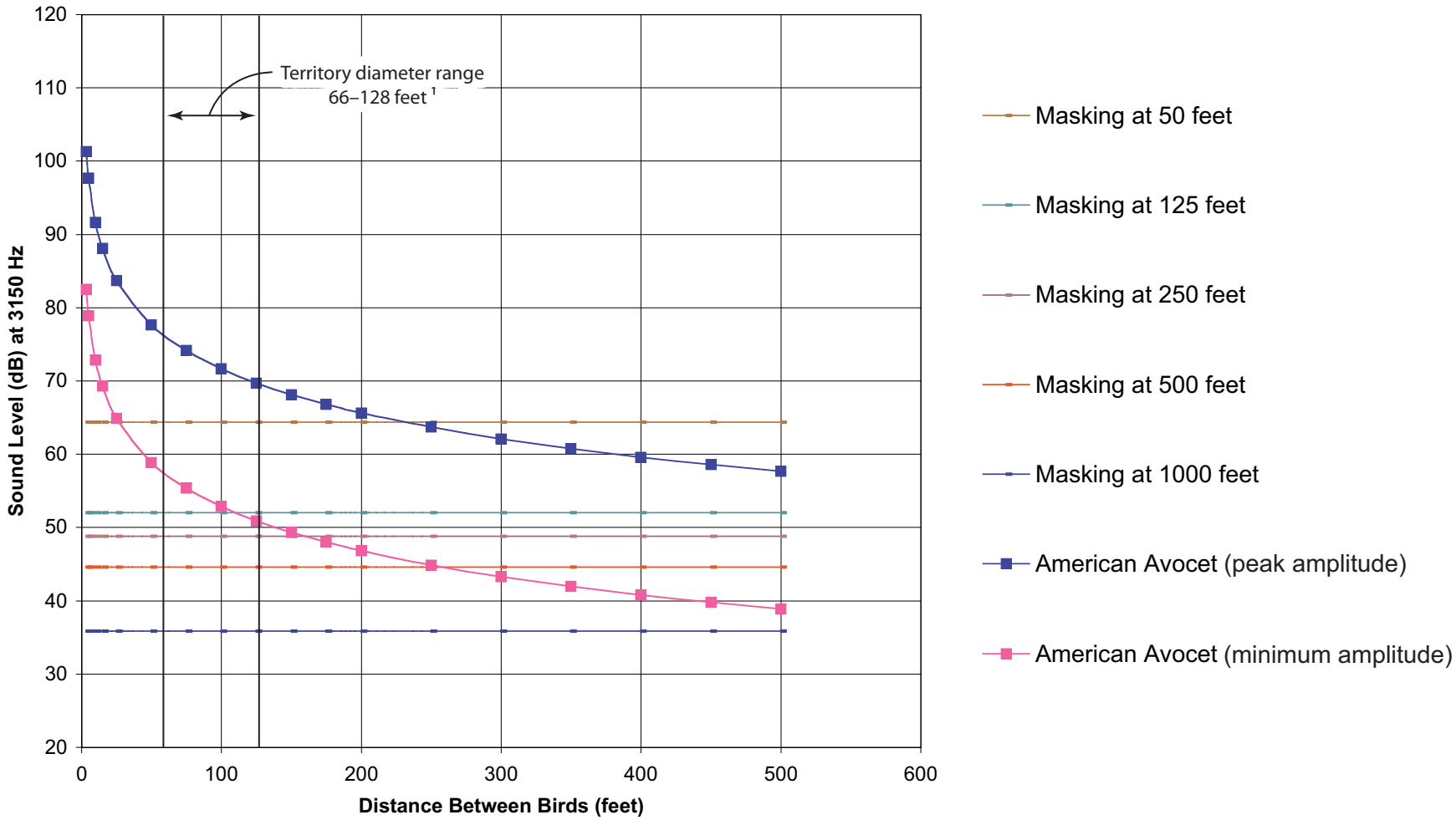
Figure 3-28i
Bobolink Masking Distance



[1] Robinson et al. 1997

03076.03 Wildlife Tech Memo

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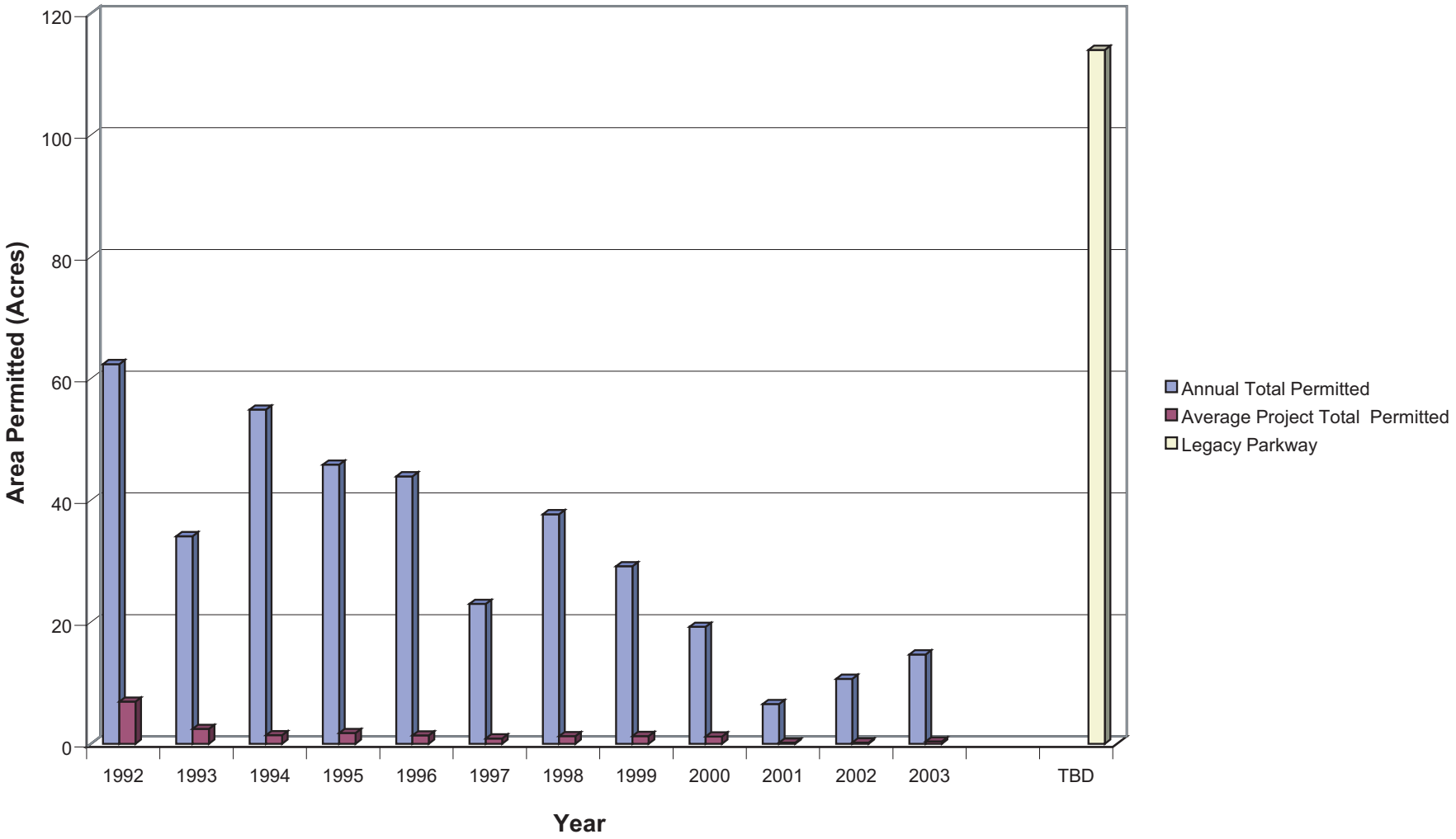
Figure 3-28j
Avocet Masking Distance



03076.03 002 Wildlife Tech Memo

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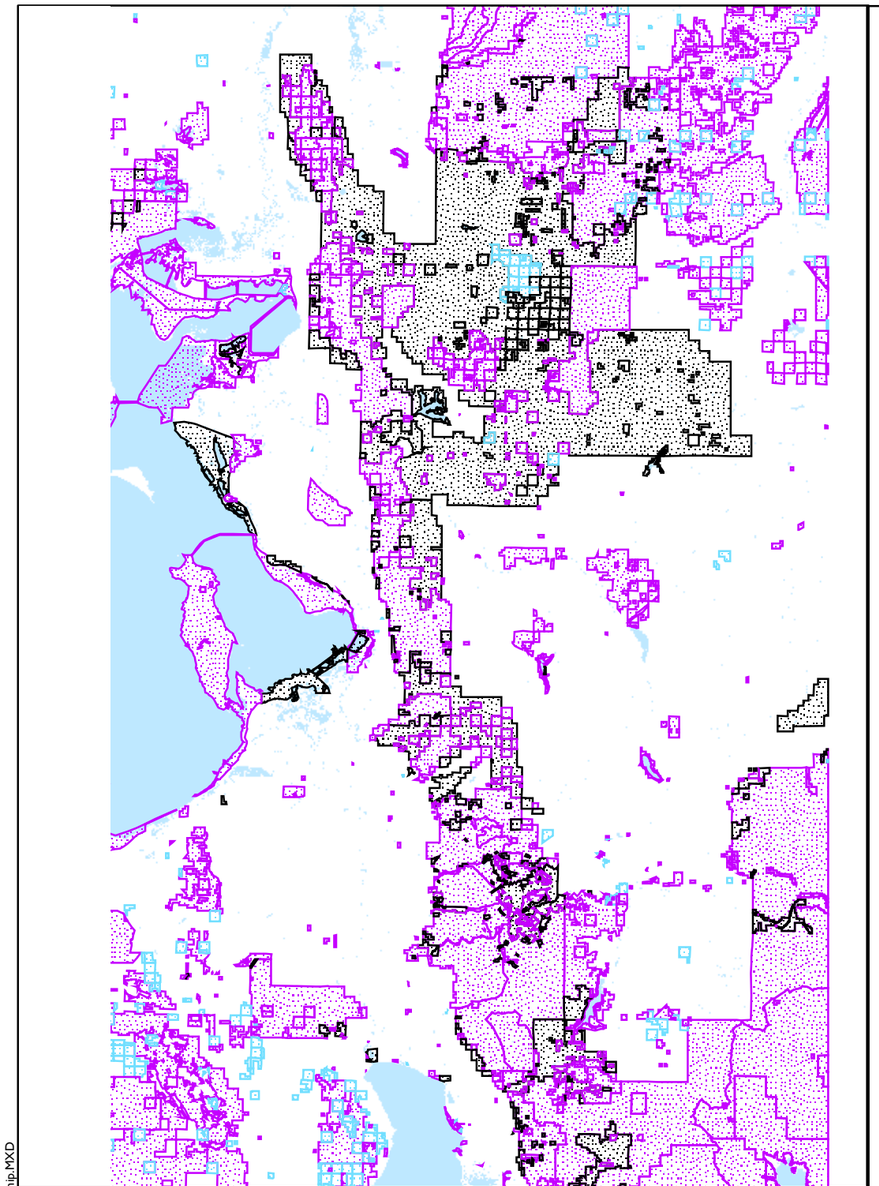
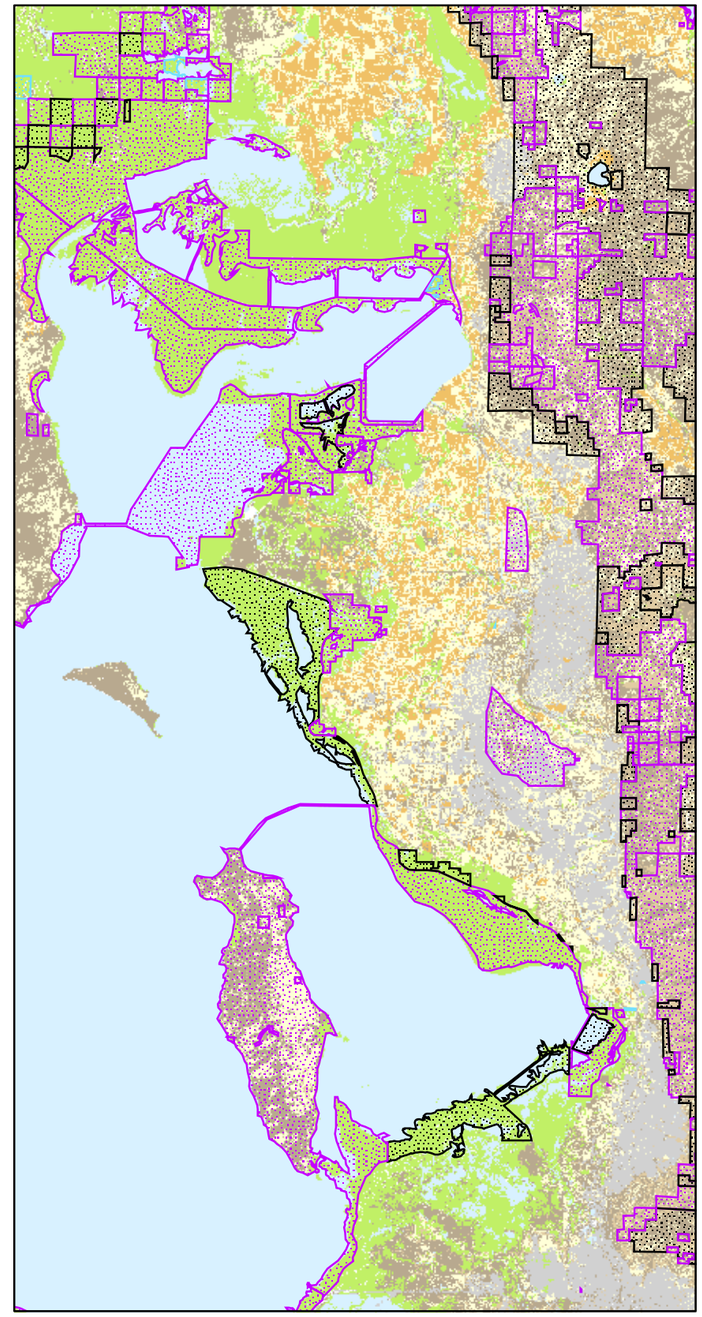
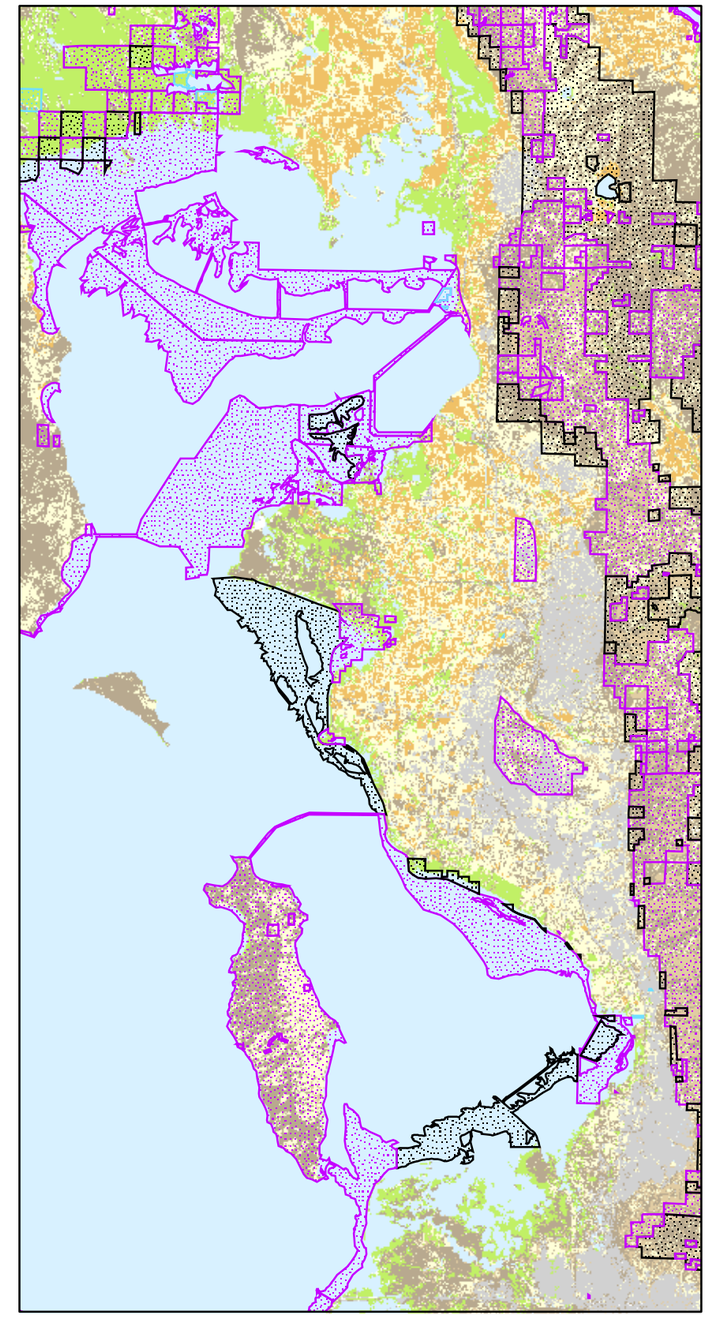
Figure 3-29
Extent of Permitted Actions in Wetlands in Salt Lake and Davies Counties (1992–2003)



Low Water



High Water



Legend

Ownership
- Private
- Public
- Public - Private
- Public Trust

Land Cover
- Cropland
- Developed
- Wetlands
- Open Water
- Pasture
- Scrub
- Unclassified
- Upland (Forested)

N

Map Production: 12/15/03

Data Sources: USGS National Land Cover Dataset and USFSW National Wetlands Inventory, Utah School and Institutional Trust Lands Administration

Low Water is based on the water level at the time of the USGS and USFWS mapping. High Water is 1984 (Univeristy of Utah)

N:/UDOT/037076.03/ARCMAP/f3_30_r84ownership.MXD

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Figure 3-30
Land Cover, Ownership Status, and Lake Level Change

Chapter 4

References

Chapter 4
References

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Chapter 5

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Appendix A

Species-Habitat Matrices

Appendix A-1. Legacy Parkway/GSLE Bird Species Habitat Matrix

	Migratory Species	GSL Ecosystem					Legacy Parkway Project Study Area							Farmington Bay WMA					Bear River NWR					Habitat Use								
		Seasonal Abundance				Breeds in GSLE	Seasonal Abundance				Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Seasonal Abundance				Breeds in FBWMA	Seasonal Abundance				Breeds in BRNWR	Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
		P	S	W	T		P	S	W	T				P	S	W	T		P	S	W	T										
Loons																																
Pacific Loon	X				RT								X									RT		F								
Common Loon	X				RT								X									UT		F								
Grebes																																
Pied-billed Grebe	X		CS	UW		X		US	RW		X	X			CS	UW		X		CS	UW		X	F		FB	F					
Horned Grebe	X			RW	RT								X			RW	RT				RW	RT		F		F						
Eared Grebe	X		CS	RW		X		RS		CT		X			CS	RW		X		US		CT	X	FB		B						
Western Grebe	X		CS	RW		X				RT		X			CS			X		CS	RW		X	FB		B						
Clark's Grebe	X		CS			X							X		CS			X		CS	RW		X	FB		B						
Pelicans and Cormorants																																
American White Pelican (WSC)	X		CS			X		RS				X			CS					CS				F		F						
Double-crested Cormorant	X		CS			X		RS			X	X			CS			X		CS				F	B	F						
Wading Birds																																
American Bittern	X		RS			X							X		RS			X		RS						FB						
Great Blue Heron	X	CP				X	CP				X	X		CP				X	CP					F	FB	FB	F					
Great Egret	X		RS		RT								X				RT			RS				F		F						
Snowy Egret	X		CS			X		US				X			CS			X		CS			X	F	B	FB	F	F	F			
Cattle Egret	X		CS			X				RT		X			US					CS						B	F		F	F		
Black-crowned Night-heron	X		CS	RW		X		CS			X	X			CS	UW		X		CS			X	F	B	FB	F	F	F			
White-faced Ibis	X		CS			X		CS				X			CS			X		CS			X	F		FB	F	F	F	F		
Swans, Geese, Ducks																																
Tundra Swan	X			RW	CT`								X			RW	CT				RW	CT		F								
Trumpeter Swan	X			RW									X				O				RW			F								
Greater White-fronted Goose	X				RT								X				RT					A		F						F		
Snow Goose	X				UT								X				UT					UT				F				F		
Ross' Goose	X				RT								X				RT					RT				F				F		
Canada Goose	X	CP				X	CP				X	X		CP				X	CP				X	F		F	F	F	FB	F	F	F
Wood Duck	X	RP											X	RP							RW			F								F
Green-winged Teal	X		US	CW	CT	X				UT		X			US	CW	CT			US	CW	CT	X	F		FB	FB	F	F	F		
Mallard	X	CP				X	UP				X	X		CP				X	CP				X	F	F	FB	FB	F	FB	FB		F
Northern Pintail	X		RS	RW	CT	X				UT		X			RS	UW	CT	X		RS	UW	CT	X	F		FB	FB	F	F	F	B	
Blue-winged Teal	X		US			X		RS				X			US		UT	X		US			X	F		FB	FB	F	F			
Cinnamon Teal	X		CS	RW		X		RS				X			CS	RW		X		CS	RW		X	F		FB	FB	F	F	F		
Northern Shoveler	X		RS	UW	CT	X				UT		X			RS	UW	CT	X		RS	UW	CT	X	F		FB	FB	F	F		B	
Gadwall	X		CS	UW		X		US	UT		X	X			CS	UW		X		CS	UW		X	F		FB	FB	FB	FB	FB	B	
Eurasian Wigeon	X				RT					RT		X										RT		F		F	F	F	F	F		
American Wigeon	X			UW	CT					RT		X				UW	CT				UW	CT		F		F	F	F	F	F		
Canvasback	X		RS	RW	CT	X							X		RS	RW	CT	X		RS	RW	UT	X	F		FB						
Redhead	X		CS	RW		X							X		CS	UW		X		CS	RW		X	F		FB						
Ring-necked Duck	X			RW	RT								X			RW					RW	RT		F								
Greater Scaup	X				UT								X				RT					RT		F								
Lesser Scaup	X			CW									X			UW	CT				UW	CT		F								
Long-tailed Duck	X			RW									X				O				RW			F								
White-winged Scoter	X			RW									X				O				RW			F								
Surf Scoter	X			RW									X				O				RW			F								
Common Goldeneye	X			CW					RW			X				UW	CT				UW	CT		F								
Barrow's Goldeneye	X			RW									X			RW					RW			F								
Bufflehead	X			CW									X			UW	CT				UW	CT		F								
Hooded Merganser	X			RW	RT								X			RW	RT				RW	RT		F								
Common Merganser	X			UW	CT								X			UW	CT				RW	CT		F								
Red-breasted Merganser	X			UW	CT								X			RW	CT				RW	CT		F								
Ruddy Duck	X		CS	UW		X				RT		X			CS	UW		X		CS	UW		X	F		FB						
Diurnal Raptors																																
Turkey Vulture	X		CS					US				X			US					CS								F	F	F	F	F
Osprey	X				RT					RT		X					RT					RT		F								
Bald Eagle (FT)	X		RS	CW		X		RS	CW		X	X				CW					CW				FB	F	F	F	F		F	
Northern Harrier	X	CP				X	CP				X	X		CP				X	CP				X		F	FB	F	F	FB	F	FB	F
Sharp-shinned Hawk	X			UW	UT					RT		X					RT				UW	UT			F			F	F	F	F	F
Cooper's Hawk	X			UW	UT					RT		X					RT				UW	UT			F			F	F	F	F	F
Northern Goshawk (CAS)	X				RT							(X)									RW	RT			F						F	
Swainson's Hawk (BCC)	X		RS		UT	X		RS			X	X					UT			CS					B		F	F	F	F	F	
Red-tailed Hawk	X	CP				X	UP				X	X		CP				X	CP				X		B		F	F	F	F	F	F
Ferruginous Hawk (BCC; WSC)	X		RS										X				RT			US							F	F	F	F	F	
Rough-legged Hawk	X			CW					CW			X				CW					CW						F	F	F	F	F	F
Golden Eagle (BCC)	X	RP								RT		X		RP					UP								F	F	F	F	F	

	Migratory Species	GSL Ecosystem					Legacy Parkway Project Study Area							Farmington Bay WMA					Bear River NWR					Habitat Use								
		Seasonal Abundance				Breeds in GSLE	Seasonal Abundance				Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Seasonal Abundance				Breeds in FBWMA	Seasonal Abundance				Breeds in BRNWR	Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
		P	S	W	T		P	S	W	T				P	S	W	T		P	S	W	T										
American Kestrel	X	CP				X	CP				X	X		CP				X	CP						B		F	F	F	F	F	F
Merlin	X			RW					RW			X				RW					UW							F	F	F	F	F
Peregrine Falcon (BCC)	X	RP				X	RP				X	X		UP				X	UP					F		F	F	F	F	F	F	F
Prairie Falcon (BCC)	X	RP				X	RP					X		UP					UP								F	F	F	F	F	
Pheasant and Quail																																
Ring-necked Pheasant		UP				X	RP				X	X		CP				X	UP						F		F	F	FB	FB	FB	FB
California Quail		RP											X	UP											FB					F		FB
Gruiformes																																
Virginia Rail	X		CS	RW		X		RS			X	X			CS	UW		X		CS			X			FB	F	F	F			
Sora	X		CS			X		RS			X	X			CS			X		CS			X			FB	F	F	F			
Common Moorhen	X	RP				X							X		RS			X	RP				X	F		FB						
American Coot	X	CP				X	UP				X	X		CP				X	CP				X	F		FB	FB	F	F	F		
Sandhill Crane	X		RS		UT	X				RT		X			RS			X		US		CT		F		FB	F	F	F	F		
Shorebirds																																
Black-bellied Plover	X				CT					RT		X					UT					UT					F	F	F			
American Golden-plover (BCC)	X				RT								X				RT					RT					F	F	F			
Snowy Plover (BCC)	X		CS			X							X		US			X		CS			X					FB				
Semipalmated Plover	X				UT								X				UT					RT						F				
Killdeer	X	CP				X	CP				X	X		CP				X		CS	RW		X				FB	FB	FB	FB	FB	FB
Black-necked Stilt	X		CS			X		CS			X	X			CS			X		CS			X	F		FB	FB	FB	FB			
American Avocet (BCC)	X		CS			X		CS			X	X			CS			X		CS			X	F		FB	FB	FB	FB			
Greater Yellowlegs	X				CT					UT		X					CT					CT		F			F	F	F			
Lesser Yellowlegs	X				CT					UT		X					CT					CT		F			F	F	F			
Solitary Sandpiper (BCC)	X				RT					RT		X					RT					UT			F		F	F	F			
Willet	X		CS			X		RS			X	X			CS			X		CS			X				FB	FB	FB	FB	FB	
Spotted Sandpiper	X		US			X				RT		X			CS			X				UT			FB			F				
Whimbrel (BCC)	X				RT								X				RT					RT						F	F			
Long-billed Curlew (BCC)	X		US		CT	X				RT		X			US			X		CS			X				F	FB			FB	
Marbled Godwit (BCC)	X				CT					RT		X					CT					CT		F			F	F	F			
Ruddy Turnstone	X				RT								X				RT					RT						F				
Red Knot	X				UT								X				RT					RT						F	F			
Sanderling (BCC)	X			RW	UT								X				UT				UW	RT						F				
Semipalmated Sandpiper	X				RT								X				UT					RT						F				
Western Sandpiper	X				CT					RT		X					CT					CT						F				
Least Sandpiper	X			RW	CT					RT		X				RW	CT				RW	CT						F				
Baird's Sandpiper	X				CT					RT		X					UT					UT						F				
Pectoral Sandpiper	X				UT					RT		X					UT					RT					F	F	F			
Dunlin	X				RT								X				RT					RT						F				
Stilt Sandpiper	X				RT								X				RT					RT						F				
Short-billed Dowitcher	X				RT								X				RT					RT		F		F	F	F				
Long-billed Dowitcher	X				CT					RT		X					CT					CT		F		F	F	F				
Wilson's Snipe	X	CP				X	CP				X	X			CS	UW		X		CS	UW		X			F	FB	F	FB			
Wilson's Phalarope (BCC)	X		US		CT	X		RS		UT	X	X			CS			X		US		CT		F		F	FB	F	F			
Red-necked Phalarope	X				CT					RT		X					CT					CT		F								
Gulls and Terns																																
Franklin's Gull	X		CS			X				CT		X			CS			X		CS				F		FB	F	F	F	F		
Bonaparte's Gull	X				UT					RT		X					UT					UT		F		F						
Ring-billed Gull	X		RS	CW		X			UW			X				CW				US	CW		X	F		F	F	F	F	F		F
California Gull	X	CP				X	UP					X		CP				X	CP				X	F		F	F	F	F	F	F	F
Herring Gull	X			UW									X			UW					UW			F								F
Thayer's Gull	X			RW									X			RW					RW			F								F
Glaucous Gull	X			RW									X			RW					RW			F								F
Caspian Tern	X		US			X		RS					X		US									F								
Common Tern	X				RT								X				RT					RT		F								
Forster's Tern	X		CS			X		CS			X	X			CS			X		CS			X	F		FB						
Black Tern	X		US			X		RS				X			US					US		CT		F								
Pigeons and Doves																																
Rock Pigeon	X	CP				X	UP				X	X							CP				X									FB
Mourning Dove	X		US	RW		X		US	RW		X	X			CS			X		CS			X		FB			F	F	F	F	FB
Cuckoos																																
Yellow-billed Cuckoo (FC)	X				RT								X												FB							FB
Owls																																
Barn Owl	X	UP				X	RP				X	X		RP					UP								F	F	F	F	F	FB
Great Horned Owl	X	UP				X	UP				X	X		CP					UP						FB	F	F	F	F	F	F	FB
Burrowing Owl (BCC; WSC)	X		RS			X		RS			X	X								US			X					F	F		FB	
Long-eared Owl	X				RW								X												F		F	F	F		F	
Short-eared Owl (WSC)	X	CP				X	UP				X	X		UP				X	UP				X			F	F	F	F	F	FB	

	Migratory Species	GSL Ecosystem					Legacy Parkway Project Study Area							Farmington Bay WMA					Bear River NWR					Habitat Use								
		Seasonal Abundance				Breeds in GSLE	Seasonal Abundance				Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Seasonal Abundance				Breeds in FBWMA	Seasonal Abundance				Breeds in BRNWR	Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
		P	S	W	T		P	S	W	T				P	S	W	T		P	S	W	T										
Goatsuckers and Swifts																																
Common Nighthawk	X				UT					UT		X					CT			CS				F	F	F	F	F	F	F	F	F
Common Poorwill	X			US						RT			X							US				F	F	F	F		F	F	F	F
White-throated Swift	X			US						RT			X				RT			US					F	F	F		F	F	F	F
Hummingbirds																																
Black-chinned Hummingbird	X		RS		RT					RT		X					UT			US					F		F	F	F	F	F	F
Calliope Hummingbird	X				RT								X				RT								F		F	F	F	F	F	F
Broad-tailed Hummingbird	X		RS		RT					RT		X					RT			US					F		F	F	F	F	F	F
Rufous Hummingbird	X				RT					RT		X					RT					UT			F		F	F	F	F	F	F
Kingfishers																																
Belted Kingfisher	X	UP				X	UP				X	X		UP					UP					F	FB							
Woodpeckers																																
Red-naped Sapsucker	X				RT								X				RT								F							F
Downy Woodpecker	X	RP				X							X	RP					UP						F							F
Northern Flicker	X	RP				X				RT		X		UP				X	UP						FB						F	FB
Flycatchers																																
Olive-sided Flycatcher	X				RT					RT		X													F						F	F
Western Wood-peewee	X				RT					RT		X										RT			F						F	F
Cordilleran Flycatcher	X				RT					RT		(X)										RT			F						F	F
Willow Flycatcher	X				RT					RT		(X)										RT			F						F	F
Hammond's Flycatcher	X				RT					RT		(X)										RT			F						F	F
Dusky Flycatcher	X				RT					RT		(X)										RT			F						F	F
Gray Flycatcher	X				RT					RT		(X)										RT			F						F	F
Say's Phoebe	X	RP				X							X				O		UP												FB	
Ash-throated Flycatcher	X				RT					RT		(X)										RT			F						F	F
Western Kingbird	X		CS			X		US			X	X			RS			X		US			X		FB		F	F	F	F	F	FB
Eastern Kingbird	X				RT								X				O								F							F
Shrikes																																
Northern Shrike	X			UW					UW			X				RW					UW				F	F	F	F	F	F	F	F
Loggerhead Shrike (BCC)	X	UP				X	UP					X		RP					RP						F	F	F	F	F	F	FB	F
Vireos																																
Plumbeous Vireo	X				RT								X				RT					RT			F							F
Warbling Vireo	X				RT					RT		X					RT					RT			F						F	F
Jays, Crows, and Allies																																
Black-billed Magpie	X	UP				X	UP				X	X		UP				X	CP				X		FB		F	F	F	F	F	FB
American Crow	X			RW									X								RW						F		F	F	F	F
Common Raven	X	CP				X	CP				X	X		CP				X	CP				X		B	F	F	F	F	F	F	FB
Larks																																
Horned Lark	X	CP				X	CP				X	X		CP				X	CP				X				F	FB	F		FB	
Swallows																																
Purple Martin	X				RT								X				O							F	F	F	F	F	F	F	F	F
Tree Swallow	X				CT					CT		X					CT			US		CT		F	F	F	F	F	F	F	F	F
Violet-green Swallow	X				UT					UT		X					CT			US		CT		F	F	F	F	F	F	F	F	F
Northern Rough-winged Swallow	X				UT					UT		X					CT			US		CT		F	F	F	F	F	F	F	F	F
Bank Swallow	X				CT					CT		X					CT			US		CT		F	F	F	F	F	F	F	F	F
Cliff Swallow	X		CS			X		CS			X	X					CT	X		CS			X	F	F	F	F	F	F	F	F	B
Barn Swallow	X		CS			X		CS			X	X					CT	X		CS			X	F	F	F	F	F	F	F	F	B
Chickadees																																
Black-capped Chickadee	X			RW	UT				RW	RT		X				RW						UT			F						F	F
Mountain Chickadee	X			RW									X			RW						RT			F							F
Wrens																																
Rock Wren	X				RT								X									UT									F	
House Wren	X				UT								X				UT					UT			F						F	F
Marsh Wren	X		CS	RW		X		US			X	X			CS			X		CS	UW		X			FB						
Kinglets and Thrushes																																
Ruby-crowned Kinglet	X			UW						RT		X				RW						UT			F						F	F
Blue-gray Gnatcatcher	X				RT								X									RT			F						F	F
Mountain Bluebird	X				RT					RT		X					UT					UT					F	F	F	F	F	
Townsend's Solitaire	X				RT					RT			X									RT					F		F	F	F	
Hermit Thrush	X				RT								X				RT					UT			F							F
Swainson's Thrush	X				RT								X				RT								F							F
American Robin	X	UP				X	UP				X	X		UP				X	UP						FB		F	F	F	F		FB
Mimids																																
Gray Catbird	X		RS			X							X												FB							
Northern Mockingbird	X				RT								X							US		RT			F						F	F
Sage Thrasher	X		US			X		RS				X					RT			US		CT	X								FB	

	Migratory Species	GSL Ecosystem					Legacy Parkway Project Study Area							Farmington Bay WMA					Bear River NWR					Habitat Use								
		Seasonal Abundance				Breeds in GSLE	Seasonal Abundance				Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Seasonal Abundance				Breeds in FBWMA	Seasonal Abundance				Breeds in BRNWR	Open Water	Riparian	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
		P	S	W	T		P	S	W	T				P	S	W	T		P	S	W	T										
Starlings																																
European Starling		CP				X		US	CW		X	X		CP				X	CP				X		FB		F	F	F	F	F	FB
Pipits																																
American Pipit	X			UW	CT					CT		X				UW	CT				UW	CT			F		F	F	F	F		
Waxwings																																
Bohemian Waxwing	X			UW					RW			X				RW					RW				F							F
Cedar Waxwing	X			UW					RW			X				RW					RW				F							F
Wood-Warblers																																
Orange-crowned Warbler	X				RT					RT		X					RT					UT			F						F	F
Nashville Warbler	X				RT					RT		X					RT					RT			F							F
Virginia's Warbler (BCC)	X				RT								X				RT					RT			F						F	F
Yellow Warbler	X				UT					UT		X					UT					UT			F	F					F	F
Yellow-rumped Warbler	X				CT					CT		X					CT					UT			F	F					F	F
Townsend's Warbler	X				RT					RT		X					RT								F							F
American Redstart	X												X												F							F
Northern Waterthrush	X				RT								X				RT								F							
MacGillvray's Warbler	X				UT					RT		X										RT			F	F					F	F
Common Yellowthroat	X		CS		CT	X		US			X	X			CS			X		CS		CT	X		F	FB						
Wilson's Warbler	X				UT					RT		X					RT					UT			F	F					F	F
Tanagers, Grosbeaks and Cardinaline, Buntings																																
Western Tanager	X				RT								X				UT					UT			F							F
Black-headed Grosbeak	X				RT								X				RT					UT			F							F
Lazuli Bunting	X				UT					UT		X					RT					UT			F						F	F
Emberizine Sparrows and Allies																																
Green-tailed Towhee	X				RT								X				RT					UT			F							F
Spotted Towhee	X				UT					RT		X					RT					UT			F						F	F
American Tree Sparrow	X			UW					UW			X				UW					UW				F	F	F	F	F	F	F	F
Chipping Sparrow	X				CT					CT		X					RT					UT			F		F	F	F	F	F	F
Brewer's Sparrow (BCC)	X		CS		CT	X		RS				X					RT			CS		CT	X		F		F	F	F	F	FB	F
Vesper Sparrow	X		US		UT	X				RT		X					RT			CS		CT	X		F		F	F	F	F	F	F
Lark Sparrow	X		US		UT	X				RT		X					RT			US		UT			F		F	F	F	F	F	F
Lark Bunting	X				RT								X									RT									F	
Savannah Sparrow	X		CS		CT	X		US			X	X			CS			X		CS		CT	X				FB		F			
Song Sparrow	X	CP				X	UP				X	X		CP				X	CP				X		FB	F	F		F			F
Lincoln's Sparrow	X				RT					RT		X					RT					UT			F		F		F	F	F	F
Harris' Sparrow	X			RW									X				O				RW				F		F	F	F	F	F	F
White-throated Sparrow	X			RW									X								RW				F		F	F	F	F	F	F
White-crowned Sparrow	X			CW	CT				CW			X				UW					CW	CT			F	F	F	F	F	F	F	F
Dark-eyed Junco	X			CW	CT				CW			X				UW					CW	CT			F	F	F	F	F	F	F	F
Lapland Longspur	X			RW									X								UW						F	F			F	
Snow Bunting	X			RW									X								UW						F	F			F	
Icterids																																
Red-winged Blackbird	X	CP				X	CP				X	X		CP				X	CP				X		F	FB	F	F	F	F		F
Western Meadowlark	X	CP				X	CP				X	X		CP				X	CP				X				F	F	FB	F	FB	F
Bobolink (WSC)	X		RS			X							X									RT					FB		F	F	F	
Yellow-headed Blackbird	X		CS			X		CS			X	X			CS			X		CS			X		F	FB	F	F	F	F	F	F
Brewer's Blackbird	X	UP				X	UP				X	X		CP				X	CP				X		F	F	F	F	FB	FB	F	F
Brown-headed Cowbird	X	CP				X	UP				X	X			RS					CS			X		FB	FB	FB	FB	FB	FB	FB	FB
Northern Oriole	X		US			X		US			X	X			RS							UT			FB							FB
Finches and Old World Sparrows																																
Cassin's Finch	X			RW									X				O								F							F
House Finch	X	CP				X	CP				X	X		CP					CP				X		FB	F	F	F	F	F	FB	FB
Pine Siskin	X			CW					CW			X				UW						UT			F					F	F	F
American Goldfinch	X		RS	CW					UW			X				UW			CP						F	F	F			F	F	F
Evening Grosbeak	X			RW					RW				X				O					RT			F							F
House Sparrow		UP				X			UP		X	X							CP				X		F				F	F		FB
Summary																																
Total number of cells with values	215	38	60	62	108	88	29	34	20	67	51	140	79	32	44	44	96	61	34	62	54	105	59	78	107	79	100	109	103	85	99	107

Special-Status Species

FT	Federally Listed as Threatened
FC	Federal Candidate Species
BCC	Birds of Conservation Concern
CAS	Conservation Agreement Species
WSC	Wildlife Species of Concern
X	Breeds in Project Study Area

Abundance Status

C = Common: Found consistently in fair numbers in appropriate habitat and season
U = Uncommon: Found consistently in small numbers in appropriate habitat and season
R = Rare: Found infrequently bur regularly in very small numbers in appropriate habitat and season

Residence Status

P = Permanent Resident: Found year-round
S = Summer visitant: Present during the nesting season
W = Winter visitant: Present during January and February
T = Transient: Migrates through the area in the spring and/or fall
X = Column heading status applies
(X) = Very few GSLE records; low probability of occurrence at LP Site

Examples of Combined Codes

CP = Common Permanent Resident
RW = Rare Winter Visitant
UT = Uncommon Transient

Habitat Use Codes

F = Foraging Habitat
B = Breeding Habitat
FB = Foraging and Breeding Habitat

Appendix A-2. Non-Bird Species Habitat Matrix

	Species Status						Habitat Use									
	GSLE		LP Project Study Area													
	Occurrence Status	Potential Occurrence	Project Study Area	Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Open Water	Riparian	Stream/River	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
Fish																
Brown trout	A			P		X			X							
Rainbow trout	A			P		X			X							
Carp	C		C	X	X		X		X	X						
Speckled dace	D			P		X			X							
Long-nose dace	D			P		X			X							
Utah sucker	D			P		X	X		X	X						
Channel catfish	D			P		X	X		X	X						
Bullhead	D			P		X	X		X	X						
White bass	D		C	P		X			X							
Green sunfish	D		C	X		X	X		X	X						
Bluegill	D		C	P		X			X							
Walleye	D		C	P		X			X							
Amphibians																
Tiger salamander	R			P		X				X	X					
Great Basin spadefoot	U			P		X				X	X	X			X	
Woodhouse's toad	R			P		X		X		X	X		X			
Western chorus frog	C		C	P	X					X	X					
Northern leopard frog	U			P		X			X	X	X					
American bullfrog	U		R	P		X				X	X					
Reptiles																
Common sagebrush lizard	D			P		X									X	
Side-blotched lizard	D			P		X									X	
Desert horned lizard	D		P	P	X										X	
Tiger whiptail	D		P	P	X										X	
Eastern racer	C		C	P	X						X		X		X	
Gopher snake	C		C	P	X			X					X	X	X	
Common garter snake	C		C	P	X			X		X	X		X			
Terrestrial garter snake	D			P	X			X		X	X		X			
Night snake	D		P	P		X									X	
Western rattlesnake	D		P	P		X									X	
Mammals																
Vagrant shrew	D		P	P		X				X						
Masked shrew	D		P	P		X				X						
Preble's shrew (WSC)	D		P	P		X				X						
Western small-footed myotis		X				X		X		X	X		X		X	
Little brown bat		X				X		X		X	X		X		X	
Long-legged myotis	C					X		X		X	X		X		X	
Western pipistrelle	C					X		X		X	X		X		X	
Big brown bat	C					X		X		X	X		X		X	
Hoary bat		X		P		X		X								
Spotted bat (WSC)	R					X							X		X	
Townsend's big-eared bat (WSC)	C					X		X		X	X		X		X	
Brazilian free-tailed bat	C			P		X		X		X	X		X		X	
Nuttall's cottontail		X		P		X							X	X	X	
White-tailed jackrabbit		X		P	X								X			
Black-tailed jackrabbit	C		C	X	X								X	X	X	
Least chipmunk	D		P	P		X		X							X	
Piute ground squirrel	D		P	P		X							X	X	X	
Rock squirrel	C		C	X	X								X	X	X	
Northern pocket gopher		X		P		X		X					X	X		
Botta's pocket gopher		X		P		X		X					X	X	X	
Great Basin pocket mouse	D		P	P		X									X	
Ord's kangaroo rat		X		P		X									X	
Beaver	R		R	P		X		X	X							
Western harvest mouse		X		X		X		X					X		X	
Deer mouse	C		C	X	X			X					X	X	X	X
Northern grasshopper mouse	U			P		X									X	
Desert woodrat		X	D	P		X							X		X	
Bushy-tailed woodrat		X	D	P		X							X		X	
Meadow vole	C		C	X	X			X			X		X		X	
Montane vole	D		P	P		X				X	X			X		
Long-tailed vole	D			P		X		X					X			

	Species Status						Habitat Use									
	GSLE		LP Project Study Area													
	Occurrence Status	Potential Occurrence	Project Study Area	Breeds in Project Study Area	Documented Occurrence within Project Study Area	Could Potentially Occur within Project Study Area	Open Water	Riparian	Stream/River	Emergent Marsh	Wet Meadow	Mudflat/Pickleweed	Pasture	Cropland	Salt Desert Scrub	Developed
Sagebrush vole	R		P	P		X									X	
Muskrat	C		C	X	X		X	X	X	X	X					X
House mouse	C		C	X	X			X					X	X	X	X
Black rat	U			X		X		X								X
Norway rat		X		P	X			X		X	X		X	X		X
Porcupine	R			P		X		X								
Coyote	C		R	X	X							X	X	X	X	X
Red fox	C		C	X	X			X				X	X	X	X	X
Kit fox (WSC)	A					X									X	
Raccoon	C		C	X	X			X		X	X	X	X	X	X	X
Long-tailed weasel	C		R	X	X			X					X		X	X
Mink	U			P		X		X	X	X	X					
Badger	U		D	P		X							X		X	
Spotted skunk	R		R	P	X			X					X			
Striped skunk	C		C	X	X			X				X	X	X	X	X
Mountain lion	R					X										
Bobcat	U			P		X									X	X
Mule deer	C		C	X	X			X		X			X	X	X	
Pronghorn	R			P		X							X		X	

Summary

Fish (12 species)	12	0	5	12	1	11	5	0	12	5	0	0	0	0	0	0
Amphibians (6 species)	6	0	2	6	1	5	0	1	1	6	6	1	1	0	1	0
Reptiles (10 species)	10	0	7	10	4	6	0	3	0	2	3	0	4	1	8	0
Mammals (50 species)	38	12	25	41	15	35	1	28	3	16	13	4	32	15	34	11

Special-Status Species

WSC Wildlife Species of Concern

Abundance Status

C = Common
U = Uncommon
R = Rare
D = Within species range but insufficient data to determine abundance
A = Accidental
X = Column heading status applies

Appendix A-3. GSLE Accidental/Occasional Bird Species

	Migratory Species	Documented at Farmington Bay WMA	Documented at Bear River NWR	Other GSLE Records
Red-throated Loon	X		X	
Tricolored Heron	X	X		
Green Heron	X			X
Brant	X	X	X	
Harlequin Duck	X		X	
Black Scoter	X		X	
Chukar				X
Pacific Golden-plover	X		X	
Mountain Plover	X		X	
Buff-breasted Sandpiper	X		X	
Wandering Tattler	X	X		
Red Phalarope	X	X	X	
Long-tailed Jaeger	X		X	
Parasitic Jaeger	X	X	X	
Mew Gull	X	X		
Glaucous-winged Gull	X		X	
Sabine's Gull	X	X	X	
White-winged Dove	X		X	
Western Scrub-Jay	X			X
Red-breasted Nuthatch	X	X		
Yellow-breasted Chat	X			X
Sage Sparrow (BCC)	X	X		
Swamp Sparrow	X	X		
Golden-crowned Sparrow	X			X
Common Grackle	X			X
Lesser Goldfinch	X			X

Special Status Species

BCC Birds of Conservation Concern

X = Column Heading Status Applies

Appendix B

GIS Data Documentation and Methods

Appendix B

GIS Data Documentation and Methods

This appendix provides metadata about the data sets used for the geographic information system (GIS) analysis of the Legacy Parkway project. *Metadata* is information about data, such as the sources used to compile data and the methods used to gather data. The metadata in this appendix includes a brief description of the sources of data applied in the GIS analysis and a description of the methods used to interpret the data and other information about the data used. In addition, the appendix summarizes the results and conclusions of the GIS analysis.

B.1 Sources of Data Used in GIS Analysis

B.1.1 Project Study Area: Wetland/Wildlife Habitats

Data

Title: Wetland/Wildlife Habitats

Source: Dataset compiled by Jones & Stokes

Primary Sources: Wetland delineation report prepared for the final environmental impact statement (Final EIS) for the Legacy Parkway project (Baseline Data Inc. et al. 1998), land cover data from the Final EIS, and additional field evaluation

GIS Dataset Publication Date: 12/1/03

Content Description Abstract

The wetland/wildlife habitat dataset is the base dataset for the analysis of impacts on wetland/wildlife habitat in the project study area. The data were classified by habitat types: emergent marsh, wet meadow, mudflat/pickleweed, open water, riparian, cropland, pasture, scrub, and developed/urban. The data sources used in the compilation of the dataset were the wetland delineation from the Final EIS, which was used to map the wetland habitat types (emergent marsh, mudflat/pickleweed, wet meadow); aerial photography and field visits (2003), which were used to map riparian habitat; and the land cover dataset from the Final EIS, which was used to map the land cover or upland habitat types (cropland, pasture, scrub, and urban). The Final EIS land cover dataset was correlated (or *crosswalked*) with the wetland/wildlife habitat types (Table B-1).

Mapping Methods

Open Water, Emergent Marsh, Wet Meadow, and Mudflat

A detailed description of the mapping of these four wildlife habitat types can be found in the *Legacy-West Davis Highway Wetland Delineation* technical report (Baseline Data Inc. et al. 1998). The methods are also discussed in Subappendix B1 of the Final EIS. A brief description of the mapping methods is provided below.

Aerial photography was obtained for the project area in late March 1997. The aerial photographs were converted into digital orthophotos and enlarged, creating 80 individual 8.5 X 11-inch photographs that cover the entire project study area (scale 1 inch = 50 feet [ft]). Habitats were mapped during field sampling in 1997, and boundaries were digitized to produce the habitat map.

All of the wetlands were assigned a hydrogeomorphic methodology (HGM) wetland classification (riverine, lacustrine, slope, or depressional). Some of the wetlands were also assigned an HGM wetland cover type (marsh, wet meadow, vegetated, and un-vegetated playa [special aquatic site of mudflat], open water, upland). These HGM wetland cover types were the basis for assigning wildlife habitat types. Because the subclasses (wetland cover types) more accurately account for wildlife use of the project study area, they are used for this analysis.

On July 18, 2003, Justin Dolling, Ella Sorensen, and Byron Parker evaluated the wetland maps. Based on their extensive personal knowledge and experience with wildlife and habitats in the study area, they made minor adjustments to the habitat type boundaries. On July 30, 2003, field review of the mapping units (polygons) was conducted by Justin Dolling, Ella Sorensen, and Byron Parker. Some of the polygons were not assigned the HGM wetland cover types; these polygons were assigned wildlife habitats types based on aerial photographs, local knowledge, and site visits. In June 2004, the wildlife technical team responsible for reviewing and making recommendations on the general technical analysis approach and methods used in this wildlife technical memorandum identified a misclassified open water polygon. To have corrected that misclassification would have resulted in only minor changes in the acreage of each type of habitat directly affected and would not have changed the conclusion about the alternatives. In addition, the open water polygon in question was not a delineated wetland and would not impact the wetlands analysis or any calculations of wetland impacts. The wildlife technical team therefore decided not to make any changes to the dataset.

Riparian

Based on the 1997 aerial photography, Justin Dolling, Ella Sorensen, and Byron Parker initially delineated riparian habitats. Justin Dolling and Mike Perkins conducted field review and verification of the boundaries of this wildlife habitat type on October 22, 2003. Riparian habitat type was determined by visually estimating the amount of vegetation directly influenced by stream hydrology. Best professional judgment was used to estimate the extent of hydrologic connection. Key locations along each waterway in the project study area were visited. Onsite inspections were then compared to aerial images[1] to delineate the total amount of riparian coverage. All vegetation associated with stream hydrology was mapped, including trees, shrubs, grasses, forbs, emergent plants, and flowing water. Natural waterways that

[1] The scale of the 1997 photographs was 1:1,200. The 2003 aerial photographs were used for Jordan River, Mill Creek, and Farmington Creek mapping in the field. The riparian habitats identified on the 2003 photos were screen digitized on the 1997 aerial photographs at a 1:1,200 scale.

Table B-1. Crosswalk of Land Use Classes: Final EIS Land Use Cover Classification and Legacy Parkway Wildlife Habitat Classification

Final EIS Land Cover Classification	Legacy Parkway Wildlife Habitat Classification
	Scrub
Alfalfa	Cropland
Bldgs/Homes	Developed
Cattail/Bullrush	Emergent Marsh
Commercial	Developed
Corn	Cropland
Emergent Marsh	Emergent Marsh
Evaporation Pond	Open Water
Fallow	Pasture
Fruit	Cropland
Grain	Cropland
Grass Hay	Cropland
High-Density Bldgs/Homes	Developed
Idle	Cropland
Idle Spaces	Developed
Industrial	Developed
Low-Density Bldgs/Homes	Developed
Mudflat/Pickleweed	Mudflat/Pickleweed
Open Space	Developed
Open Spaces	Developed
Open Water	Open Water
Pasture	Pasture
Riparian	Riparian
Temporary Flood	Cropland
Transportation & Utilities	Developed
Vegetables	Cropland
Wet/Vegetation	Mudflat/Pickleweed
Wet Flats	Open Water or Pasture (subject to aerial photograph verification)
Wet Meadow	Wet Meadow
Developed	Developed

contained some channel modification were included as riparian habitat. Cement-lined natural stream channels or human-made drains and ditches used to convey groundwater or intermittent amounts of surface water were not included in the riparian habitat category. Some riparian areas bordered delineated wetland areas. The boundaries of some of the delineated wetlands were realigned with the riparian habitat boundaries, resulting in small reductions of the overall delineated wetland area. Areas with an overstory of riparian and an understory of a wetland habitat type were classified as riparian.

Cropland, Pasture, and Scrub

Cropland and pasture areas were identified using the land cover data from the Final EIS. The dataset compiled for this 2003 GIS analysis is a combination of the Final EIS land cover data and the Utah Department of Natural Resources (UDNR), Utah Division of Water Resources, water-related land use dataset, with updates from the local counties.

On September 25, 2003, Justin Dolling, Ella Sorensen, and Byron Parker conducted field review and verification of the unclassified upland polygons. Based on their extensive personal knowledge and experience with wildlife and habitats in the project study area, they assigned the polygons to the wildlife habitat category salt desert scrub. Areas identified as upland in the HGM classification system were also assigned the value of salt desert scrub.

Developed/Urban Landscaping

Developed areas were identified using the land cover data from the Final EIS. The dataset compiled for this 2003 GIS analysis is a combination of the Final EIS land cover data and UDNR, Utah Division of Water Resources, water-related land use dataset, with updates from the local counties.

Habitat Descriptions

Open Water

Open water habitat consists of inundated or flooded areas with no emergent vegetation. The water in these areas may be fresh (ponds), brackish (estuaries), or saline (Great Salt Lake). The amount of open water habitat can vary tremendously with the rise and fall of the lake level. If periods of high-water inundation are long, the saline water of the lake will denude the vegetated habitats it covers, thereby converting shoreline emergent marshes and vegetated mudflats to open water habitat.

Emergent Marsh

Emergent marsh is a wetland dominated by erect, herbaceous vegetation. Emergent marsh appears as grasslands or stands of reedy growth in areas that are flooded all or most of the year. Water depth in emergent marsh habitat varies but is not deep enough to restrict the growth of emergent plants. Vegetation commonly observed in these marshes include hard stem bulrush, (*Scirpus acutus*), alkali bulrush *(Scirpus maritimus),* three square bulrush (*Scirpus americanus* and *Scirpus pungens),* cattail *(Typha latifolia),* creeping spikerush (*Eleocharis palustris),* reed canary grass (*Phalaris arundinacea),* common reed (*Phragmites australis),* blister buttercup (*Ranunculus scleratus),* water buttercup (*Ranunculus aquatilis*), and Nebraska sedge (*Carex nebrascensis).*

These marshes are typically located in depressions where the ground surface drops below the level of the water table. Therefore, both groundwater and surface water may contribute to the hydrologic regime of

emergent marshes. In the Great Salt Lake valley, these areas are generally inundated during the spring when the water table is high because of snowmelt and seasonal rain.

Wet Meadow

Wet meadow habitat in the project study area is typically found in poorly drained depressions where the water table is within 20 inches of the surface at least part of the time and runoff is very slow. Early in the growing season, the water table commonly may be higher than the ground surface, causing inundation. However, in wet meadow habitat, this inundation occurs less frequently and for shorter duration than in emergent marshes. Agriculture and urbanization have also modified the hydrologic regime of wet meadows in the study area in the same way as of emergent marshes.

Plant species commonly observed in wet meadows in the study area include Baltic rush (*Juncus balticus*), clustered field sedge (C*arex praegracilis*), Nebraska sedge, rabbitfoot grass (*Polypogon monspeliensis),* foxtail barley (*Hordeum jubatum),* little barley (*Hordeum pusillum),* curly dock (*Rumex crispus),* and saltgrass (*Distlichlis spicata).*

Mudflat/Pickleweed

Mudflats are typically barren or sparsely vegetated playas with deep or moderately deep poorly drained to very poorly drained clay soils. In the project study area, they are usually located in the lowest topographical areas that have internal drainage. After a rain, these mudflats collect much of the runoff from surrounding areas and form ephemeral pools. Most of this water is strongly alkaline because of evaporation, which brings salts in the soils to the surface. Vegetation found on mudflats in the project study area includes western seepweed (*Suaeda occidentalis*), slender seepweed *(Suaeda depressa*), and pickleweed (*Salicornia europea*).

Riparian

Riparian habitat is habitat found along a freshwater watercourse. The riparian habitat in the project study area is generally severely degraded and is restricted to small patches of riparian vegetation along stream courses and irrigation canals. Remnant native vegetation in riparian areas includes Fremont cottonwood (*Populus fremontii*), box elder maple (*Acer negundo*), sandbar willow (*Salix exigua*), and narrowleaf cottonwood (*Populus angustifolia*). However, in many areas these species have been replaced by Russian olive (*Elaeagnus angustifolius*), Siberian elm (*Ulmus pumila*), and salt cedar (*Tamarix ramoisissima*).

The riparian habitat was mapped for the wetland/wildlife habitat map and was not part of the jurisdictional wetlands mapping conducted for the Final EIS.

Pasture

Much of the farmland in the project study area consists of pasture. Pastures are generally located on flat or gently sloping lands and are vegetated with a mixture of perennial non-native grasses and legumes. Typical forage species planted in pastures include meadow brome (*Bromus riparius*), smooth brome (*B. inermis*), tall fescue (*Festuca arundinacea*), meadow fescue (*F. pratensis*), perennial ryegrass (*Lolium perenne*), creeping meadow foxtail (*Alopecurus arundinaceus*), intermediate wheatgrass (*Elymus hispidus*), tall wheatgrass (*E. elongatus),* and timothy (*Phleum pratense*). The height of the vegetation

varies according to season, level of irrigation, drainage, fertilization, mowing, and livestock stocking levels, ranging from a few inches to 2 or more feet on fertile soils before grazing.

Cropland

Large tracts of cropland are located in the project study area. The major crops actively farmed on these lands include corn, wheat, sod, and alfalfa.

Salt Desert Scrub

The salt desert scrub wildlife habitat in the project study area occurs primarily in the saline upland areas. It is characterized by shadscale (*Atriplex confertifolia),* Gardner saltbush (*Atriplex gardneri),* and greasewood *(Sarcobatus vermiculatus).* This habitat in the project study area has been largely disturbed by free-range livestock grazing and other activities. Native grasses have been largely replaced by exotic grasses and forbs, including an abundance cheatgrass (*Bromus tectorum).* Japanese brome *(Bromus japonicus),* wheatgrass (*Elymus* spp.*),* bulbous bluegrass *(Poa bulbosa),* whitetop *(Caldaria draba),* storksbill (*Erodium cicutarium),* and gumweed, (*Grindelia squarrosa*) are also abundant throughout the project study area.

Developed/Urban

Developed habitat includes areas that are used for residential, commercial, or industrial purposes. Most of these areas are covered by pavement and buildings. However, much of the developed habitat (lawns, shrubs, and trees) in the project study area provides important food and shelter resources for a variety of wildlife.

B.1.2 Project Alternative Footprints

Data

Title: Project Alternative Footprints

Primary Sources: Utah Department of Transportation (UDOT) and HDR Engineering Inc.

GIS Dataset Publication Date: 12/1/03

Content Description Abstract

The footprints of the project alternatives were provided by UDOT and HDR Engineering Inc. The data was used in the wildlife habitat analysis to calculate direct and indirect impacts.

Jones & Stokes Processing Steps

1. Converted computer-aided design (CAD) dxf files to Arc/Info file format for GIS analysis.

B.1.3 Project Study Area Boundary

Data

Title: Project Study Area Boundary

Primary Sources: UDOT and HDR Engineering Inc.

GIS Dataset Publication Date: 12/1/03

Content Description Abstract

The boundary of the project study area was provided by UDOT and HDR Engineering Inc. The boundary data was used in the wildlife habitat analysis to define the extent of the project study area analyzed.

Jones & Stokes Processing Steps

1. Converted CAD dxf files to Arc/Info file format for GIS analysis.

2. The boundaries of the project study area were modified from those of the Final EIS. Jones & Stokes modified the project study area to include all the geographic extent of delineated wetlands from the Final EIS.

B.1.4 Project Study Area: Inundation Zones

Data

Title: Elevation-Based Inundation Zones

Source: Dataset compiled by Jones & Stokes

Primary Source: U.S. Geological Survey (USGS) 10-meter (m) digital elevation model (DEM) (available at: <http://agrc.utah.gov/agrc_sgid/dem.html>)

GIS Dataset Publication Date: 12/1/03

Content Description Abstract

The elevation-based inundation zones for the project study area were based on the USGS 10-meter (m) DEM. A DEM is a digital file consisting of terrain elevations for ground positions at regularly spaced horizontal intervals. Contour lines were generated in 4-ft intervals for the compiled dataset. The 4-foot contour intervals were used to create the elevation-based inundation zones. The intervals range from <1,281 m (4,204 ft) to >1,286 m (4,220 ft). The <1,281-m (4204-ft) interval is the lowest interval because the lack of information about the bathymetry of Great Salt Lake in the DEM precluded identifying any lower intervals.

Jones & Stokes Processing Steps

1. Merge the 10-m DEMs into a single file.
2. Fill the sinks and clean the edges of the quadrangles.
3. Change the elevation units from meters to feet.
4. Generate contours in 4-ft intervals.
5. Create a polygon dataset representing the inundation intervals.

B.1.5 Potential Future Development in the Project Study Area

Data

Title: Potential Future Development

Primary Sources: Future development from the Final EIS, UDOT, and HDR Engineering Inc.

GIS Dataset Publication Date: 8/1/04

Content Description Abstract

Two categories of development were identified in the dataset: areas developed since 1997 (developed), and areas potentially developable in the future (developable).

Mapping Methods

The concept underlying developable lands is that the uplands in the study area are desirable for intensive land use because they are readily accessible to I-15, I-215, I-80, and the communities they serve. Further, without the Legacy Parkway, these lands would be developed in accordance with local land use plans. During preparation of the Final EIS, the land use planners of the cities in the study area indicated they would allow development down to the Federal Emergency Management Agency (FEMA) 100-year floodplain.

Potential developable lands were identified by identifying all undeveloped land in the study area and eliminating all land below the FEMA 100-year floodplain. The resulting land was reviewed to determine whether access was available without having to obtain a 404 permit. If access required a 404 permit, the area was not considered developable. This was a somewhat conservative approach to identifying developable lands because FEMA regulates but does not prohibit development within the 100-year. In calculating potential future build-out, wetland habitat within the developed or developable categories was acknowledged as requiring a 404 permit or being potentially degraded if surrounding land uses were converted to developed.

The polygons provided identify all the land developed since the preparation of the Final EIS and all the developable land, as defined above.

Jones & Stokes Processing Steps

1. Identified overlapping polygons. Where polygons overlapped, areas identified as developed and developable were considered developed.
2. Areas identified as protected were not included in calculations of developed or developable.

B.1.6 Regional Study Area: Modified Hydrologic Units

Data

Title: Regional Hydrologic Units

Source: Modifications to hydrologic unit boundaries by Jones & Stokes

Primary Sources: USGS and National Resources Conservation Service (NRCS) hydrologic units

GIS Dataset Publication Date: 1999

Content Description Abstract

Jones & Stokes modified the hydrologic unit divisions of the dataset for the regional study area. The following description is from the hydrologic unit metadata, as provided by the Utah Automated Geographic Reference Center (available at: < http://www.ftw.nrcs.usda.gov/huc_data.html>).

This dataset is a complete digital hydrologic unit boundary layer to the subwatershed (12-digit) 6th level for the State of Utah. This dataset consists of geo-referenced digital data and associated attributes created in accordance with the *FGDC Proposal, Version 1.0 - Federal Standards For Delineation of Hydrologic Unit* Boundaries (Natural Resources Conservation Service 2002) (available at: <http://www.ftw.nrcs.usda.gov/huc_data.html>). Polygons are attributed with hydrologic unit codes for 4th level sub-basins, 5th level watersheds, 6th level subwatersheds, name, size, downstream hydrologic unit, type of watershed, non-contributing areas, and flow modification. Line features are attributed with the highest hydrologic unit code for each watershed, line source, and a metadata reference file.

Purpose

The watershed and subwatershed hydrologic unit boundaries provide a uniquely identified and uniform method of subdividing large drainage areas. The smaller sized 6th-level subwatersheds (up to 250,000 acres) are useful for numerous application programs supported by a variety of local, state, and federal agencies. This dataset is intended to be used as a tool for water-resource management and planning activities, particularly for site-specific and localized studies requiring a level of detail provided by large-scale map information. The dataset will be appended to a larger, seamless, nationally consistent geospatial database as other states complete their portion of the watershed boundary dataset.

Jones & Stokes Processing Steps

1. Divided hydrologic unit 16020309 from north to south. Assigned the western portion the name "Promontory Point West" and combined the eastern portion with Bear River hydrologic unit 16010204.

2. Combined hydrologic units 16010202 and 16010203 to create Cache Valley.

3. Combined the Bear River Bay portion of hydrologic unit 16020310 with Bear River hydrologic unit 16010204.

4. Combined hydrologic units 16020201, 16020203, 16020202 to create Lake Utah.

5. Selected the area in the hydrologic unit below an elevation of 1,433 m (4,700 ft). Used the USGS National Elevation Dataset (NED) as the elevation dataset.

6. Clipped all of the hydrologic units to the regional study area.

B.1.7 Regional Estimated Historic Wetland/Wildlife Habitat

Data

Title: Regional Estimated Historic Wetland/Wildlife Habitat

Primary Source: NRCS Soil Survey Geographic (SSURGO) data

Publication Date: Varies for each county. The most recent digital data was used from the NRCS web site (http://www.ncgc.nrcs.usda.gov/branch/ssb/products/ssurgo/); data was downloaded June 1, 2003.

Content Description Abstract

The regional estimated historic wetland/wildlife habitat dataset provides a basic estimate of the historic wetland/wildlife habitat within the mapped area. The estimate is based on soils identified in the NRCS SSURGO dataset as supporting "the habitat element shallow water," "habitat requirements for wetland wildlife," or "the wildlife habitat element for wetland plants." A soil class needs to be "good" for any of the categories to be included in the final dataset. In addition, for this GIS analysis, the soil types "Saltair" and "Playa" were included in the dataset.

The following descriptions are from SSURGO Data Base Data Use Information, United States Department of Agriculture Natural Resource Conservation Service, National Soil Survey Center, Miscellaneous Publication Number 1527 (available at: <http://www.ncgc.nrcs.usda.gov/branch /ssb/products/ssurgo/>).

The SSURGO database provides the most detailed level of soil geographic data and was designed primarily for natural resource planning and management for farm and ranch, landowner/user, township, county, or parish. Using the soil attributes, this database serves as an excellent source for determining erodible areas and developing erosion control practices; reviewing site development proposals and land use potential; making land use assessments and chemical fate assessments; and identifying potential wetlands and sand and gravel aquifer areas.

Using National Cooperative Soil Survey (NCSS) mapping standards, soil maps in the SSURGO database are made using field methods. Surveyors observe soils along delineation boundaries and determine map unit composition by field traverses and transects. Aerial photographs are interpreted and used as the field map base. Maps are made at scales ranging from 1:12,000 to 1:63,360. Typically, scales are 1:15840, 1;20,000, or 1:24,000. The maps, along with comprehensive descriptions, produce an attribute and spatial database for NCSS publications.

B.1.8 Regional Study Area: Land Use/Land Cover

Data

Title: Regional Land Cover Dataset

Source: Dataset compiled by Jones & Stokes

Primary Sources: USGS national land cover dataset (NLCD) and U.S. Fish and Wildlife Service (USFWS) national wetlands inventory (NWI) dataset.

Content Description Abstract

The regional study area land use/land cover dataset is a combination of the USGS national land cover dataset (NLCD circa 1992) and the USFWS national wetlands inventory dataset (NWI 2001). Jones & Stokes combined and reclassified the two datasets to general wetland/wildlife habitat types.

USGS National Land Cover Dataset (NLCD)

The following descriptions are from the NLCD metadata web site (available at: <http://edcwww.cr.usgs.gov/programs/lccp/natllandcover.html>).

Abstract: The data from the NLCD can be used in a GIS analysis for various purposes such as assessing wildlife habitat, water quality, pesticide runoff, and land use change. The state datasets are provided to USGS with a 300-m (984-ft) buffer beyond the state border to facilitate combining state files into larger regions. To use the NLCD correctly, the user must have a firm understanding of how the datasets were compiled and the resulting limitations of these data. The NLCD was compiled from Landsat Thematic Mapper (TM) satellite imagery (circa 1992) with a spatial resolution of 30 m (98 ft), and supplemented by various ancillary data (where available). The satellite imagery was analyzed and interpreted for the NLCD using very large, sometimes multi-state image mosaics (i.e., up to 18 Landsat scenes). The thematic interpretations were necessarily conducted from a spatially broad perspective, and a relatively small number of aerial photographs was used to ground truth the results. Furthermore, the accuracy assessments correspond to federal regions, which are groupings of contiguous states. Thus, the reliability of the data is greatest at the state or multi-state level. The statistical accuracy of the data is known only for the region.

Important Advisory: Users are cautioned to carefully scrutinize the data to determine whether the data are of sufficient reliability before attempting to use the dataset for larger-scale or local analyses. When making this determination, the user must keep in mind that the NLCD represents conditions in the early 1990s.

The Utah portion of the NLCD was created as part of a project area encompassing portions of Federal Region VIII, including the states of North Dakota, South Dakota, Wyoming, Montana, Utah, and

Colorado. The NLCD classification contains 21 different land cover categories with a spatial resolution of 30 m (98 ft). The NLCD was produced as a cooperative effort between the USGS and the U.S. Environmental Protection Agency (EPA) to produce a consistent, land cover data layer for the 48 conterminous states, using early 1990s Landsat TM data purchased by the Multi-Resolution Land Characterization (MRLC) Consortium. The MRLC Consortium is a partnership of federal agencies that produce or use land cover data. Partners include the USGS (National Mapping, Biological Resources, and Water Resources Divisions), U.S. EPA, U.S. Forest Service, and National Oceanic and Atmospheric Administration.

Purpose: The main objective of the NLCD project was to generate a generalized and nationally consistent land cover data layer for the entire conterminous United States. These data can be used as a layer in a GIS for various purposes, such as assessing wildlife habitat, water quality and pesticide runoff, and land use change.

USFWS National Wetlands Inventory

The following description is from the national wetlands inventory (NWI) metadata as provided by the Utah Automated Geographic Reference Center (available at: <http://agrc.utah.gov/agrc_sgid/sgidintro.html>).

The NWI dataset represents wetland areas in Utah, as delineated by the NWI conducted by USFWS. Two methods were used to capture data for the NWI: conversion of USFWS digitized quads from Digital Line Graph (DLG) format and in-house digitizing of polygons from mylar overlays. The data is presented in a scale of 1:24,000. Data from the NWI was used for the Legacy Parkway GIS analysis to show the wetland areas in Utah as delineated by the NWI.

Jones & Stokes Processing Steps

1. Crosswalked NLCD and NWI attributes to the wetland/wildlife habitat types used for the project study area in the wildlife technical memo (Tables B-2 and B-3).

2. Converted NWI data from vector to raster using the raster parameters from the NLCD dataset (30-meter grid, the same origin).

3. Combined the two datasets. Areas in the NWI dataset assigned a “NULL” value were assigned values from the NLCD dataset.

Table B-2. Crosswalk of Land Cover Types: USGS National Land Cover Classification and Legacy Parkway Wildlife Habitat Classification

National Land Cover Classification	Legacy Parkway Wildlife Habitat Classification
Open Water	Open Water
Perennial Ice/Snow	Unclassified
Low Intensity Residential	Developed
High Intensity Residential	Developed
Commercial/Industrial/Transportation	Developed
Bare Rock/Sand/Clay	Unclassified
Quarries/Strip Mines/Gravel Pits	Developed
Transitional	Developed
Deciduous Forest	Forested Upland
Evergreen Forest	Forested Upland
Mixed Forest	Forested Upland
Shrubland	Scrub
Orchards/Vineyards/Other	Cropland
Grasslands/Herbaceous	Pasture
Pasture/Hay	Pasture
Row Crops	Cropland
Small Grains	Cropland
Fallow	Cropland
Urban/Recreational Grasses	Developed
Woody Wetlands	Riparian
Emergent Herbaceous Wetlands	Emergent Marsh

B.1.9 Regional Study Area: 1984 Lake Level

Data

Title: Great Salt Lake 1984 Lake Level

Primary Source: University of Utah, Mapping and Monitoring Great Salt Lake Dynamics (1972–1996)

Content Description Abstract

The 1984 Great Salt Lake Level is based on Landsat imagery used in the Mapping and Monitoring Great Salt Lake Dynamics (1972–1996) study conducted by the University of Utah. For a detailed explanation of the mapping process, refer to the *Mapping and Monitoring Great Salt Lake Dynamics Report*

Table B-3. Crosswalk of Land Unit Classes and Flood Regimes: National Wetland Inventory (NWI) Land Unit Classification and Legacy Parkway Wildlife Habitat Classification

NWI Land Unit Class	NWI Flood Regime	Legacy Parkway Wildlife Habitat
Other	Temporarily Flooded	Open Water
Aquatic Bed	Seasonally Flooded - Saturated	Open Water
Aquatic Bed	Semi-permanently Flooded	Open Water
Aquatic Bed	Unknown Code	Open Water
Unconsolidated Bottom	Intermittently Exposed	Open Water
Open Water/Unknown Bottom	Semi-permanently Flooded	Open Water
Unconsolidated Bottom	Semi-permanently Flooded	Open Water
Open Water/Unknown Bottom	Permanently Flooded	Open Water
Aquatic Bed	Intermittently Exposed	Open Water
Unconsolidated Bottom	Seasonally Flooded	Open Water
Unconsolidated Bottom	Temporarily Flooded	Open Water
Unconsolidated Bottom	Unknown Code	Open Water
Unconsolidated Shore	Permanently Flooded	Open Water
Unconsolidated Shore	Seasonally Flooded	Open Water
Aquatic Bed	Seasonally Flooded	Open Water
Unconsolidated Shore	Semi-permanently Flooded	Open Water
Aquatic Bed	Permanently Flooded	Open Water
Unconsolidated Shore	Unknown Code	Open Water
Unconsolidated Bottom	Permanently Flooded	Open Water
Scrub/Shrub	Semi-permanently Flooded	Scrub
Scrub/Shrub	Temporarily Flooded	Scrub
Scrub/Shrub	Unknown Code	Scrub
Scrub/Shrub – Broad-Leaved Deciduous	Seasonally Flooded	Scrub
Scrub/Shrub – Broad-Leaved Deciduous	Temporarily Flooded	Scrub
Scrub/Shrub	Saturated	Scrub
Scrub/Shrub	Seasonally Flooded	Scrub
Forested	Temporarily Flooded	Riparian
Streambed	Seasonally Flooded	Riparian
Streambed	Semi-permanently Flooded	Riparian
Streambed	Temporarily Flooded	Riparian
Forested	Seasonally Flooded	Riparian
Forested	Unknown Code	Riparian
Forested – Broad-Leaved Deciduous	Seasonally Flooded	Riparian

Table B-3. Continued

NWI Land Unit Class	NWI Flood Regime	Legacy Parkway Wildlife Habitat
Forested – Broad-Leaved Deciduous	Temporarily Flooded	Riparian
Forested	Saturated	Riparian
Emergent	Permanently Flooded	Emergent Marsh
Emergent – Persistent	Semi-permanently Flooded	Emergent Marsh
Emergent	Intermittently Exposed	Emergent Marsh
Emergent	Semi-permanently Flooded	Emergent Marsh
Emergent	Unknown Code	Emergent Marsh
Emergent – Persistent	Temporarily Flooded	Emergent Marsh

(University of Utah 1972–1996). In the Legacy Parkway analysis, the dataset was used as an example of high-water conditions in the regional analysis.

B.1.10 Regional Study Area: Administrative Ownership

Data

Title: Ownership Status

Source: Ownership types reclassified by Jones & Stokes

Primary Source: Administrative ownership information provided by Utah State University

GIS Dataset Publication Date: 5/30/2003

Content Description Abstract

This dataset depicts the Bureau of Land Management (BLM) 1:100,000-scale land ownership quadrangle maps published by BLM between 1980 and 1989. The data were digitized for the USFWS Utah GAP Analysis project by the Remote Sensing and GIS Laboratories, Department of Geography and Earth Resources, Utah State University (GIS/USU). The Utah School and Institutional Trust Lands Administration (SITLA) revises these data regularly to reflect changes in state trust lands. Other information is edited and updated as needed but not on a regular schedule. For additional information on the data development, see the full metadata online (available at: <http://agrc.utah.gov/agrc_sgid/sgidintro.html *or* ftp://lands5.state.ut.us/pub/index.htm>).

Legacy Parkway Analysis

For the Legacy Parkway analysis, the land ownership categories were generalized to evaluate the general trend of ownership in the Great Salt Lake Ecosystem (GSLE). Table B-4 shows the crosswalk from the original ownership categories to the Legacy Parkway generalized categories.

Lands that are public lands (BLM, state lands, wildlife management, Forest Service, National Parks, etc.) were categorized as “public.” The assumption is that these lands are unlikely to be sold or developed, and are managed for natural resources. Many of these lands have multiple uses; however, without further refinement on the mapping and detailed information about long-term management plans, it is not possible to evaluate the management for wildlife.

State trust lands were labeled as “public trust.” These lands are managed for twelve beneficiaries and have the potential to be developed or sold. For additional information on the definition of trust lands see the STILA web site (available at: <http://www.utahtrustlands.com/faqs.htm#What%20 are%20Trust%20Lands>).

Lands that are either managed by private groups, such as The Nature Conservancy, or are private holdings on public lands were labeled “public/private.” Although these lands are not entirely publicly owned, they would most likely have a lower potential for development then private lands.

The Legacy Parkway Nature Preserve was not included in the ownership dataset as public ownership.

Jones & Stokes Processing Steps

1. Crosswalked the ownership categories to the generalized categories (Table B-4).

B.1.11 Regional Study Area: Population Density 2001, 2010, 2020, 2030

Data

Title: Wasatch Front Regional Council Socioeconomic Projections

Source: Jones & Stokes calculated population density based primarily on Wasatch Front Regional Council socioeconomic projections GIS dataset.

GIS Dataset Publication Date: 12/2/03

Content Description Abstract

The Wasatch Front Regional Council (WFRC) socioeconomic projections GIS data is based on traffic analysis zones. The dataset has projected future population for each traffic zone.

For the Legacy Parkway analysis, these data were converted into a potential density value and then categorized into high, moderate, and low population density (low = 0 people/acre, moderate = >0 and <2 people/acre, and high = >2 people/acre). The data were then combined with regional land cover data to evaluate the potential loss of wildlife habitat for the 29 years of population growth projected by the WFRC. The divisions were based on a visual inspection of the densities and available 2002 aerial photos of the project study area. Areas of >2 people/acre were generally areas of residential housing. The population density of >0 and <2 people/acre had only a few houses or a small development. Areas of 0 people/acre were open natural areas, cropland, or pasture with little or no development.

Jones & Stokes Processing Steps

1. Calculated the people/acre for each year of population growth projected by the WFRC.

2. Visually inspected aerial photographs and population density values.

3. Reclassified polygons into high, moderate, low.

B.2 GIS Methods and Analysis

B.2.1 Project-Level Analysis Methods

Wildlife Habitat Mapping

Wildlife habitats identified in the Final EIS included farmland, urban scrub, salt desert scrub, lowland riparian scrub, and wetlands (Section 3.13.2 of the Final EIS). Except for wetlands, which were fully delineated for the Final EIS (Baseline Data Inc. et al. 1998), this habitat classification did not consistently

Table B-4. Crosswalk of Ownership Types and Generalized Ownership Status

Ownership Types	Generalized Ownership Status
Bankhead Jones	Public
Bankhead Jones/USFS	Public
BLM	Public
BLM/Bureau of Reclamation/State	Public
BLM/Bureau of Reclamation	Public
BLM/DOD	Public
BLM/power withdrawal and classifications	Public
BLM/protective withdrawal	Public
BLM/public water reserve	Public
USFS	Public
USFS/acquired land	Public
USFS/Bureau of Reclamation	Public
USFS/power withdrawal and classifications	Public
USFS/protective withdrawal	Public
Intermittent water	Water
Military reservations	Public
National parks/monuments/historic sites	Public
Native American reservations	Reservations
Private	Private
Private/Bureau of Reclamation/USFS	Public/private
Private/Bureau of Reclamation	Public/private
Private/DOD	Public/private
Private/USFS	Public/private
Private/leach pond	Water
Private/Native American	Public/private
Private/The Nature Conservancy	Public/private
Private/power withdrawal and classifications	Public/private
Private/protective withdrawal	Public/private
Private/public water reserve	Public/private
Private/USFS and BLM wilderness area	Public/private
Private/USFWS wildlife refuge	Public/private
Sovereign lands/wildlife management area	Public
Sovereign lands	Public
State trust	Public trust

Table B-4. Continued

Ownership Types	Generalized Ownership Status
State park/recreation area	Public
State wildlife reserves	Public
State/DOD	Public
USFWS national wildlife refuge	Public
Water	Water
Wilderness area/protective withdrawal/USFS	Public
Wilderness area/USFS	Public

allow clear delineation of all wildlife habitats discernable from aerial photographs of the project area. The wildlife habitat classification scheme was therefore updated for this GIS analysis to include the following readily identifiable habitats: open water, emergent marsh, wet meadow, mudflat/pickleweed, riparian, salt desert scrub, pasture, cropland, and developed/urban. The wildlife habitat types were determined by the wildlife technical team (WTT) (consisting of ecologists and biologists from FHWA, the Corps, and UDOT, and their representative technical consultants) to be appropriate for the analysis of existing wildlife habitats.

Using 1997 aerial photographs and existing GIS land use maps, UDOT and Utah Division of Wildlife Resources (UDWR) biologists, with assistance from local wildlife ecologists, mapped all areas of each of these habitats within the project study area. Most of the wetland habitats (emergent marsh, wet meadow, mudflat/pickleweed, open water) had been previously delineated for the Final EIS and only needed verification. The boundaries of other areas that had not been included in the original delineation submitted to the Corps (Baseline Data Inc. et al. 1998) to support the Clean Water Act Section 404 permit, such as riparian habitat, were also surveyed for this GIS analysis to more accurately define wildlife habitat.

Other upland areas such as scrub, pasture, cropland, and developed areas were best defined by existing GIS data layers used for the Final EIS. This information was based on the 1988 water-related land use data inventory conducted by the UDNR, Division of Water Resources, and the 1997 Davis County irrigated cropland data. However, for purposes of this analysis, the land use classifications in the dataset were consolidated by the WWT from specific land use categories into more general wildlife habitat categories, as described in Table B-4.

The maps of all of the wildlife habitats were integrated into a consolidated GIS map. The final wildlife habitat map was reviewed and approved both by the WTT and the science technical team (STT) (consisting of the WTT members and wildlife biologists and technical experts from USFWS, EPA, and UDNR.)

Identification of Inundation Zones

The inundation zones were identified for this GIS analysis using an elevation band dataset created from a 10-meter USGS DEM. The elevation intervals were set at 4 ft, starting at the 1,281-m (4,204-ft) elevation and ending at the 1,286-m (4,220-ft) elevation. These intervals were selected based on the intervals defined in the *Great Salt Lake Comprehensive Management Plan Resource Document* (Department of Natural Resources 2000). The percentage of probability that the lake level would occur within these intervals was also obtained from this report.

The 10-m DEM was selected because it covered the entire study area, was the best available for the entire study area, and could be used to create the intervals defined in the *Great Salt Lake Comprehensive Management Plan Resource Document*. The national elevation dataset (30-meter DEMs), the high-resolution elevation data that was used in the Final EIS, as well as other contour datasets, were evaluated for use in this analysis but were not selected because of their lower levels of resolution, incomplete coverage of the project study area, and insufficient data (i.e., a single contour line rather than multiple contour lines).

Evaluation of the Effect of Great Salt Lake Dynamics on Habitat Availability

The effects of Great Salt Lake dynamics in conjunction with the Legacy Parkway project on the availability of terrestrial habitat was evaluated by calculating (1) the total area of each available habitat in

each inundation interval, and (2) the areal intersection of each right-of-way with mapped habitat patches in each interval. The inundation intervals were overlaid on the habitat map; any terrestrial habitat patch that occurred across adjacent intervals was divided along the interval boundary. The extent of habitat that would be affected by each alternative at the various lake levels (i.e., above each successive inundation interval) was calculated using the equations provided below.

The effects of Great Salt Lake dynamics in conjunction with the Legacy Parkway project on the availability of open water habitat was evaluated using the same equations as the terrestrial habitat impacts. However, open water habitats were assumed to be fresh water. Because rising lake levels introduce salinity to freshwater habitats as they are inundated, open water polygons that occurred across interval boundaries were assigned to the lower interval.

The following equations were used to evaluate the percentage of available habitat that would be affected by the project alternative and inundation in each inundation interval.

- Percentage of habitat affected by the proposed right-of-way and inundation in the 1,281 m (4,204 ft) interval = ((1x)+(13x-7x)/14x))*10))
- Percentage of habitat affected by the proposed right-of-way and inundation in the 1,281–1,283 m (4,204 – 4,208 ft) = ((1x+2x)+(13x-7x –8x)/14x))*10))
- Percentage of habitat affected by the proposed right-of-way and inundation in the 1,283–1,284 m (4,208–4,212 ft) = ((1x+2x+3x)+(13x-7x –8x-9x)/14x))*10))
- Percentage of habitat affected by the proposed right-of-way and inundation in the 1,284–1,285 m (4,212–4,216 ft) = ((1x+2x+3x+4x)+(13x-7x –8x-9x-10x)/14x))*10))
- Percentage of habitat affected by the proposed right-of-way and inundation in the 1,285–1,286 m (4,216 – 4,220 ft) = ((1x+2x+3x+4x+6x)+(13x-7x –8x-9x-10x-11x)/14x))*10))

<u>Definitions of the variables</u>

1x = acres of habitat in the study area in inundation interval 1,281m (4204 ft)

2x = acres of habitat in the study area in inundation interval 1,281–1,283 m (4204–4208 ft)

3x = acres of habitat in the study area in inundation interval 1,283–1,284 m (4208–4212 ft)

4x = acres of habitat in the study area in inundation interval 1,284–1,285 m (4,212–4,216 ft)

5x = acres of habitat in the study area in inundation interval 1,285 – 1,286m (4,216-4,220ft)

6x = acres of habitat in the study area in inundation interval >1,286 m (>4,220 ft)

7x = acres of habitat in the right-of-way in inundation interval 1,281 m (4,204 ft)

8x = acres of habitat in the right-of-way in inundation interval 1,281–1,283 m (4,204–4,208 ft)

9x = acres of habitat in the right-of-way in inundation interval 1,283–1,284 m (4,208–4,212 ft)

10x = acres of habitat in the right-of-way in inundation interval 1,284–1,285 m (4,212–4,216 ft)

11x = acres of habitat in the right-of-way in inundation interval 1,285–1,286 m (4,216–4,220 ft)

12x = acres of habitat in the right-of-way in inundation interval >1,286 m (>4,220 ft)

13x = total acres of habitat in the right-of-way

14x = total acres of habitat in the study area

Fragmentation Analysis: Patch Size, Nearest Neighbor Distances, and Perimeter-to-Area Ratio

Summary Statistics for Patch Size Distribution

The analysis of patch size in Chapter 3 describes the distribution of patch sizes and the summary statistics of mean and median patch size. In addition to those summary statistics, standard deviation and the coefficient of variation were calculated for each individual habitat (Table B-5) and for the generalized categories of upland and wetlands (Table B-6). The standard deviation and coefficient of variation were not included in the final analysis because the data are not normally distributed and the results did not provide additional information about the distribution of patch sizes that was not already described by the other metrics.

Analysis and Summary Statistics for Nearest Neighbor Distances

The nearest neighbor distance and summary statistics are often used to determine the ability of species to move from patch to patch. If the nearest neighbor distances become too great, species cannot disperse among patches. In the case of Legacy Parkway, the road would divide the project study area into multiple contiguous areas (two landscapes [contiguous area on one side of the proposed alignment] under Alternatives A, C, and E; three landscapes under Alternative B) (Figure B-1). This division of the landscape presents some difficulty in calculating and interpreting the results because of the manner in which the nearest neighbor distances are calculated. If the proposed project alignments are simply added to the dataset and the nearest neighbor distances are calculated, then there is the potential for any patch that is divided by the proposed highway to result in an increase in the number of patches that are close together. Under the No-Build Alternative, the number of these close-together patches might be smaller because all of the patches are whole polygons (undivided by the proposed highway) and are further away from each other. The assumption is that the proposed highway would be a barrier to some species (species that cannot fly over the road or disperse through the culverts); the nearest neighbor distance can then be calculated for each individual landscape.

Methods

The nearest neighbor distances were calculated using the ArcView3.2 Patch Analyst extension. The nearest neighbor distances were calculated for the No-Build Alternative and for each contiguous area under each build alternative (FigureB-1).

Discussion

The nearest neighbor distances were calculated for each landscape, but the results can potentially be misleading. For upland habitats, nearest neighbor distance would decrease under the proposed build alternatives compared to the No-Build Alternative (Table B-7). The decrease in mean nearest neighbor distance might be expected to be a benefit for wildlife; however, that does not take into account that what

is a single landscape under the No-Build Alternative would be two or three distinct areas under any of the build alternatives. For wetland habitats, mean nearest neighbor distances in the area east of the proposed alignments would increase under the proposed build alternatives, but the nearest neighbor distances would remain essentially the same in the western and northern areas. Open water would have larger mean nearest neighbor distances under the proposed build alternatives than the other habitats, but that reflects the low number of open water habitat patches in the study area. For open water habitat, mean nearest neighbor distance in the eastern area would increase under the proposed build alternatives and remain similar in the western sections; the mean nearest neighbor distances in the northern section of Alternative B would also be larger compared to the No-Build Alternative.

The majority of upland and wetland patches in the landscape under all proposed build alternatives would be within 50 m (164 ft) of another habitat patch.

Mean Perimeter-to-Area Ratio

Perimeter-to-area ratio is often used to describe the complexity of the different shapes of habitat patches. Patches with low perimeter-to-area ratio tend to be fairly simple shapes with large core area. As the complexity of the shape increases, increasing edge area, the perimeter-to-area ratio increases. Changes in perimeter-to-area ratio affect wildlife in a variety of ways. Habitats with high perimeter-to-area ratios favor edge species and disadvantage species that require large core area. Some habitats inherently have high perimeter-to-area ratio; for example, some wetlands have long narrow areas that reflect the topography in which they are located. Perimeter-to-area ratio provides some useful information, but it should be interpreted in the context of the landscape in which the patches are located.

Methods

The mean perimeter-to-area ratios for the generalized wetland, upland, and open water categories, as well as the more specific habitats, were calculated using the ArcView3.2 Patch Analyst extension. The calculations were conducted for the No-Build Alternative and each build alternative.

Discussion

The results of the perimeter-to-area ratio calculations are inconclusive (Table B-8). For cropland, there would be very little change in the perimeter-to-area ratio. Other habitats such as emergent marsh, mudflat/pickleweed, open water, scrub, and wet meadow would have more complex shapes with the addition of the proposed highway. The perimeter-to-area ratio for pasture decreases with implementation of the build alternatives, indicating a decrease in the complexity of the shapes. Riparian has mixed results; some of the alternatives would result in more complex shapes than the No-Build Alternative, others less complex. Both pasture and cropland have fairly simple shapes under the No-Build Alternative, and the addition of the build alternatives would not greatly change the general simplicity of the habitat patches. The other habitat types are generally more complex in shape and often have smaller polygons, which would be divided with implementation of the build alternatives, increasing the perimeter-to-area ratio.

The final step in the evaluation of perimeter-to-area ratio is to evaluate individual species responses to the changes in ratio. Currently, data on the response of specific species to changes in ratio are unavailable for the species of concern in the study area. The literature indicates that effects have been found with change in perimeter-to-area ratio, but the results from this analysis cannot be evaluated for individual species. Overall, the effects of direct habitat loss would have a greater impact on wildlife species then the changes in the perimeter-to-area ratio.

Table B-5. Summary of Habitat Fragmentation Statistics by Habitat Type Resulting from Build Alternatives

Habitat Type	Alternative		Number of Patches in Each Size Class					Summary Statistics (Acres)				
			<1	1–10	10–50	50–100	>100	Number of Patches	Mean Patch Size	Median Patch Size	Patch Size Coefficient of Variance	Standard Deviation
Cropland	No Action		25	18	18	5	4	70	24.76	4.49	0.06	56.43
	Alternative A	Patches Fragmented	2	2	7	3	3					
		Total Patches	30	22	19	8	3	82	19.46	4.33	0.04	34.94
	Alternative B	Patches Fragmented	3	6	11	5	4					
		Total Patches	33	25	28	7	2	95	15.61	4.33	0.04	26.27
	Alternative C	Patches Fragmented	2	2	7	3	3					
		Total Patches	32	26	21	4	5	88	18.34	3.35	0.05	37.84
	Alternative E	Patches Fragmented	2	1	6	1	3					
		Total Patches	31	21	20	8	3	83	19.31	4.33	0.04	34.68
Emergent Marsh	No Action		68	41	9	2	1	121	5.84	0.73	0.08	17.80
	Alternative A	Patches Fragmented	4	8	3							
		Total Patches	77	45	7	2	1	132	5.19	0.62	0.08	16.99
	Alternative B	Patches Fragmented	18	9	4	1	1					
		Total Patches	71	41	8	2	1	123	5.35	0.72	0.08	17.29
	Alternative C	Patches Fragmented	9	9	5	1						
		Total Patches	70	41	9	2	1	123	5.59	0.72	0.08	17.41
	Alternative E	Patches Fragmented	6	9	2							
		Total Patches	76	40	9	2	1	128	5.33	0.60	0.08	17.26
Mudflat/Pickleweed	No Action		211	61	6	1		279	1.58	0.26	0.10	6.23
	Alternative A	Patches Fragmented	7	4								
		Total Patches	208	60	6	1		275	1.58	0.25	0.10	6.26

Table B-5. Continued

Habitat Type	Alternative		Number of Patches in Each Size Class					Summary Statistics (Acres)				
			<1	1–10	10–50	50–100	>100	Number of Patches	Mean Patch Size	Median Patch Size	Patch Size Coefficient of Variance	Standard Deviation
	Alternative B	Patches Fragmented	20	16	1							
		Total Patches	224	56	5	1		286	1.47	0.24	0.10	6.13
	Alternative C	Patches Fragmented	26	18	1							
		Total Patches	221	54	6	1		282	1.45	0.22	0.11	6.17
	Alternative E	Patches Fragmented	17	9								
		Total Patches	212	57	6	1		276	1.53	0.24	0.10	6.25
Open Water	No Action		25	12	4	1	1	43	7.27	0.69	0.07	20.92
	Alternative A	Patches Fragmented	2		2	1						
		Total Patches	28	15	3	1	1	48	6.31	0.61	0.08	19.36
	Alternative B	Patches Fragmented	1	1	2	1						
		Total Patches	28	14	4		1	47	6.09	0.74	0.08	18.97
	Alternative C	Patches Fragmented	2		2							
		Total Patches	28	14	4	1	1	48	6.31	0.64	0.08	19.40
	Alternative E	Patches Fragmented	2		2	1						
		Total Patches	26	14	4	1	1	46	6.41	0.69	0.07	19.41
Pasture	No Action		65	23	16	7	7	118	25.11	0.45	0.10	97.38
	Alternative A	Patches Fragmented	5	5	8	4	6					
		Total Patches	84	45	19	3	7	158	17.42	0.79	0.12	81.73
	Alternative B	Patches Fragmented	2	6	8	5	6					
		Total Patches	95	37	26	6	6	170	15.54	0.45	0.10	64.41
	Alternative C	Patches Fragmented	5	8	5	5	6					
		Total Patches	79	35	25	4	6	149	18.55	0.83	0.11	83.92
	Alternative E	Patches Fragmented	4	5	6	6	6					

Table B-5. Continued

Habitat Type	Alternative		Number of Patches in Each Size Class					Summary Statistics (Acres)				
			<1	1–10	10–50	50–100	>100	Number of Patches	Mean Patch Size	Median Patch Size	Patch Size Coefficient of Variance	Standard Deviation
		Total Patches	85	39	19	7	5	155	17.71	0.72	0.11	82.02
Riparian	No Action		9	16	1			26	2.73	1.61	0.03	3.62
	Alternative A	Patches Fragmented	5	6								
		Total Patches	9	16	1			26	2.58	1.61	0.03	3.57
	Alternative B	Patches Fragmented	5	10								
		Total Patches	15	13	1			29	2.25	0.92	0.04	3.50
	Alternative C	Patches Fragmented	5	9								
		Total Patches	9	15	1			25	2.64	1.61	0.03	3.61
	Alternative E	Patches Fragmented	5	7								
		Total Patches	5	16	1			22	3.04	2.04	0.03	3.71
Scrub	No Action		57	29	6	1	1	94	13.64	0.49	0.19	104.57
	Alternative A	Patches Fragmented	3	2			1					
		Total Patches	61	30	8	2	3	104	10.89	0.56	0.12	52.38
	Alternative B	Patches Fragmented	1	4	3		1					
		Total Patches	68	35	5	1	4	113	10.49	0.49	0.11	47.56
	Alternative C	Patches Fragmented	2	4	5		1					
		Total Patches	70	39	4	3	2	118	9.42	0.57	0.13	48.37
	Alternative E	Patches Fragmented	1	2			1					
		Total Patches	66	31	8	2	3	110	10.33	0.49	0.12	50.08

Table B-5. Continued

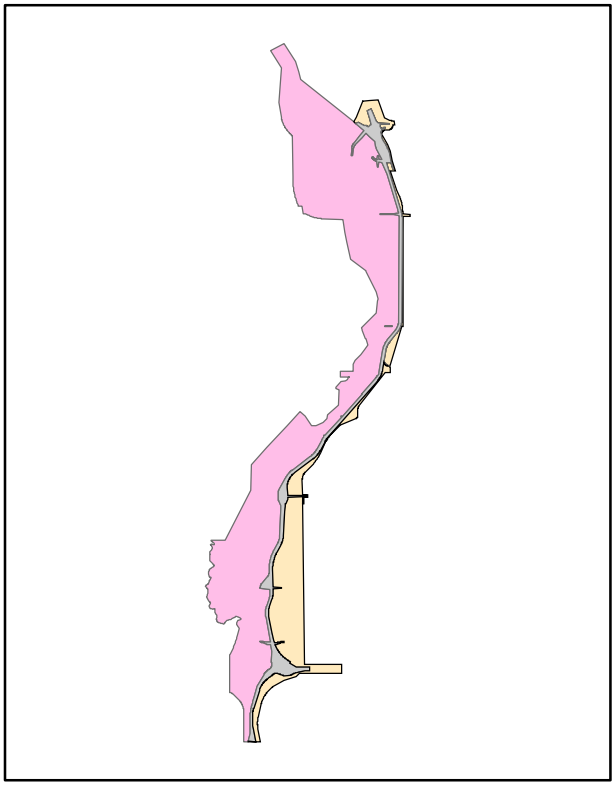
Habitat Type	Alternative		Number of Patches in Each Size Class					Summary Statistics (Acres)				
			<1	1–10	10–50	50–100	>100	Number of Patches	Mean Patch Size	Median Patch Size	Patch Size Coefficient of Variance	Standard Deviation
Wet Meadow	No Action		176	109	23	2	1	311	3.60	0.85	0.08	10.93
	Alternative A	Patches Fragmented	22	39	6	1	1					
		Total Patches	200	97	22	2	1	322	3.26	0.71	0.08	10.50
	Alternative B	Patches Fragmented	35	43	10	2	1					
		Total Patches	190	96	25	3		314	3.26	0.72	0.06	8.26
	Alternative C	Patches Fragmented	30	38	7	1	1					
		Total Patches	198	96	20	4		318	3.23	0.71	0.07	8.75
	Alternative E	Patches Fragmented	27	40	5	1	1					
		Total Patches	193	95	23	2	1	314	3.35	0.72	0.08	10.65

Table B-6. Summary of Habitat Fragmentation Statistics by Habitat Category Resulting from Build Alternatives

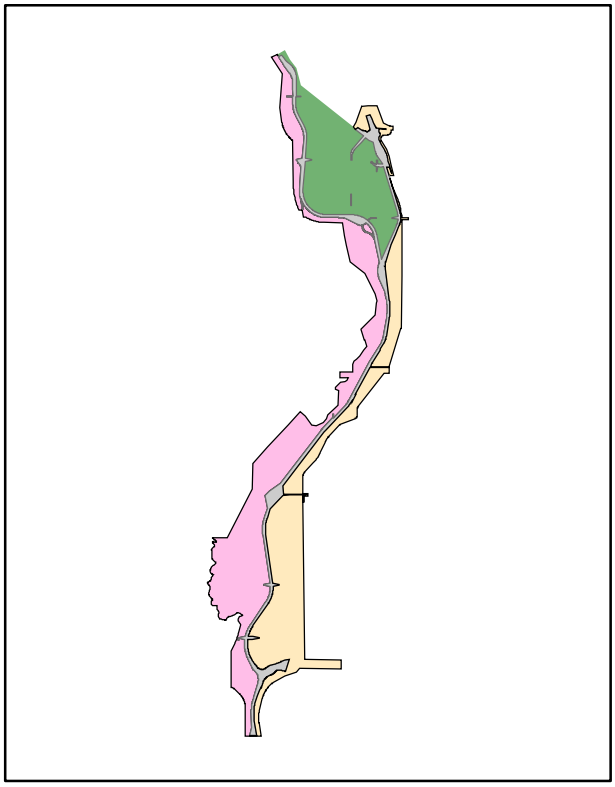
			Number of Patches in Each Size Class						Summary Statistics (acres)			
Habitat Category	Alternative		<1	1–10	10–50	50–100	>100	**Total Number of Patches**	Mean Patch Size	Median Patch Size	Patch Size Coefficient of Variance	Standard Deviation
Upland	No Action		147	70	40	13	12	**282**	21.20	0.79	0.11	91.82
	Alternative A	Patches Fragmented	10	9	15	7	10					
		Total Patches	175	97	46	13	13	**344**	15.93	0.90	0.10	64.81
	Alternative B	Patches Fragmented	6	16	22	10	11					
		Total Patches	196	97	59	14	12	**378**	14.05	0.84	0.09	52.16
	Alternative C	Patches Fragmented	9	14	17	8	10					
		Total Patches	181	100	50	11	13	**355**	15.46	0.94	0.10	64.08
	Alternative E	Patches Fragmented	7	8	12	7	10					
		Total Patches	182	91	47	17	11	**348**	15.76	0.79	0.10	63.95
Wetlands	No Action		464	227	39	5	2	**737**	3.17	0.60	0.09	10.95
	Alternative A	Patches Fragmented	38	57	9	1	1					
		Total Patches	494	218	36	5	2	**755**	2.96	0.48	0.09	10.67
	Alternative B	Patches Fragmented	78	78	15	3	2					
		Total Patches	500	206	39	6	1	**752**	2.88	0.48	0.08	9.70
	Alternative C	Patches Fragmented	70	74	13	2	1					
		Total Patches	498	206	36	7	1	**748**	2.93	0.45	0.08	9.96
	Alternative E	Patches Fragmented	55	65	7	1	1					
		Total Patches	486	208	39	5	2	**740**	3.01	0.45	0.09	10.79

Table B-6. Continued

Habitat Category	Alternative		Number of Patches in Each Size Class						Summary Statistics (acres)			
			<1	1–10	10–50	50–100	>100	**Total Number of Patches**	Mean Patch Size	Median Patch Size	Patch Size Coefficient of Variance	Standard Deviation
Open Water	No Action		25	12	4	1	1	**43**	7.27	0.69	0.07	20.92
	Alternative A	Patches Fragmented	2		2	1	0					
		Total Patches	28	15	3	1	1	**48**	6.31	0.61	0.08	19.36
	Alternative B	Patches Fragmented	1	1	2	1	0					
		Total Patches	28	14	4	0	1	**47**	6.09	0.74	0.08	18.97
	Alternative C	Patches Fragmented	2	0	2	0	0					
		Total Patches	28	14	4	1	1	**48**	6.31	0.64	0.08	19.40
	Alternative E	Patches Fragmented	2	0	2	1	0					
		Total Patches	26	14	4	1	1	**46**	6.41	0.69	0.07	19.41



Alternative A



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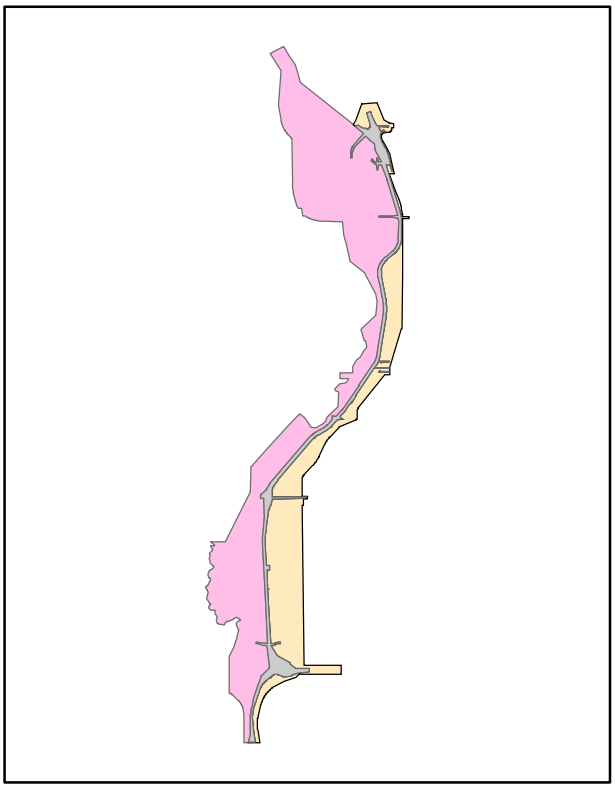

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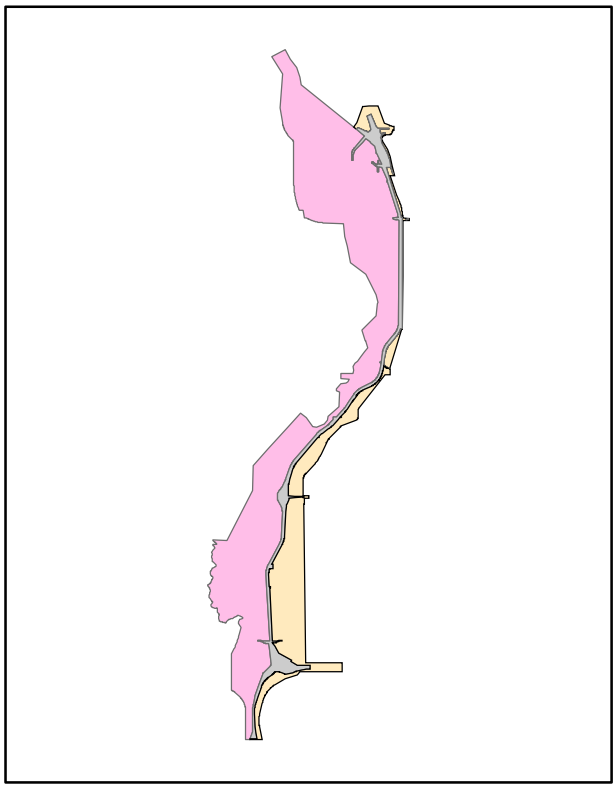

Alternative E

Legend

- Developed
- East
- North
- West

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Figure B-1
Contiguous Area of Habitat After Implementation of Proposed Alternatives

Table B-7. Nearest Neighbor Distance Distribution and Summary Statistics

			Nearest Neighbor Distance (meters)					Nearest Neighbor Summary Statistics (meters)			
Habitat		Study Area	0–10	10–20	20–50	5–100	>100	Mean	Median	Standard Deviation	Coefficient of Variation (CV)
Upland	No Action	Project Study Area	92	34	22	2	4	99.05	57.75	155.63	157.12
	Alternative A	East	22	7	12	4	4	27.97	12.00	38.15	136.40
	Alternative A	West	78	38	25	4	3	17.00	9.00	26.92	158.36
	Alternative B	East	54	17	13	5	3	17.69	7.50	27.35	154.56
	Alternative B	West	69	13	17	3	4	17.14	7.50	27.57	160.85
	Alternative B	North	22	18	5	1	3	26.46	14.03	37.05	140.00
	Alternative C	East	48	18	14	4	3	18.01	8.75	27.82	154.48
	Alternative C	West	75	28	20	2	5	22.27	9.00	50.32	225.99
	Preferred Alternative (E)	East	32	15	11	3	4	22.54	10.06	34.38	152.54
	Preferred Alternative (E)	West	75	34	20	3	3	16.59	9.00	28.78	173.41
Wetland	No Action	Project Study Area	221	134	103	35	31	29.91	12.00	78.33	261.88
	Alternative A	East	20	9	25	12	21	87.58	35.78	123.60	141.14
	Alternative A	West	210	125	84	20	21	26.69	10.61	81.13	303.92
	Alternative B	East	53	40	37	18	18	44.54	17.13	77.75	174.56
	Alternative B	West	123	53	41	9	11	29.32	9.60	108.44	369.90
	Alternative B	North	45	46	33	7	7	26.46	14.03	37.05	140.00
	Alternative C	East	42	36	37	23	17	47.15	19.50	74.32	157.63
	Alternative C	West	181	94	74	17	18	27.75	10.61	87.64	315.79
	Preferred Alternative (E)	East	24	18	29	15	18	67.00	29.31	103.37	154.28
	Preferred Alternative (E)	West	192	110	83	28	18	27.62	11.42	82.84	299.89

Habitat		Study Area	Nearest Neighbor Distance (meters)					Nearest Neighbor Summary Statistics (meters)			
			0–10	10–20	20–50	5–100	>100	Mean	Median	Standard Deviation	Coefficient of Variation (CV)
Open Water	No Action	Project Study Area	9	12	8	3	13	154.07	17.13	301.51	195.70
	Alternative A	East	0	0	4	1	2	829.06	45.22	1643.28	198.21
	Alternative A	West	11	12	6	3	11	116.59	19.56	240.28	206.09
	Alternative B	East	0	0	4	0	5	751.89	112.06	1278.60	170.05
	Alternative B	West	9	10	4	3	7	145.06	18.55	537.81	370.75
	Alternative B	North	0	2	2	0	3	365.61	22.50	476.28	130.27
	Alternative C	East	0	0	4	0	4	519.45	281.52	702.55	135.25
	Alternative C	West	12	12	6	3	9	105.51	18.55	240.55	227.99
	Preferred Alternative (E)	East	0	0	4	0	2	524.15	45.22	820.07	156.46
	Preferred Alternative (E)	West	11	12	6	3	11	116.37	19.56	240.38	206.57

Note: The numbers of patches in each nearest neighbor distances classes will not total to the number in the project study area

Table B-8. Mean Perimeter-to-Area Ratio

Alternative	Cropland	Developed	Emergent Marsh	Mudflat/ Pickleweed	Open Water	Pasture	Riparian	Scrub	Wet Meadow
Alternative A	0.37	8.78	0.19	0.29	0.21	31.06	0.18	0.15	0.16
Alternative B	0.34	9.38	0.19	0.38	0.18	28.90	0.22	0.20	0.16
Alternative C	0.37	8.22	0.31	0.40	0.22	33.27	0.21	0.22	0.15
Preferred Alternative (E)	0.38	8.52	0.23	0.32	0.17	31.61	0.16	0.22	0.15
No Build	0.39	6.65	0.15	0.28	0.17	41.41	0.18	0.14	0.13

B.2.2 Regional-Level Analysis Methods

Regional Study Area

The regional study area was defined by the portion of the GSLE that included hydrologic units that drain to the eastern shore of Great Salt Lake, are below 1,433 m (4,700 ft), and for which GIS land use data are available. This area extends from the southern Utah Lake to the northern reaches of the Bear River in Utah. It does not include the upstream reaches of the Bear River beyond the Utah/Idaho border or Cache Valley. When appropriate, the data was analyzed at the regional study area and by hydrologic unit. The hydrologic units used in this series of analysis are modified versions of the USGS hydrologic units. The hydrologic units were generalized to reduce the number of units analyzed while still retaining the distinct geographic areas. The area below 1,433 m (4,700 ft) was included because the migratory species that use the habitats in the project study area are most likely to use habitat in this area. The 1,433-m (4,700-ft) elevation boundary identifies the approximate transition between the lowland habitat and the higher elevation habitats.

Regional Habitat Availability Analysis Methods

The calculation of habitat availability in the regional study area provides a baseline of current conditions. This information can be used to compare current conditions to historic habitat availability as well as to evaluate potential future habitat loss at a regional scale.

A GIS-based analysis was conducted to determine the current habitat availability for the regional study area. To evaluate available habitat, the NLCD and the NWI datasets were combined to create a single land cover dataset, which includes wetlands for the regional study area. The NLCD represents land cover types and can be used for assessing wildlife habitat, water quality, pesticide runoff, and land use change. The NLCD land cover classes were crosswalked to the habitat classification used at the project study area scale analysis (Table B-2). The NWI dataset includes wetland areas in Utah as determined by the USFWS. The wetlands are categorized into several wetland classes and flooding regimes (Cowardin et al. 1979). The NWI data was mapped at a scale of 1:24,000. For this analysis the NWI classes were reclassified to match as closely as possible the wildlife habitat definitions used at the project study area-scale analysis, which used a finer scale of information (Table B-3).

The scale used for the regional study area mapping is a smaller geographic scale than that used for the project-level study area mapping. It is an appropriate scale for a regional analysis, but it results in a variation in the acres of wetland habitat calculated between the regional-level and the project-level analysis. Because of this variation in scale and the corresponding variation in area calculations between the two study areas, representative comparisons between the two acreages cannot necessarily be made.

Effects of the Dynamics of Great Salt Lake on Habitat Availability

The effect of inundation on habitat availability is important on both the project level and the regional level. Analyzing the availability of habitat at different lake levels can identify the habitat areas that are more likely to be flooded and the habitats that are more likely to be available regardless of lake level.

Two different lake levels were used in this analysis. The low-water level was represented by the area classified as open water in the land cover dataset used in the habitat availability analysis. This dataset was used to represent the low lake level because the NWI and NLCD data was not mapped at lower water

(i.e., it is not possible to extrapolate the available habitat beyond the mapped extent.) The high-water dataset was based on the University of Utah Mapping and Monitoring Great Salt Lake Dynamics (1972–1996) project 1984 lake level dataset. The 1984 lake level was the highest lake level in the university datasets that were provided (Figure B-2). The 1987 lake level was very similar to that compiled in 1984 but appeared to be lower from a visual inspection of the two datasets. The datasets should not be viewed as representing a specific inundation level, but rather as an example of low-water and high-water conditions.

B.3 Results and Conclusions

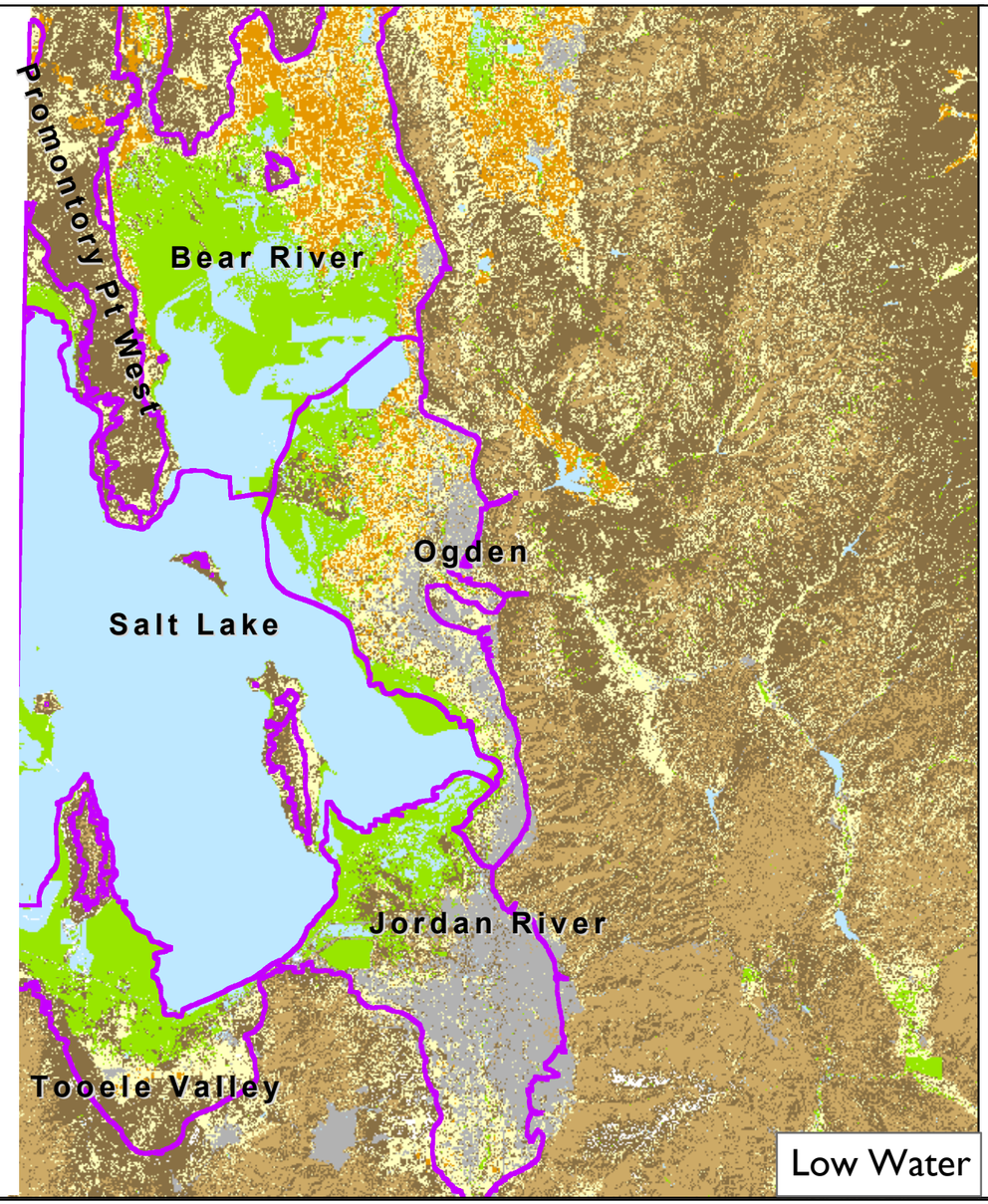
The regional study is dominated by upland habitat at both low and high water. The wetland wildlife habitats represent a small portion of the regional study area. Emergent marsh represents 4 percent of the regional study area at low water and 2 percent at high water. Mudflat/pickleweed represents 15 percent at low water and 6 percent at high water. Wet meadow represents 9 percent at low water and 7 percent at high water. Table B-9 illustrates the variation in different habitat types across the region at low and high water.

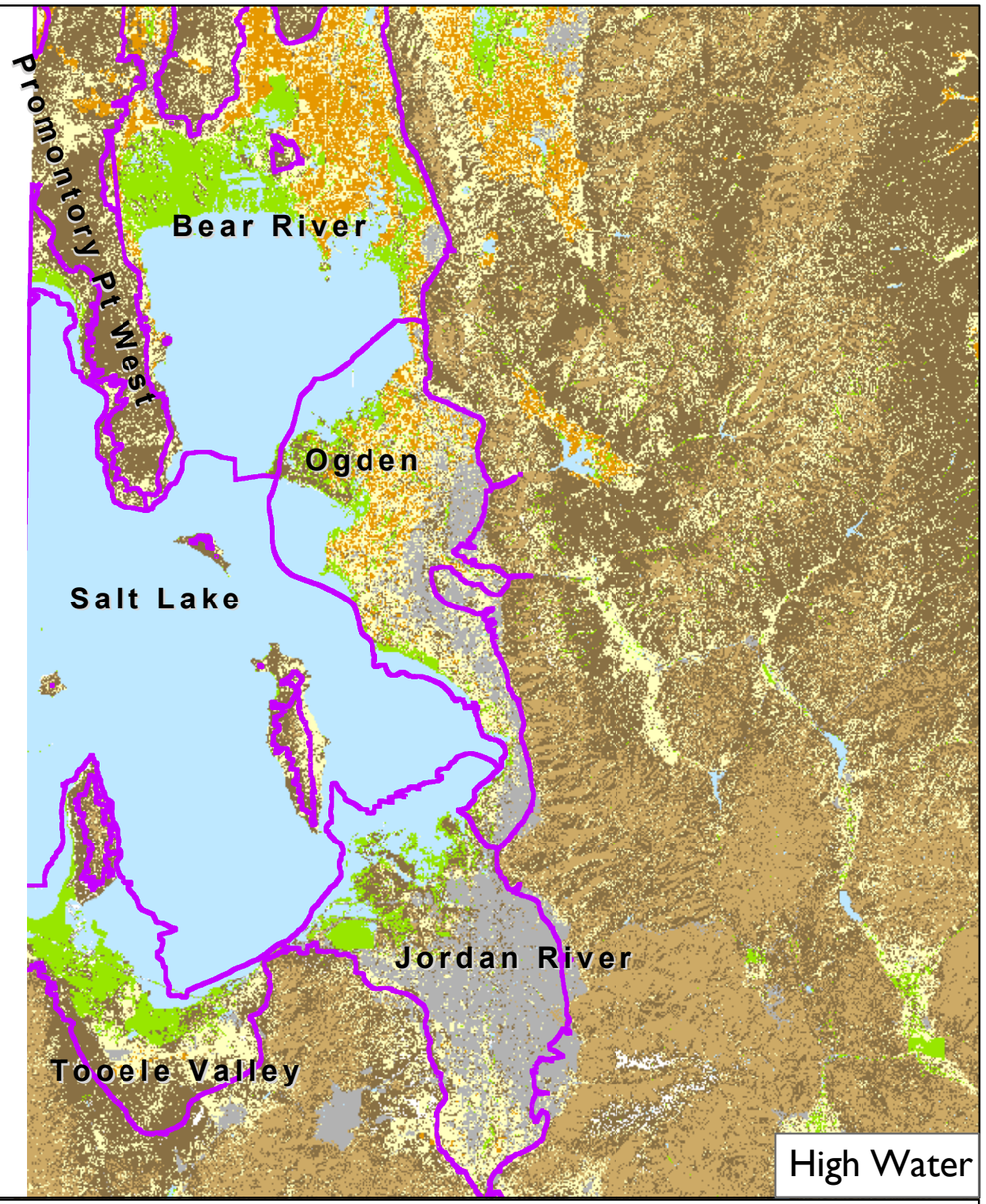
Table B-9. Distribution of Available Habitat in Regional Study Area at Low and High Water

	Low Water		High Water	
Habitat Type	acres	%	acres	%
Cropland	175,019	14	174,472	16
Developed	164,958	13	164,569	15
Emergent Marsh	48,586	4	21,200	2
Mudflat/Pickleweed	185,195	15	66,217	6
Pasture	330,198	26	328,137	31
Riparian	4,954	<1	4,365	<1
Scrub	211,684	17	208,280	20
Forested Upland	22,369	2	22,235	2
Wet Meadow	107,639	9	77,505	7
Total Area	1,250,602	100	1,066,981	100

Table B-10 illustrates the distribution of the habitat types in the region across each of the hydrologic units. For example, 46 percent of the mudflat/pickleweed habitat in the regional study area is located in the Bear River hydrologic unit, 13 percent is in the Jordan River, and 23 percent is in Tooele Valley; 55 percent of developed habitat in the region occurs in the Jordan River hydrologic unit, and 74 percent of the cropland is in the Bear River.

As the lake level fluctuates, the terrestrial habitats are converted to open water habitat, as shown in Table B-11. For example, 99 percent of the cropland in the Bear River hydrologic unit is available at high water, but only 38 percent of the mudflat/pickleweed available in the Bear River hydrologic unit is available at high water. Because the Bear River hydrologic unit contains 46 percent of the mudflat/pickleweed in the





Legend

Regional Study Area

Land Cover

- Cropland
- Developed
- Wetlands
- Open Water
- Pasture
- Scrub
- Unclassified
- Upland (Forested)

N

20 10 0 20 40

Kilometers

Map Production: 12/15/03

Data Sources: USGS National Land Cover Dataset, USFWS National Wetlands Inventory, University of Utah

Low Water is based on the water level at the time of the USGS and USFWS mapping. High Water is 1984 (Univeristy of Utah)

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Figure B-2

Great Salt Lake High and Low Water Levels

Table B-10. Distribution of Habitats by Hydrologic Unit at Low Water in the Regional Study Area

	Bear River		Jordan River		Ogden		Promontory Pt West		Salt Lake		Tooele Valley		Utah Lake		Study Area Total
Habitat Type	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres
Cropland	84,507	74	627	1	22,987	20	1,047	1	0	0	589	1	3,985	4	113,742
Developed	5,180	3	87,588	55	40,650	25	8	0	77	0	3,163	2	22,750	14	159,416
Emergent Marsh	8,283	19	11,261	26	15,363	36	89	0	1,740	4	425	1	5,657	13	42,817
Mudflat/Pickleweed	84,797	46	24,065	13	13,045	7	3,747	2	14,608	8	43,120	23	1,533	1	184,915
Pasture	84,362	30	32,903	12	61,931	22	8,025	3	7,796	3	27,557	10	62,591	22	285,165
Riparian	1,566	42	188	5	1,490	40	32	1	59	2	188	5	205	6	3,728
Scrub	37,659	18	31,923	15	27,201	13	14,917	7	12,258	6	47,565	23	34,495	17	206,017
Forested Upland	433	2	8,053	36	4,905	22	1	0	598	3	2,231	10	5,864	27	22,084
Wet Meadow	44,377	45	8,601	9	17,201	17	819	1	887	1	13,265	13	13,989	14	99,139

Table B-11. Extent (acres) of Available Habitat in the Regional Study Area by Hydrologic Unit and Percentage Remaining at High Water

Habitat Type	Bear River			Jordan River			Ogden			Promontory Pt West			Salt Lake			Tooele Valley			Utah Lake		
	Low Water	High Water	%	Low Water	High Water	%	Low Water	High Water	%	Low Water	High Water	%	Low Water	High Water	%	Low Water	High Water	%	Low Water	High Water	%
Cropland	84,507	83,970	99	627	627	100	22,987	22,979	100	1,047	1,047	100	0	0	0	589	588	100	3,985	3,985	100
Developed	5,180	5,169	100	87,588	87,467	100	40,650	40,579	100	8	7	86	77	35	46	3,163	3,019	95	22,750	22,750	100
Emergent Marsh	8,283	3,509	42	11,261	2,428	22	15,363	3,302	21	89	89	100	1,740	118	7	425	327	77	5,657	5,657	100
Mudflat/Pickleweed	84,797	31,983	38	24,065	9,278	39	13,045	2,068	16	3,747	1,832	49	14,608	245	2	43,120	19,000	44	1,533	1,533	100
Pasture	84,362	82,785	98	32,903	32,835	100	61,931	61,841	100	8,025	8,015	100	7,796	7,632	98	27,557	27,404	99	62,591	62,591	100
Riparian	1,566	1,119	71	188	177	94	1,490	1,447	97	32	32	100	59	13	22	188	146	78	205	205	100
Scrub	37,659	36,326	96	31,923	31,421	98	27,201	26,808	99	14,917	14,888	100	12,258	11,698	95	47,565	46,977	99	34,495	34,495	100
Forested Upland	433	428	99	8,053	7,994	99	4,905	4,900	100	1	1	100	598	573	96	2,231	2,191	98	5,864	5,864	100
Wet Meadow	44,377	23,527	53	8,601	6,503	76	17,201	12,254	71	819	809	99	887	180	20	13,265	11,743	89	13,989	13,989	100

region, the conversion of 62 percent (52,814 acres) of this habitat to open water represents a large change in the availability of mudflat/pickleweed during high-water years. The percentage of change in habitat availability from low to high water illustrates the variation in the distribution of habitats within the hydrologic units. The temporary reduction in available habitat during high-water years varies by hydrologic unit and by habitat type. For example, cropland, developed, pasture, scrub, and upland habitat types in the Jordan and Ogden River hydrologic units are not affected by the lake level fluctuations, whereas emergent marsh, mudflat/pickleweed, and wet meadow habitats are converted to open water habitat as lake levels change. The data in Tables B-9, B-10, and B-11 can be used to identify which hydrologic units contain the most of each habitat type and the vulnerability the habitats in a hydrologic unit to the dynamics of Great Salt Lake.

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Appendix C

Common and Scientific Names of Wildlife Species

Appendix C. Common and Scientific Names of Wildlife Species

Common Name	Scientific Name
Loons	
Red-throated Loon	*Gavia stellata*
Pacific Loon	*Gavia pacifica*
Common Loon	*Gavia immer*
Grebes	
Pied-billed Grebe	*Podilymbus podiceps*
Horned Grebe	*Podiceps auritus*
Eared Grebe	*Podiceps nigricollis*
Western Grebe	*Aechmorphorus occidentalis*
Clark's Grebe	*Aechmorphorus clarkii*
Pelicans and Cormorants	
American White Pelican (WSC)	*Pelecanus erythrorhynchus*
Double-crested Cormorant	*Pelecanus occidentalis*
Wading Birds and New World Vultures	
American Bittern	*Botaurus lentiginosus*
Great Blue Heron	*Ardea herodias*
Great Egret	*Ardea alba*
Snowy Egret	*Egretta thula*
Tricolored Heron	*Egretta tricolor*
Cattle Egret	*Bubulcus ibis*
Green Heron	*Butorides virescens*
Black-crowned Night-heron	*Nycticorax nycticorax*
White-faced Ibis	*Plegadis chihi*
Turkey Vulture	*Cathartes aura*
Swans, Geese, Ducks	
Tundra Swan	*Cygnus columbianus*
Trumpeter Swan	*Cygnus buccinator*
Greater White-fronted Goose	*Anser albifrons*
Snow Goose	*Chen caerulescens*
Ross' Goose	*Chen rossii*
Canada Goose	*Branta canadensis*
Brant	*Branta bernicla*

Common Name	Scientific Name
Wood Duck	*Aix sponsa*
Gadwall	*Anas strepera*
Eurasian Wigeon	*Anas penelope*
American Wigeon	*Anas americana*
Mallard	*Anas acuta*
Blue-winged Teal	*Anas discors*
Cinnamon Teal	*Anas cyanoptera*
Northern Shoveler	*Anas clypeata*
Northern Pintail	*Anas platyrhynchos*
Green-winged Teal	*Anas crecca*
Canvasback	*Aythya valisineria*
Redhead	*Aythya americana*
Ring-necked Duck	*Aythya collaris*
Greater Scaup	*Aythya marila*
Lesser Scaup	*Aythya affinis*
Harlequin Duck	*Histrionicus histrionicus*
Surf Scoter	*Melanitta perspicillata*
White-winged Scoter	*Melanitta fusca*
Black Scoter	*Melanitta nigra*
Long-tailed Duck	*Clangula hyemalis*
Bufflehead	*Bucephala albeola*
Common Goldeneye	*Bucephala clangula*
Barrow's Goldeneye	*Bucephala islandica*
Hooded Merganser	*Lophodytes cucullatus*
Common Merganser	*Mergus merganser*
Red-breasted Merganser	*Mergus serrator*
Ruddy Duck	*Oxyura jamaicensis*
Diurnal Raptors	
Osprey	*Pandion haliaetus*
Bald Eagle (FT)	*Haliaeetus leucocephalus*
Northern Harrier	*Circus cyaneus*
Sharp-shinned Hawk	*Accipiter striatus*
Cooper's Hawk	*Accipiter cooperii*

Common Name	Scientific Name
Northern Goshawk (CAS)	*Accitiper gentilis*
Swainson's Hawk (BCC)	*Buteo swainsoni*
Red-tailed Hawk	*Buteo jamaicensis*
Ferruginous Hawk (BCC; WSC)	*Buteo regalis*
Rough-legged Hawk	*Buteo lagopus*
Golden Eagle (BCC)	*Aquila chrysaetos*
American Kestrel	*Falco sparverius*
Merlin	*Falco columbarius*
Peregrine Falcon (BCC)	*Falco peregrinus*
Prairie Falcon (BCC)	*Falco mexicanus*
Pheasant and Quail	
Chukar	*Alectoris chukar*
Ring-necked Pheasant	*Phasianus colchicus*
California Quail	*Callipepla californica*
Gruiformes	
Virginia Rail	*Rallus limicola*
Sora	*Porzana carolina*
Common Moorhen	*Gallinula chloropus*
American Coot	*Fulica americana*
Sandhill Crane	*Grus canadensis*
Shorebirds	
Black-bellied Plover	*Pluvialis squatarola*
American Golden-Plover (BCC)	*Pluvialis dominica*
Pacific Golden-Plover	*Pluvialis fulva*
Snowy Plover (BCC)	*Charadrius alexandrinus*
Semipalmated Plover	*Charadrius semiplamatus*
Killdeer	*Charadrius vociferus*
Mountain Plover	*Charadrius montanus*
Black-necked Stilt	*Himantopus mexicanus*
American Avocet (BCC)	*Recurvirostra americana*
Greater Yellowlegs	*Tringa melanoleuca*
Lesser Yellowlegs	*Tringa flavipes*
Solitary Sandpiper (BCC)	*Tringa solitaria*

Common Name	Scientific Name
Willet	*Catoptrophorus semipalmatus*
Wandering Tattler	*Heteroscelus incanus*
Spotted Sandpiper	*Actitis macularia*
Whimbrel (BCC)	*Numenius phaeopus*
Long-billed Curlew (BCC)	*Numenius americanus*
Marbled Godwit (BCC)	*Limosa fedoa*
Ruddy Turnstone	*Arenaria interpres*
Red Knot	*Calidris canutus*
Sanderling (BCC)	*Calidris alba*
Semipalmated Sandpiper	*Calidris pusilla*
Western Sandpiper	*Calidris mauri*
Least Sandpiper	*Calidris minutilla*
Baird's Sandpiper	*Calidris bairdii*
Pectoral Sandpiper	*Calidris melanotos*
Dunlin	*Calidris alpina*
Stilt Sandpiper	*Calidris himantopus*
Buff-breasted Sandpiper	*Tryngites subruficollis*
Short-billed Dowitcher	*Limnodromus griseus*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Wilson's Snipe	*Gallinago delicata*
Wilson's Phalarope (BCC)	*Phalaropus tricolor*
Red-necked Phalarope	*Phalaropus lobatus*
Red Phalarope	*Phalaropus fulicaria*
Jaegars, Gulls and Terns	
Parasitic Jaegar	*Stercorarius parasiticus*
Long-tailed Jaegar	*Stercorarius longicaudus*
Franklin's Gull	*Larus pipixcan*
Bonaparte's Gull	*Larus philadelphia*
Mew Gull	*Larus canus*
Ring-billed Gull	*Larus delawarensis*
California Gull	*Larus californicus*
Herring Gull	*Larus argentatus*
Thayer's Gull	*Larus thayeri*

Common Name	Scientific Name
Glaucous-winged Gull	*Larus glaucescens*
Glaucous Gull	*Larus hyperborus*
Sabine's Gull	*Xema sabini*
Caspian Tern	*Sterna caspia*
Common Tern	*Sterna hirundo*
Forster's Tern	*Sterna forsteri*
Black Tern	*Chlidonias niger*
Pigeons and Doves	
Rock Pigeon	*Columbia livia*
White-winged Dove	*Zenaida asiatica*
Mourning Dove	*Zenaida macroura*
Cuckoos	
Yellow-billed Cuckoo (FC)	*Coccyzus americanus*
Owls	
Barn Owl	*Tyto alba*
Great Horned Owl	*Bubo virginiatus*
Burrowing Owl (BCC; WSC)	*Athene cunicularia*
Long-eared Owl	*Asio otus*
Short-eared Owl (WSC)	*Asio flammeus*
Goatsuckers and Swifts	
Common Nighthawk	Chordeiles minor
Common Poorwill	Chordeiles acutipennis
White-throated Swift	Aeronautes saxatalis
Hummingbirds	
Black-chinned Hummingbird	*Archilochus alexandri*
Calliope Hummingbird	*Stellula calliope*
Broad-tailed Hummingbird	*Selasphorus platycercus*
Rufous Hummingbird	*Selasphorus rufus*
Kingfishers	
Belted Kingfisher	*Ceryle torquata*
Woodpeckers	
Red-naped Sapsucker	*Sphyrapicus nuchalis*
Downy Woodpecker	*Picoides pubescens*

Common Name	Scientific Name
Northern Flicker	*Colaptes auratus*
Flycatchers	
Olive-sided Flycatcher	*Contopus cooperi*
Western Wood-peewee	*Contopus sordidulus*
Willow Flycatcher (BCC)	*Empidonax traillii*
Hammond's Flycatcher	*Empidonax hammondii*
Gray Flycatcher	*Empidonax wrightii*
Dusky Flycatcher	*Empidonax oberholseri*
Cordilleran Flycatcher	*Empidonax occidentalis*
Say's Phoebe	*Sayornis saya*
Ash-throated Flycatcher	*Myiarchus cinerascens*
Western Kingbird	*Tyrannus verticalis*
Eastern Kingbird	*Tyannus tyrannus*
Shrikes	
Loggerhead Shrike (BCC)	*Lanius ludovicianus*
Northern Shrike	*Lanius excubitor*
Vireos	
Plumbeous Vireo	*Vireo plumbeus*
Warbling Vireo	*Vireo gilvus*
Jays, Crows and Allies	
Western Scrub-Jay	*Aphelocoma californica*
Black-billed Magpie	*Pica hudsonia*
American Crow	*Corvus brachyrhynchos*
Common Raven	*Corvus corax*
Larks	
Horned Lark	*Eremophila alpestris*
Swallows	
Purple Martin	*Progne subis*
Tree Swallow	*Tachycineta bicolor*
Violet-green Swallow	*Tachycineta thalassina*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Bank Swallow	*Riparia riparia*
Cliff Swallow	*Petrochelidon pyrrhonota*

Common Name	Scientific Name
Barn Swallow	*Hirundo rustica*
Chickadees and Nuthatch	
Black-capped Chickadee	*Poecile atricapilla*
Mountain Chickadee	*Poecile gambeli*
Red-breasted Nuthatch	*Sitta canadensis*
Wrens	
Rock Wren	*Salpinctes obsoletus*
House Wren	*Troglodytes aedon*
Marsh Wren	*Cistothorus palustris*
Kinglets and Thrushes	
Ruby-crowned Kinglet	*Regulus calendula*
Blue-gray Gnatcatcher	*Polioptila caerulea*
Mountain Bluebird	*Sialia currucoides*
Townsend's Solitaire	*Myadestes townsendi*
Hermit Thrush	*Catharus guttatus*
Swainson's Thrush	*Catharus ustulatus*
American Robin	*Turdus migratorius*
Mimids	
Gray Catbird	*Dumetella carolinensis*
Northern Mockingbird	*Mimus polyglottos*
Sage Thrasher	*Oreopscoptes montanus*
Starlings	
European Starling	*Sturnus vulgaris*
Pipits	
American Pipit	*Anthus rubescens*
Waxwings	
Bohemian Waxwing	*Bombycilla garrulus*
Cedar Waxwing	*Bombycilla cedrorum*
Wood-Warblers	
Orange-crowned Warbler	*Vermivora celata*
Nashville Warbler	*Vermivora ruficapilla*
Virginia's Warbler (BCC)	*Vermivora virginiae*
Yellow Warbler	*Dendroica petechia*

Common Name	Scientific Name
Yellow-rumped Warbler	*Dendroica coronata*
Townsend's Warbler	*Dendroica townsendi*
American Redstart	*Setophaga ruticilla*
Northern Waterthrush	*Seiurus noveboracensis*
MacGillvray's Warbler	*Oporornis tolmiei*
Common Yellowthroat	*Geothlypis trichas*
Wilson's Warbler	*Wilsonia pusilla*
Yellow-breasted Chat	*Icteria virens*
Tanagers, Grosbeaks and Cardinaline Buntings	
Western Tanager	*Piranga ludoviciana*
Black-headed Grosbeak	*Pheucticus melanocephalus*
Lazuli Bunting	*Passerina amoena*
Emberizine Sparrows and Allies	
Green-tailed Towhee	*Pipilo chlorurus*
Spotted Towhee	*Pipilo maculatus*
American Tree Sparrow	*Spizella arborea*
Chipping Sparrow	*Spizella passerina*
Brewer's Sparrow (BCC)	*Spizella breweri*
Vesper Sparrow	*Pooecetes gramineus*
Lark Sparrow	*Chondestes grammacus*
Sage Sparrow (BCC)	*Amphispiza belli*
Lark Bunting	*Calamospiza melanocorys*
Savannah Sparrow	*Passerculus sandwichensis*
Song Sparrow	*Melospiza melodia*
Lincoln's Sparrow	*Melospiza lincolnii*
Swamp Sparrow	*Melospiza georgiana*
White-throated Sparrow	*Zonotrichia albicollis*
Harris' Sparrow	*Zonotrichia querula*
White-crowned Sparrow	*Zonotrichia leucophrys*
Golden-crowned Sparrow	*Zonotrichia atricapilla*
Dark-eyed Junco	*Junco hyemalis*
Lapland Longspur	*Calcarius lapponicus*
Snow Bunting	*Plectorphoenax nivalis*

Common Name	Scientific Name
Icterids	
Bobolink (WSC)	*Dolichonyx oryzivorus*
Red-winged Blackbird	*Agelaius phoeniceus*
Western Meadowlark	*Sturnella neglecta*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Brewer's Blackbird	*Euphagus cyanocephalus*
Common Grackle	*Quiscalus quiscula*
Brown-headed Cowbird	*Molothrus ater*
Bullock's Oriole	*Icterus bullockii*
Finches and Old World Sparrows	
Cassin's Finch	*Carpodacus cassinii*
House Finch	*Carpodacus mexicanus*
Pine Siskin	*Carduelis pinus*
Lesser Goldfinch	*Carduelis psaltria*
American Goldfinch	*Carduelis tristis*
Evening Grosbeak	*Coccothraustes vespertinus*
House Sparrow	*Passer domesticus*
Fish	
Brown Trout	*Salmo trutta*
Rainbow Trout	*Onchorhynchus mykiss*
Carp	*Cyprinus carpio*
Speckled Dace	*Rhinichthys osculus*
Long-nose Dace	*Rhinichthys cataractae*
Utah Sucker	*Catostomus ardens*
Channel Catfish	*Ictalurus punctatus*
Bullhead	*Ameiurus nebulosus*
White Bass	*Morone chrysops*
Green Sunfish	*Lepomis cyanellus*
Bluegill	*Lepomis macrochirus*
Walleye	*Stizostedion vitreum*
Amphibians	
Tiger Salamander	*Ambystoma californiense*
Great Basin Spadefoot	*Scaphiopus intermontanus*

Common Name	Scientific Name
Woodhouse's Toad	*Bufo woodhousei*
Western Chorus Frog	*Pseudacris triseriata*
Northern Leopard Frog	*Rana pipiens*
American Bullfrog	*Rana catesbeiana*
Reptiles	
Common Sagebrush Lizard	*Sceloporus graciosus*
Side-blotched Lizard	*Uta stansburiana*
Desert Horned Lizard	*Phrynosoma platyrhinos*
Tiger Whiptail	*Cnemidophorus tigris*
Eastern Racer	*Coluber constrictor*
Gophersnake	*Pituophis melanoleucus*
Common Gartersnake	*Thamnophis sirtalis*
Terrestrial Gartersnake	*Thamnophis elegans*
Nightsnake	*Hypsiglena torquatat*
Western Rattlesnake	*Crotalus viridis*
Mammals	
Vagrant Shrew	*Sorex vagrans*
Masked Shrew	*Sorex cinereus*
Preble's Shrew (WSC)	*Sorex preblei*
Western Small-footed Myotis	*Myotis ciliolabrum*
Little Brown Bat	*Myotis lucifugus*
Long-legged Myotis	*Myotis volans*
Western Pipistrelle	*Pipistrellus hesperus*
Big Brown Bat	*Eptesicus fuscus*
Hoary Bat	*Lasiurus cinereus*
Spotted Bat (WSC)	*Euderma maculatum*
Townsend's Big-eared Bat (WSC)	*Plecotus townsendii*
Brazilian Free-tailed Bat	*Tadarida brasiliensis*
Nuttall's Cottontail	*Sylvilagus nuttallii*
White-tailed Jackrabbit	*Lepus townsendii*
Black-tailed Jackrabbit	*Lepus californicus*
Least Chipmunk	*Tamias minimus*
Piute Ground Squirrel	*Spermophilus mollis*

Common Name	Scientific Name
Rock Squirrel	*Spermophilus variegatus*
Northern Pocket Gopher	*Thomomys talpoides*
Botta's Pocket Gopher	*Thomomys bottae*
Great Basin Pocket Mouse	*Perognathus parvus*
Ord's Kangaroo Rat	*Dipodomys ordii*
Beaver	*Castor canadensis*
Western Harvest Mouse	*Reithrodontomys megalotis*
Deer Mouse	*Peromyscus maniculatus*
Northern Grasshopper Mouse	*Onychomys leucogaster*
Desert Woodrat	*Neotoma lepida*
Bushy-tailed Woodrat	*Neotoma cinerea*
Meadow Vole	*Microtus pennsylvanicus*
Montane Vole	*Microtus montanus*
Long-tailed Vole	*Microtus longicaudus*
Sagebrush Vole	*Lemmiscus curtatus*
Muskrat	*Ondatra zibethicus*
House Mouse	*Mus musculus*
Black Rat	*Rattus rattus*
Norway Rat	*Rattus norvegicus*
Porcupine	*Erethizon dorsatum*
Coyote	*Canis latrans*
Red Fox	*Vulpes vulpes*
Kit Fox (WSC)	*Vulpes macrotis*
Raccoon	*Procyon lotor*
Long-tailed Weasel	*Mustela frenata*
Mink	*Mustela vison*
Badger	*Taxidea taxus*
Spotted Skunk	*Spiliogale gracilis*
Striped Skunk	*Mephitis mephitis*
Mountain Lion	*Felis concolor*
Bobcat	*Felis rufus*
Mule Deer	*Odocoileus hemionus*
Pronghorn	*Antilocarpa americana*

Special Status Species

FT	Federally Threatened Species
FC	Federal Candidate Species
BCC	Birds of Conservation Concern
CAS	Conservation Agreement Species
WSC	Wildlife Species of Concern

Appendix D

Effects of Artificial Light on Wildlife

Appendix D

Effects of Artificial Light on Wildlife

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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Appendix E

Bioacoustics Analysis of Potential Effects of Highway Noise on Wildlife of Great Salt Lake

Appendix E

Bioacoustics Analysis of Potential Effects of Highway Noise on Wildlife of Great Salt Lake

E.1 Introduction

Noise, defined as unwanted or annoying sound, can affect wildlife in a number of ways. Many animals detect and use sound to communicate, navigate, avoid danger, and find food (Bowles 1997; Bradbury and Vehrencamp 1998; Forman et al. 2003). Human-made noise, including highway noise, can interfere with these functions by blocking or masking important sounds and/or by inducing stress in the animals (Sarigul-Klin et al. 1997). These adverse affects can potentially alter the reproductive success, survivorship, habitat use patterns, distribution, abundance, and genetic composition of affected species.

Studies of the ecological effects of highways on grassland bird communities in the Netherlands (Reijnen et al. 1995; Reijnen et al. 1996) showed declines in both species diversity and abundance of birds near highways. Disturbance distances varied from 65 m (0.04 mi) to 3,530 m (2.19 mi) out from highways with traffic volumes of 50,000 vehicles per day (veh/d). Within this range, species experienced estimated population losses of between 12 and 52% at 500 m (0.31 mi) and between 14 and 44% out to 1,500 m (0.93 mi). In these studies, traffic noise was identified as the principal cause of these effects. Both visual disturbance and vehicular pollutants were found to extend only a short distance out from the roads, whereas traffic noise and reduced bird densities extended much farther (Reijnen et al. 1995). Both road-kill of birds and losses from predators moving along the road corridors have a comparatively negligible effect on avian diversity; moreover, such occurrences are evident only for a short distance from the road (Mumm et al. 2000). These occurrences are not, therefore, considered an important cause of most road-avoidance zones.

Additional studies on grassland birds in open patches near roads in a suburban landscape in Massachussetts showed significant reductions in reproduction up to 1,200 m (0.75 mi) from roads (Forman and Deblinger 2000; Forman et al. 2002). Road effects studies on amphibians, reptiles, and small mammals have shown similar population effects out to 2,000 m (Getz et al. 1978; Bowles 1997; Findlay and Houlahan 1997; Rudolph et al. 1999). Soil vibration and road-kill were suggested as the primary causes for the highway effects on amphibians, reptiles, and small mammals (Getz et al. 1978; Fahrig et al. 1995; Bowles 1997).

Comparable survey data are not available for the project study area. However, the effects described above are likely to be representative, if not conservative, estimates of the range of effects that noise disturbance resulting from the Proposed Action could have on local wildlife. The project study area includes large areas of pasture and agricultural lands that support many grassland species (Appendix A). Moreover, the projected traffic volume for the proposed Legacy Parkway project is significantly higher (approx. 72,000 veh/d vs. 50,000 veh/d) than that in the Netherlands study. Because noise levels increase with traffic

volume (Forman et al. 2003), the area of potential noise disturbance from the proposed project would likely be comparable, if not higher than, those reported in the above described studies.

In a review of the Netherlands bird studies, however, Sarigul-Klijn et al. (1997) noted that such multi-species survey studies can potentially produce spurious conclusions because they lump species together and do not consider effects on the individual species level. Species in different environments have developed highly species-specific levels of vocalization complexity that vary widely in their acoustic properties (Dooling 1982; Bradbury and Vehrencamp 1998). While the Netherlands and other multi-species studies do show a wide range of responses to traffic noise, Sarigul-Klijn et al. recommended that before adopting noise limiting criteria [mitigation], it would be prudent to evaluate species-specific auditory capabilities and their behavioral responses to different background stimuli (e.g., natural sounds and highway noise). To examine how highway noise can potentially affect species directly, the following analysis considers species-specific characteristics.

E.2 Bioacoustics Background Information

This section presents an overview of acoustics terminology and concepts fundamental to understanding the complexities of highway noise analysis. A description of the methods used for this analysis follows.

E.2.1 Terminology

- **Sound.** A vibratory disturbance created by a vibrating object, which, when transmitted by pressure waves through a medium such as air, is capable of being detected by a receiving mechanism, such as a bird or mammal ear or a microphone.

- **Ambient Sound.** The all-encompassing sound associated with a given community site, usually being a composite of sounds from many sources, near and far, with no particular sound being dominant.

- **Frequency.** The pitch or tone of a sound. Technically, the number of times per second a sound wave passes a reference point, expressed as cycles per second or hertz (Hz). One hertz equals one cycle per second. High frequencies are more commonly expressed in kilohertz (kHz), or thousands of hertz. The normal range of frequencies that can be heard by the healthiest human ears is from 16 Hz to about 20,000 Hz (20 kHz). High-pitched sounds produce high frequencies; low-pitched sounds produce low frequencies.

- **Amplitude.** The loudness of sound, measured in decibels.

- **Decibel (dB).** A unitless measure of sound on a logarithmic scale, which indicates the squared ratio of sound pressure amplitude to a reference sound pressure amplitude. The reference pressure is 20 micro-pascals, the absolute threshold of hearing in healthy young adults. When using this reference threshold the measure dB is followed by SPL (Sound Pressure Level). Some sample sounds and their measured amplitudes are listed below.

- Rustling leaves 10 dB

- Quiet rural nighttime, soft whisper 20 dB

- Quiet urban nighttime, purring cat 30 dB

- Large conference room (background) 40 dB
- Classroom, nearby bird singing 50 dB
- Normal conversation, heavy traffic (at 300 ft) 60 dB
- Noisy urban area, gas lawn mower 70 dB
- Diesel truck (at 50 ft at 50 mph) 80 dB
- Roaring lion 90 dB
- Echolocating little brown bat 100 dB
- Thunder, rock band 110 dB
- Jet taking off nearby 120 dB

The decibel is a logarithmic measure of actual sound pressures. It is therefore important to recognize that the sound levels produced by two or more sources cannot simply be added to give the total combined sound level. Instead, the sum of the two sound levels must be computed as the root mean square (RMS) of the combined pressures. For example, if the sound of a distant truck passing by is 60 dB SPL by the time it reaches you, and that of car passing at the same time is 40 dB SPL at your ear, the amplitude of the combined sound you hear is not 100 dB SPL. The sound pressure of the truck is 1,000 times greater than the threshold of human hearing at 1 kHz, or about 0.2 dynes/cm^2. The sound pressure of the passing car is only 100 times greater than the same threshold, or about 0.02 dynes/cm^2. The combined noise level would be:

Combined pressures (RMS) = $\sqrt{(0.2)^2 + (0.02)^2}$ = 0.201 dynes/cm^2 =
60.04 dB SPL

This example shows that the additive affect of the noise from the car, which is only 10% of the pressure of the truck, contributes relatively little to the overall noise level of the combination. As a practical matter, the sum of two sound levels that differ by more than 10 dB is not affected by the lower sound level.

E.2.2 Noise Descriptors

- **dB(A).** A-Weighted Decibel. An overall frequency-weighted sound level in decibels that approximates the frequency response of the human ear.
- **Lmax.** Maximum Sound Level. The maximum sound level measured during the measurement period.
- **Lmin.** Minimum Sound Level. The minimum sound level measured during the measurement period.
- **Leq.** Equivalent Sound Level. The equivalent steady-state sound level that, in a stated period of time, would contain the same acoustical energy.

- **Lxx.** Percentile-Exceeded Sound Level. The sound level exceeded "x" percent of a specific time period. L10 is the sound level exceeded 10% of the time.

E.2.3 Bioacoustics Concepts

Sound Propagation and Attenuation

When an animal calls, the sound wave emitted can be envisioned as a sphere that expands as it moves away from the animal. The amount of energy being propagated by that sphere is fixed, equaling the energy used by the animal to give the call. With expansion, the area of the sphere increases (spherical spreading), but the intensity of the sound falls off proportionally as the square of the distance from the calling animal. The sound level attenuates, or drops off, at an ideal rate of 6 dB for each doubling of distance. Excess attenuation is the additional falloff in intensity due to sound absorption and scattering resulting from local variation in air temperature, wind, humidity, and habitat and substrate composition.

If the sound source is long in one dimension, such as traffic on a highway or a long train, the sound source is considered to be a line source. As a general rule, the sound level from a line source will drop off at a rate of 3 dB per doubling of distance. If the intervening ground between the point or line source and the receptor is acoustically *soft* (e.g., ground vegetation, scattered trees, clumps of bushes), the rate of attenuation increases by 1 to 2 dB per doubling of distance.

Meteorological effects such as wind, temperature, and humidity can also have a substantial effect on how sound propagates over large distances (i.e., greater than about 152 m [500 ft]). These effects can either increase or decrease sound levels depending on the orientation of the source and receptor and the nature of the particular effect. As a practical matter, these effects cannot be reasonably evaluated in environmental noise predictions. Understanding these effects, however, can help explain variations that occur between calculated and measured sound levels.

The science of highway traffic noise analysis has traditionally focused on the effects of noise on humans. Accordingly, sound-level meters and traffic noise models have been developed primarily to provide A-weighted sound levels. Because the hearing response curves of nonhuman species are different from those of humans, A-weighted sound levels may not be appropriate for assessing noise impacts on wildlife. In this discussion, A-weighted sound levels are used to generally describe the traffic noise environment because this is the primary single number result that is provided by the traffic noise model. For the purposes of assessing noise impacts on wildlife, a more specific discussion, using the un-weighted 1/3 octave spectra generated by the model, is also provided.

Sound Perception

Most people have difficulty distinguishing the louder of two sound sources if they differ by less than 1.5–2.0 dB. Research into the human perception of changes in sound level indicates the following parameters.

- A 3-dB change is just perceptible.
- A 5-dB change is clearly perceptible.
- A 10-dB change is perceived as being twice or half as loud.

A doubling or halving of acoustic energy changes the resulting sound level by 3 dB, which corresponds to a change that is just perceptible. In practice, this means that a doubling of traffic volume on a roadway or doubling the number of wind turbines in a wind farm will, as a general rule, only result in a 3-dB (or just perceptible) increase in noise.

Sound Masking

Sound masking is the mechanism by which one sound (e.g., highway noise) interferes with the hearing of another sound (e.g., animal vocal signals). Species that have evolved complex vocalizations may be subject to significant biological impacts if they cannot hear their own species' signals because of masking by noise (Sarigul-Klin et al. 1997). Also, species that rely on hearing to detect danger (especially the presence of predators) and to navigate could be adversely affected if this ability is impaired by noise interference.

Spectrum Level Analysis

In contrast with the broad-spectrum noise analysis approach typically employed in noise impact analysis for effects on human receptors, bioacoustic scientists that study auditory masking in wildlife commonly measure noise levels in terms of power per hertz or power per cycle (Dooling 2002). This per-hertz energy distribution in a noise is referred to as the *spectrum level* of noise. It is different from the broad-spectrum measure described above in that the spectrum level reflects the amount of energy in a single frequency, not that present in a broad frequency range. If a noise is relatively constant in amplitude, the difference between these two measures (i.e., broad-spectrum vs. spectrum-level) is approximately 40 dB. The spectrum level can be calculated by subtracting ten times the log of the bandwidth of the noise (or 40 dB) from the overall noise level (65 dB). In this example—where the overall noise level registering on the sound level meter is 65 dB SPL—the spectrum level (i.e., the energy in a single cycle of noise) is approximately 40 dB lower than the broad-spectrum level, or about 25 dB SPL, given that the energy is distributed equally across the entire band.

This difference between these analysis methods is important because, while the overall sound pressure level readings from a sound-level meter are commonly used to describe highway noise, the auditory system of wildlife potentially affected by this noise is only concerned with those frequencies in the noise immediately surrounding the signal. The two measures are not the same. The spectrum level analysis more accurately allows measurement of how far out from the highway traffic noise can mask the vocal signals of different species or different signals of the same species (e.g., songs as opposed to soft calls in birds). The spectrum level in the region of the animal's signal is the most useful in calculating signal-to-noise ratios and determining whether the signal can be detected above the noise by other animals at biologically important distances.

Wildlife Audibility Curves

The minimum audible sound that can be detected in quiet across an animal's frequency range of hearing defines its audibility curve. Audibility curves are unique to each species and differ between and within species. Figure E-1 shows typical variation in the audibility curves of assorted bird species.

Birds hear best at frequencies between about 1 and 5 kHz (Dooling et al. 2002), with absolute sensitivity approaching 0–10 dB SPL at the most sensitive frequency—generally 2–3 kHz (Dooling 1980, 1982, 1992). Owls can generally detect softer sounds than either songbirds or non-songbirds over their entire

range of hearing (Dooling et al. 2002). Songbirds hear better at high frequencies than non-songbirds, and non-songbirds hear better at low frequencies than songbirds. On average, the sound "space" available for birds for vocal communication extends from about 0.5 kHz to 6.0 kHz (the frequency range 30 dB above the most sensitive region of the typical audibility curve). Studies also show that there tends to be a correlation between hearing sensitivity at high frequencies and the highest frequencies contained in the species' vocalizations (Dooling 1980, 1982; Dooling et al. 2002).

Signal Detection, Discrimination, Recognition, and Identification

Signal detection only may not be sufficient for wildlife species to respond appropriately to different behavioral contingencies. It is also important that the listener be able to discriminate the sound from other similar sounds and to recognize the sound. For example, the listener must be able to determine whether the sound is a natural sound or if it originates from a conspecific or from a potential predator; additionally, it is necessary to discriminate between, for example, a neighboring territorial male's defense song, a potential mate's availability signal, and a begging call from a chick (Sarigul-Klign et al.1997). It is important to recognize, therefore, that different levels of highway noise may affect these different levels of perception unequally. While loud traffic noise may make all of these perceptual functions impossible, an intermediate level of noise could permit detection, but hamper discrimination and prevent recognition and identification. Low-level noise might have minimal effects on detection and discrimination, interfere moderately with recognition, but make accurate identification difficult. This differential masking effect is potentially very important for species that use complex vocal signals (e.g., bird songs) that contain a variety of signals of different amplitudes, as well as for species that have multiple calls used in different behavioral situations requiring variable distances for effective communication (e.g., a parent-offspring warning call at or near the nest contrasted with a territorial male singing from an elevated perch to a rival male in a neighboring territory). The potential masking effects of the highway noise is therefore not only a function of the amplitude, frequency, and acoustic characteristics of the noise, but also the communication requirements of the species under consideration and the acoustic variability of their signals.

Acoustic Variation in GSLE Birds

Table F-1 summarizes the acoustic characteristics of many of the bird species identified as occurring or potentially occurring within the project study area. These species have been sorted in ascending order by the lowest frequency characteristic of signals in each species' vocal repertoire. The shaded cells in the Vocalization Frequency Range columns provide a visual summary of the vocal diversity within and across these species. The repertoires of species at the top of the chart have the lowest-frequency sounds, but these repertoires may also include high-frequency signals. The species at the bottom of the chart tend not to have low-frequency signals in their repertoires.

These data show that while some species, such as owls, bitterns, herons, and some passerines (e.g., Mourning Doves), tend to use low-frequency signals, and others, such as many songbirds and shorebirds, have songs and calls that include signals with much higher frequencies, there is no clearly discernable pattern defining vocal patterns used in specific habitats. There is essentially a continuum of vocal signals used by the birds in all habitats within the project study area.

Active Space

Many birds use a variety of different vocal signals to communicate with conspecifics, including loud songs used for territorial defense and mate attraction, high-pitched predator warning calls, inter-mate and flock contact calls, and the soft begging calls of nestlings. The distance over which these signals can be heard varies with their function. Songs are believed to have evolved to provide optimal long-distance transmission to attract mates and deter rivals (Marler 1955; Wiley and Richards 1982; Klump et al.1986). Softer calls are mostly limited to short-distance communication. When the amplitude of the signal is attenuated over distance to a level equal to the sensory threshold of the receiver, the maximum transmission distance of the signal has been reached. The three-dimensional volume in which these signals can be detected and recognized by a receiver is referred to as the *active space* of the signaler (Marten and Marler 1977; Brenowitz 1982).

E.3 Methods

E.3.1 Approach

The nature and extent of noise disturbance associated with highway traffic depends largely on the acoustic characteristics (e.g., frequency, duration, loudness, periodicity) of the noise; the sound attenuation properties of the adjacent habitat; the hearing capacity and sound requirements of the species potentially affected; their stress response levels; and the distance the animals are from the highway. Because birds communicate vocally and are the wildlife group most likely to be most affected by road noise, they were selected as the focus of this analysis. Three species—American Bittern, Black-necked Stilt, and Brewer's Sparrow—were selected for this analysis because they represent the breadth of avian vocal capabilities of the species occurring in the Proposed Action area. American Bitterns use intense, low-frequency calls to communicate with conspecifics (Gibbs et al. 1992). This acoustic pattern is well suited for transmission of sound through dense vegetation typical of the bittern's emergent marsh habitat (Bradbury and Vehrencamp 1998). Black-necked Stilts are open area flocking birds that use loud, high-frequency calls (Robinson et al. 1999). Brewer's Sparrows are territorial, desert scrub birds that use complex songs of varying frequency and intensity to maintain their territories (Rottenberry et al. 1999). Additional analysis was conducted on the acoustic requirements of Barn Owls and domestic cats to assess the potential effects of road noise on masking important environmental sounds used by local Barn Owls and cats for predator/prey detection.

The principal objective of this analysis was to estimate the area of potential effects of noise on wildlife within the project study area. To do this it was first necessary to measure the existing background sound levels, then model the potential future noise conditions associated with each project alternative. The main criterion used to evaluate noise effects in this analysis was the masking potential of the highway noise. This measure is a function of not only the acoustic properties of the highway noise, but also of the vocalizations/environmental sounds that could be affected. Based on measurements of these properties and determination of the critical ratios of hearing for different species (see *Background Information* below), masking thresholds were determined for the highway noise at varying distances from the proposed rights-of-way. All these factors were evaluated for effects on the sound detection ability of individuals at varying distances from the proposed rights-of-way, as well as between pairs of communicating individuals (e.g., neighboring territorial birds) at varying distances between each other and from the highway. When the highway noise level exceeded the amplitude of the vocalization, it was considered to have a potential effect on that species. The approximate distance from the highway that this effect could occur was estimated, and an area of potential indirect effects was calculated. Various aspects

of predictable variability in the highway noise and behavioral adaptations used by wildlife to reduce the masking thresholds, and hence the effective impact area, were also evaluated.

E.3.2 Analysis Methods

The methods used in this analysis are summarized and described below.

- The noise levels in the project study area were measured to determine existing conditions. This analysis included both short-term (1-hour) and long-term (3-day) measurements at selected locations.
- Using data on expected traffic loads during peak hours on the proposed highway, future noise levels were modeled to evaluate how the project alternatives would change the traffic noise environment.
- The area of potential noise impact adjacent to the proposed highway was determined by plotting absolute noise level contours and noise change contours over the wildlife habitat map.
- The acoustic characteristics of the highway noise (frequency and amplitude profiles over distance from the highway) were detailed to provide baseline information from which to calculate potential masking thresholds.
- The general hearing capacities (auditory curves) of representative birds, mammals, amphibians, and reptiles were determined from literature research.
- The critical ratio profiles of these vertebrate groups were estimated.
- The masking thresholds for birds were calculated and plotted.
- The source amplitudes of vocalizations of each of the study birds was calculated, and the frequency range of each species' acoustic signals was determined from the literature.
- Highway noise impact distances were estimated by simultaneously plotting the highway masking thresholds and the acoustic profiles of each species.
- Based on comparison of the acoustic properties of each study species and the masking thresholds, the potential for highway noise to mask other species of wildlife within the project study area was evaluated.
- Using similar analysis methods, the potential impact distances of highway noise on predator/prey detection by owls, bobcats, and mice were estimated.

E.3.3 Existing Sound Environment

Short-Term Field Measurements

Field noise measurements were taken on July 1 and 2, 2003, in the open space and wildlife areas west of the project study area (Figure E-2). A series of short-term measurements, typically 10–15 minutes in length, were taken at selected locations over the 2-day period. The short-term measurements were made using a Larson-David Model 812 Type 1 sound-level meter. The meter was placed on a tripod with the microphone 1.5 m (5 ft) above the ground. The calibration of the meter was checked before and after each

measurement with a Larson-Davis Model CA250 calibrator. Local meteorological conditions at each measurement position were noted using a Kestral Instruments Model 3000 handheld weather meter. Sound-level data were sampled in 1-minute intervals at each position. Acoustical events that occurred during each minute were noted. At selected positions, sound level data were also collected at 1-second intervals so that discrete variations in sound levels could be observed. Figure E-2 depicts the measurement positions.

Skies were clear during both days. On July 1, high wind conditions (average wind speed of 9–24 kph [8–15 mph]) generally prevailed throughout the afternoon. In the early evening, winds reduced to 3–6 kph (2–4 mph). On July 2, winds were relatively calm. During the high winds, local noise levels were typically elevated by wind blowing through vegetation. In addition, at wind speeds above approximately 19 kph (12 mph), noise generated by wind blowing across the microphone can begin to contaminate the measurement. During the high wind conditions, there was little if any bird activity, and therefore little if any sound generated by birds. On July 2, when winds were substantially reduced, there was a marked increase in bird activity and audible bird vocalizations. Because of the proximity of the measurement positions to the airport, noise from aircraft overflights occurred during many of measurements.

Long-Term Field Measurements

Long-term measurements were taken over a 34-hour period beginning at 11:00 a.m. on July 1, 2003. The long-term measurements were conducting using Larson-Davis Model 700 sound-level meters. Figure E-2 depicts the measurement positions. Hourly wind speed data were taken from data collected by Salt Lake City International Airport.

E.3.4 Legacy Parkway Traffic Noise Modeling

Projected future traffic noise levels for the Legacy Parkway were estimated using the Federal Highway Administration Traffic Noise Model (TNM) Version 2.1. Based on predicted peak traffic volumes given in the Legacy Parkway Final EIS, a traffic volume of 1,800 vehicles per hour per lane, or 7,200 for four lanes (72,000 veh/d), was used. This model assumes neutral meteorological conditions and therefore does not take into account the effects of wind, temperature, or other meteorological factors on noise level. The noise level contours generated by the TNM have not yet been verified beyond 305 m (1,000 ft). The locations of contours beyond this distance are projected estimates only and could vary significantly depending on existing background noise, atmospheric conditions, and substrate type.

E.3.5 Sound Masking Threshold Determination

Bird Auditory Curves

The auditory threshold curves, established on the basis of behavioral responses, have been obtained for 14 species of birds, comprising songbirds, non-songbirds, and nocturnal predators (Dooling 2002). An average curve for 10 species of birds was developed as part of the Dooling study. In practical terms, the auditory curve is the absolute threshold level in decibels above the *spectrum level* (power per hertz) of the background noise that a pure tone must be in order to be heard. Table F-2 summarizes the decibel values reported for the 10-bird average (Dooling 2002).

Highway Sound Masking Thresholds

TNM calculates 1/3 octave traffic sound pressure levels. The traffic noise spectrum level at various distances from the highway has been estimated by assuming that traffic noise is broadband in nature (i.e., equal energy across the 1/3 octave band). With this assumption, the spectrum level of the predicted traffic noise can be estimated by calculating 10 times the logarithm of the 1/3 octave bandwidth and subtracting this value from the 1/3 octave sound pressure level. The masking threshold for a given traffic noise 1/3 octave traffic noise spectrum is then calculated by adding the masking threshold for each 1/3 octave band determined from Table F-2 to the 1/3 octave band traffic noise spectrum levels. The 1/3 octave band masking thresholds were interpolated from the octave thresholds presented in Table F-2.

Bird Vocalization Profiles

To assess whether highway noise could potentially mask wildlife vocalizations in the project study area, information on the acoustic characteristics of species with known or potential occurrence in these areas was obtained from the literature where possible. For birds, this information was obtained from *The Birds of North Americ*a species accounts (Poole and Gill). Information obtained included the minimum, maximum, median, and range of frequencies used in all described vocal signals; an index of structural complexity; and a notation of whether the vocalizations included marked frequency modulation and/or harmonics. Because contrasting signals can often be detected against background noise below the masking threshold (Klump 1996), the information on the vocal signal structural complexity, frequency modulation, and use of harmonics was used to evaluate whether the vocal signals of each species could be detected at greater than expected distances due to these properties.

Masking Distance Calculations

To estimate masking distances for each bird species, a spectral analysis was conducted of prerecorded calls for each bird. Spectral analysis was conducted for the loudest part of the call and the softest part of the call. The peak frequency of the call was identified through this analysis. Because the prerecorded calls were simply recorded audio signals with no sound-level calibration, source amplitudes for each species were estimated using a body size-to-sound power output formula presented by Calder (1990):

$$P = 0.042m^{1.14}$$

where P is the sound power output in milliwatts adjusted to a distance of 1 m (3.3 ft) from the bird and *m* is the body mass in kilograms. These power outputs were converted to SPL (dB) values, and the overall sound level of the bird call spectrum was then scaled up to match the reference value. The corresponding pea- frequency sound level was taken as the reference value at 1 m (3.3 ft) for the peak frequency of the call. To evaluate the sound level of the call between two birds at various distances, simple point source attenuation of 6 dB per doubling of distance was applied to the call reference value. Figures E-10 and E-11 show the bird call sound level as a function of the distance between two birds. The highway noise masking level at various distances from the freeway for the peak frequency of the call is also plotted. A comparison of the call sound level to the masking level indicates the distance between birds at which calls would be masked.

E.3.6 Noise Effects and Impact Area Analysis

Highway noise was considered to have a potential impact on birds if:

- there was an overlap in frequency/amplitude spectrum of the highway noise and the vocal signals of species or environmental sounds on which they depend for normal survival and social behavior, and
- the amplitude of the highway noise exceeded the masking threshold of the species for vocal signals such that it could potentially impede the normal behavior of the species in a biologically significant way.

Noise Effects Area

From the model results, absolute noise level contours (A-weighted) were developed for each of the alternatives (Figure E-3). The noise contours, when placed over the wildlife habitat map, allow calculation of the extent to which each habitat can be affected by noise levels defined by the contours. In addition to the modeling analysis described above, TNM was used to develop 1/3 octave band traffic noise levels at various distances from the roadway.

Other Wildlife Species Potentially Affected by Noise

Wildlife habitats that could potentially be affected by noise from the Legacy Parkway project were identified by overlaying the GIS noise level contours (as described above) onto the wildlife habitat map (Figure 2-6 in the *Legacy Parkway Wildlife Impact Analysis* [Technical Memo]) and identifying all habitats that occur within these contours. Wildlife species that are known to occur or could potentially occur within these areas and that were consequently subject to noise impacts were identified by filtering the species-habitat matrix (Appendix A) for species that use the habitat types found within the noise contours. To evaluate the range of possible effects on different wildlife species, three bird species—American Bittern, Black-necked Stilt, and Brewer's Sparrow—were selected because their vocal signals span a range of frequencies potentially affected by highway noise. For analysis of the potential effects of highway noise on predator/prey detection sounds, the acoustic hunting requirements and environment of Barn Owls and cats were evaluated.

E.4 Results

E.4.1 Short-Term Noise Measurements

Table F-3 summarizes the sound levels for the short-term measurements at each sampling location in the study area. The loudest noise values (Lmax) ranged between 53 and 79 dB(A) (Mean +/- Standard Deviation = 64.3 +/- 7.6); the lowest noise values (Lmin) ranged between 31 and 45 dB(A) (Mean +/- Standard Deviation = 35.4 +/- 4.7). During the measurement periods, the sound levels exceeded, on average, 51 dB(A) 10% of the time (L10), 43 dB(A) 50% of the time (L50) and 39 dB(A) 90% of the time (L90). The highest Lmax values were generally associated with plane overflights; the highest wildlife signals (duck vocalizations) were approximately 52 dB(A) (at approximately 30 meters from the microphone). The mean equivalent steady state sound level (Leq) across the entire study area was 48.6 dB(A) (S.D. = +/- 6.6) with a minimum value of 37.1 dB(A) and a maximum value of 59.9 dB(A).

E.4.2 Long-Term Noise Measurements

Figure E-4 shows the long-term hourly sound levels and the local wind speeds measured at survey location L1. The wind speed profile shows the wind speeds recorded at Salt Lake City International Airport for July 1–3, 2003; this profile is the same in each figure.

Table F-4 presents the mean, standard deviation, minimum, and maximum sound levels measured at the three long-term measurement stations in the study area (Figure E-2). The highest noise level (81 dB[A]), was recorded at location L1, closest to I-15; the lowest value (32 dB[A]) was recorded at L2. The mean equivalent steady state sound level (Leq) across the entire study area (L1–L3) was 50 +/- 10 dB(A), with a minimum value of 36 dB(A) and a maximum value of 78 dB(A). Overall, sound levels exceeded 51 +/- 11 dB(A) 10% of the time, 45 +/- 8 dB(A) 50% of the time, and 40 +/-7 dB(A) 90% of the time. There were no significant differences in the mean values for Leq, L10, L50, or L90 between the long-term sound level measurements (Table F-4) and the short-term measurements (Table F-3) ($P > 0.1$; df = 148 for all comparisons). However, the ranges of sound levels recorded for these values (Leq, L10, L50, L90) were significantly larger for the long-term measurements ($P < 0.01$; df = 6). On average, the noise levels (Leq, L10, L50, L90) recorded at L2 were significantly lower than those recorded at L1 ($P < 0.001$; df = 88) and at L3 (Student's t test; $P < 0.001$; df = 88). The same values recorded at L1 and L3 were not statistically different ($P > 0.1$; df = 88).

E.4.3 Modeled Legacy Parkway Traffic Noise

Existing Noise Levels

Figure E-3 shows the background noise-level contours for the No-Build Alternative. Background noise levels for the project study area would be identical to those described above for existing conditions.

Projected Noise Levels

Figure E-3 shows the projected future noise level contours modeled for the Alternatives A, B, C, and E. Differences in the patterns of noise level for each alternative are a function of the physical alignments of each right-of-way. The baseline traffic noise data used for modeling the noise contours were the same for each alternative.

Change in Noise Level

Wildlife can be affected not only by the intensity of noise, but by the relative change in intensity. For example, species already experiencing high levels of noise may not "notice" a 10–15 dB(A) change from highway noise. However, species currently experiencing only low-level natural background noise could readily notice a change in noise level that could interfere with communication.

E.4.4 Highway Noise Impacts

Species Hearing Capacity

Figure E-1 shows the amplitude-frequency masking profiles of highway noise adjusted to accommodate the amplitude profiles of an average songbird. Also shown in this figure is an average hearing curve of a

non-passerine bird, as well as those of an owl, a cat, and a human. These curves indicate the amplitudes at each frequency above which the species represented can theoretically (under laboratory conditions) detect an acoustic signal. Any vocal signal above this threshold and above the traffic noise masking threshold at each survey distance can be detected by the subject species. If the vocal signal falls below the hearing curve, it cannot be heard by that species. If it is above the hearing curve, but below the masking threshold line of the highway noise, it cannot be detected due to masking. For example, a 30 dB 200 Hz signal (Point A) could not be heard by a non-passerine bird because it is below the hearing curve (Figure E-1). A 30 dB 1 kHz signal (Point B) could be detected by the non-passerine bird because it is above this curve, but would be masked by highway noise at distances closer than 1,219 m (4,000 ft). Finally, a 75 dB 1425 Hz signal (Point C) could be heard by the non-passerine bird at distances closer than 38.1m (125 ft) and would be minimally affected by highway noise.

The differences in the shape and locations of the hearing curves reflect differences in the hearing capabilities of each species. The lower the curve on the graph, the more sensitive the species is to hearing low-amplitude sounds. The owl, for example, can hear the lowest sounds, with a peak sensitivity at 4,000 Hz. The cat is comparable in its hearing capabilities; this correlation is likely associated with the two species' similar prey detection requirements and capabilities. The non-passerine bird (e.g., a kestrel) does not have as acute hearing requirements, but is notably better able to hear lower sounds than the bird represented by the generalized top curve.

It is important to note that with regard to masking effects of the highway noise, the amplitudes of the vocal signals described above are those that the receiver hears, not those emitted by the individual giving the call. All sounds, including vocal signals, attenuate with distance. Therefore, as the distance between communicating individuals increases, the amplitude of the sound received by the listener decreases and the relative potential for highway noise to mask the signal increases. The importance of this relationship is that individuals communicating at distances sufficiently close to maintain amplitudes of the received signals above the masking thresholds can communicate effectively; however, if the same individuals move apart, vocalizations could attenuate to levels below the masking threshold, and the highway noise could impede communication. This spatial relationship is further complicated by the positions of the birds relative to the highway. If they are parallel to the highway, the attenuation of their vocal signals will follow the inverse square law for attenuation, with the highway noise remaining essentially constant. However, if the birds are aligned perpendicularly to the highway, both the vocal signals and the highway noise attenuate simultaneously over the distance between the birds, if the caller is closer to the highway. If the caller is the individual farther from the highway, the vocal signal attenuates over the distance to the receiver, but the masking threshold is higher at the receiver's location than at the caller's.

The spatial relationship is particularly important in evaluating the potential for masking of territorial defense or mate attraction vocalizations given by territorial species. Depending on the proximity of the territories to the highway, the singers may or may not be able to communicate over distances typically required for territorial maintenance. These distances may be determined by factors other than communication constraints, notably the area required to provide sufficient food and shelter resources for the female and nestlings. If highway noise precludes communication over these requisite distances, the males may not be able to effectively attract mates and/or successfully reproduce in the area. Additionally, the distances over which soft calls can be effective between adults and between adults and young may be constrained by proximity to the highway; such constraints may lead to miscommunication or missed communication, with resultant failed behaviors (e.g., failure to adequately feed nestlings, failure to warn nestlings of a predator nearby).

Species Acoustic Profiles

Figures E-5, E-6, and E-7 show the vocal signal profiles of American Bittern, Black-necked Stilt, and Brewer's Sparrow, respectively, and the traffic noise masking threshold spectrum. These charts show the peak frequencies (maximum amplitude) of each species' vocal signals relative to the masking potential of the highway noise at different distances from the highway. Also included are vocal signals of the same species as they would be heard by a conspecific at 15.2, 30.5, and 45.7 m (50, 100, and 150 ft) (the yellow, blue, and green lines). Note that the peak frequency (highest point on the signal profile) for the American Bittern is approximately 200 Hz, with a secondary peak of lower amplitude at approximately 1,000 Hz. The peak frequencies of both Black-necked Stilt and Brewer's Sparrow are approximately 4,000 Hz. When one compares the signal profiles of each bird with the traffic noise masking thresholds it is possible to determine the relative potential that the signals will be masked at different distances from the highway, as well as the maximum distances at which individuals can communicate at different distances from the highway without their signals being masked.

One important aspect of comparing vocal signals of different species is the inherent variation and complexity in the signals in each species' repertoire. Figure E-8 shows the sonograms of the three species being analyzed in this technical report. While the structure of the calls of American Bittern and Black-necked Stilt are relatively simple, that of the Brewer's Sparrow song is highly complex, with multiple signals of varying frequency and amplitude. Figure E-9 shows the power spectrum of a typical Brewer's Sparrow song. Note the variation in amplitude between element groups. This variation is an important determinant of the transmission capacity of the song as a whole and the potential for highway noise masking part or all of the song (see below). The limiting factor in both processes is the relative amplitude of the individual elements. The complete song will be successfully transmitted and received only if the intensity of the softest element is sufficient to reach the receiver and be recognized above background noise.

Vocal Signal Masking

Two important highway noise characteristics should be noted. First, the potential for masking is highest at the lower frequencies (50–225 Hz). Second, the masking effect is less at higher frequencies for all distances from the highway due to differential attenuation of sound (traffic noise) with distance. By comparing the positions of the three species' vocal signal profiles, it becomes evident that the American Bittern profile, which has the lowest peak frequency, is most aligned with the area of highest masking potential from highway noise (50–225 Hz). The Black-necked Stilt and Brewer's Sparrow profiles are shifted much farther to the right, where the masking potential is reduced at the higher frequencies. What these differences mean is that because low-frequency sound (traffic noise) travels farther without significant attenuation, the potential for highway noise to mask bittern calls will extend to a greater distance from the highway than will the potential to mask either the Black-necked Stilt of Brewer's Sparrow calls. Inversely, Black-necked Stilts and Brewer's Sparrows can effectively communicate closer to the highway than can bitterns, given the same level of traffic noise.

When one examines the sets of three parallel signal profile curves for each species and compares their position relative to the masking profile lines, it becomes evident that as individuals move apart, the amplitude of their signals attenuates proportionally to the distance between them. The greater the distance, the softer the signal will be at the receiver. Accordingly, if the birds move apart parallel to the highway, the traffic noise level will remain constant, but because the vocal signal attenuates with the distance between the birds, the masking effect will increase. For example, the Black-necked Stilt signal, represented by the secondary peak at 1,250 Hz, could be heard at 152.4 m (500 ft) from the highway

when the birds are 15.2 m (50 ft) apart, but would be masked by traffic noise if the birds were to move 30.5 m (100 ft) apart.

This differential masking effect with communication distance is perhaps more clearly illustrated in Figures E-10 and E-11, which show the natural attenuation of vocal signals for each species and the distances the birds can move apart at different distances from the highway before traffic noise will mask their signals. In Figure E-10, the differences in the heights of the attenuation lines of the Black-necked Stilt and the Brewer's Sparrow is a function of the source amplitude of the signals: Black-necked Stilt calls are louder than Brewer's Sparrow vocal signals (elements in a song). The lower Brewer's Sparrow line indicates the attenuation of the softer element in the song (see discussion below). This figure shows that due to the strength of the Black-necked Stilt call, individuals can communicate effectively at inter-individual distances of 76.2 m (250 ft) or more without masking from traffic noise. Brewer's Sparrows, however, would be restricted to communication distances of 15.2 m (50 ft) when both are 15.2 m (50 ft) feet from the highway, 45.7 m (150 ft) at 38.1 m (125 ft) from the highway, and 76.2 m (250 ft) feet at 76.2 m (250 ft) feet from the highway

These results illustrate several important aspects of the species-specific nature of traffic noise impacts, which can only be properly interpreted relative to the biology of each species. Black-necked Stilts are very gregarious, with nonbreeding inter-individual distances typically averaging only 0.03 m (0.1 ft) and breeding distances averaging 0.5 m (1.6 ft). The amplitude of their call (99 dB) is easily high enough to offset interference from highway noise (75 dB) at these distances, and even to allow inter-individual communication with other individuals that are 76 m (250 ft) or more away (Figure E-10). This longer-range communication may be critical for individuals to warn other birds of predators and/or to solicit a mobbing response from others when a nest is being preyed upon (Robinson et al.1999). Because of this vocal pattern, Black-necked Stilts are not likely to be affected by traffic noise from the Legacy Parkway project.

By comparison, Brewer's Sparrows maintain territories with center-to-center distances ranging between 35.4 m and 178.6 m (116 ft and 586 ft) (calculated from territory size data in Rottenberry et al. 1999). Figure E-10 (top curve) shows that in order to communicate at these distances using the loudest song elements (86 dB), the territories would need to be approximately 30.5–152.4 m (100–500 ft) from the highway, respectively, to avoid masking. For complete transmission of the song, including the softest notes (66 dB at the source) (Figure E-10 bottom curve), the territories would need to be approximately 300–610 m (1,000–2,000 ft) from the highway. These distances define the noise impact zone for this species.

Finally, Figure E-11 shows the same masking potential relationship for American Bittern. As described above, because of the lower dominant frequency (200 Hz) in this species' principal vocal signal and the predominant low-frequency characteristics of the highway noise, the traffic noise masking effects are greater despite a high source amplitude (104 dB). However, this species requires this high intensity, low frequency sound to communicate effectively through the dense vegetation of its emergent marsh habitat. No information is available on territorial behavior or spacing of nests in American Bitterns (Gibbs et al. 1992), but males within range of about 500 meters (0.31 mi) are known to respond to each other's calls. Figure E-11 shows that in order to communicate effectively at this distance without masking from traffic noise, the birds would have to be more than 4,800 m (16,000 ft or 3.03 mi) from the highway. For this species, this distance defines the potential noise impact zone within the project study area.

One aspect of these distance predictions not included in the calculations is the effect of the sound of wind on the hearing capacity and communicating ability of these species. Wind and air turbulence can affect communication in two ways: disruption of signals and creation of additional noise. Wind blowing over

irregular surfaces can generate local vortices in the air within which the speed of sound and the density of the air differ from the surrounding medium (Bradbury and Vehrencamp 1998). These vortices can scatter sound—acoustic signals from birds as well as highway noise. Such disruptive turbulence is more likely to be found in open areas where the sun can heat the ground to create thermal currents and/or where strong winds blow over irregular surfaces such as rocks and clumps of vegetation. The presence of wind turbulence can significantly increase the rate of signal attenuation over distance (Wiley and Richards 1982). Without wind, sound naturally attenuates at approximately 1-12 db/100m (328 ft) for frequencies of 1–10 kHz. With wind and turbulence attenuation, rates can increase from two to several hundred dB/100 m (328 ft). Such conditions can result in significant reduction in the distances sound, including highway noise, can be heard. Gibbs and Melvin (1993) noted that calling activity in American Bitterns in response to playback surveys was dampened by winds > 5 kmh (3.1 mph). This is likely due to a reduced ability of the birds to hear the signals, to which, under quiet conditions, they can respond at 500 m (1,640 ft or 0.31 mi.) Similarly, the transmission distance (masking effect) of highway noise is likely to be reduced by wind-generated air turbulence in direct proportion to wind velocity.

Wind passing over vegetation, substrate edges, and the head and body of the receiver also creates background noise that can potentially mask some vocal signals (Bradbury and Vehrencamp 1998). Regardless of habitat, the wind-generated noise is greatest at low frequencies. Wind contributes little to background noise at frequencies above 2 kHz. Typical levels for frequencies under 100 Hz range from 20–30 dB (SPL) for winds about 1 m/sec (2.2 mph) to 60–70 dB (SPL) for winds of 8 m/sec (18 mph). Figure E-4 shows the daily wind pattern in the proposed project study area (min. 1.1 m/sec [2.5 mph]; max. 10.7 m/sec [24 mph]). This observation indicates that even low-level winds could have a masking effect on communication in American Bitterns.

Using a moderately high wind noise level (52 dB[A]), Figure E-12 shows the relationship between wind-generated noise and highway noise with distance from the highway. Close to the highway, the highway noise exceeds wind noise. With increasing distance from the highway, the highway noise attenuates but the wind noise stays relatively constant. Fundamental principals of acoustics indicate that two noise sources will not influence each other if they are more than 10 dB apart; that is, if the two noise sources are more than 10 dB apart, the louder noise will predominate. When the noise sources are within 10 dB, the lower noise levels begin to influence the overall noise effect (i.e., combined noise level). When the two sources are equal (at the intersection of the highway noise and wind noise lines in Figure E-12), the combined sound level is 3 dB higher than each source. Figure E-12 illustrates that highway noise is not affected by wind noise until the highway noise attenuates to approximately 62 dB (10 dB above the wind noise). This occurs at approximately 152 m (500 ft or 0.09 mi) from the highway. The noise levels are equal at about 580 m (1,900 ft or 0.36 mi) from the highway. The highway noise attenuates to 42 dB (10 dB below the wind noise) at approximately 4,877 m (16,000 ft or 3.03 mi) from the highway, where it effectively no longer contributes to the overall background noise level. This chart shows that wind noise at 52 dB it will contribute to the combined noise effect within this range (152 – 4877 m [500–16,000 ft or 0.09–3.03 mi]). While the combined noise remains higher than the wind noise across this distance, it is evident that the highway noise becomes proportionally less important from 580 m (1,900 ft or 0.36 mi) outward. By the same analysis, wind noise of approximately 30 dB would not effectively contribute to road noise nearer than 5,486 m (18,000 ft or 3.4 mi) from the highway.

While it is not possible to determine precisely where wind noise would effectively become the primary masking source in the environment for birds, humans can detect 3-dB differences between noise levels and can clearly discern 5-dB differences. In this context, the road noise attenuates to 3 dB below the wind noise (52 dB in Figure E-12) at approximately 914 m (3,000 ft or 0.57 mi) from the highway; it attenuates to 5 dB below the wind noise at approximately 1,524 m (5,000 ft or 0.95 mi). For wind noise at 45 dB, these distances would increase to approximately 4,877 and 5,486 m (16,000 and 18,000 ft or 3.03 and 3.4

mi), respectively. This analysis shows that moderate to high wind velocities can potentially produce sufficient noise (52 db and above) to dominate the potential masking effects of road noise at 966 m (3,168 ft or 0.6 mile); this distance decreases as higher wind velocity increases. With decreasing wind velocity, the distance from the highway at which wind noise would dominate road noise increases rapidly, effectively becoming inconsequential for wind speeds that would generate noise levels of 40 dB or less (approximately 19 k/hr [12 mph]).

Figure E-4 shows that for the period of measurement in the vicinity of the project study area, wind noise can exceed 52 db, but for a large part of the day does not. This pattern indicates that wind-generated noise would only potentially dominate road noise during the night and short periods during the day. For effective communication during windy conditions, birds must either communicate more loudly, move closer to their intended receivers, or avoid calling except during lulls in wind or during periods of the day when the wind is minimal. Gibbs et al. (1992) indicate that American Bitterns reduce their calling frequency during high winds.

Predator/Prey Detection

The ability to detect and locate sounds of prey is critical to the survival of many predatory birds and mammals. Barn Owls are the quintessential acoustic predators in the project study area; cats have comparable auditory sensitivity. Figure E-1 shows both species' exceptional hearing capacity. Owls tested with pure tones and artificial noise can optimally localize frequencies between 5 and 9 kHz (Konishi 1993; Volman 1994; Wagner 1995); they can locate broad-band signals more easily than narrow-band signals. This hearing optimization is consistent with the general broad-band vocalizations of many mice (fundamental frequency approximately 2.5 kHz with harmonics to 8 kHz) and the sounds from rustling leaves caused by the mice (broad-band noise 1–9 kHz [Swanson and Sanderson 1999]). Figure E-1 shows that under very quiet conditions, road noise could potentially interfere with the ability of the owls to detect low-amplitude (4–8 kHz) prey sounds out to 4,000 feet. However, natural background noise, (moving vegetation, wind), can reach up to 70 dB (SPL) for winds 8 m/sec (18 mph); such conditions would require owls to move much closer to the prey to hear it. The inherent ability of owls to hunt close to the ground allows them to behaviorally reduce the masking threshold and effective acoustic impact area of the highway noise (see discussion below). Similarly, cats, by virtue of their mobility and stealth, would be able to approach relatively close to potential prey, minimizing the long-range masking effects of highway noise.

E.5 Discussion

The results of this acoustics study indicate that the potential effects distances for noise masking of wildlife communication within the project study area are potentially greater than those determined from the bird demographic studies described in the *Introduction*. For grassland birds, declines in species diversity and abundance have been documented out to 3,500 m (11,581 ft or 2.17 mi) from highways with traffic volumes of 50,000 vehicles per day (Reijnen et al. 1995; Reijnen et al. 1996). Figure E-11 illustrates that highway noise (with traffic volumes of 72,000 vehicles per day for the Legacy Parkway project) could potentially affect American Bittern communications at 4,877 m (16,000 ft or 3.03 mi) and beyond. However, wind and heat-generated turbulence in the open fields of the project study area are likely to reduce this distance, at least during some periods of the day.

The results of this study also indicate that the effects distances are species-specific and therefore highly variable. The communication requirements of American Bitterns differ significantly from those of Black-

necked Stilts and Brewer's Sparrows. Presumably, each species responds differently to traffic noise, seeking areas away from the highway at distances that are optimal for communication. By physically avoiding areas where masking can occur, each species behaviorally adapts to the existing noise environment. Ongoing research in avian bioacoustics has shown that there are a variety of adaptations by which species can reduce the masking threshold, and hence the distance from the highway at which they can communicate. Some of these adaptations are discussed in the following paragraphs.

The source amplitude of the signal is not the only determinant of effective communication distance. Characteristics of the receiver's signal detection capabilities, including temporal summation, amplitude co-modulation, and directional hearing sensitivity, can potentially reduce the effects of masking and increase the effective distance at which birds can detect signals in background noise.

Temporal summation is an acoustic response in the listener wherein the detectability of signals in noise improves with increasing signal duration (Dooling 1979; Dooling and Searcy 1985; Klump and Maier 1990; Klump 1996). In some birds this effect can result in a lowering of the detection threshold up to 3 dB per doubling of the signal duration (Klump 1996).

Amplitude co-modulation (co-modulation masking release) is an adaptive response to predictable amplitude fluctuations in the noise that allows the listener to improve the detection of signals by using correlated amplitude fluctuations in different frequency channels of the auditory system (Hall et al.1984; Schooneveldt and Moore 1987; Moore 1990, 1992). The detection of a signal added to one of the channels (e.g., a bird call) may be enhanced by a cross-spectral comparison of the time course of the signal amplitude in the different analysis channels. If, for example, highway noise shows correlated amplitude fluctuations in different frequency channels, the addition of a signal (e.g., a bird call) will reduce the correlation between the amplitude fluctuations in the different channels, which is then detected by the listener. Alternatively, a low-amplitude noise level in one frequency channel could predict a good time for the listener to detect vocal signals embedded in the noise in other frequency channels. Furthermore, amplitude constancy in a signal, sharp frequency modulations, or redundant predictable signal patterns that contrast against the regular amplitude fluctuations of the background noise offer additional acoustic opportunities for enhanced signal detection in noise (Fastl 1993; Klump 1996). The amount of masking release under these conditions may be as great as 15 dB (Richards and Wiley 1980; Schooneveldt and Moore 1987; Klump and Langemann 1995; Klump 1996).

Finally, signals of interest to wildlife and highway noise often originate from different locations. Most wildlife species can therefore make use of innate *directional hearing sensitivity* to improve their detection of important signals in noise. This spatial release from masking is frequency dependent, with maximum threshold detection changes of up to 12 dB at optimal sensitivity frequencies for some birds (Klump and Larsen 1992; Klump 1996). Use of any or all of the masking release mechanisms described here can potentially allow wildlife species to detect signals in background noise at much greater distances than those predicted by simple critical ratio detectability determinations.

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Table E-1. GSLE Bird Vocalization Frequency Data

Species	Vocalization Frequency Data (kHz)				Frequency Range (kHz units)										Reference
	Low	High	Range	Median	1	2	3	4	5	6	7	8	9	10	
Belted Kingfisher	0.1	8.5	8.4	4.3											Hamas 1994
Trumpeter Swan	0.1	6	5.9	3.05											Mitchell 1994
Black Tern	0.1	6	5.9	3.05											Dunn and Agro 1995
Sandhill Crane	0.2	6	5.8	3.1											Tacha, Nesbitt, and Vohs 1992
Short-eared Owl	0.2	8	7.8	4.1											Holt and Leasure 1993
Mourning Dove	0.2	0.3	0.1	0.25											Mirarchi and Baskett 1994
Double-crested Cormorant	0.2	1.2	1	0.7											Hatch and Weseloh 1999
Great Horned Owl	0.25	0.39	0.14	0.32											Houston, Smith, and Rohner 1998
Brown-headed Cowbird	0.3	12	11.7	6.15											Lowther 1993
Long-eared Owl	0.3	10	9.7	5.15											Marks, Evans, and Holt 1994
Pectoral Sandpiper	0.3	5	4.7	2.65											Holmes and Pitelka 1998
Hooded Merganser	0.4	1.25	0.85	0.825											Dugger, Dugger, and Fredrickson 1994
White-faced Ibis	0.4	5	4.6	2.7											Ryder and Manry 1994
Greater White-fronted Goose	0.4	5	4.6	2.7											Ely and Dzubin 1994
Black-crowned Night-heron	0.5	6	5.5	3.25											Gauthier 1993
Wilson's Phalarope	0.5	3.6	3.1	2.05											Colwell and Jehl, Jr. 1994
Herring Gull	0.5	7	6.5	3.75											Pierotti and Good 1994
Northern Flicker	0.5	8	7.5	4.25											Moore 1995
Gray Catbird	0.5	10	9.5	5.25											Cimprich and Moore 1995
Virginia Rail	0.5	4.5	4	2.5											Conway 1995
Black-bellied Plover	0.5	1	0.5	0.75											Paulson 1995
Green-winged Teal	0.5	7.5	7	4											Johnson 1995
Northern Harrier	0.5	6.2	5.7	3.35											MacWhirter and Bildstein 1996
American Wigeon	0.5	3.8	3.3	2.15											Mowbray 1999
Pied-billed Grebe	0.5	5	4.5	2.75											Muller and Storer 1999
Black-necked Stilt	0.5	6	5.5	3.25											Robinson, Reed, Skorupa, and Oring 1999
California Quail	0.5	6	5.5	3.25											Calkins, Hagelin, and Lott 1999
Snow Goose	0.5	7	6.5	3.75											Mowbray, Cooke, and Ganter 2000
Forster's Tern	0.5	7.5	7	4											McNicholl, Lowther, and Hall 2001
Wood Duck	0.7	9	8.3	4.85											Hepp and Bellrose 1995
Green-tailed Towhee	0.7	8.2	7.5	4.45											Dobbs, Martin, and Martin 1998
Ring-billed Gull	0.75	7	6.25	3.875											Ryder 1993
Burrowing Owl	0.8	7.5	6.7	4.15											Haug, Millsap, and Martell 1993
Red-winged Blackbird	0.8	5.8	5	3.3											Yasukawa and Searcy 1995
Spotted Sandpiper	0.8	4	3.2	2.4											Oring, Gray, and Reed 1997
Lesser Goldfinch	0.8	5.5	4.7	3.15											Watt and Willoughby 1999
Red-necked Phalarope	0.8	5	4.2	2.9											Rubega, Schamel, and Tracy 2000
Barn Owl	1	2	1	1.5											Mari 1992
Tree Swallow	1	7	6	4											Robertson, Stutchbury and Cohen 1992
House Sparrow	1	8	7	4.5											Lowther and Cink 1992
American Bittern	1	3	2	2											Gibbs, Melvin, and Reid 1992
Great Blue Heron	1	2.5	1.5	1.75											Butler 1992
Western Grebe	1	3.5	2.5	2.25											Storer and Nuechterlein 1992
Clark's Grebe	1	3.5	2.5	2.25											Storer and Nuechterlein 1992
Glaucous-winged Gull	1	4	3	2.5											Verbeek 1993
Tundra Swan	1	8	7	4.5											Limpert and Earnst 1994
Western Sandpiper	1	5.8	4.8	3.4											Wilson 1994
Ruby-crowned Kinglet	1	10	9	5.5											Ingold and Wallace 1994
Green Heron	1	5.5	4.5	3.25											Davis, Jr and Kushlan 1994
Dunlin	1	3	2	2											Warnock and Gill 1996
Whimbrel	1	9	8	5											Skeel and Mallory 1996
Loggerhead Shrike	1	9	8	5											Yosef 1996
Gadwall	1	5	4	3											LeShack, McKnight, and Hepp 1997
Purple Martin	1	4.2	3.2	2.6											Brown 1997
Stilt Sandpiper	1	5	4	3											Reed, Ward, Derksen, and Sedinger 1998
Eared grebe	1	4	3	2.5											Cullen, Jehl Jr., and Nuechterlein 1999
Parasitic Jaeger	1	7	6	4											Wiley and Lee 1999
Barn Swallow	1	14	13	7.5											Brown and Brown 1999
Lark Bunting	1	6	5	3.5											Shane 2000
Mountain Chickadee	1	10	9	5.5											McCallum, Grundel, and Dahlsten 1999
Red-breasted Nuthatch	1	9	8	5											Ghalambor and Martin 1999
Sage Thrasher	1	7	6	4											Reynolds, Rick, and Stephens 1999
Common Raven	1	4	3	2.5											Boarman and Heinrich 1999
Snowy Egret	1	4	3	2.5											Parsons and Master 2000
Marbled Godwit	1	8	7	4.5											Gratto-Trevor 2000
Long-billed Dowitcher	1	9	8	5											Takekawa and Warnock 2000
Black-chinned Hummingbird	1	9	8	5											Baltosser and Russell 2000
Horned Grebe	1	3.8	2.8	2.4											Stedman 2000

Species	Vocalization Frequency Data (kHz)				Frequency Range (kHz units)										Reference
	Low	High	Range	Median	1	2	3	4	5	6	7	8	9	10	
Short-billed Dowitcher	1	6	5	3.5											Jehl Jr., Klima, and Harris 2001
Ring-necked Pheasant	1	6	5	3.5											Giudice and Ratti 2001
American Golden-plover	1	4	3	2.5											Johnson and Connors 1996
Cliff Swallow	1.1	7	5.9	4.05											Brown and Brown 1995
Greater Yellowlegs	1.2	6	4.8	3.6											Elphick and Tibbitts 1998
Northern Mockingbird	1.5	8	6.5	4.75											Derrickson and Breitwisch 1992
White-throated Sparrow	1.5	6.6	5.1	4.05											Falls and Kopachena 1994
Black-headed Grosbeak	1.5	12	10.5	6.75											Hill 1995
Lincoln's Sparrow	1.5	7.3	5.8	4.4											Ammon 1995
Common Nighthawk	1.5	4	2.5	2.75											Poulin, Grindal, and Brigham 1996
House Wren	1.5	9	7.5	5.25											Johnson 1998
Semipalmated Plover	1.5	3.4	1.9	2.45											Nol and Blanken 1999
Common Yellowthroat	1.5	6.5	5	4											Guzy and Ritchison 1999
Killdeer	1.5	7	5.5	4.25											Jackson and Jackson 2000
American Pipit	1.6	5.5	3.9	3.55											Verbeek and Hendricks 1994
Mountain Bluebird	1.6	4	2.4	2.8											Power and Lombardo 1996
Western Meadowlark	1.7	4.8	3.1	3.25											Lanyon 1994
Snowy Plover	1.7	6.5	4.8	4.1											Page, Warriner, Warriner, and Paton 1995
Ross' Goose	1.7	4.4	2.7	3.05											Ryder and Alisauskas 1995
House Finch	1.8	6	4.2	3.9											Hill 1993
Cooper's Hawk	1.8	7.5	5.7	4.65											Rosenfield and Bielefeldt 1993
Yellow-headed Blackbird	1.8	8	6.2	4.9											Twedt and Crawford 1995
Western Kingbird	1.8	8	6.2	4.9											Gamble and Bergin 1996
American Avocet	1.8	6.5	4.7	4.15											Robinson, Oring, Skorupa, and Boettcher 1997
Swamp Sparrow	1.8	8	6.2	4.9											Mowbray 1997
Chestnut-collared Longspur	1.8	6.5	4.7	4.15											Hill and Gould 1997
Plumbeous Vireo	1.8	7.5	5.7	4.65											Curson and Goguen 1998
Black-billed Magpie	1.8	8	6.2	4.9											Trost 1999
Willet	1.9	3	1.1	2.45											Lowther, Dougls, III, and Gratto-Trevor 2001
Violet-green Swallow	2	7	5	4.5											Brown, Knott, and Damrose 1992
Blue-gray Gnatcatcher	2	10	8	6											Ellison 1992
European Starling	2	9	7	5.5											Cabe 1993
Red-tailed Hawk	2	6	4	4											Preston and Beane 1993
Harris' Sparrow	2	7	5	4.5											Norment and Shackleton 1993
American Goldfinch	2	8.2	6.2	5.1											Middleton 1993
Solitary Sandpiper	2	5.8	3.8	3.9											Moskoff 1995
Cassin's Finch	2	6	4	4											Hahn 1996
Swainson's Hawk	2	2.8	0.8	2.4											England, Bechard, and Houston 1997
Pine Siskin	2	9	7	5.5											Dawson 1997
Say's Phoebe	2	3.8	1.8	2.9											Schukman and Wolf 1998
Lesser Yellowlegs	2	8	6	5											Tibbitts and Moskoff 1999
Western Wood-Pewee	2	6.5	4.5	4.25											Bemis and Rising 1999
American Robin	2	4	2	3											Sallabanks and James 1999
Rock Wren	2	6	4	4											Lowther, Kroodsma, and Farley 2000
Lark Sparrow	2	7	5	4.5											Martin and Parrish 2000
Olive-sided Flycatcher	2	4.1	2.1	3.05											Altman and Sallabanks 2000
Warbling Vireo	2	7	5	4.5											Gardali and Ballard 2000
Ferruginous Hawk	2.2	3	0.8	2.6											Bechard and Schmutz 1995
Marsh Wren	2.3	9.4	7.1	5.85											Kroodsma and Verner 1997
Broad-tailed Hummingbird	2.5	7.5	5	5											Calder and Calder 1992
Black-capped Chickadee	2.5	10.2	7.7	6.35											Smith 1993
Least Sandpiper	2.5	3.9	1.4	3.2											Cooper 1994
Evening Grosbeak 599	2.5	5.1	2.6	3.8											Gillahan and Byers 2001
Northern Waterthrush	2.8	7	4.2	4.9											Eaton 1995
Horned Lark	2.8	6	3.2	4.4											Beason 1995
Bank Swallow	2.8	7.5	4.7	5.15											Garrison 1999
MacGillvray's Warbler	3	8.2	5.2	5.6											Pitocchelli 1995
White-crowned Sparrow	3	6	3	4.5											Chilton, Baker, Barrentine, and Cunningham 1995
Lazuli Bunting	3	10	7	6.5											Greene, Muehter, and Davison 1996
Northern Rough-winged Swallow	3	6	3	4.5											DeJong 1996
Spotted Towhee	3	8	5	5.5											Greenlaw 1996
American Redstart	3	8	5	5.5											Sherry and Holmes 1997
Brewer's Sparrow	3	6.5	3.5	4.75											Rotenberry, Patten, and Preston 1999
Common Redpoll	3	12	9	7.5											Knox and Lowther 2000
Yellow Warbler	3	7	4	5											Lowther, Celada, Klein, Rimmer, and Spector 1999
Virginia's Warbler	3	7	4	5											Olson and Martin 1999
Sharp-shinned Hawk	3	12	9	7.5											Bildstein and Meyer 2000
Red Knot	3	6	3	4.5											Harrington 2001
American Tree Sparrow	3.2	7.2	4	5.2											Naugler 1993

Species	Vocalization Frequency Data (kHz)				Frequency Range (kHz units)										Reference
	Low	High	Range	Median	1	2	3	4	5	6	7	8	9	10	
Yellow-rumped Warbler	3.2	5.8	2.6	4.5											Hunt and Flaspohler 1998
Chipping Sparrow	3.5	8.1	4.6	5.8											Middleton 1998
Merlin	3.6	4.3	0.7	3.95											Sodhi, Oliphant, James, and Warkentin 1993
Savannah Sparrow	3.7	10	6.3	6.85											Wheelwright and Rising 1993
Nashville Warbler	3.7	10.5	6.8	7.1											Williams 1996
Townsend's Warbler	3.7	8	4.3	5.85											Wright, Hayward, Matsouka, and Hayward 1998
Cedar Waxwing	3.8	8.5	4.7	6.15											Witmer, Mountjoy, and Elliot 1997
Wilson's Warbler	3.8	9	5.2	6.4											Ammon and Gilbert 1999
Orange-crowned Warbler	4	8.5	4.5	6.25											Sogge, Gilbert, and van Riper III 1994
Eastern Kingbird	4	8.2	4.2	6.1											Murphy 1996
Caspian Tern	4	9	5	6.5											Cuthbert and Wires 1999
Western Tanager	4	9	5	6.5											Hudon 1999
Bald Eagle	5	9.5	4.5	7.25											Buehler 2000
Barrow's Goldeneye			0	0											Eadie, Savard, and Mallory 2000

Table E-2. Sound-Masking Thresholds (10 bird average)

Frequency	63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8 K Hz
Masking Threshold	13 dB*	16 dB*	19 dB	22 dB	24 dB	26 dB	30 dB	38 dB

* Extrapolated based on 3 dB per octave slope, as suggested by Dooling 2002.

Table E-3. Short-Term Sound Level Measurements

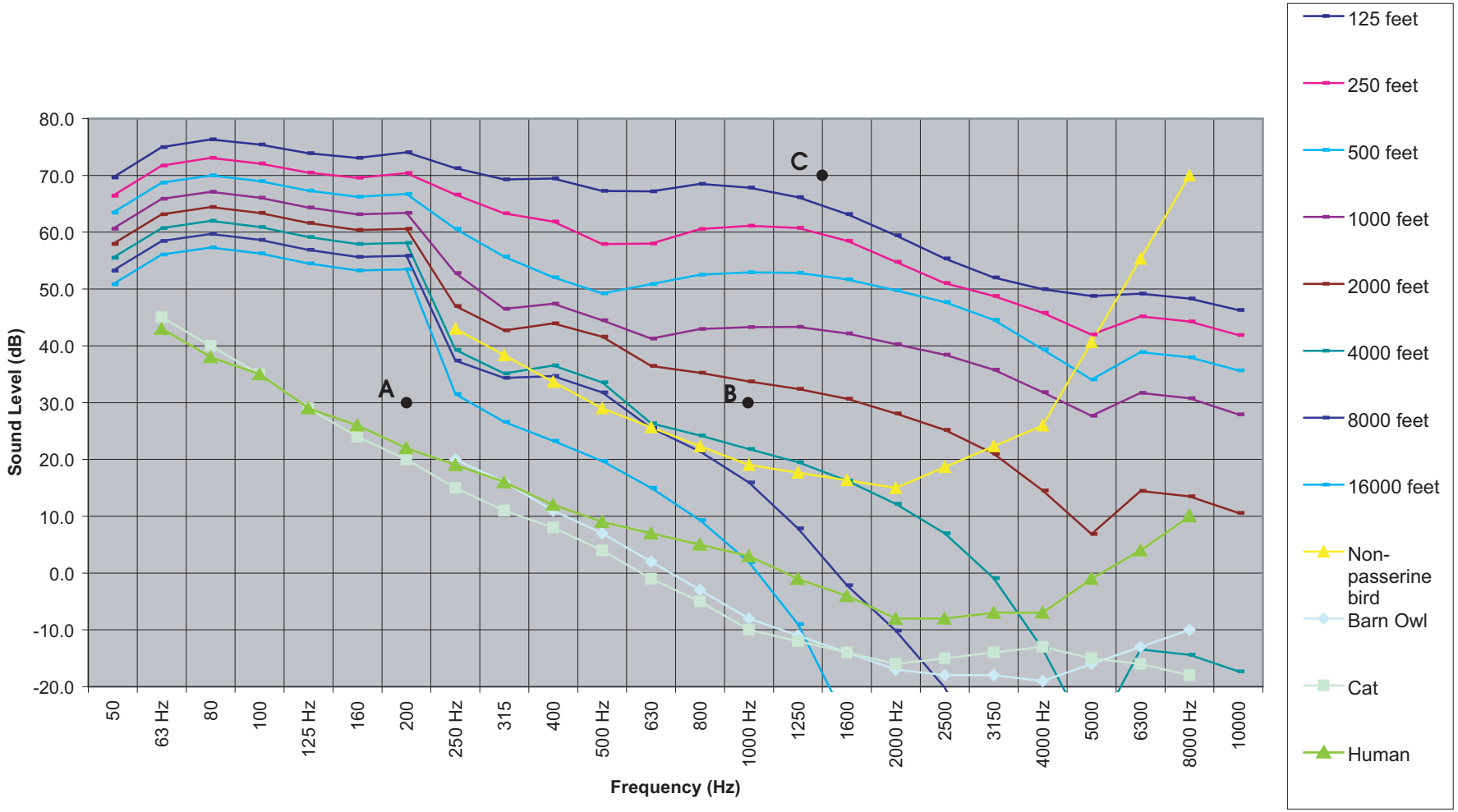
Recording Location	Date	Start Time	Duration (min)	Average Wind Speed (mph)	Leq[1]	Lmin[2]	L90[3]	L50[3]	L10[3]	Lmax[4]	Distinct Noise Sources
5	1 Jul	12:43	16:00	8.4	52.2	41.8	43.9	47.1	53.5	67.3	Vehicle passages, crickets, wind in vegetation
6	1 Jul	13:50	16:00	11.6	52.3	40.2	44.8	49.3	56.3	62.6	Aircraft, wind in vegetation
7	1 Jul	14:48	10:00	14.8	52.3	45	47.1	51.3	55.1	66.6	Wind in vegetation, no audible human sound
8	1 Jul	15:36	15:00	8.6	59.5	39.2	42.3	48	60.5	79.1	Vehicle passages, distant traffic, aircraft, wind in vegetation
9	1 Jul	18:40	18:00	11.1	48.3	32.2	39.7	44.7	52.4	60.9	Wind in vegetation, aircraft
10	1 Jul	19:20	15:00	2.7	59.9	33.2	36.2	45	62	76.5	Aircraft, birds
11	1 Jul	19:59	15:00	4.4	51.9	33.1	40.2	45.4	51.5	71.4	Aircraft, birds
12	2 Jul	7:02	19:00	2.2	43.9	32	33.7	36.1	44	61.6	Aircraft, birds
13	2 Jul	7:57	14:00	2.8	46.8	39.8	41.8	43.4	46.6	61	Aircraft, distant birds
1	2 Jul	9:36	17:00	1.2	42.6	33.4	36.5	40.6	45.8		Aircraft, birds
2	2 Jul	10:33	18:00	2.9	45.1	31.2	33.8	40.8	49.2	57.1	Aircraft, crickets
6	2 Jul	12:33	15:00	4.1	40.8	31.7	33.8	36.7	42.1	57.6	Wind in vegetation, birds, aircraft
14	2 Jul	13:29	16:00	4.5	47.2	31.8	33.7	36.6	52.3	61.2	Wind in vegetation, birds, aircraft
4	2 Jul	14:53	15:00	4.8	37.1	30.8	31.6	33.6	38.4	53.1	Distant construction activity, aircraft
				Mean	48.6	35.4	38.5	42.8	50.7	64.3	
				STDEV	6.6	4.7	5.0	5.5	6.8	7.6	
				Min	37.1	30.8	31.6	33.6	38.4	53.1	
				Max	59.9	45	47.1	51.3	62	79.1	
				Range	22.8	14.2	15.5	17.7	23.6	26.0	

[1] **Leq.** Equivalent Sound Level. The equivalent steady-state sound level that, in a stated period of time, would contain the same acoustical energy.
[2] **Lmin.** Minimum Sound Level. The minimum sound level measured during the measurement period.
[3] **Lxx.** Percentile-Exceeded Sound Level. The sound level exceeded "x" percent of a specific time period. L10 is the sound level exceeded 10 percent of the time.
[4] **Lmax.** Maximum Sound Level. The maximum sound level measured during the measurement period.

Table E-4. Mean, Standard Deviation, Minimum, and Maximum Noise Levels

SPL[1] (dBA)[2]	Leq[3]				L10[4]				L50[4]				L90[4]			
	L1	L2	L3	L1–L3	L1	L2	L3	L1–L3	L1	L2	L3	L1–L3	L1	L2	L3	L1–L3
Mean	53	45	52	50	55	48	54	51	47	41	46	45	43	36	41	40
SDEV	11	8	8	10	11	8	9	11	8	7	8	8	7	5	6	7
Minimum	41	36	40	36	42	37	41	35	37	34	36	34	36	32	35	32
Maximum	78	69	71	78	81	73	75	81	71	67	69	71	65	58	64	65

[1] SPL. Sound Pressure Level.
[2] dB(A). A-Weighted Decibel. An overall frequency-weighted sound level in decibels that approximates the frequency response of the human ear.
[3] Leq. Equivalent Sound Level. The equivalent steady-state sound level that, in a stated period of time, would contain the same acoustical energy.
[4] Lxx. Percentile-Exceeded Sound Level. The sound level exceeded “x” percent of a specific time period. L10 is the sound level exceeded 10 percent of the time.



03076.03 010 Wildlife Tech Memo

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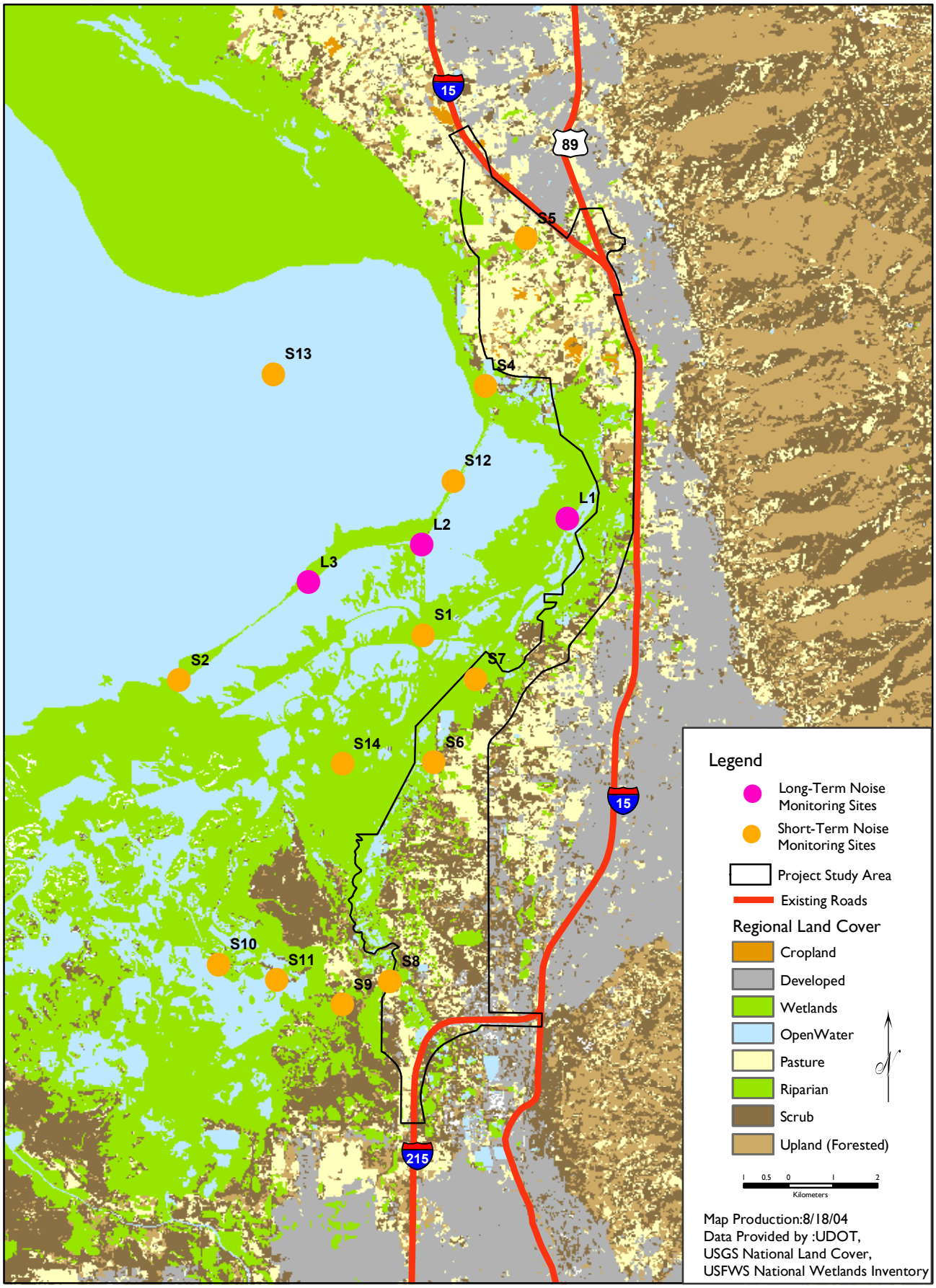
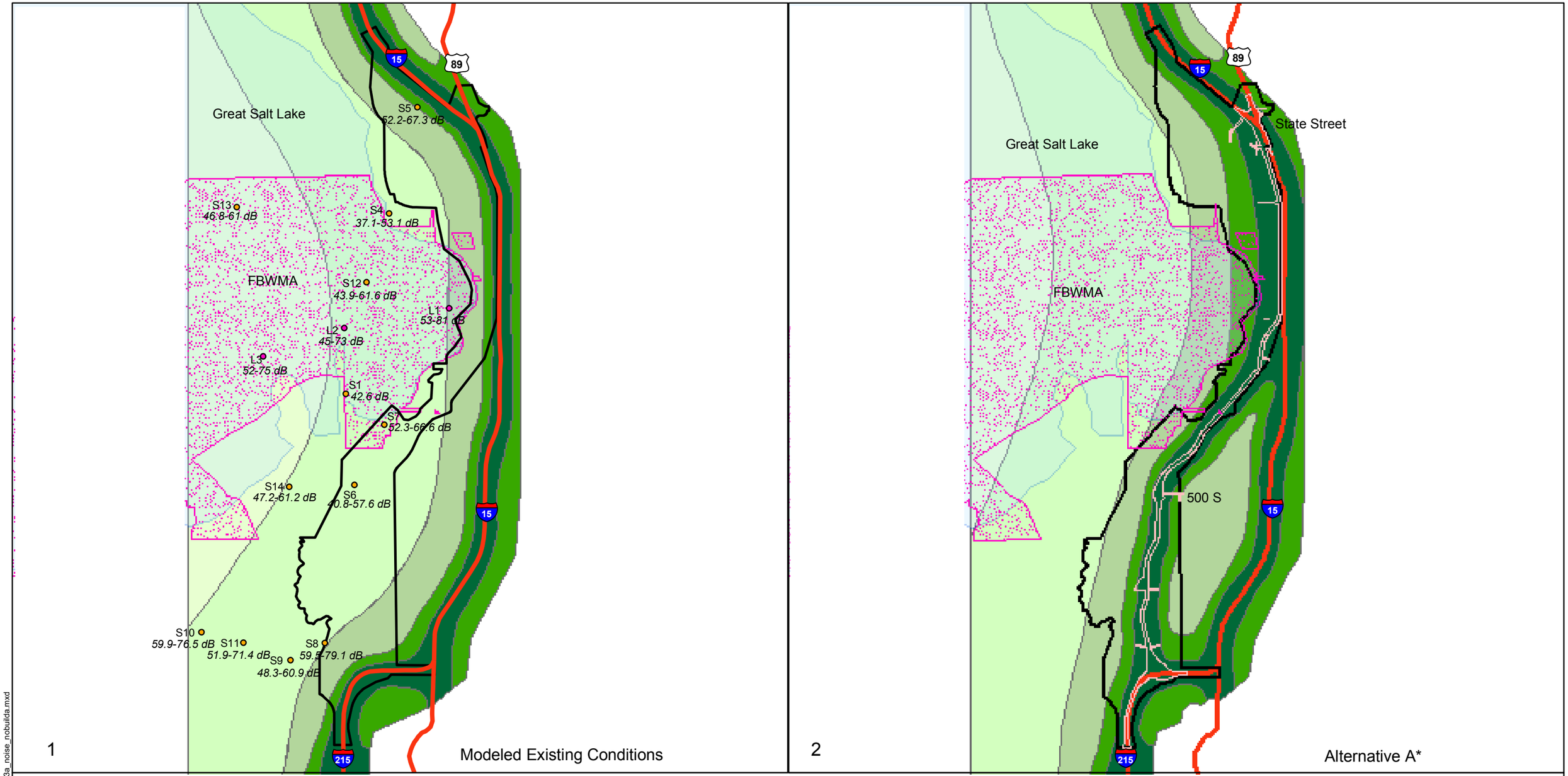
Figure E-1
Traffic Noise Masking Thresholds and Auditory Curves for Birds and Mammals



Jones & Stokes

Figure E-2
Noise Monitoring Sites in the Legacy Parkway Project Study Area



Legend

- Local Study Area Boundary
- Proposed Right of Way
- Major Existing Roads
- Great Salt Lake
- Farmington Bay Wildlife Management Area (FBWMA)

TNM Modeled Noise Levels (Decibels dBA)[1]

- <45
- > = 45 < 50
- > = 50 < 55
- > = 55 < 60
- > = 60

Monitoring Type

- Short-term Noise Measurements (Leq-Lmax): Table E-3
- Long-term Noise Measurements (Leq-Lmax); Table E-4

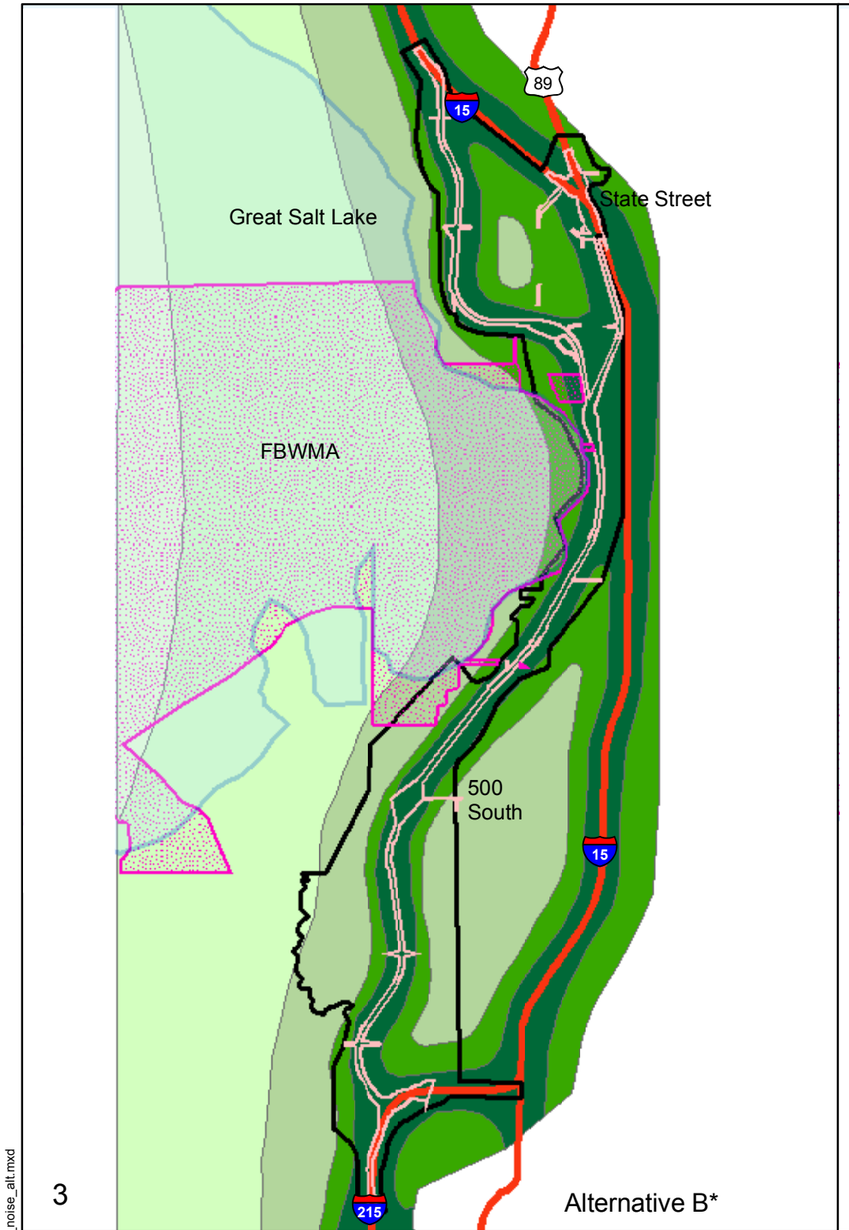
2.5 1.25 0 2.5 5
Kilometers

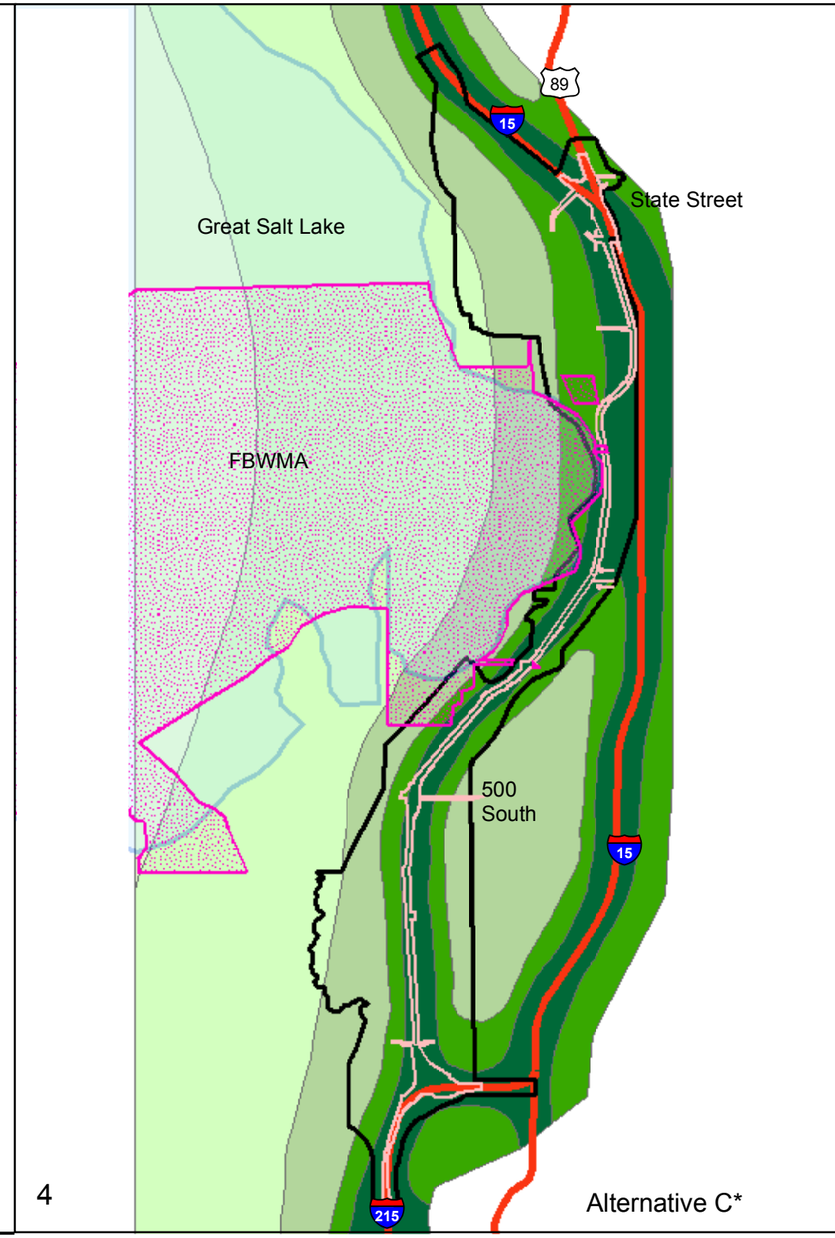
Map Production: 12/15/03
Data Sources: UDOT Project Study Area Boundary, Project Alternatives and Exsiting Roads. Contours Generated from Field Data
*Supplemental EIS 312 foot ROWs used for the Alternatives
[1] The noise level contours generated by the traffic noise model have not yet been verified beyond 305m (1000ft). The locations of contours beyond this distance are projected estimates only and could vary significantly depending on existing background noise, atmospheric conditions, and substrate type.

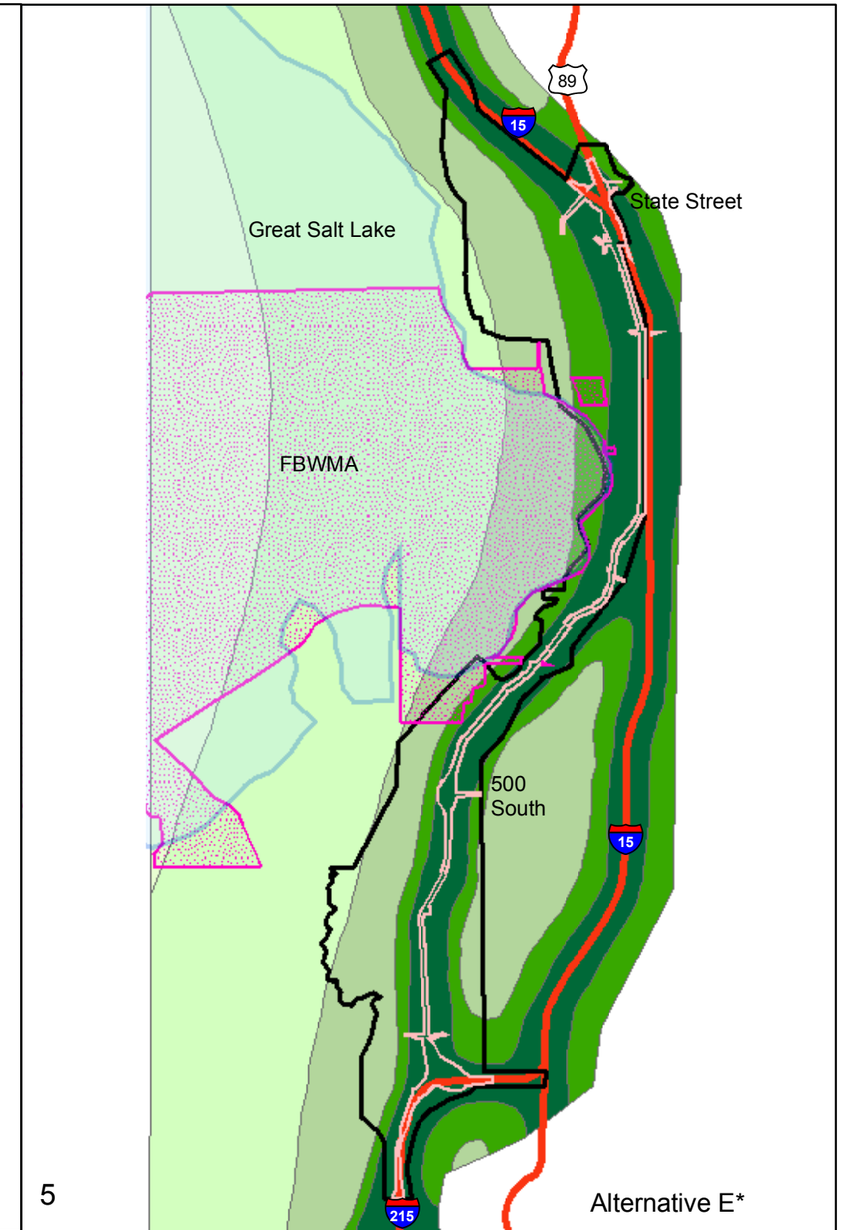
H:\GIS\Projects\udot\037076.03\arcmap\e-3a_noise_nobuilda.mxd

Jones & Stokes

Figure E-3a
Highway Noise Level for the Legacy Parkway







Legend

- Local Study Area Boundary
- Proposed Right of Way
- Major Existing Roads
- Great Salt Lake
- Farmington Bay Wildlife Management Area (FBWMA)

TNM Modelled Noise Levels (Decibels)[1]

- <45
- > = 45 < 50
- > = 50 < 55
- > = 55 < 60
- > = 60

N

2.5 1.25 0 2.5 5
Kilometers

Map Production: 12/15/03
Data Sources: UDOT Project Study Area Boundary, Project Alternatives and Exsiting Roads. Contours Generated from Field Data
*Supplemental EIS 312 foot ROWs used for the Alternatives
[1]The noise level contours generated by the traffic noise model have not yet been verified beyond 305m (1000ft). The locations of contours beyond this distance are projected estimates only and could vary significantly depending on existing background noise, atmospheric conditions, and substrate type.

H:\GIS\Projects\udot\037076.03\arcmap\e-3b_noise_alt.mxd

Jones & Stokes

Figure E-3b
Highway Noise Level for the Legacy Parkway

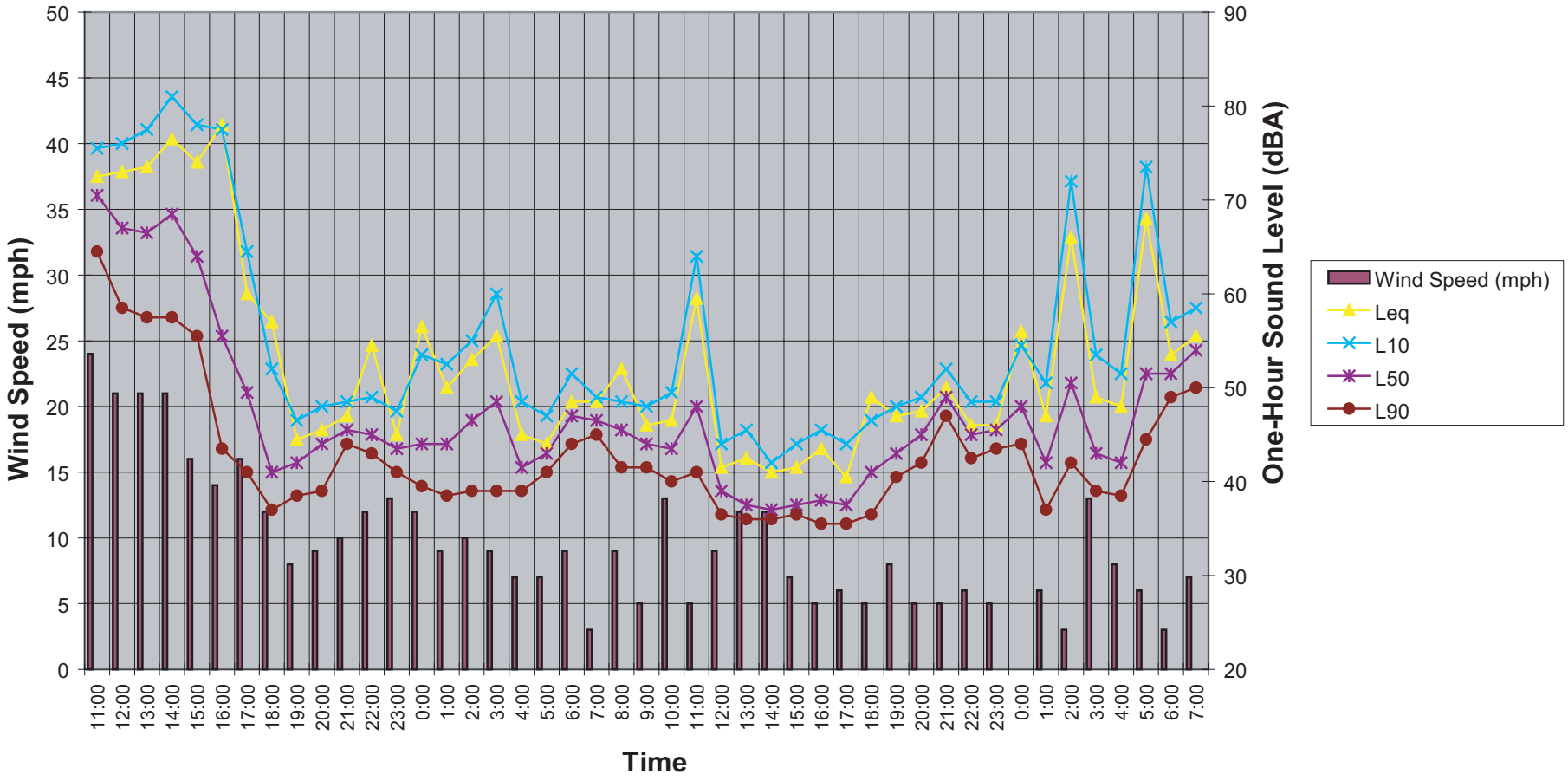


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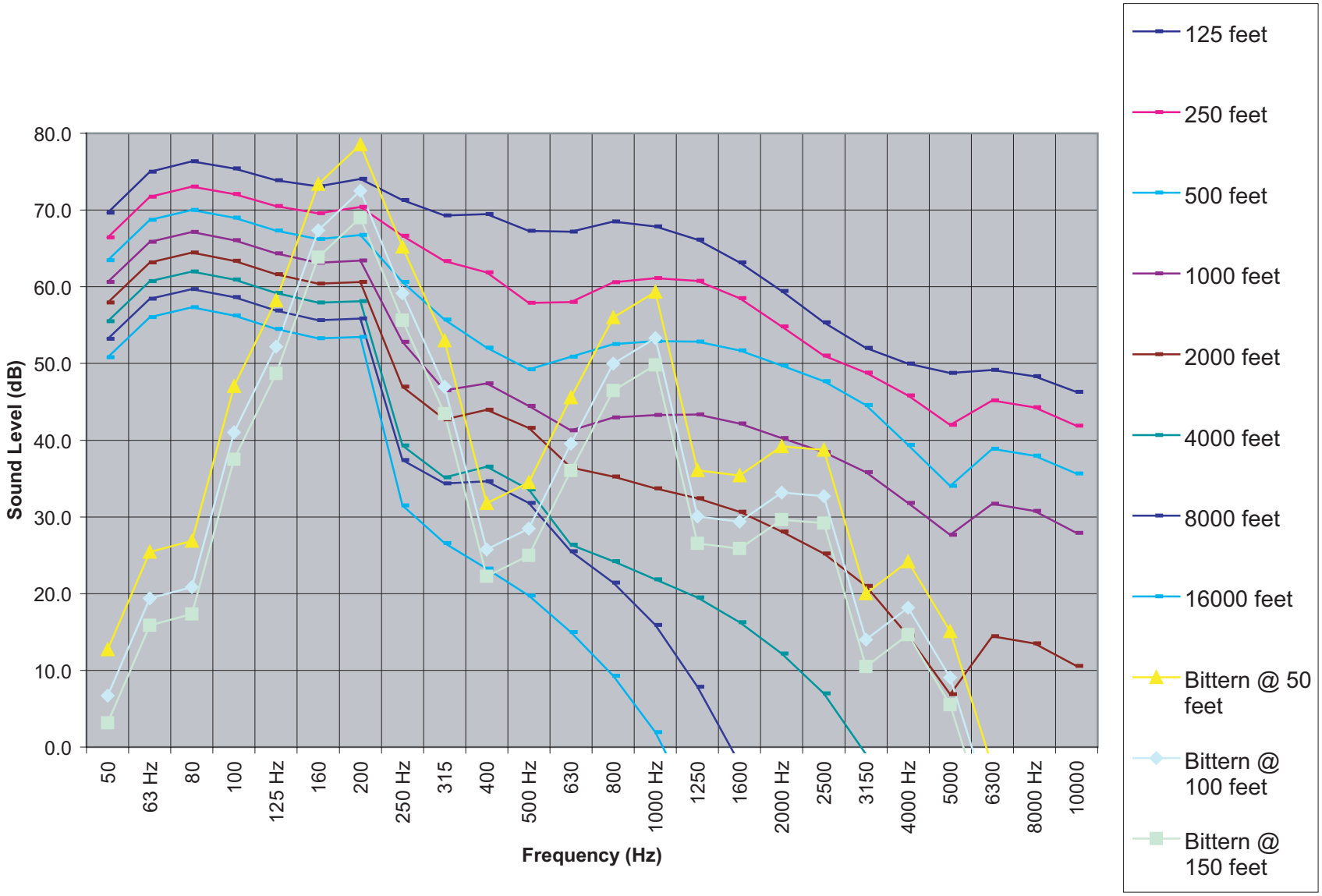
Figure E-4
Background Sound and Wind Levels at Long-Term Position



03076.03 010 Wildlife Tech Memo

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Figure E-5
Traffic Noise Masking Thresholds and American Bittern Vocal Signal Profile

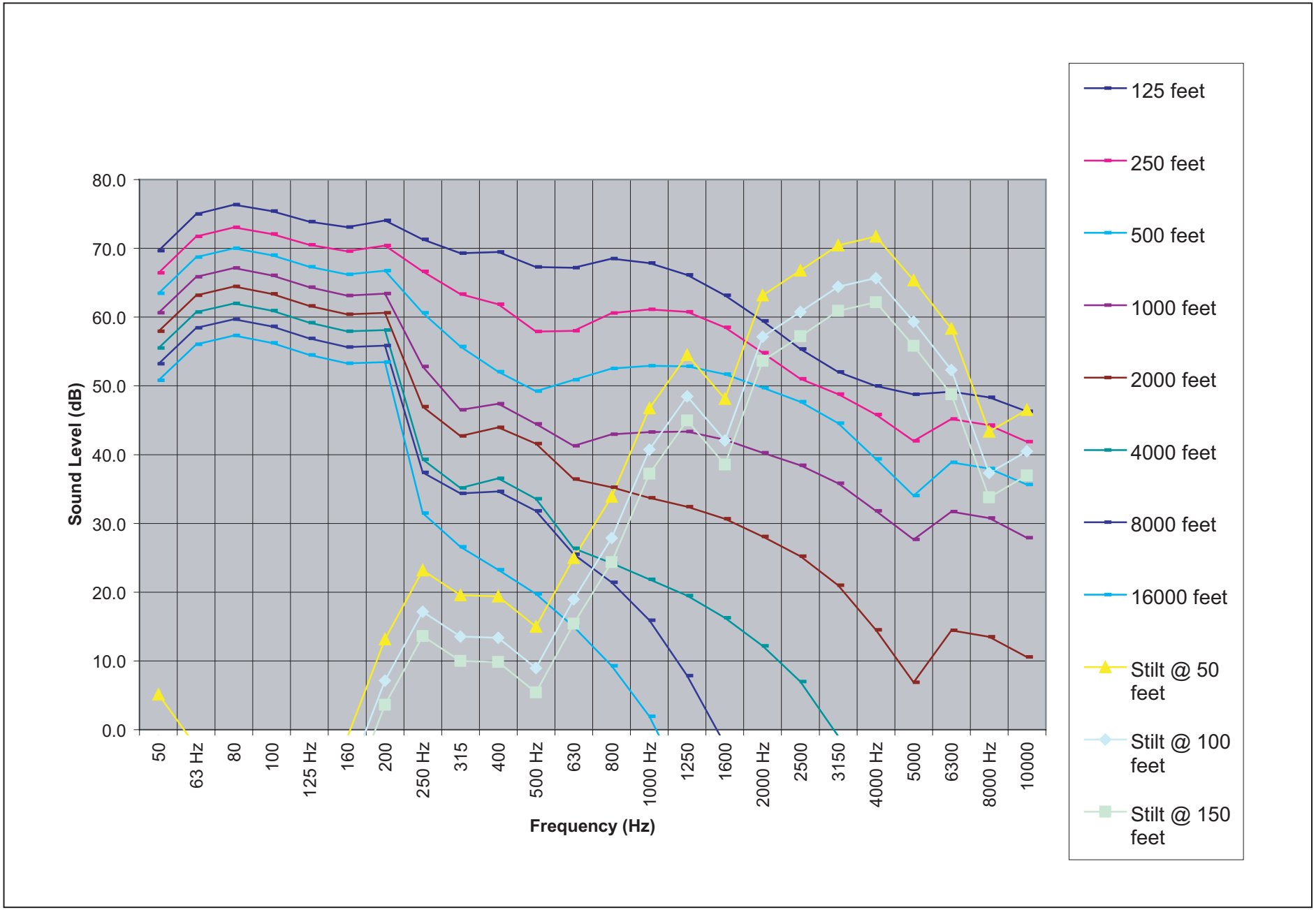

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Figure E-6
Traffic Noise Masking Thresholds and Black-Necked Stilt Vocal Signal Profile

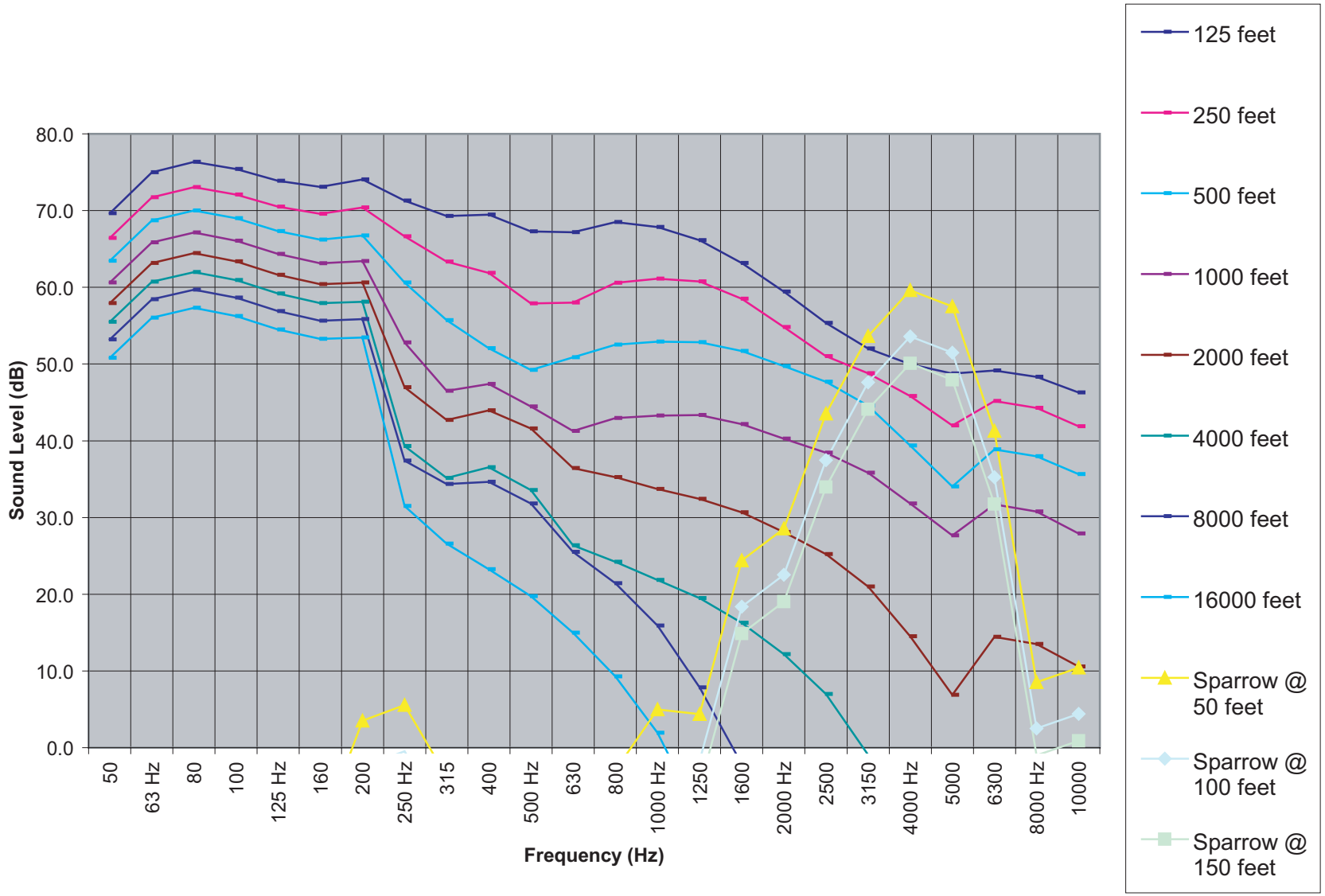

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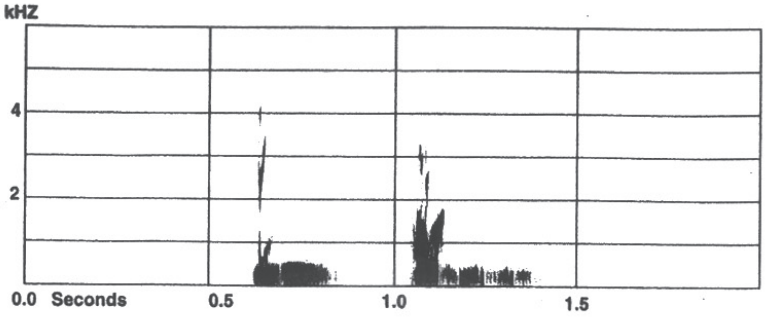
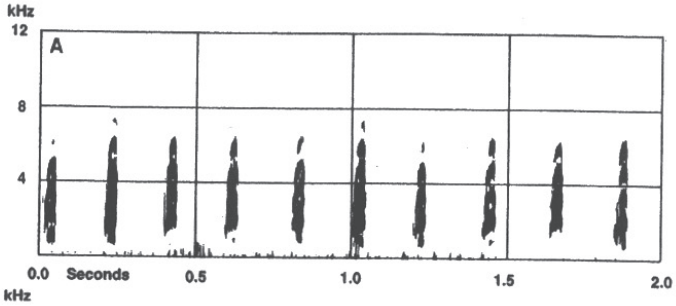
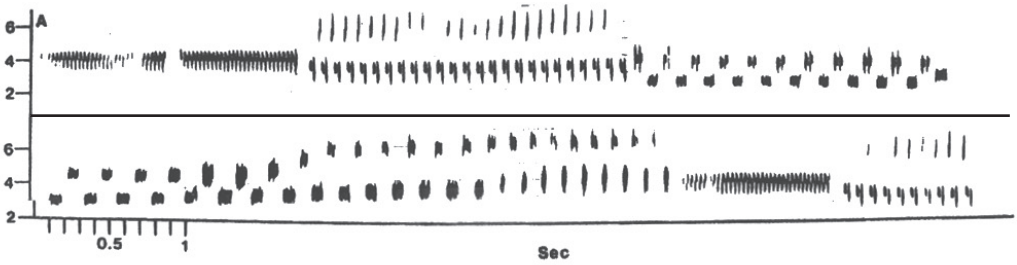
Figure E-7
Traffic Noise Masking Thresholds and Brewer's Sparrow Vocal Signal Profile



American Bittern



Black-necked Stilt

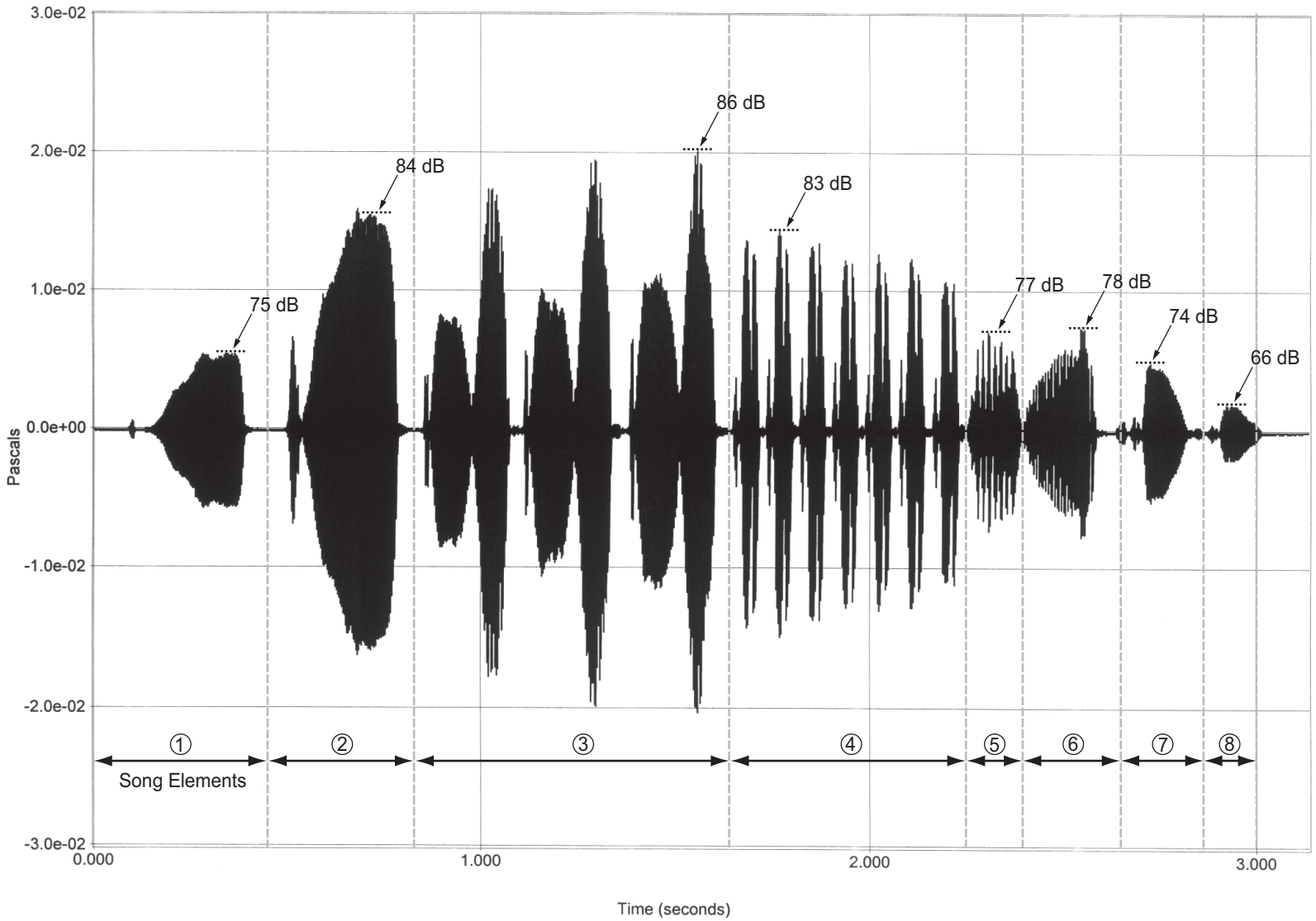


Brewer's Sparrow

03076.03 010 Wildlife Tech Memo

Jones & Stokes

Figure E-8
Sonograms of Representative Bird Vocalizations



03076.03 010 Wildlife Tech Memo

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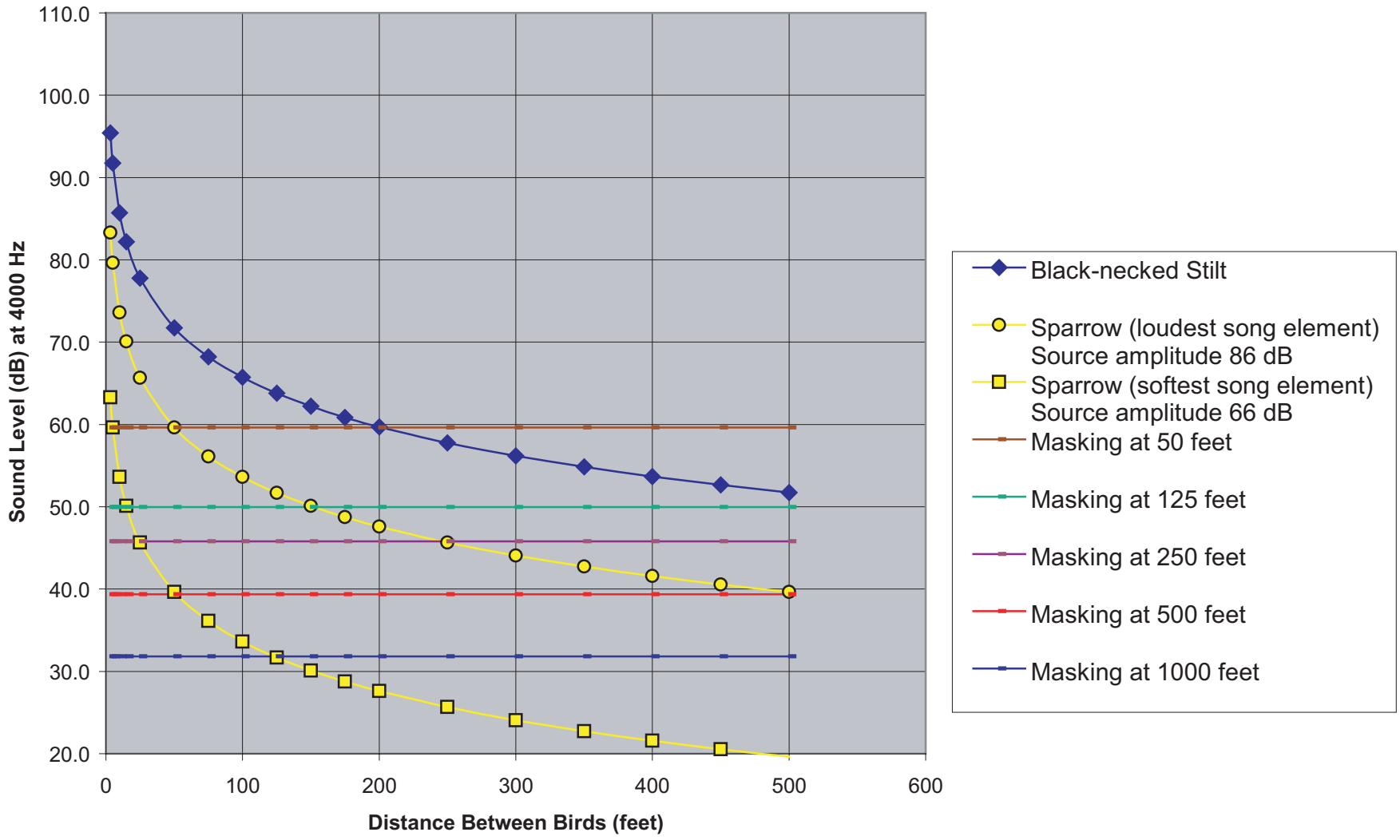
Figure E-9
Brewer's Sparrow Song Waveform



03076.03 010 Wildlife Tech Memo

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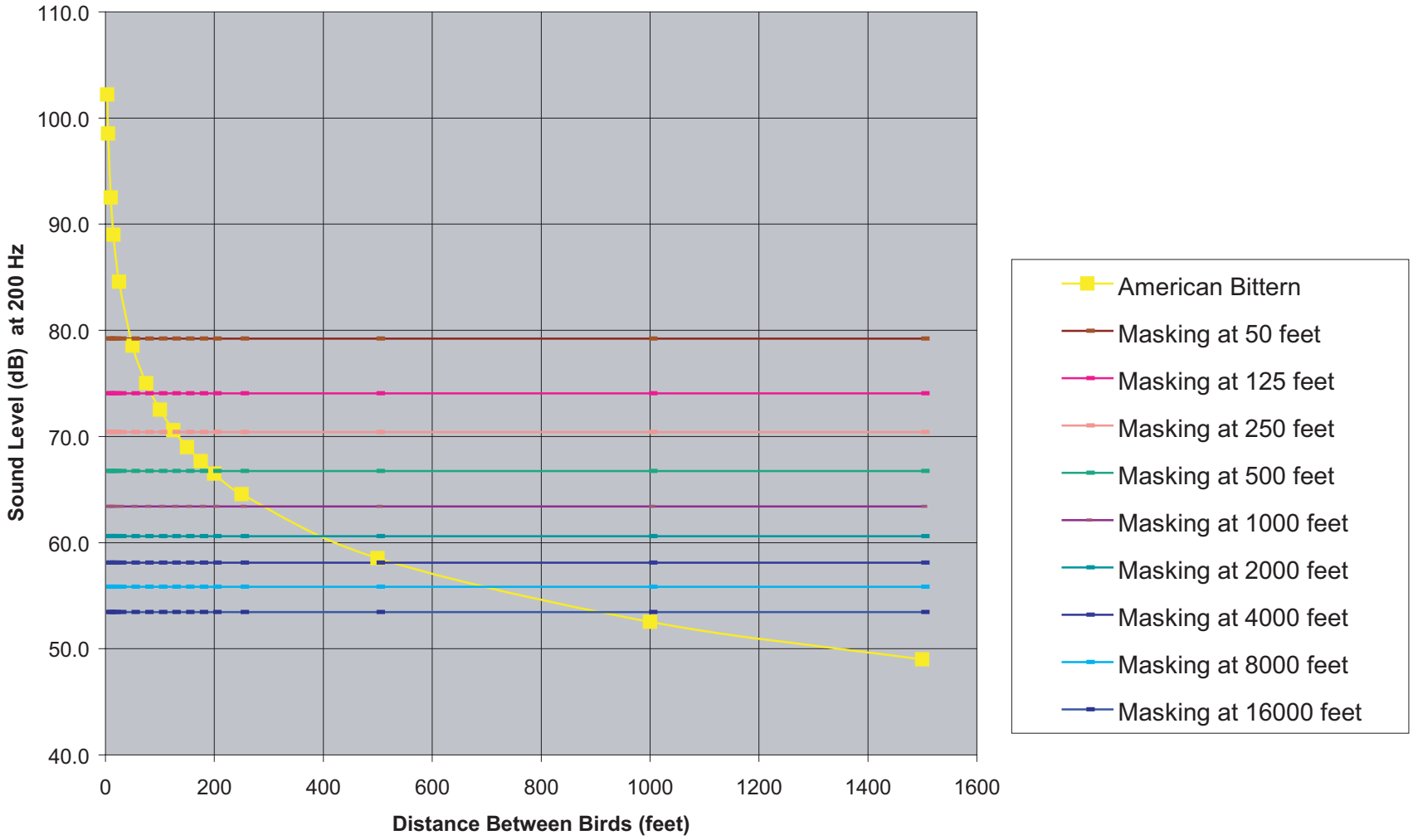
Figure E-10
Black-Necked Stilt/Brewer's Sparrow Masking Distance



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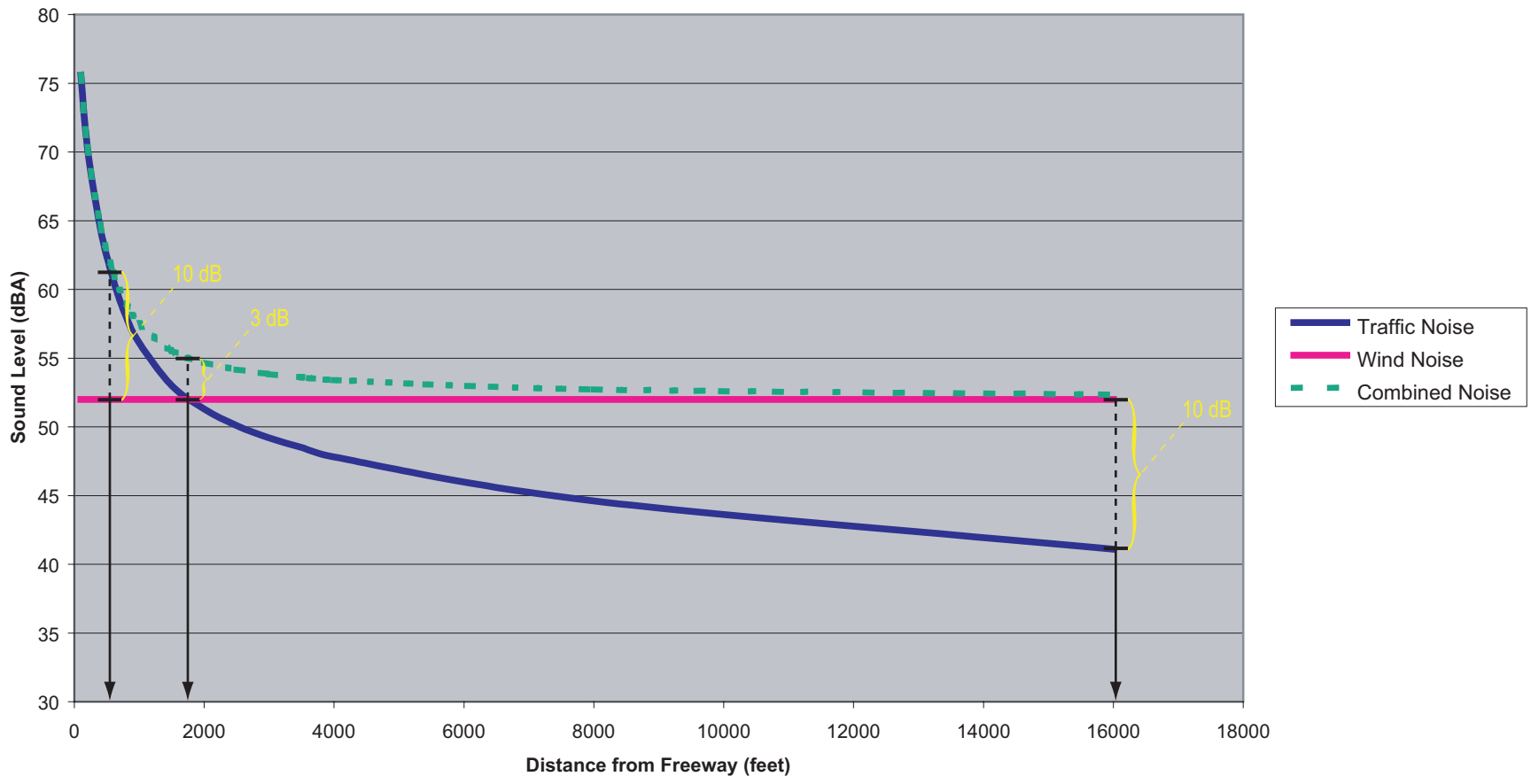
Jones & Stokes

Figure E-11
American Bittern Masking Distance



03076.03 010 Wildlife Tech Memo

Jones & Stokes

Figure E-12
Combined Effects of Traffic Noise and Background Noise

Appendix F

Agency Coordination and Consultation

(CO/KS/NE/UT)

United States Department of the Interior
FISH AND WILDLIFE SERVICE
UTAH FIELD OFFICE
LINCOLN PLAZA
145 EAST 1300 SOUTH, SUITE 404
SALT LAKE CITY, UTAH 84115

U.S. Department of the Interior 1849•1999

In Reply Refer To
(CO/KS/NE/UT)

September 17, 1999

Mr. William R. Gedris, Structural/Environmental Engineer
Federal Highway Administration
Utah Division
2520 West 4700 South, Suite 9A
Salt Lake City, Utah 84118

RE: Amendment to Biological Opinion for Project Number SP-0067, Legacy Parkway, Salt Lake and Davis Counties, Utah

Dear Mr. Gedris:

The peregrine falcon (Falco peregrinus) was included as part of the U.S Fish and Wildlife Service biological opinion for the Legacy Parkway, dated February 11, 1999. Recently, the peregrine falcon was removed from the federal list of endangered and threatened wildlife pursuant to the Endangered Species Act (64 FR 46542, August 25, 1999). Therefore, the Federal Highway Administration (FHWA) and Utah Department of Transportation (UDOT) can assume that the reasonable and prudent measures and terms and conditions of the biological opinion are no longer considered nondiscretionary under authority of the ESA with respect to the peregrine falcon.

However, the FHWA, UDOT, and contractors for Legacy Highway should be aware that the peregrine falcon is still provided protection under the Migratory Bird Treaty Act (MBTA). Under authority of the MBTA it is unlawful to take, kill, or possess migratory birds, their parts, nests, or eggs. Take is defined (50 CFR 10.12) as to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect.

Reasonable and prudent measures (RPM) #2, 3, and 4 and terms and conditions (T&C) #2, 3, and 4 in the Legacy biological opinion of February 11, 1999 were developed to minimize impacts to the peregrine falcon. The Service recommends that FHWA and UDOT implement all strategies (RPMs and T&Cs) outlined in the biological opinion to ensure that no "take" of peregrine falcons, their nests, or eggs occurs which would constitute a violation of the MBTA. These measures are consistent with the *Utah Field Office Guidelines for Raptor Protection from Human and Land Use Disturbances*.

If we can be of further assistance, please contact Laura Romin, Wildlife Biologist, of this office at (801)524-5001 ext. 142.

Sincerely,

Reed E. Harris

Reed E. Harris
Utah Field Supervisor

United States Department of the Interior

FISH AND WILDLIFE SERVICE

UTAH FIELD OFFICE
2369 WEST ORTON CIRCLE, SUITE 50
WEST VALLEY CITY, UTAH 84119

In Reply Refer To
FWS/R6
ES/UT
03-0616

May 2, 2003

RECEIVED
MAY - 6 2003
BY: NK

Greg Punske
Environmental Program Manager
Federal Highway Administration
2520 West 4700 South, Suite A
Salt Lake City, Utah 84118

Dear Mr. Punske

The U.S. Fish and Wildlife Service (Service) has reviewed the April 1, 2003, Federal Register Notice of Intent to Prepare a Supplemental Environmental Impact Statement (SEIS) for the Utah Department of Transportation's proposed construction of the Legacy Parkway project in Salt Lake and Davis Counties, Utah. The purpose of the project is to solve future traffic problems in Salt Lake and Davis Counties by implementing a three part "Shared Solutions" strategy that includes: 1) Constructing the Legacy Parkway; 2) improving and expanding Interstate 15; and 3) expanding the public transit system. This project will involve the construction of a roughly 14 mile highway from Interstate 215 in the south to U.S. 89 near Farmington, Utah in the north. A multiple use trail for pedestrians, bicyclists, and equestrians would parallel the highway. The SEIS is being prepared because the courts found certain aspects of the original EIS insufficient, including the wildlife impact analysis. The SEIS will build upon the EIS and specifically address the court-identified deficiencies.

The Service has agreed to be a cooperating agency for purposes of NEPA compliance for this project. We expect to assist the lead agencies in evaluating the potential impacts to fish and wildlife resources and developing measures to avoid, minimize, and compensate for unavoidable impacts. We are providing the following comments as general guidelines for wildlife issues we believe should be addressed. These comments are not meant to be exhaustive, however, because we expect to be closely involved with identification of wildlife issues, determining appropriate evaluation methodology, and interpreting results.

In Section 1 of this letter we convey our concerns that should be addressed in the SEIS. Section 2 of this letter addresses your responsibilities under section 7 of the Endangered Species Act (ESA) of 1973, 16 U.S.C. § 1536.

Section 1.

We recommend that the SEIS evaluate the following potential direct, indirect, and cumulative impacts on fish and wildlife resources:

Direct Effects

Mortality due to project implementation, construction, and maintenance.

Mortality due to ongoing activities associated with project (vehicle collisions with vehicles, contamination of soils/waters from road treatments, automotive fluids, truck spills, etc.).

Displacement of individuals/populations due to project implementation, construction, maintenance, and ongoing activities associated with the project. In particular, you should evaluate whether and to what extent organisms may be displaced to areas where fitness is reduced and/or mortality rates increased (population sinks).

Habitat loss/gain due to project implementation, construction, and maintenance.

Habitat loss/gain due to ongoing activities associated with project (contamination of soils/waters from road treatments, automotive fluids, truck spills, etc.).

Habitat fragmentation and its effects on mate search/selection, gene flow, predation rate, dispersal success, colonization events (as they pertain to metapopulation dynamics), and overall population size.

Effects on individual fitness (reduced nesting success, brood size, fledging success, number of matings, etc.) due to project implementation, construction, and maintenance.

Effects on individual fitness (nesting success, brood size, fledging success, number of matings, etc.) due to ongoing activities associated with project (vehicle collisions with vehicles, contamination of soils/waters from road treatments, automotive fluids, truck spills, etc.).

Effects to habitat and species diversity, both spatial and temporal, due to project implementation, construction, and maintenance.

Indirect Effects

Effects on hydrology, both temporal and spatial that relate directly with quantity, quality, and distribution of habitats.

Effects on hydrology, both spatial and temporal, that may convert one type of wetland to another, thus changing its habitat function.

Effects on water quality as it relates to habitats for wildlife and fish.

Effects on air quality due to project implementation, construction, and maintenance.

Effects on air quality due to the ongoing activities associated with the project (vehicle emissions, increased air temperatures, etc.)

Effects of ground disturbance and ongoing activities (vehicular, bike, and horse traffic, trail/berm/median maintenance) that may facilitate the introduction of invasive/exotic/noxious species.

Effects of noise on wildlife populations and individuals. Possibilities include effects on mate identification, nest location, prey location, predator location, and territory defense.

Effects of an increase of human access/activity to formerly isolated wildlife habitats on wildlife populations, mating success, mortality, foraging/hunting opportunities, etc.

Effects on development opportunities that may further reduce/impair/eliminate wildlife habitats in the project area.

Effects of increased lighting during nighttime hours on predator/prey interactions, foraging behavior, and dispersal behavior.

Cumulative Effects

Effects of continued degradation, fragmentation, and removal of wetlands in the Great Salt Lake ecosystem as it pertains to wildlife populations.

Effects of increased development and other economic opportunities as a result of improved access (induced or facilitated development) as it pertains to wildlife populations.

Effects of perpetuating single person/single vehicle transportation on future air quality, water quality, and habitat value inside and outside of the project area.

Section 2. Federal agencies have specific additional responsibilities under Section 7 of the ESA. To help you fulfill these responsibilities, we are providing an updated list of threatened (T) and endangered (E) species that may occur within the area of influence of your proposed action.

County	Species	Status
DAVIS		
Bald Eagle[1,3]	*Haliaeetus leucocephalus*	T
SALT LAKE		
Bald Eagle[1,3]	*Haliaeetus leucocephalus*	T

[1] Nests in this county of Utah.
[3] Wintering populations (only four known nesting pairs in Utah).

The proposed action should be reviewed and a determination made if the action will affect any listed species or their critical habitat. If it is determined by the Federal agency, with the written concurrence of the Service, that the action is not likely to adversely affect listed species or critical habitat, the consultation process is complete, and no further action is necessary.

Formal consultation (50 CFR 402.14) is required if the Federal agency determines that an action is "likely to adversely affect" a listed species or will result in jeopardy or adverse modification of critical habitat (50 CFR 402.02). Federal agencies should also confer with the Service on any action which is likely to jeopardize the continued existence of any proposed species or result in the destruction or adverse modification of proposed critical habitat (50 CFR 402.10). A written request for formal consultation or conference should be submitted to the Service with a completed biological assessment and any other relevant information (50 CFR 402.12). Candidate species have no legal protection under the Endangered Species Act (ESA). Candidate species are those species for which we have on file sufficient information to support issuance of a proposed rule to list under the ESA. Identification of candidate species can assist environmental planning efforts by providing advance notice of potential listings, allowing resource managers to alleviate threats and, thereby, possibly remove the need to list species as endangered or threatened. Even if we subsequently list this candidate species, the early notice provided here could result in fewer restrictions on activities by prompting candidate conservation measures to alleviate threats to this species.

Only a Federal agency can enter into formal Endangered Species Act (ESA) section 7 consultation with the Service. A Federal agency may designate a non-Federal representative to conduct informal consultation or prepare a biological assessment by giving written notice to the Service of such a designation. The ultimate responsibility for compliance with ESA section 7, however, remains with the Federal agency.

Your attention is also directed to section 7(d) of the ESA, as amended, which underscores the requirement that the Federal agency or the applicant shall not make any irreversible or irretrievable commitment of resources during the consultation period which, in effect, would deny the formulation or implementation of reasonable and prudent alternatives regarding their actions on any endangered or threatened species.

Please note that the peregrine falcon which occurs in all counties of Utah was removed from the federal list of endangered and threatened species per Final Rule of August 25, 1999 (64 FR 46542). Protection is still provided for this species under authority of the Migratory Bird Treaty Act (16 U.S.C. § 703-712) which makes it unlawful to take, kill, or possess migratory birds, their parts, nests, or eggs. When taking of migratory birds is determined by the applicant to be the only alternative, application for federal and state permits must be made through the appropriate authorities. For take of raptors, their nests, or eggs, Migratory Bird Permits must be obtained through the Service's Migratory Bird Permit Office in Denver at (303) 236-8171.

We recommend use of the *Utah Field Office Guidelines for Raptor Protection from Human and Land Use Disturbances* (Romin and Muck, January 2002) which were developed in part to provide consistent application of raptor protection measures statewide and provide full compliance with environmental laws regarding raptor protection. Raptor surveys and mitigation measures are provided in the Raptor Guidelines as recommendations to ensure that proposed projects will avoid adverse impacts to raptors, including the peregrine falcon.

If we can be of further assistance or if you have any questions, please feel free to contact Chris Witt, Ecologist, at the letterhead address or (801) 975-3330 extension 133.

Sincerely,

Henry R. Maddux
Utah Field Supervisor

cc: Nancy Kang, Chief, Utah Office, U.S. Army Corps of Engineers, 533 West 4700 South, Suite 9A, Salt Lake City, Utah 94010

UDWR – Salt Lake City, Ogden

Regional Office – Region 6 (Attn: NEPA Coordinator)

United States Department of the Interior

FISH AND WILDLIFE SERVICE

UTAH FIELD OFFICE
2369 WEST ORTON CIRCLE, SUITE 50
WEST VALLEY CITY, UTAH 84119

In Reply Refer To
FWS/R6
ES/UT
04-0221

December 3, 2003

Mike Perkins
Biologist
Legacy Parkway Team
360 North 700 West, Suite F
North Salt Lake, UT 84054

Dear Mr. Perkins:

The U.S. Fish and Wildlife Service (Service) has reviewed your letter of November 18, 2003 requesting concurrence outlined in the February 11, 1999 Biological Opinion (BO) for the Legacy Parkway Final Environmental Impact Statement. The Service maintains that the BO is still in effect. However, your document lists the mountain plover (*Charadrius montanus*) as Proposed Threatened. At this time, the mountain plover is no longer proposed for listing and can be removed from the species list for your project area.

We appreciate the opportunity to provide these comments. If you need further assistance, please contact Chris Witt, Ecologist, at the letterhead address or (801) 975-3330 ext. 133.

Sincerely,

For Henry R. Maddux
Utah Field Supervisor

cc: UDWR - SLC
FHWA - Attn: Greg Punske
COE - Attn: Nancy Kang