Chapter 3

Environmental Consequences

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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			
Habitat	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

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					

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

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*

Habitat	Regional Land Cover acres	Project Study Area acres	Project Study Area %	Alternative A acres	Alternative A %	Alternative B acres	Alternative B %	Alternative C acres	Alternative C %	Alternative E acres	Alternative E %
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

	Private				Public				Public / Private				Public Trust				
Habitat	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 (%)	Total Low Water (acres)[1]
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

	Private				Public				Public / Private				Public Trust				
Habitat	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 (%)	Total Low Water (acres)[1]
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

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

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)

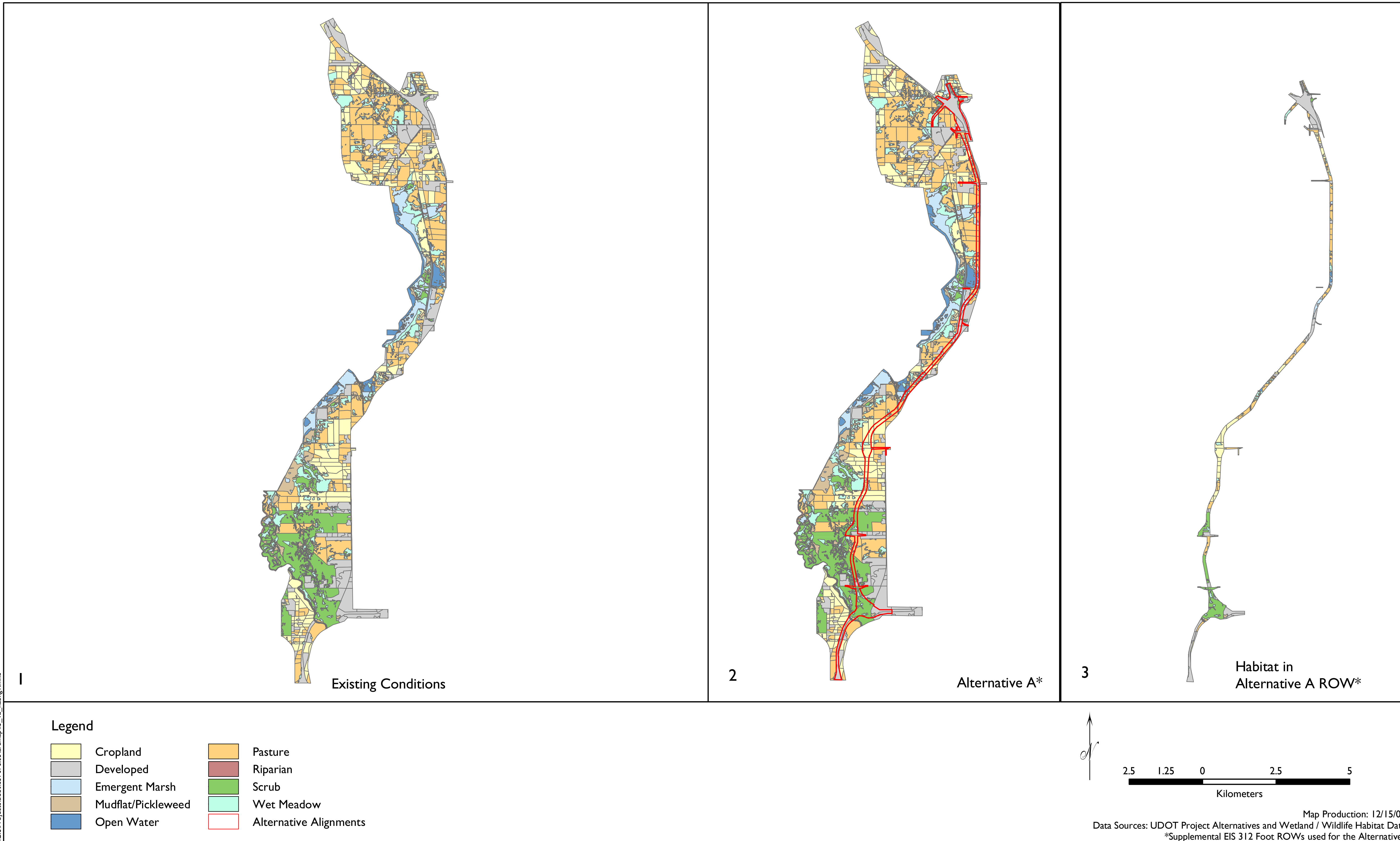
Population Density:	High		Moderate		Low		
Habitat	Acres	%	Acres	%	Acres	%	Total
Cropland	7,904	39	12,435	61	3	<1	20,342
Emergent Marsh	1,188	26	3,315	73	31	1	4,534
Mudflat/Pickleweed	208	9	2,017	91	3	<1	2,228
Pasture	39,800	62	24,049	37	847	1	64,695
Riparian	649	49	596	45	77	6	1,322
Scrub	20,056	62	11,720	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



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Jones & Stokes

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

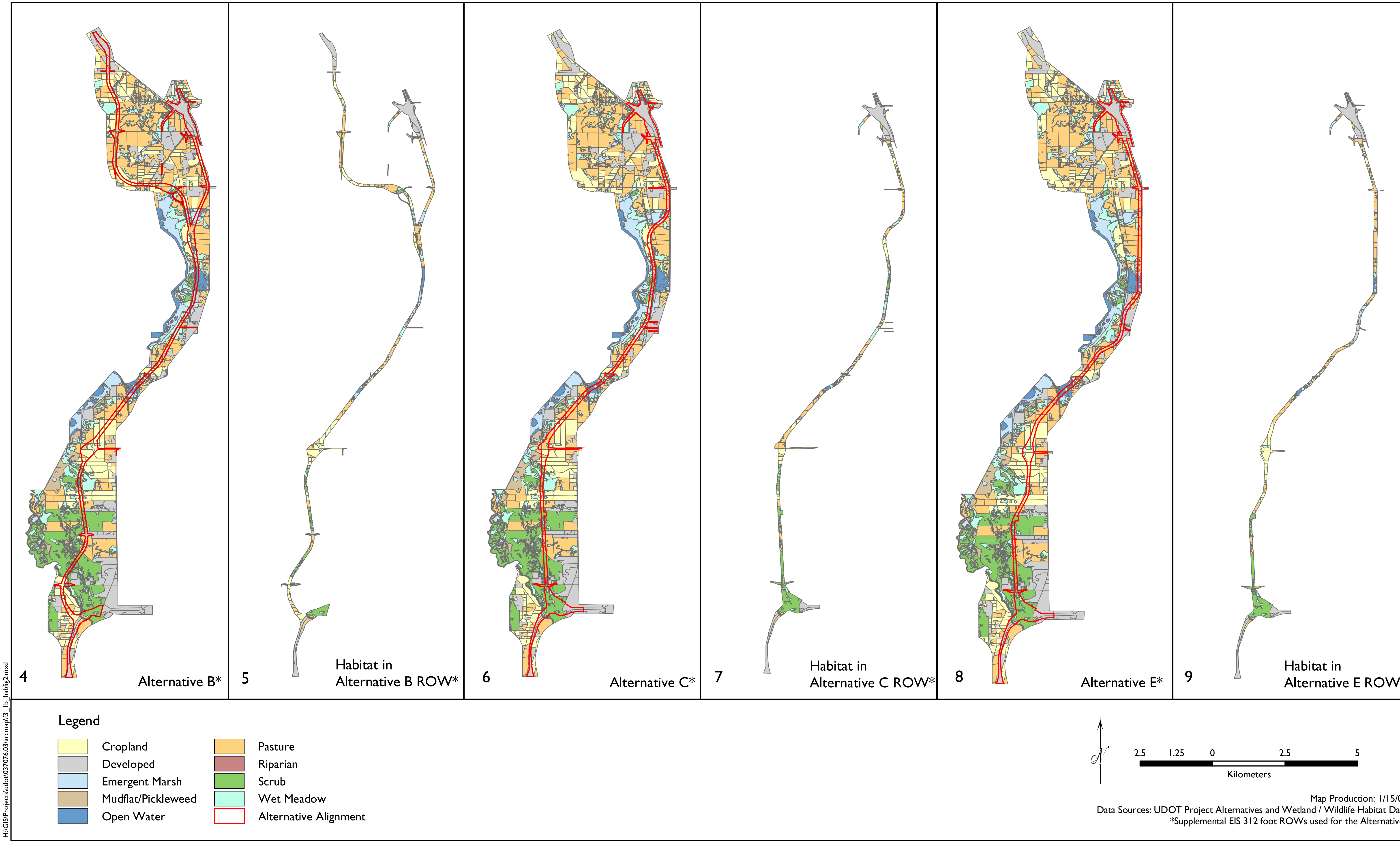

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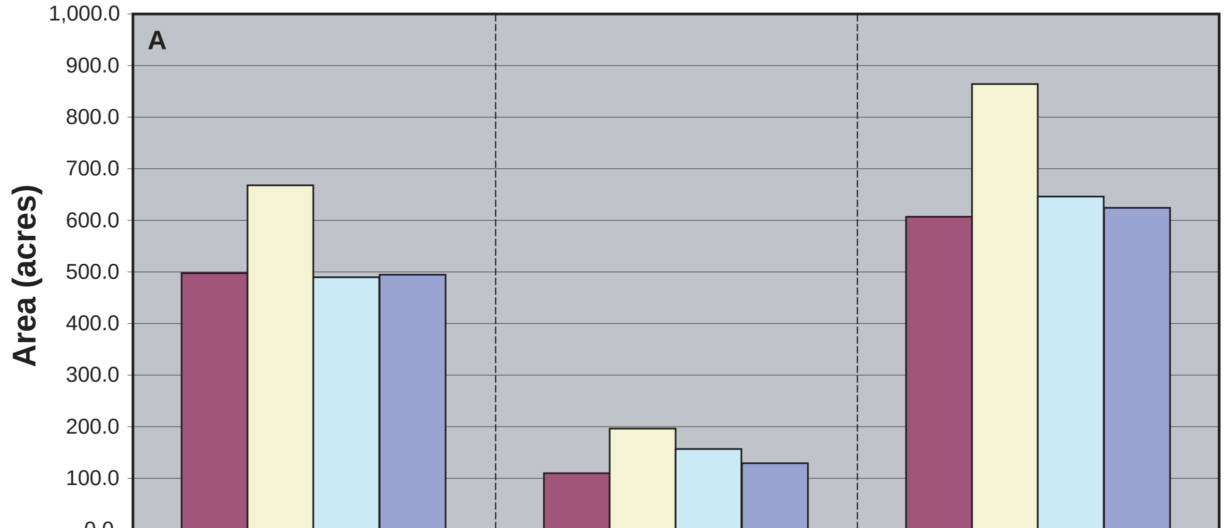
Figure 3-1b
Legacy Parkway Study Area: Potential Direct Habitat Loss



	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

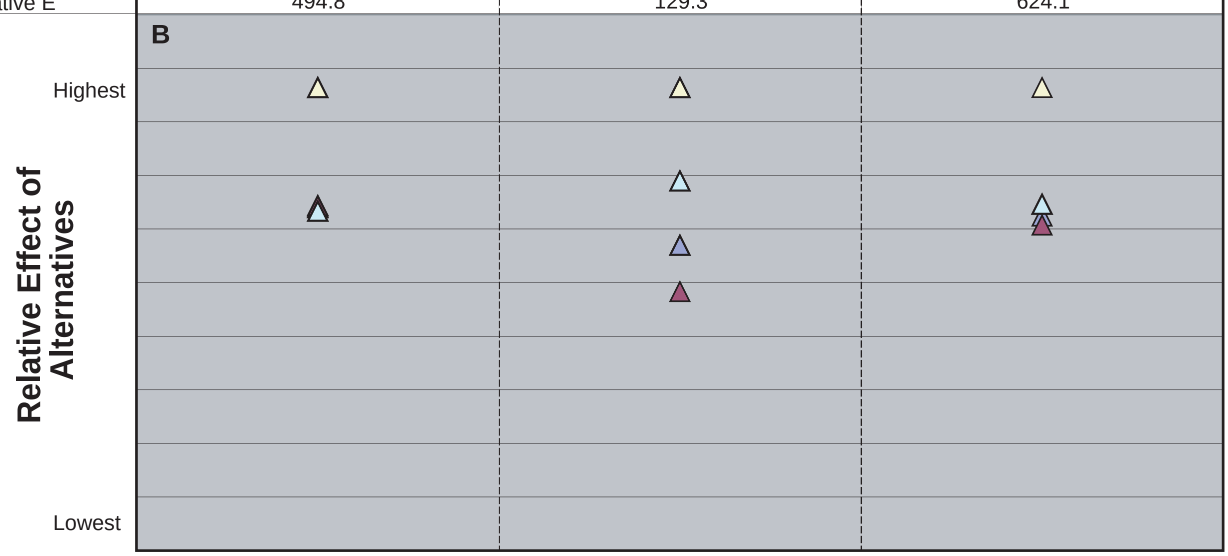


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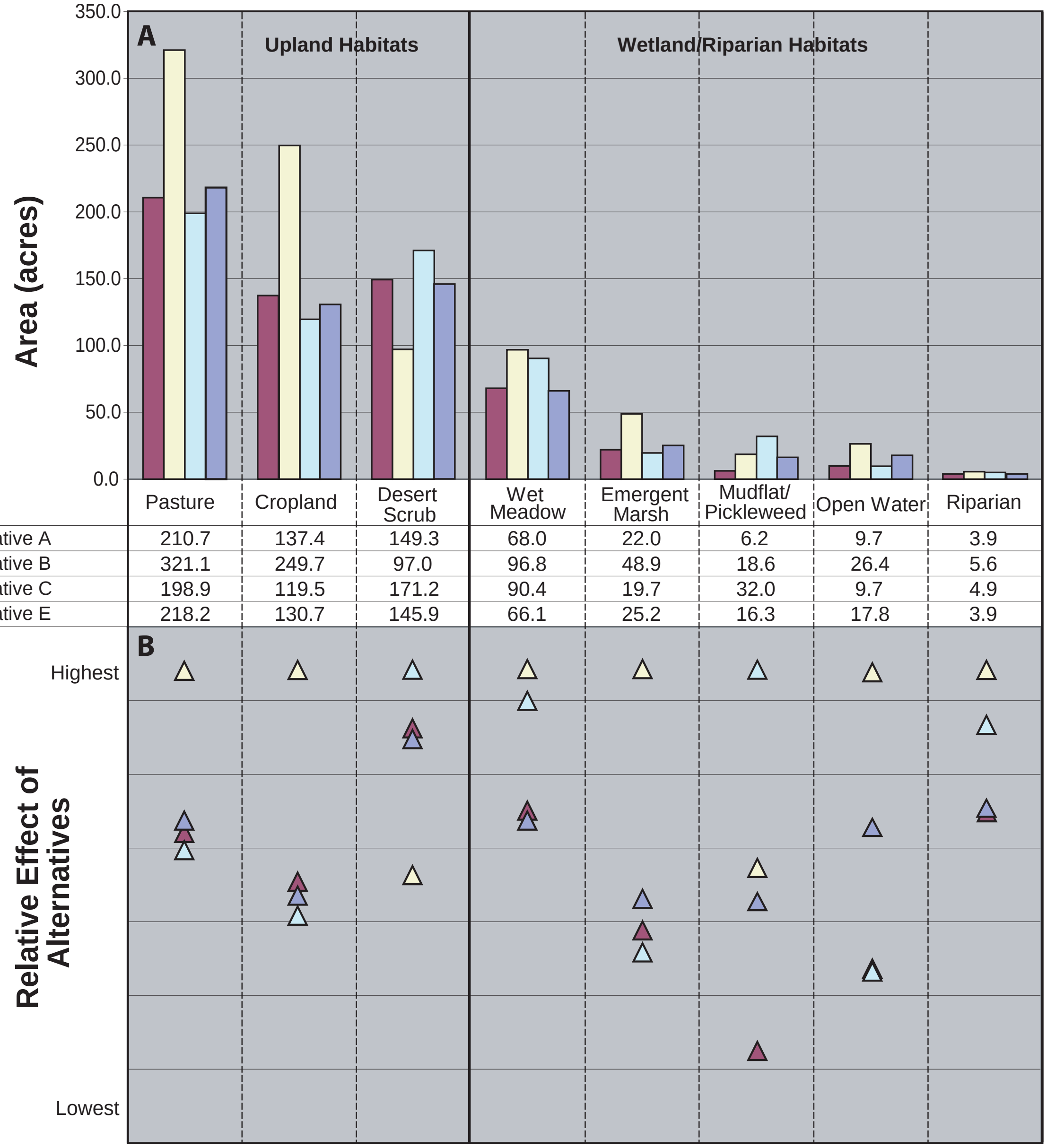
Figure 3-2
Total Direct Habitat Loss in Project Study Area



	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

03076.02 010 Wildlife Tech Memo

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

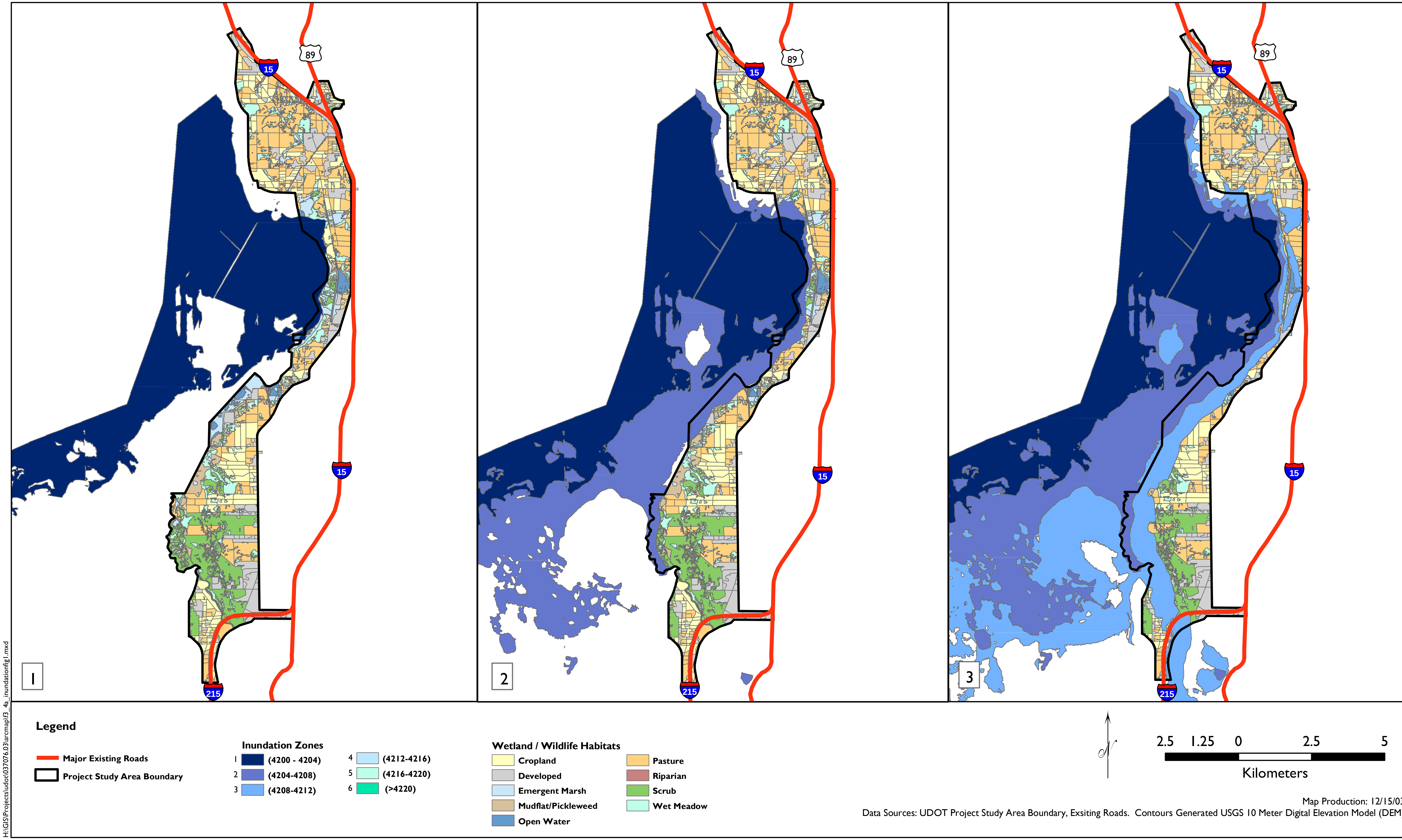

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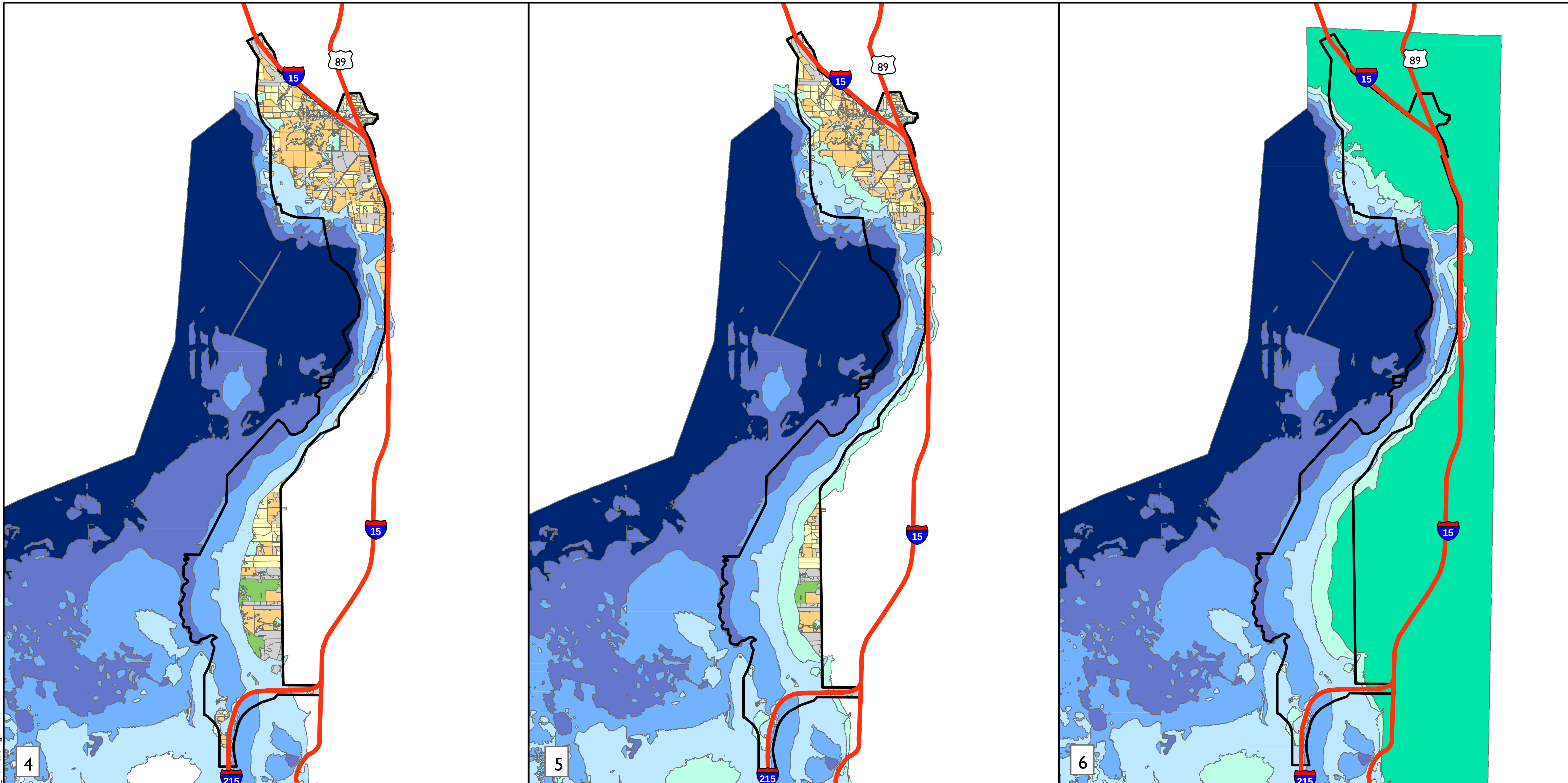
Figure 3-4a
Great Salt Lake Inundation Zones



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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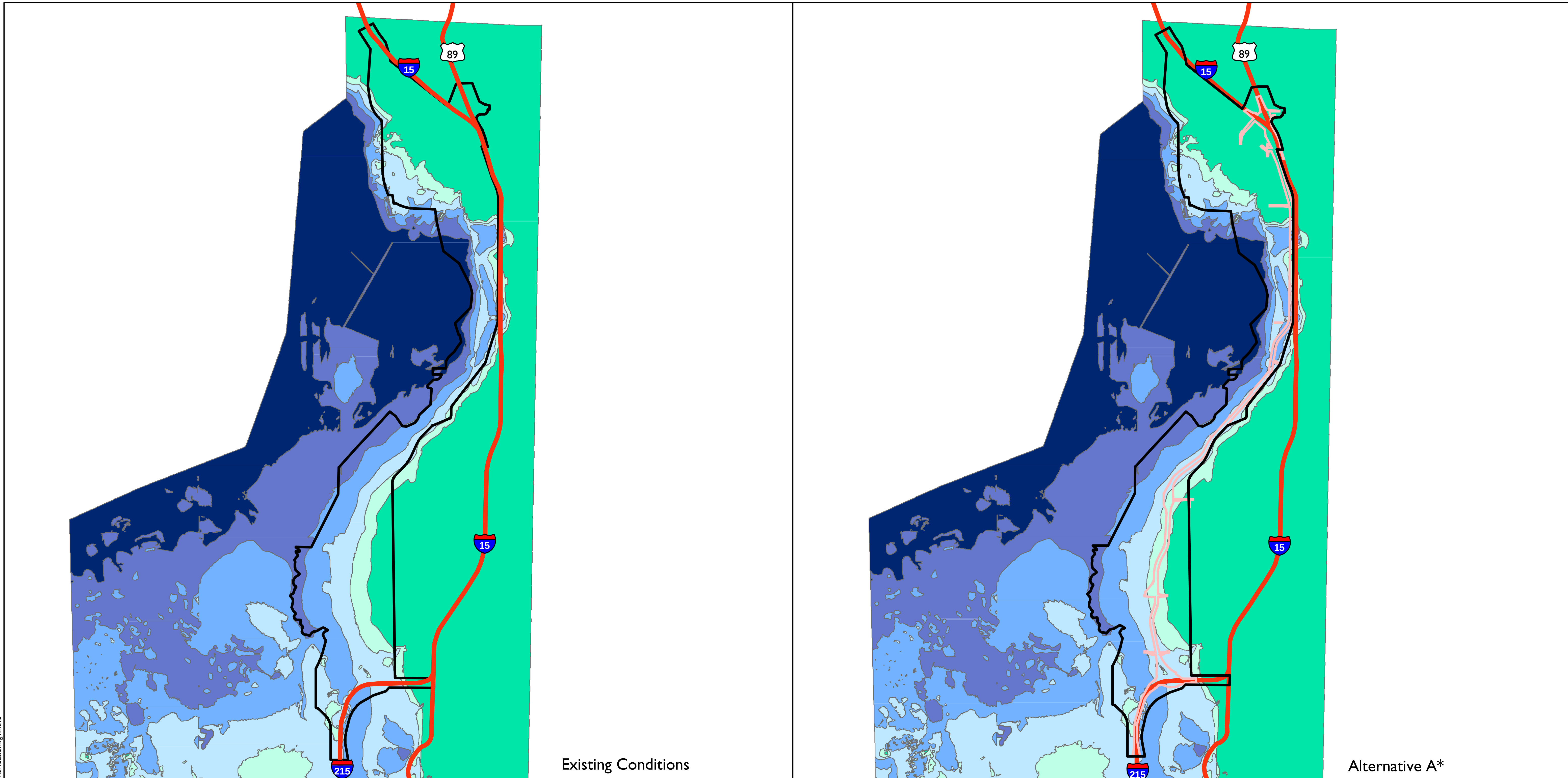
Figure 3-4b
Great Salt Lake Inundation Zones



Legend

(black outline)	Project Study Area Boundary
(pink outline)	Proposed Right of Way
(red outline)	Major Existing Roads

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

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

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

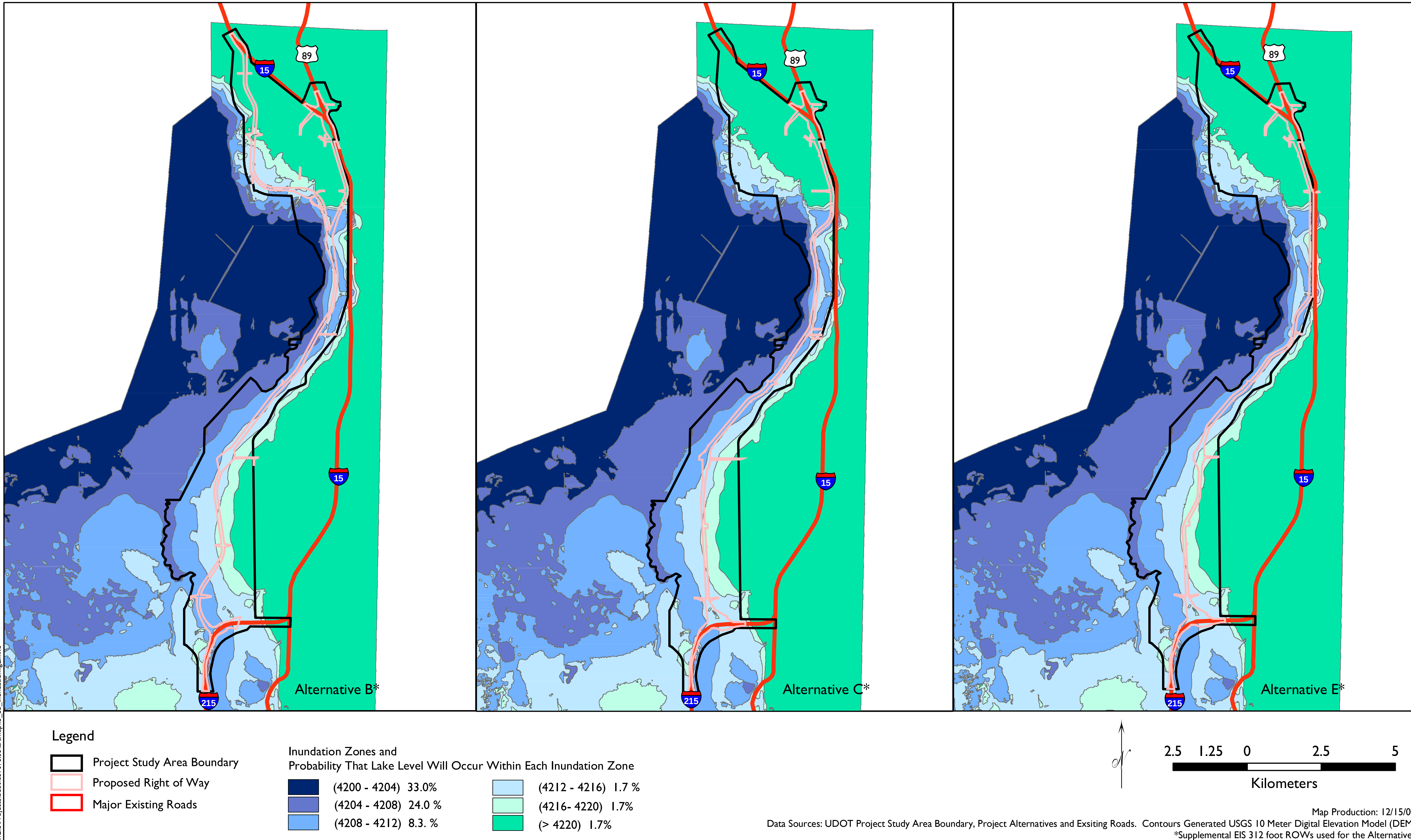

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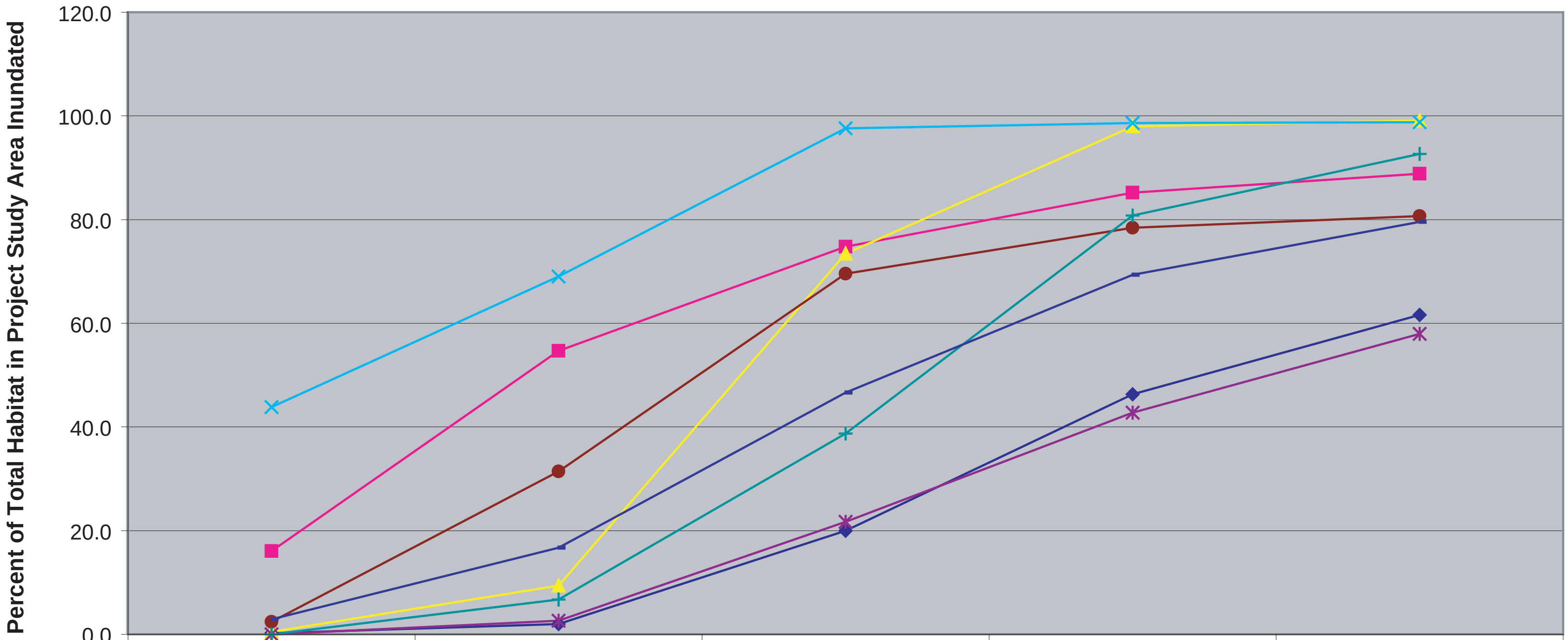
Figure 3-5b
Great Salt Lake Inundation Zones Relative to Build Alternatives



	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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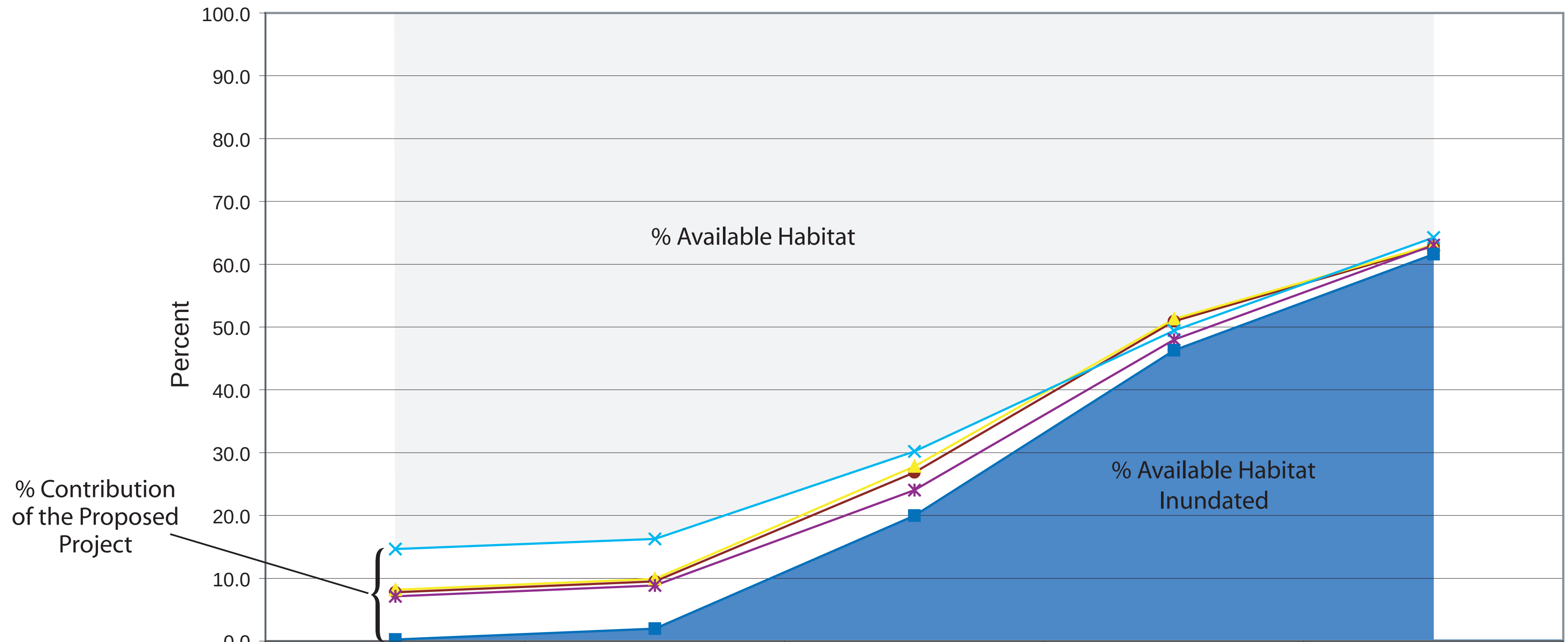
Figure 3-6
Percent Habitat Inundation with Changing Lake Levels



	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

03076.03 wildlife Tech Memo

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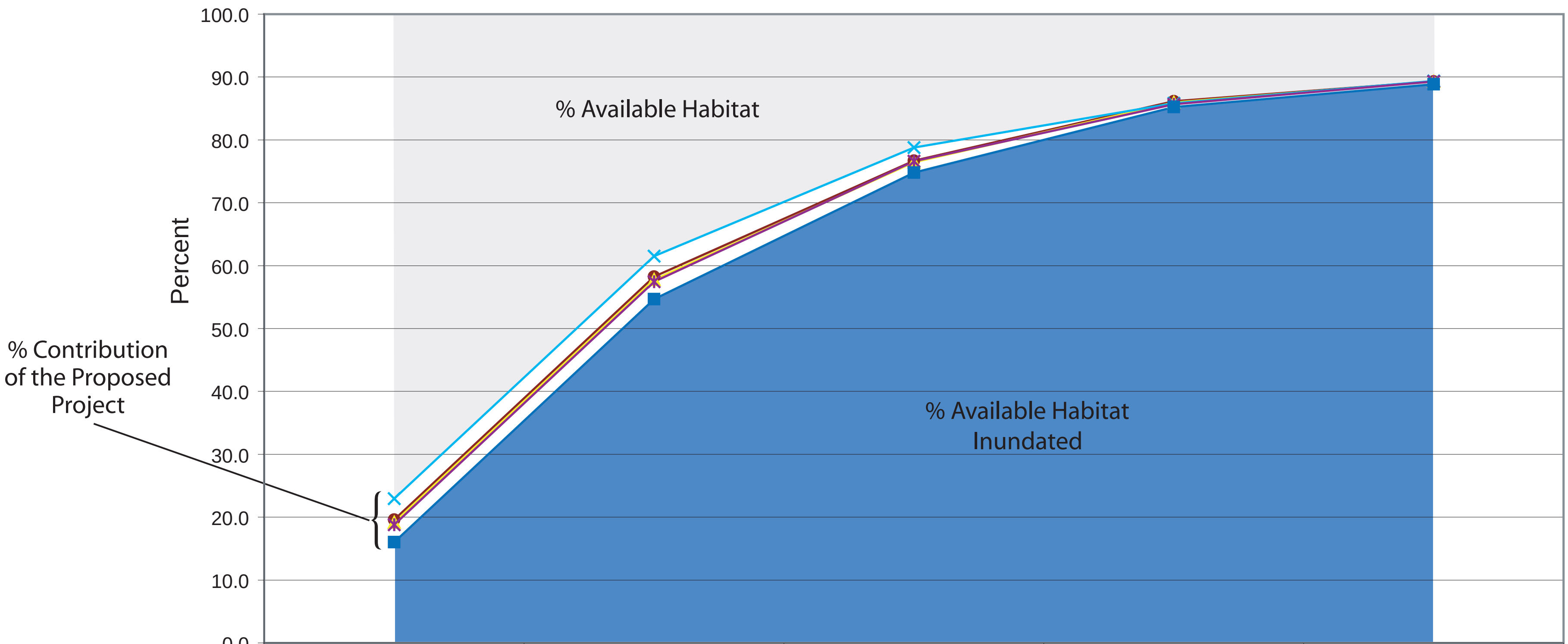
Figure 3-7
Percent Cropland Habitat Loss from Project Alternatives and Varying Lake Lake Levels



	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

03076.03 010 Wildlife Tech Memo

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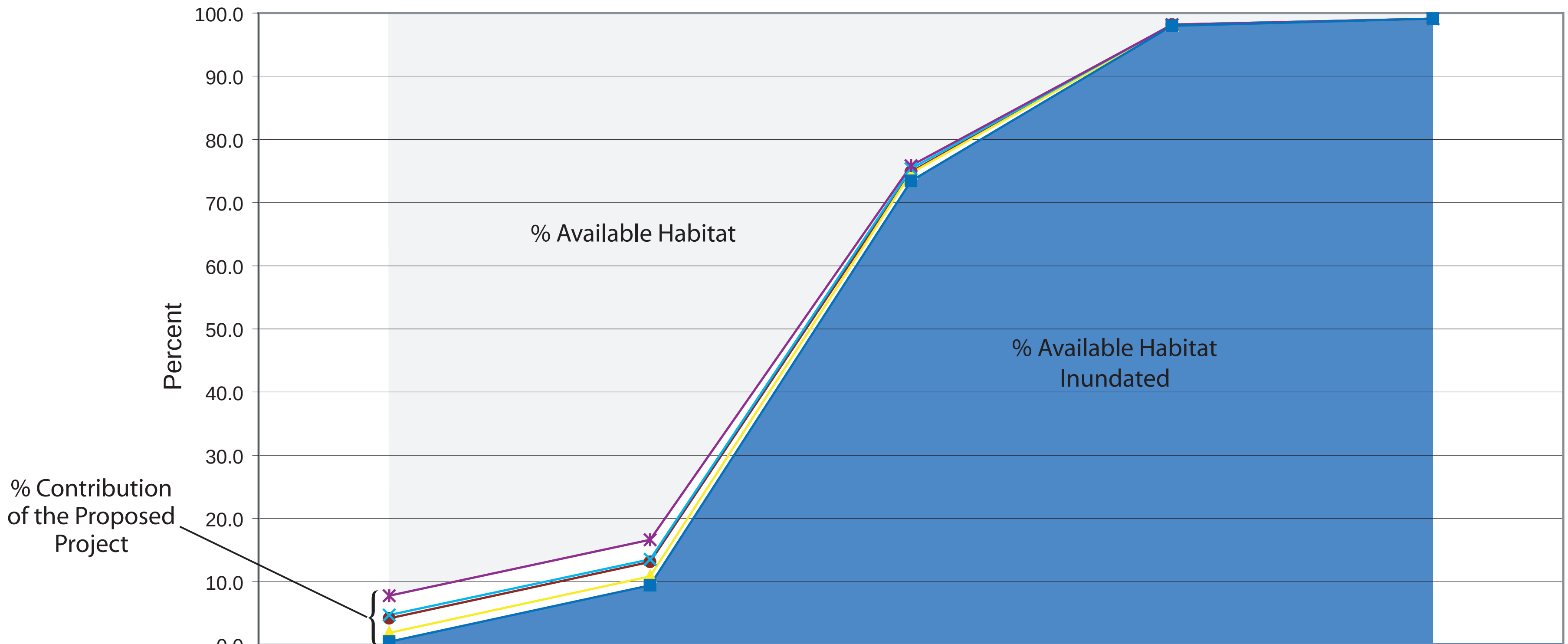
Figure 3-8
Percent Emergent Marshland Habitat Loss from Project Alternatives and Varying Lake Lake Levels



	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

03076.03 Final Tech Memo

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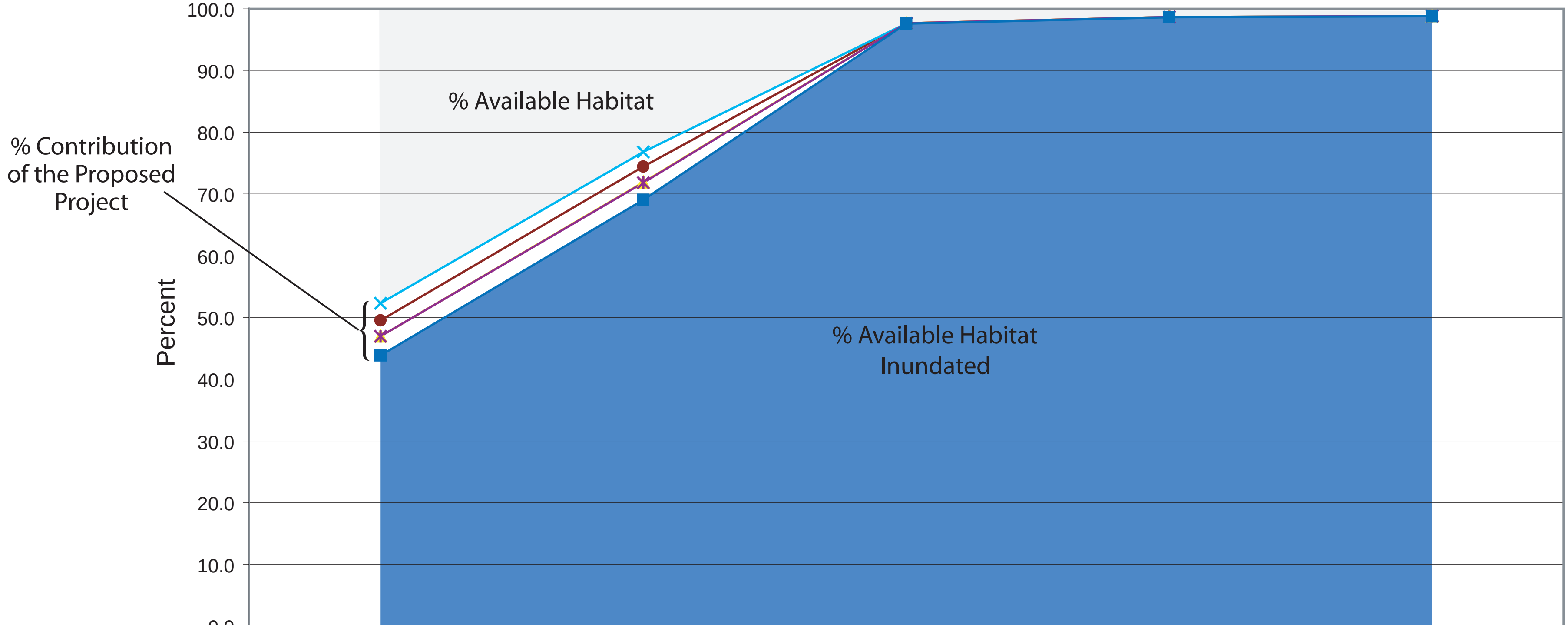
Figure 3-9
Percent Mudflat Pickleweed Habitat Loss from Project Alternatives and Varying Lake Lake Levels



	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

03076.03 Wildlife Tech Memo

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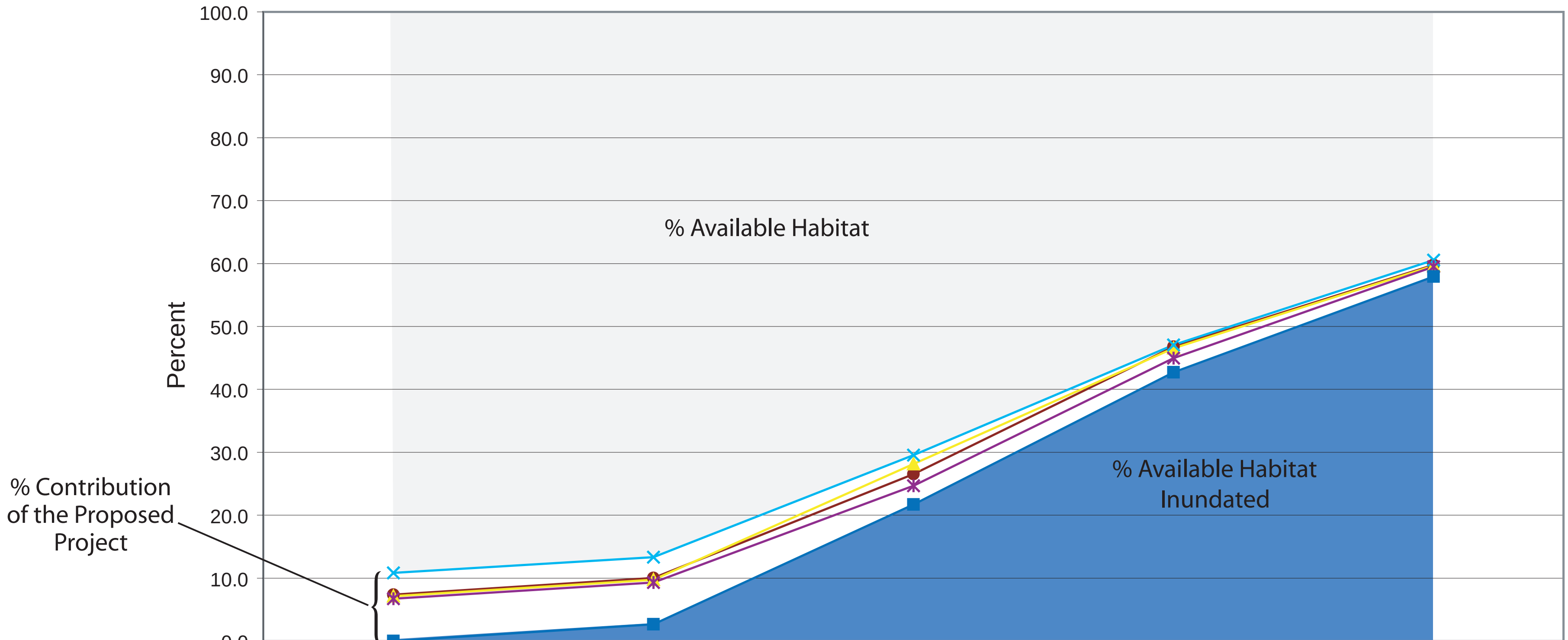
Figure 3-10
Percent Open Water Habitat Loss from Project Alternatives and Varying Lake Lake Levels



	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

03076.03 Wildlife Tech Memo

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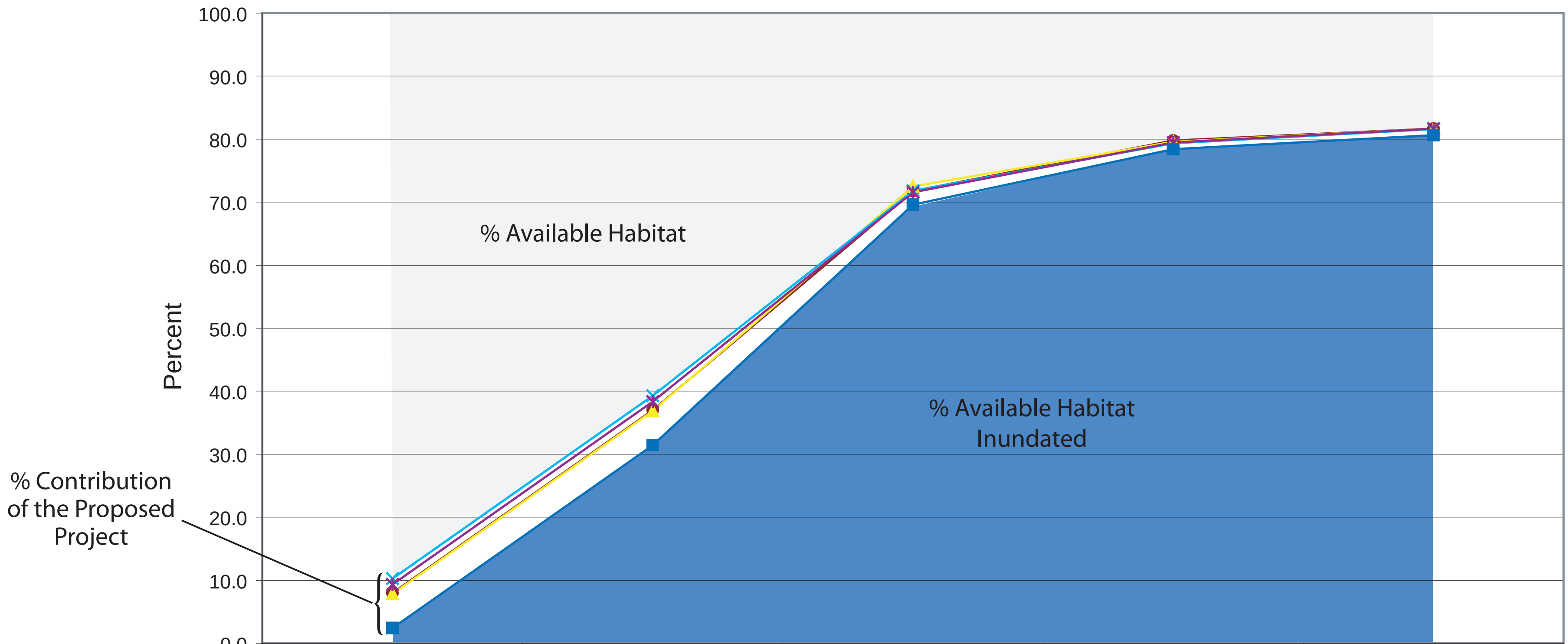
Figure 3-11
Percent Pasture Habitat Loss from Project Alternatives and Varying Lake Lake Levels



	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

03076.03 Wildlife Tech Memo

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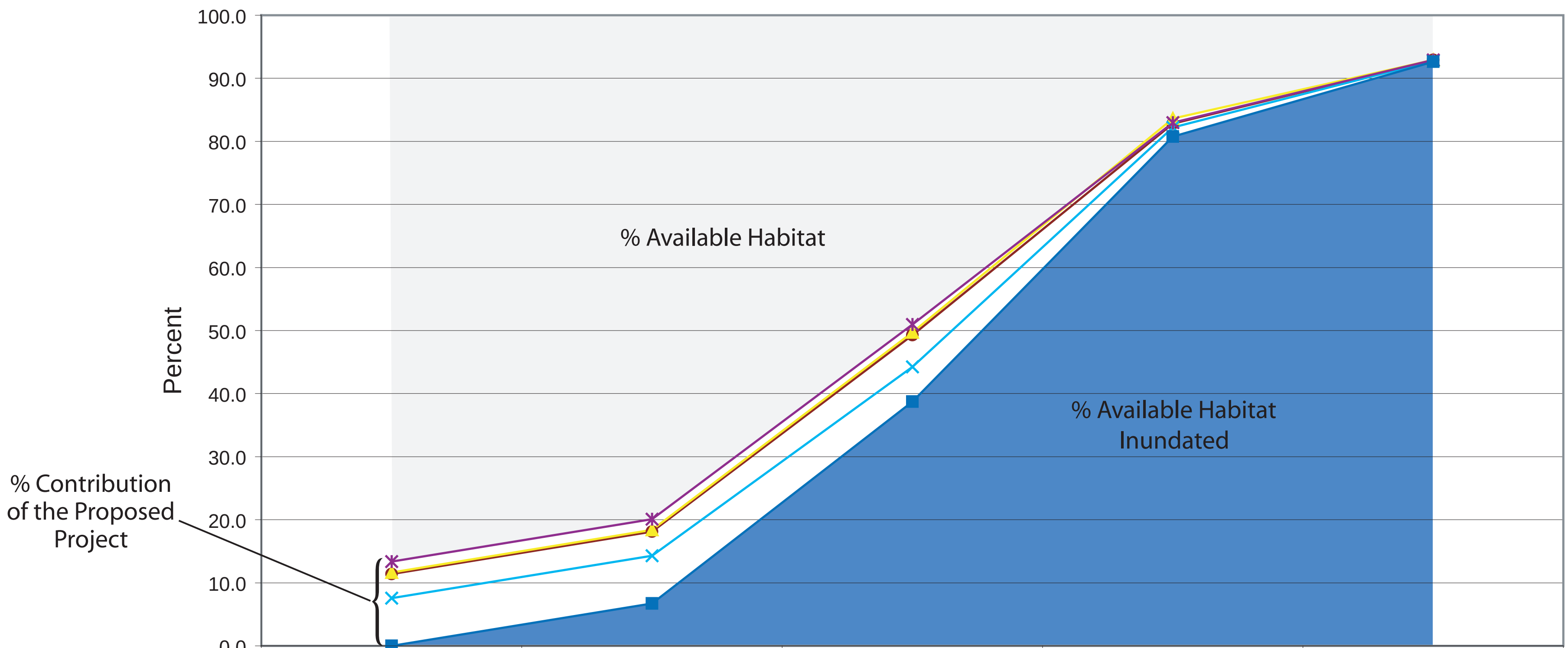
Figure 3-12
Percent Riparian Habitat Loss from Project Alternatives and Varying Lake Lake Levels



	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

03076.03 Wildlife Tech Memo

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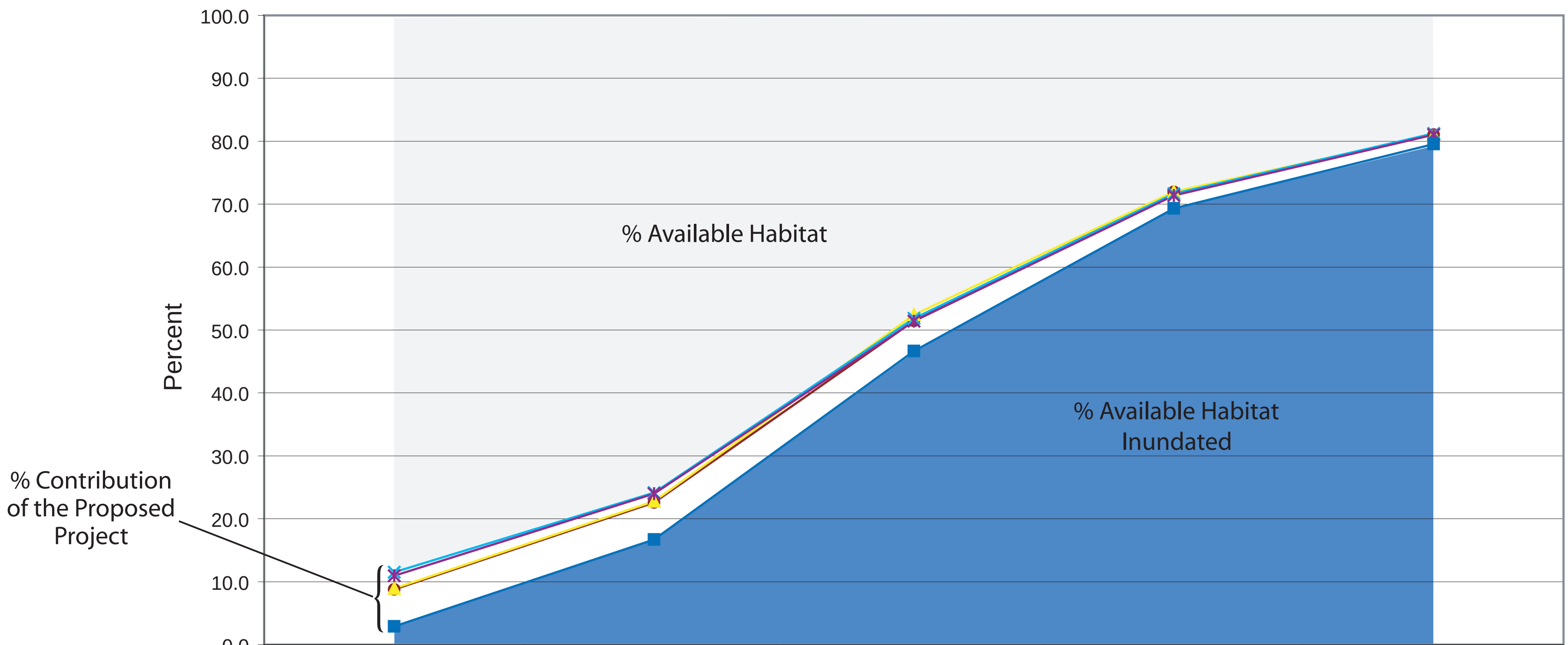
Figure 3-13
Percent Scrub Habitat Loss from
Project Alternatives and Varying Lake Lake Levels



	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

03076.03 Wildlife Tech Memo

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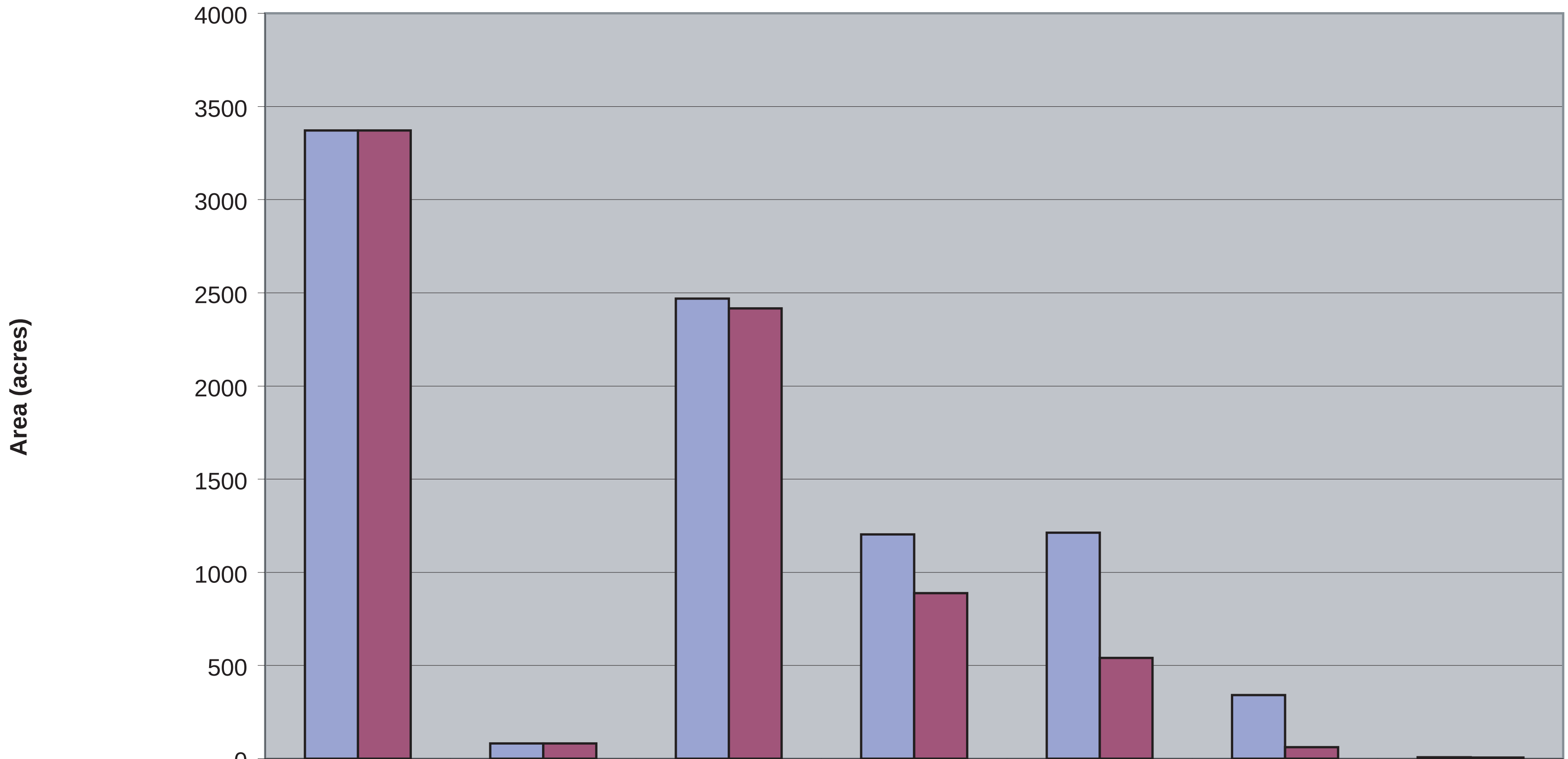
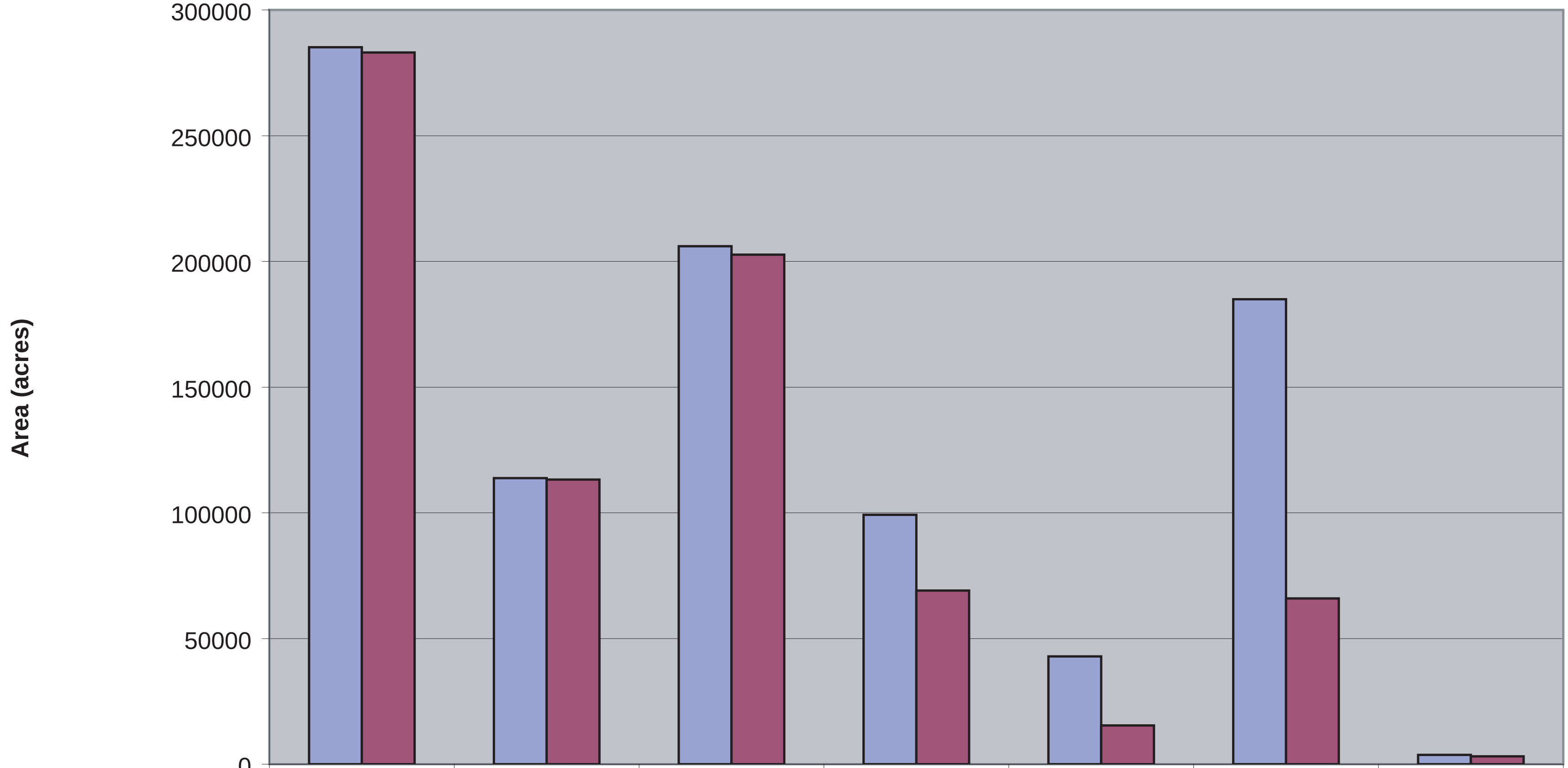
Figure 3-14
Percent Wet Meadow Habitat Loss from Project Alternatives and Varying Lake Lake Levels



	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)

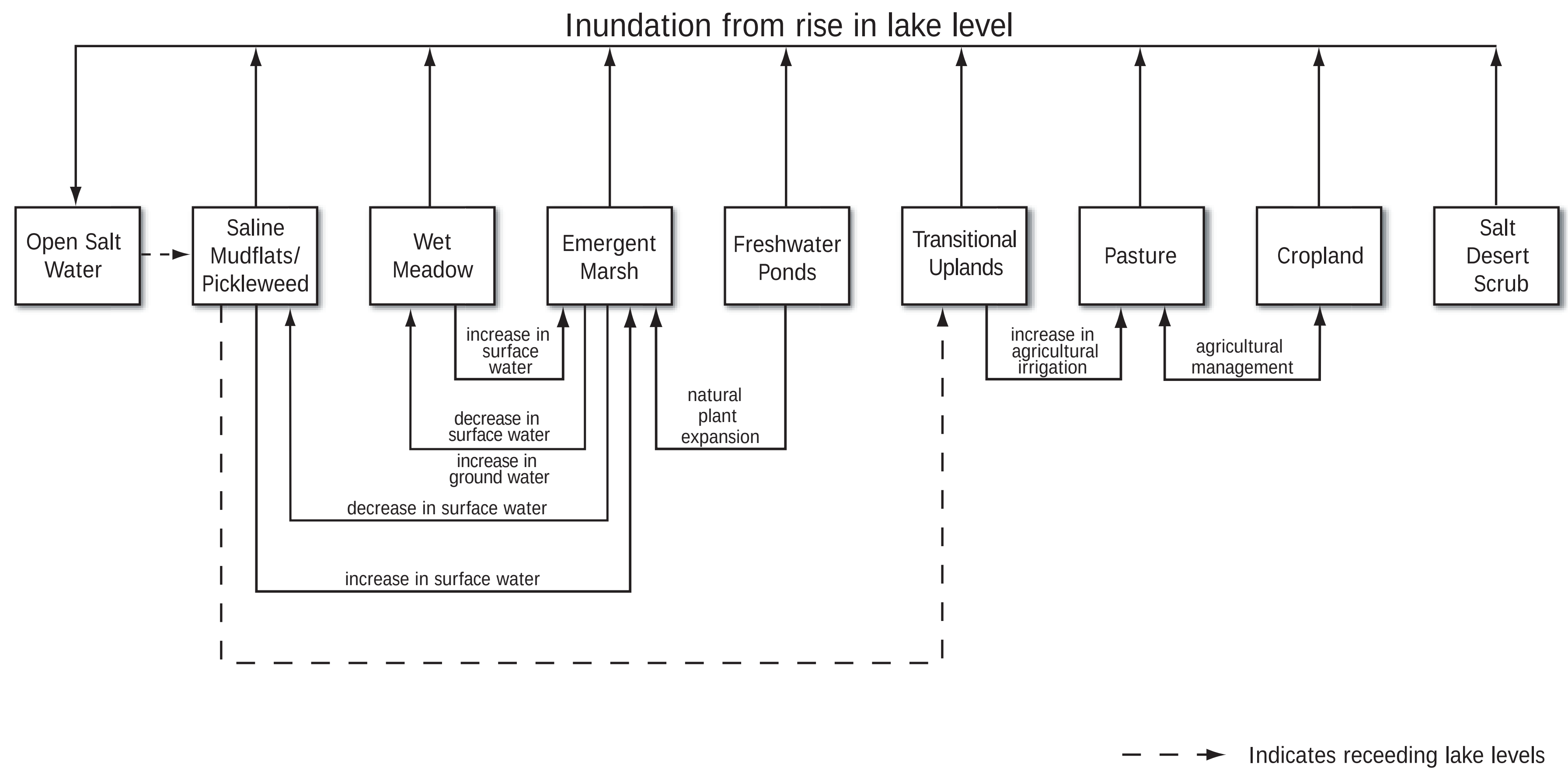
Figure 3-15
Wildlife Habitat Availability in Project Study Area at Low and High Lake Levels



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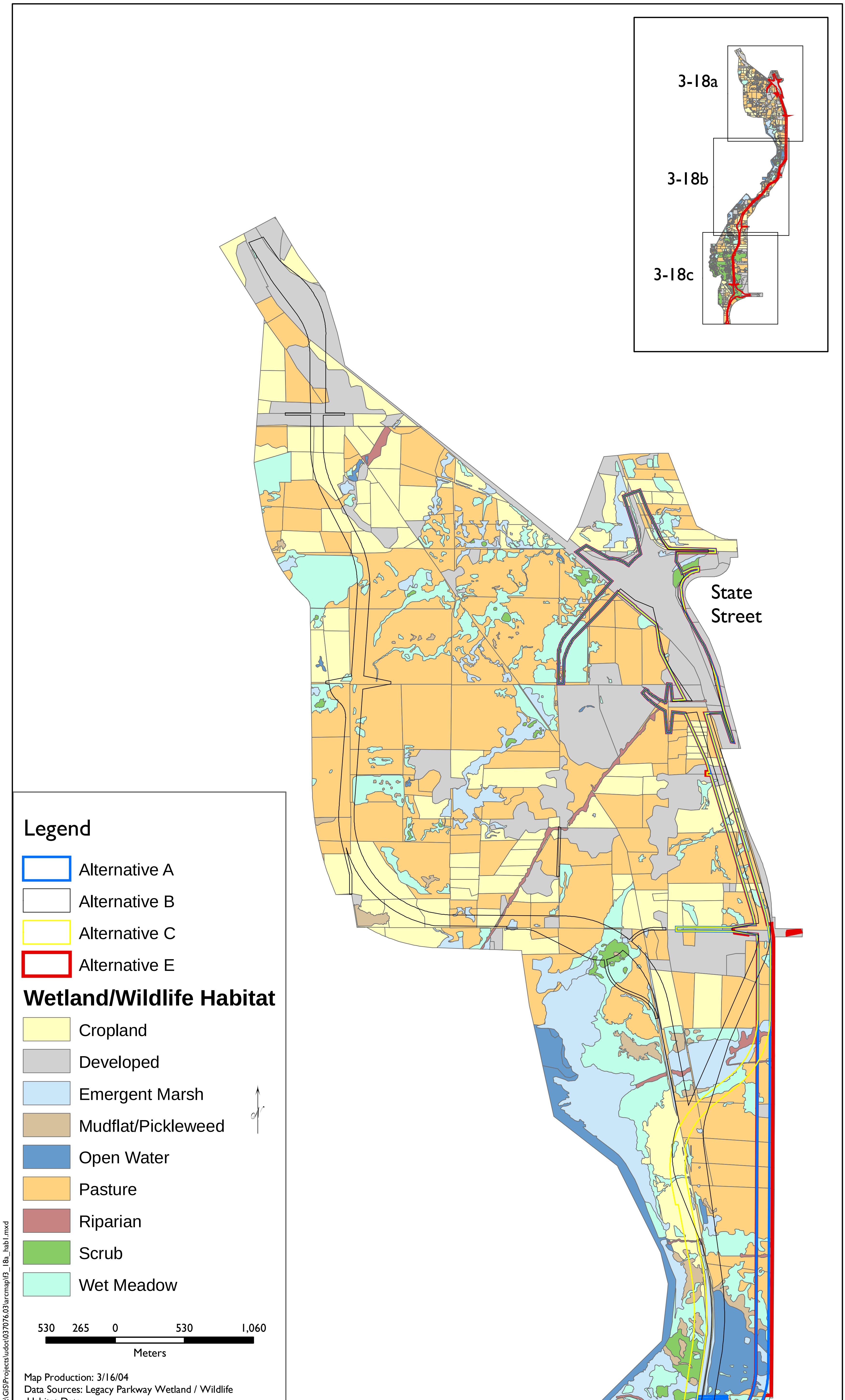
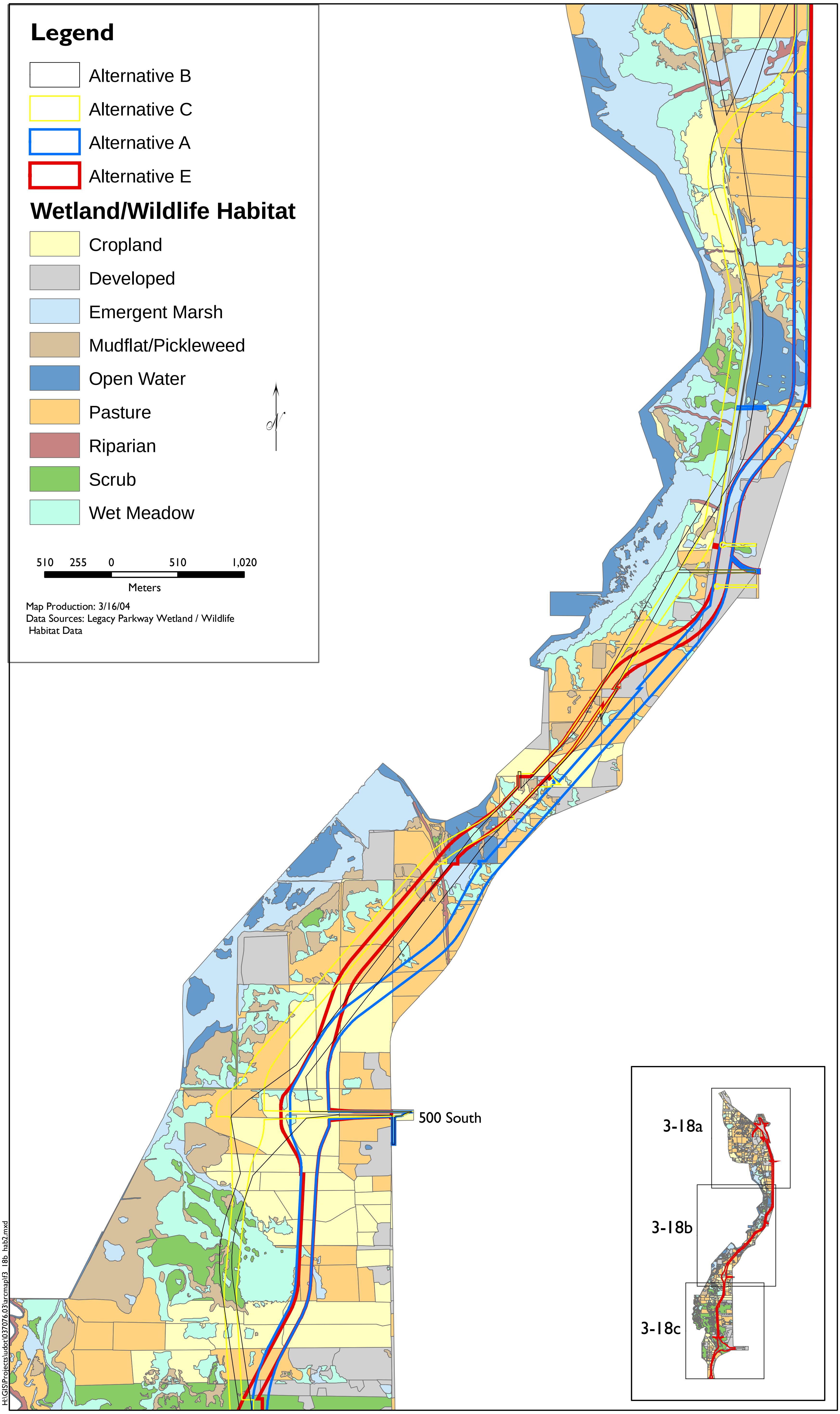
Figure 3-17
Conceptual Ecological Model:
Dynamics of Great Salt Lake Shoreline Habitats



Jones & Stokes

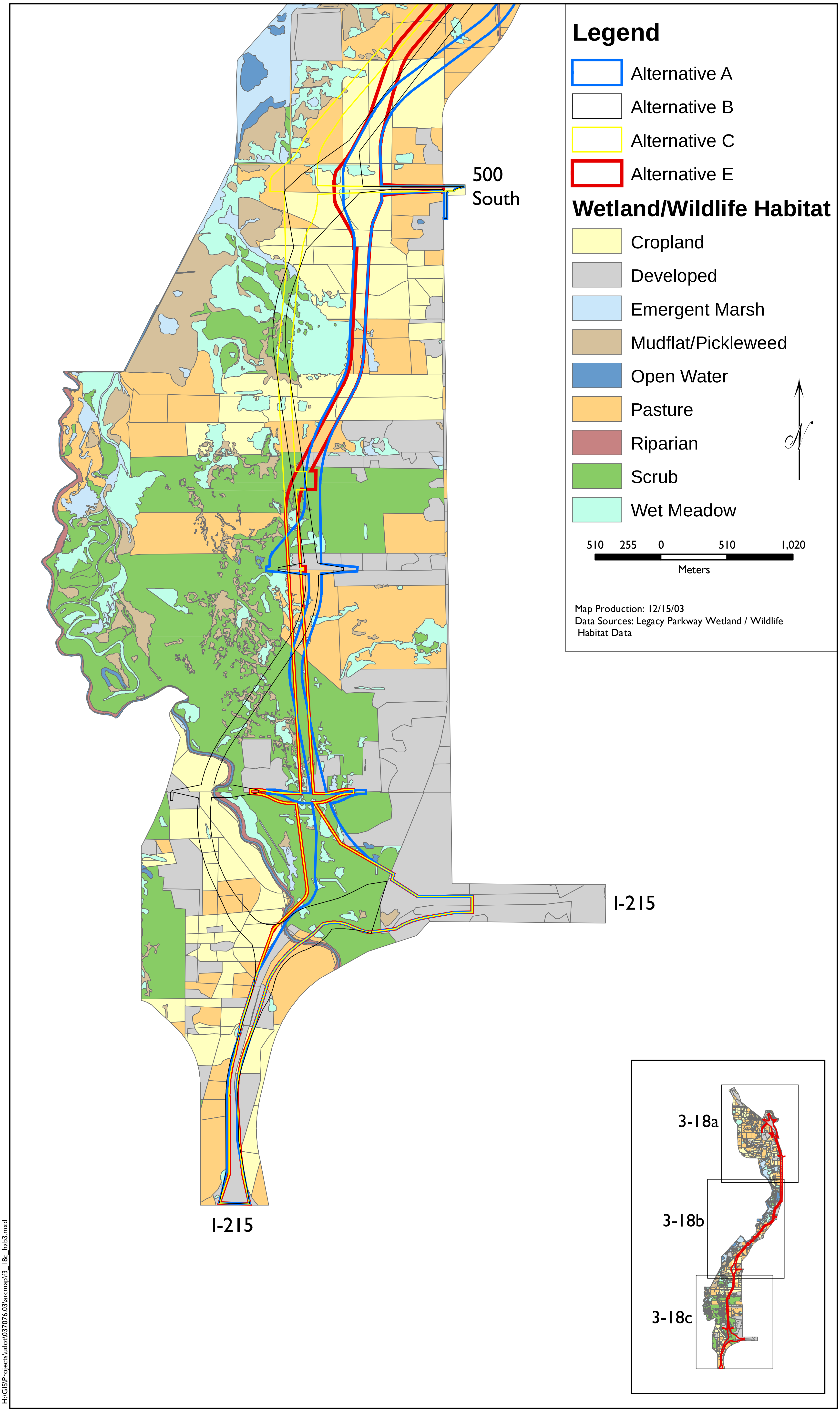
Figure 3-18a

Wildlife Habitats and Build Alternatives in the Legacy Parkway Project Study Area



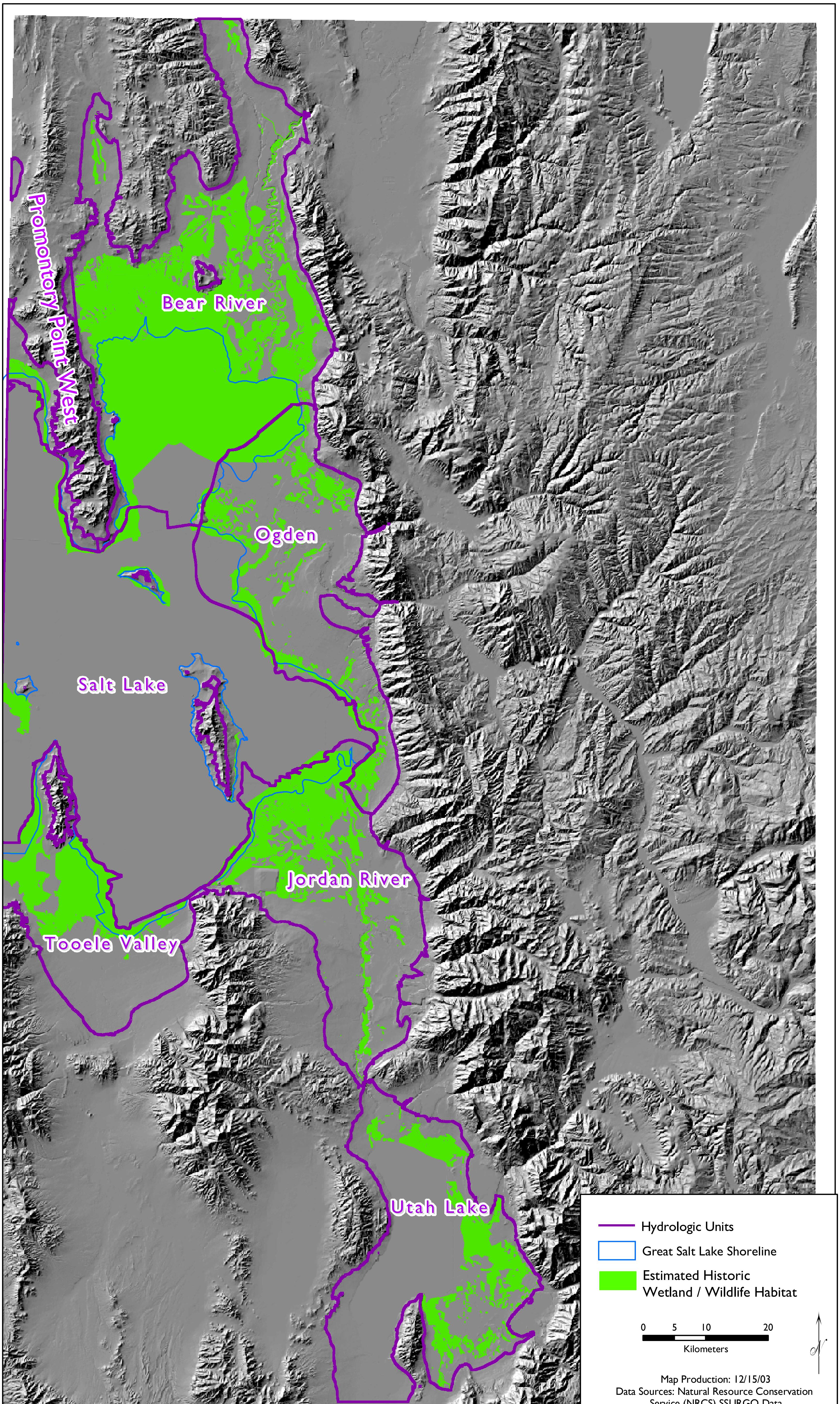
Jones & Stokes

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



Jones & Stokes

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



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Jones & Stokes

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

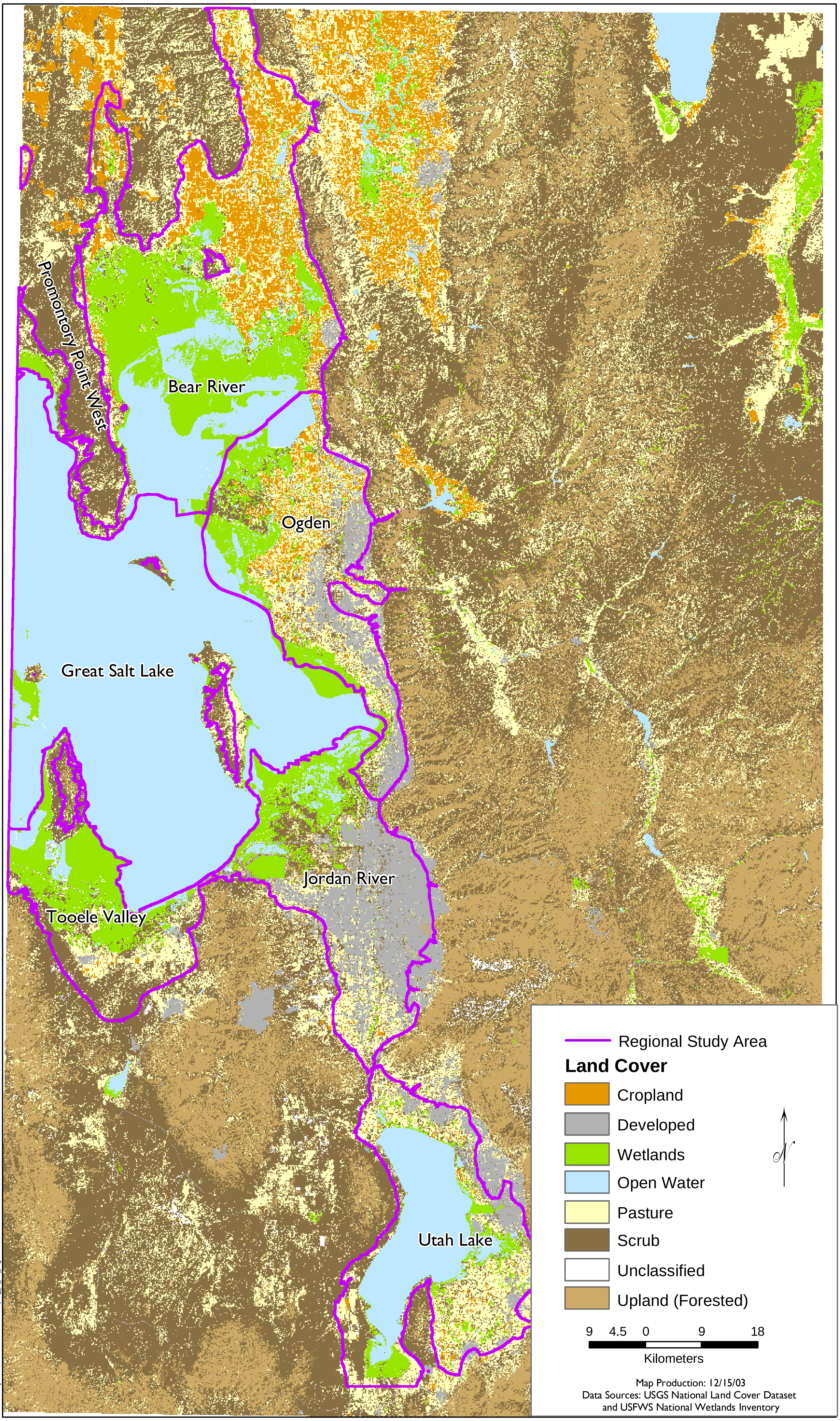

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Figure 3-20
Regional Study Area Land Cover

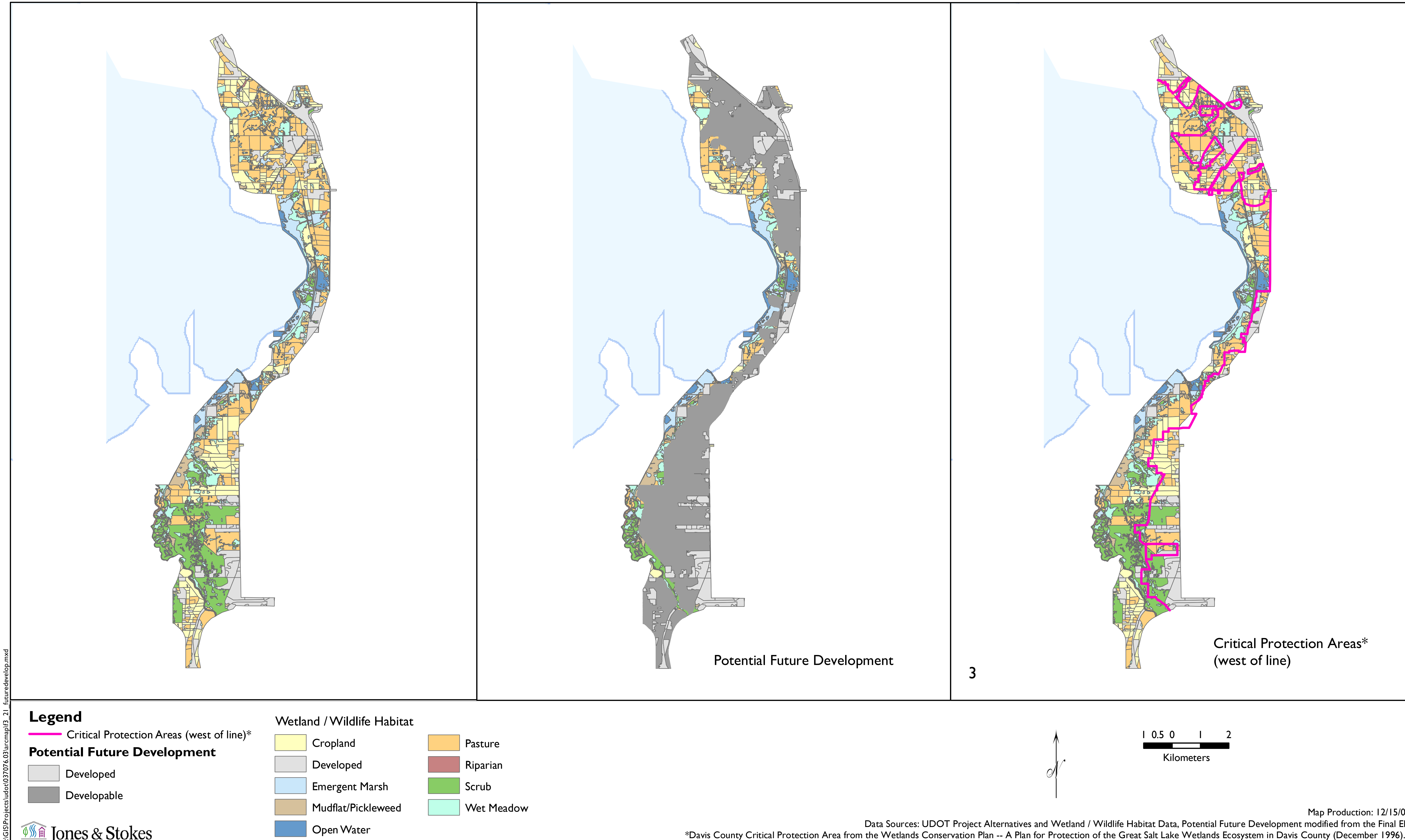

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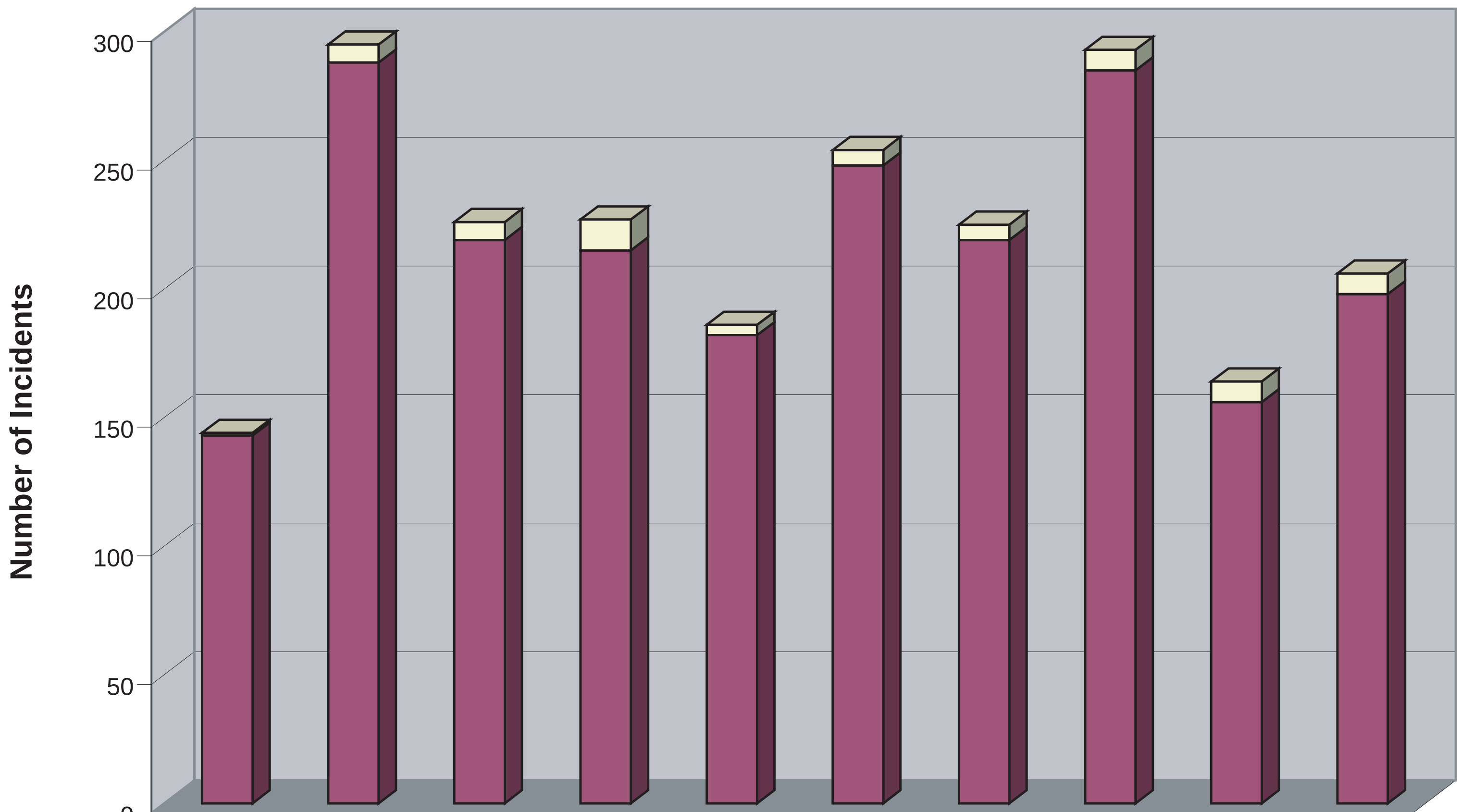
Figure 3-21
Legacy Parkway Study Area Potential Future Development



	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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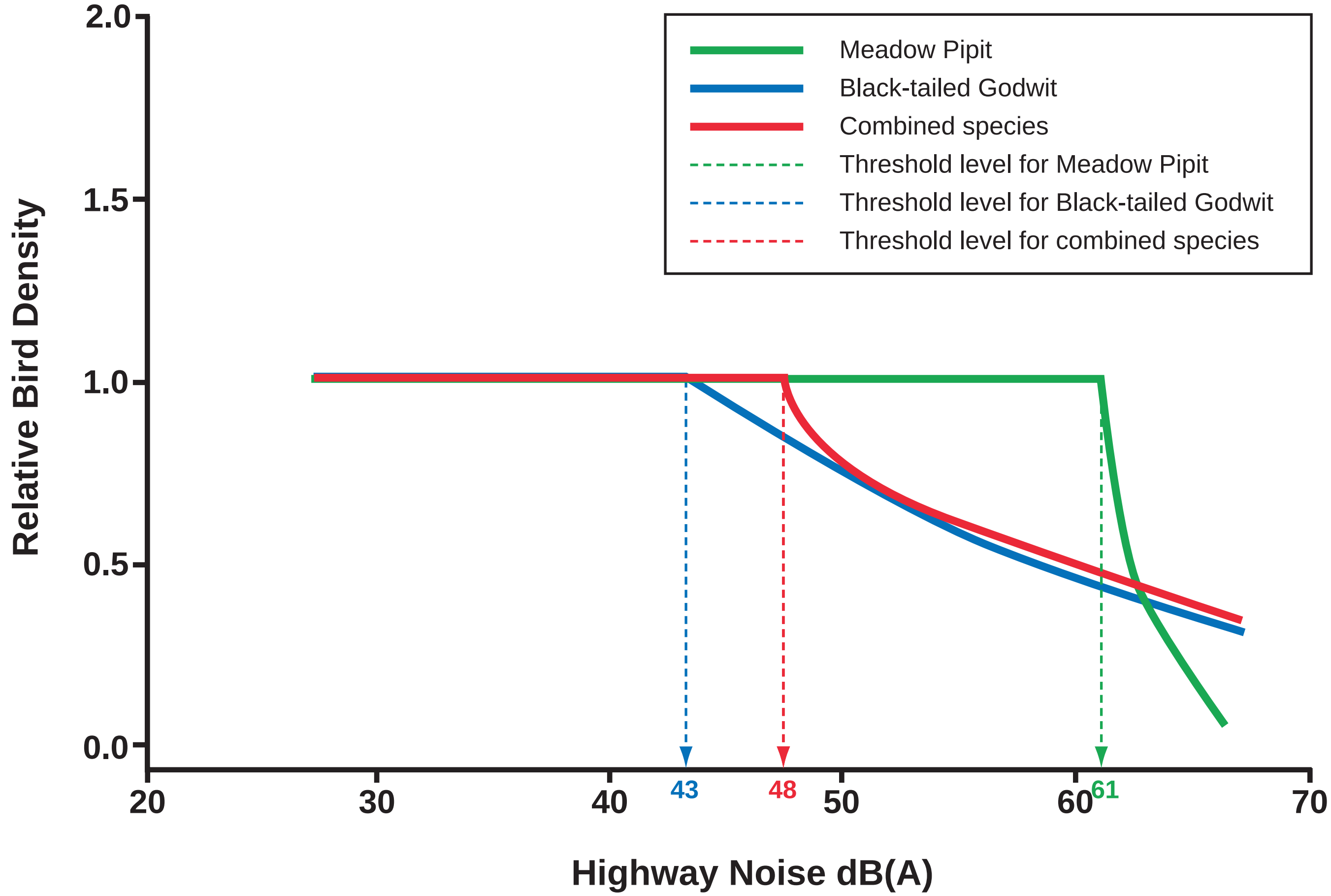
Jones & Stokes

Figure 3-22
Highway Incidents Involving Hazardous Materials in Utah



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

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

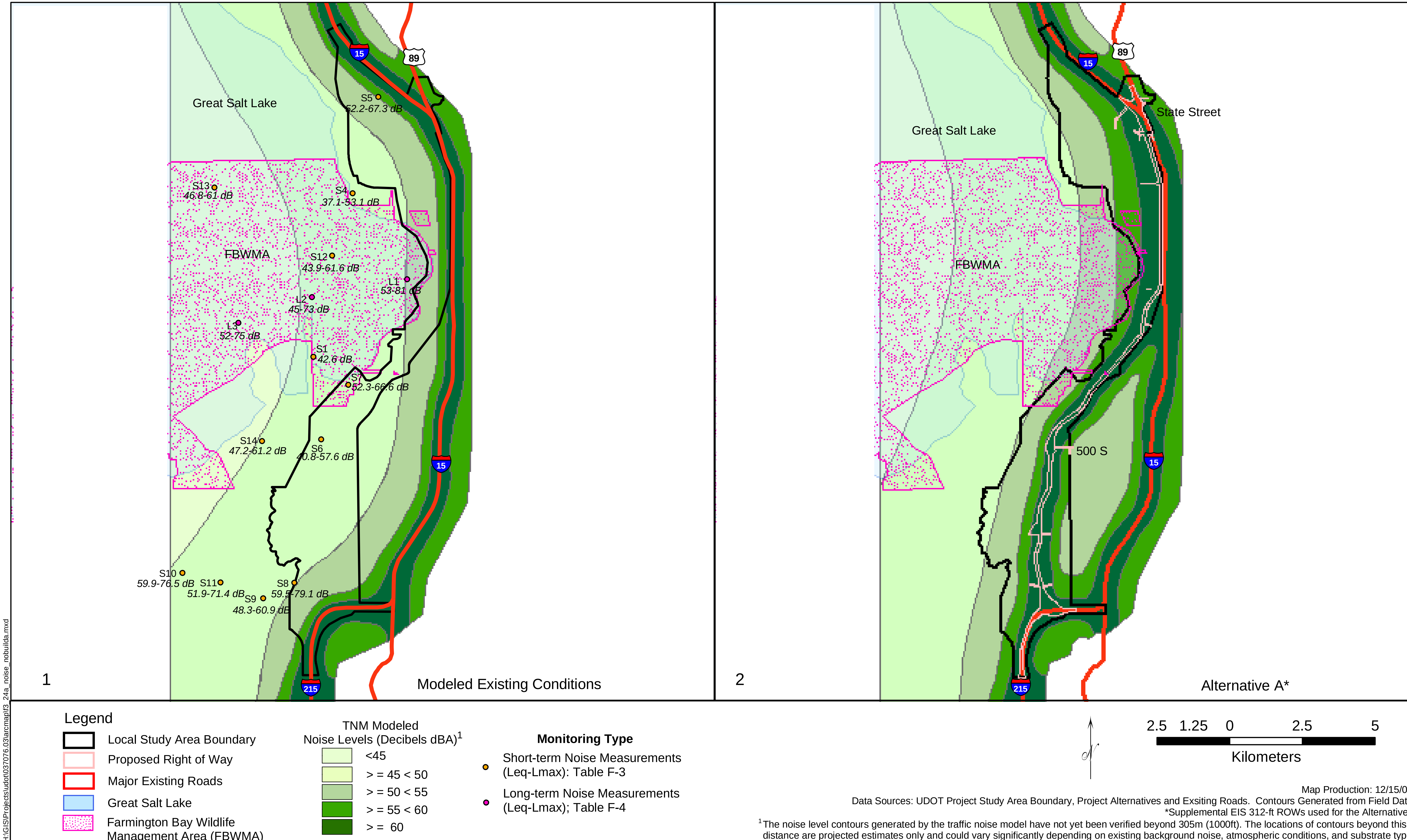


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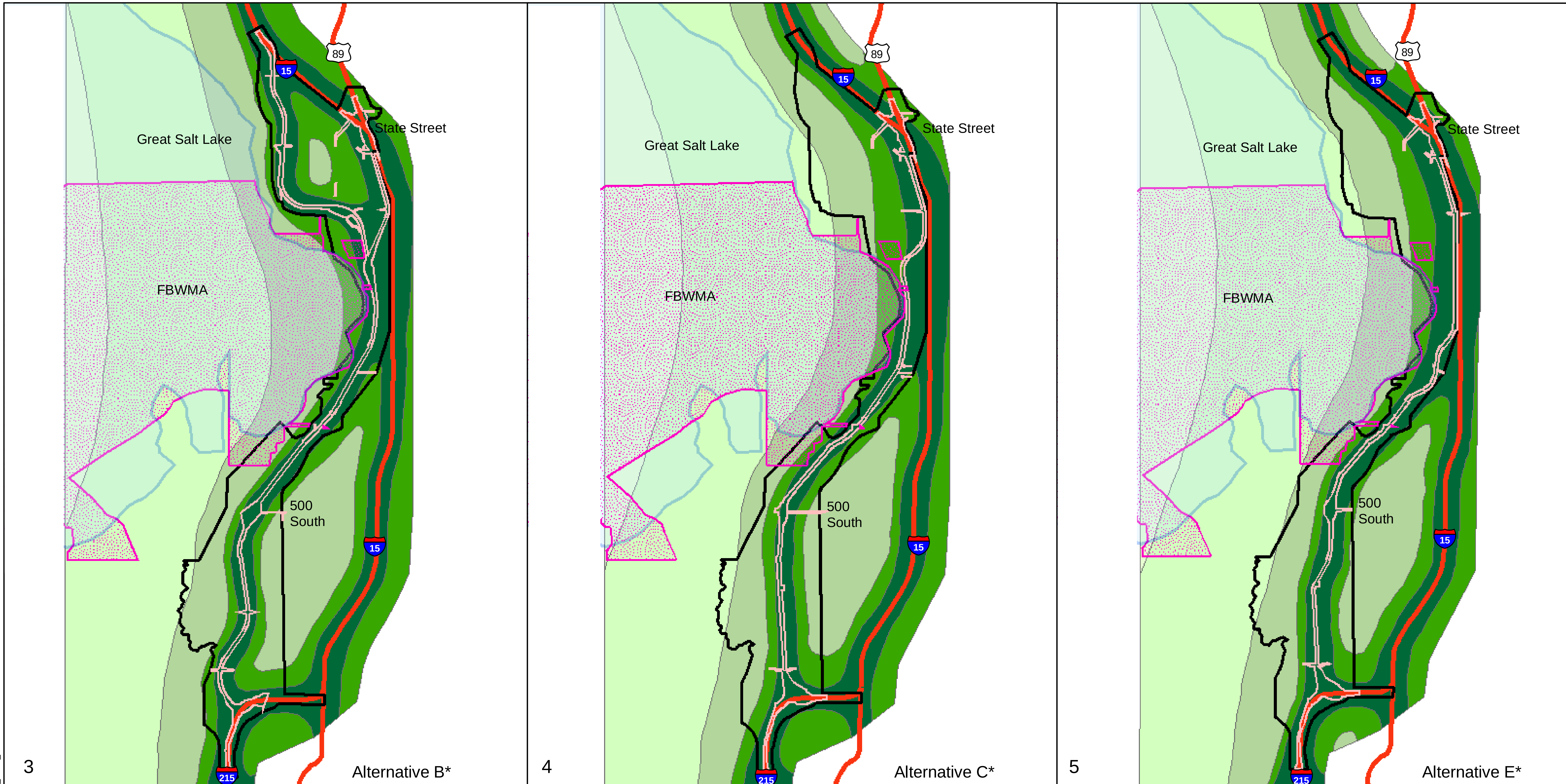
Figure 3-24a
Highway Noise Level for the Legacy Parkway



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

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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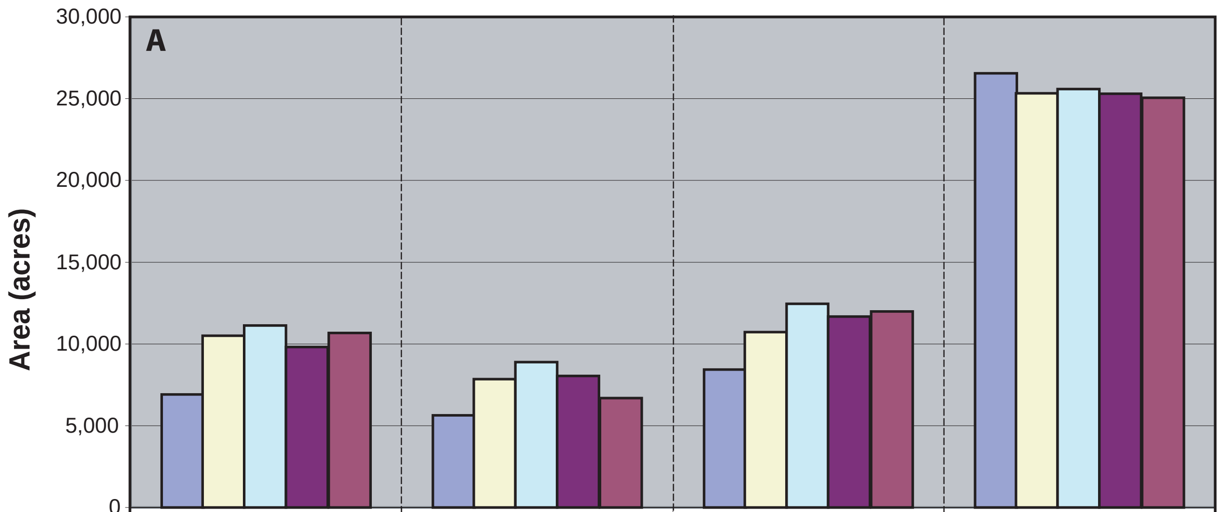
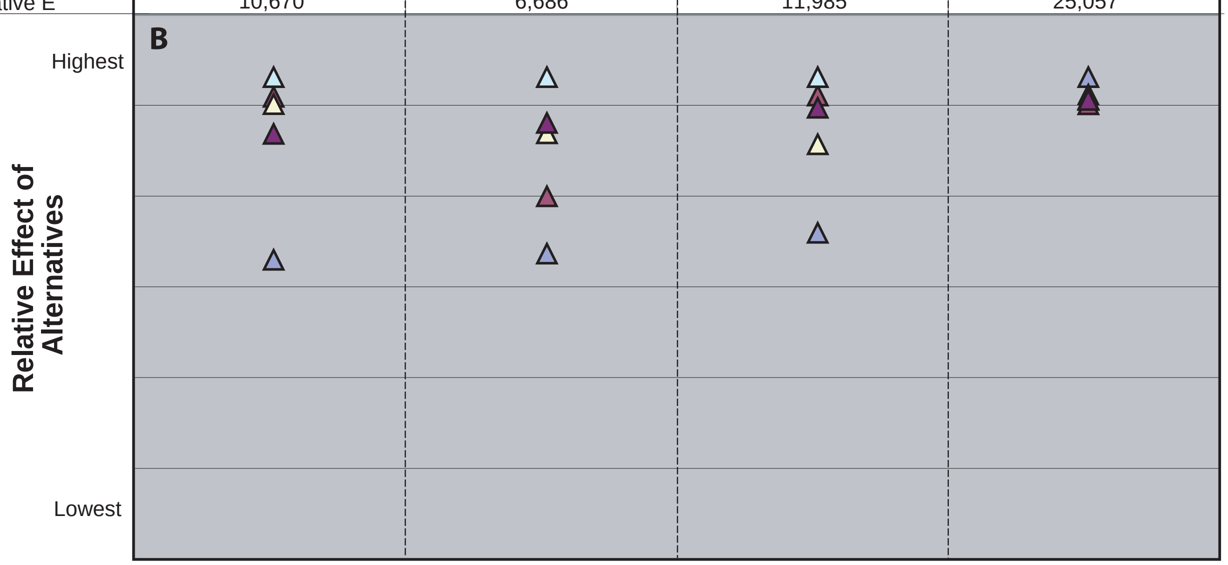
Jones & Stokes

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

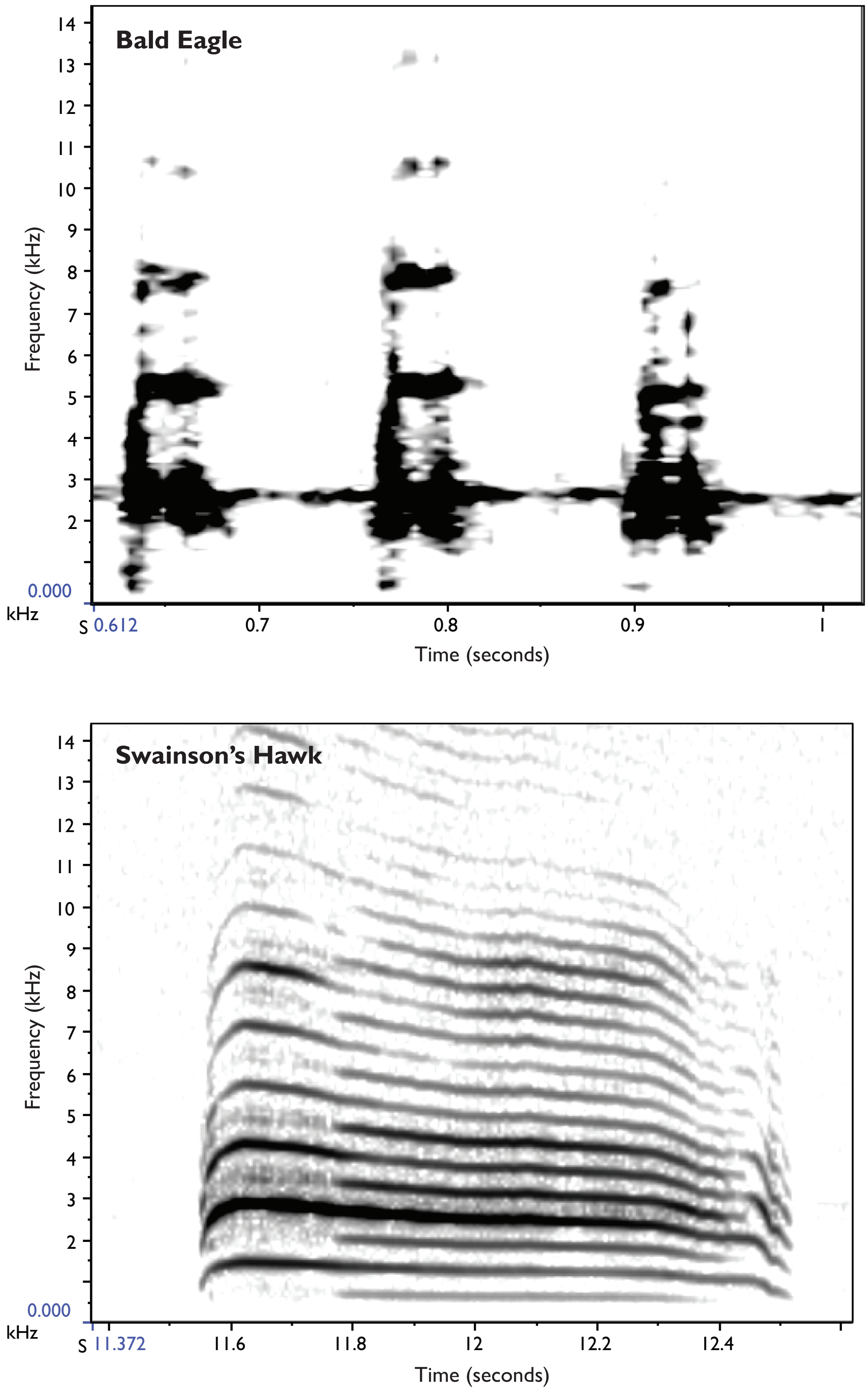

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Figure 3-26a
Bird Vocalization Sonograms
Bald Eagle and Swainson's Hawk

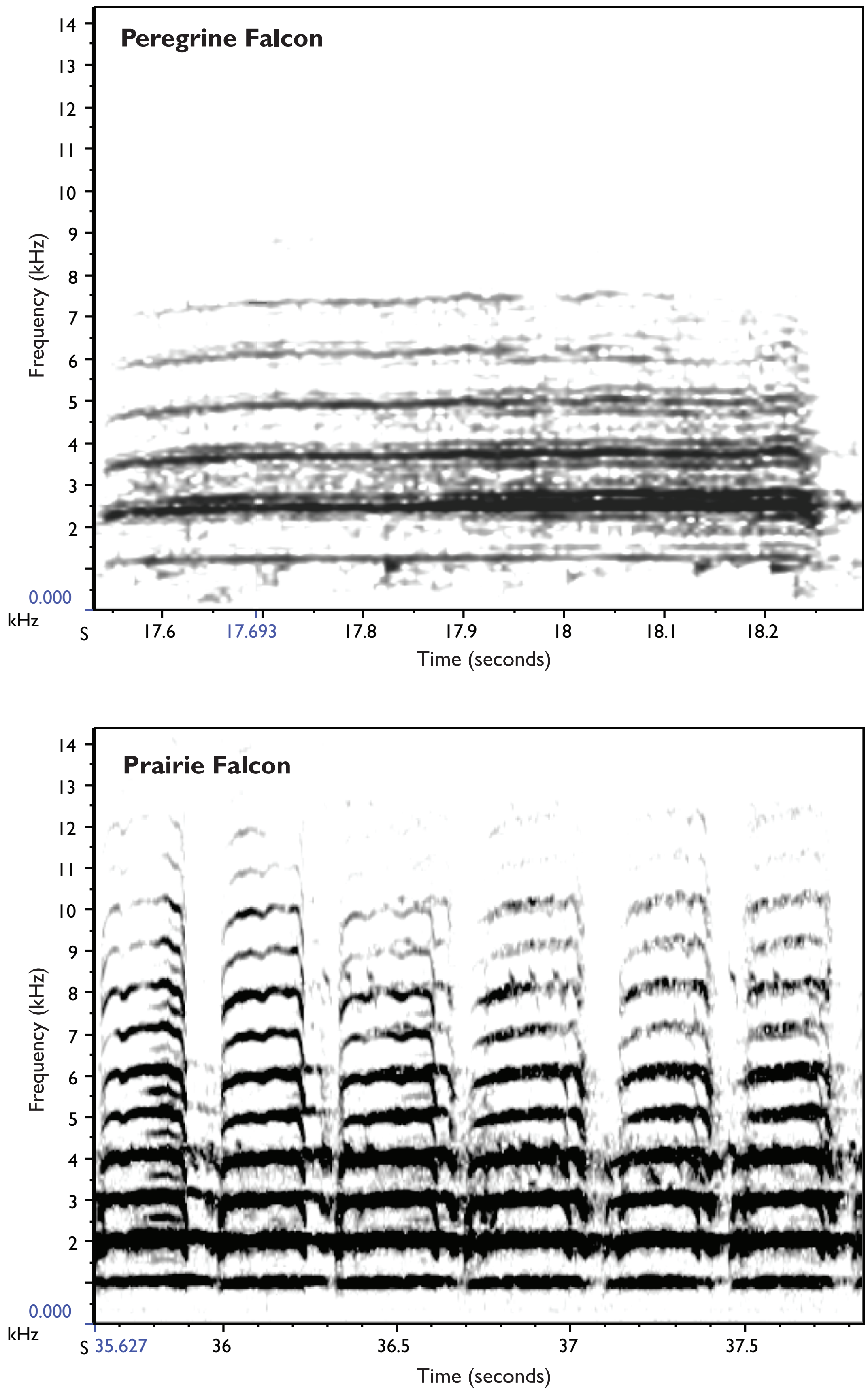

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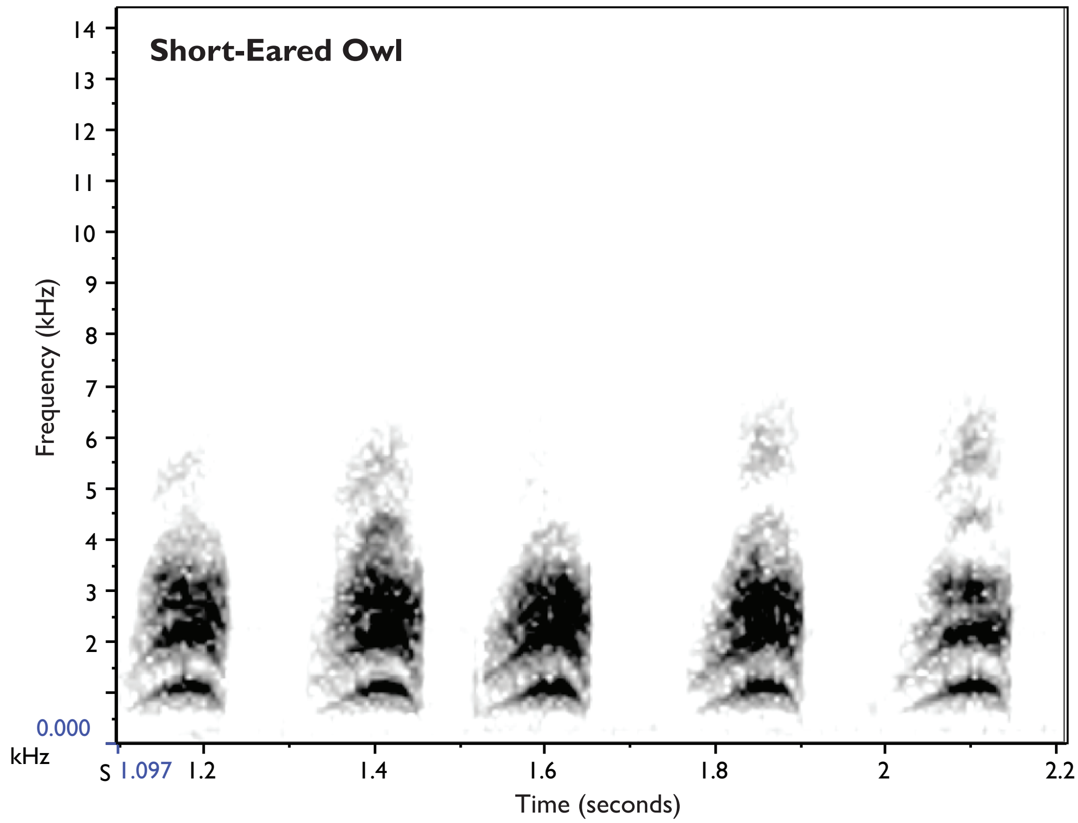
Figure 3-26b
Bird Vocalization Sonograms
Peregrine Falcon and Prairie Falcon



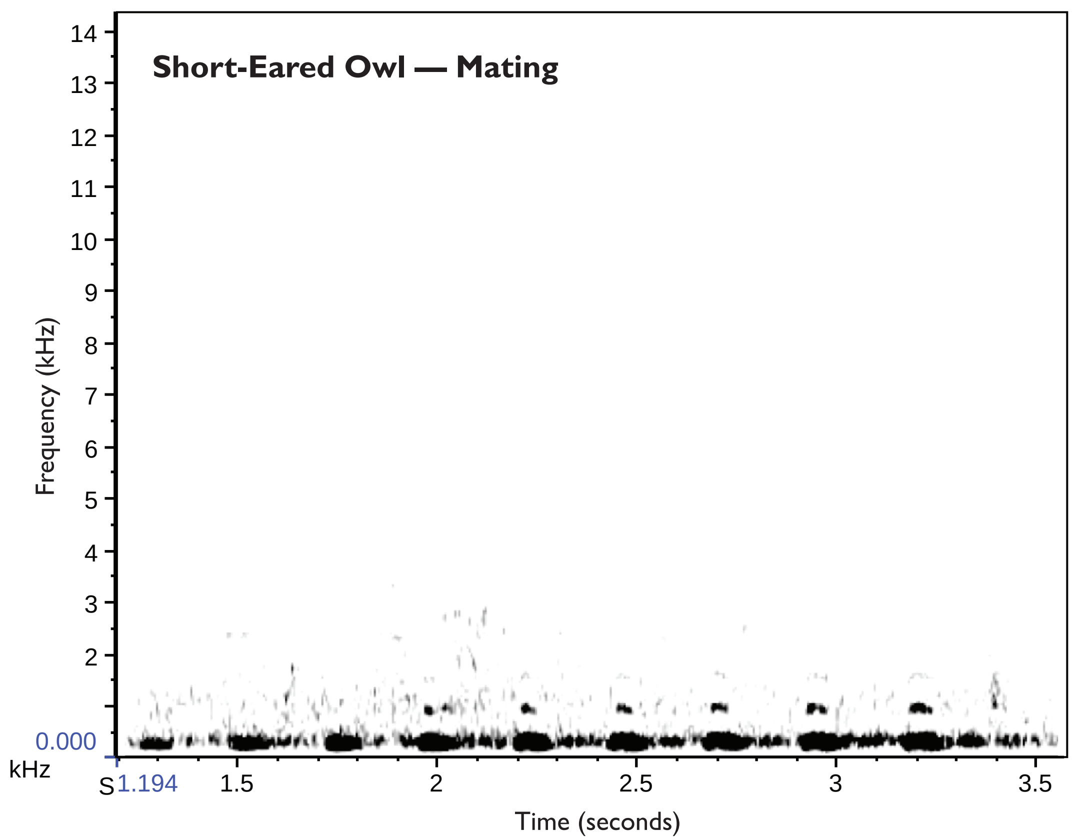


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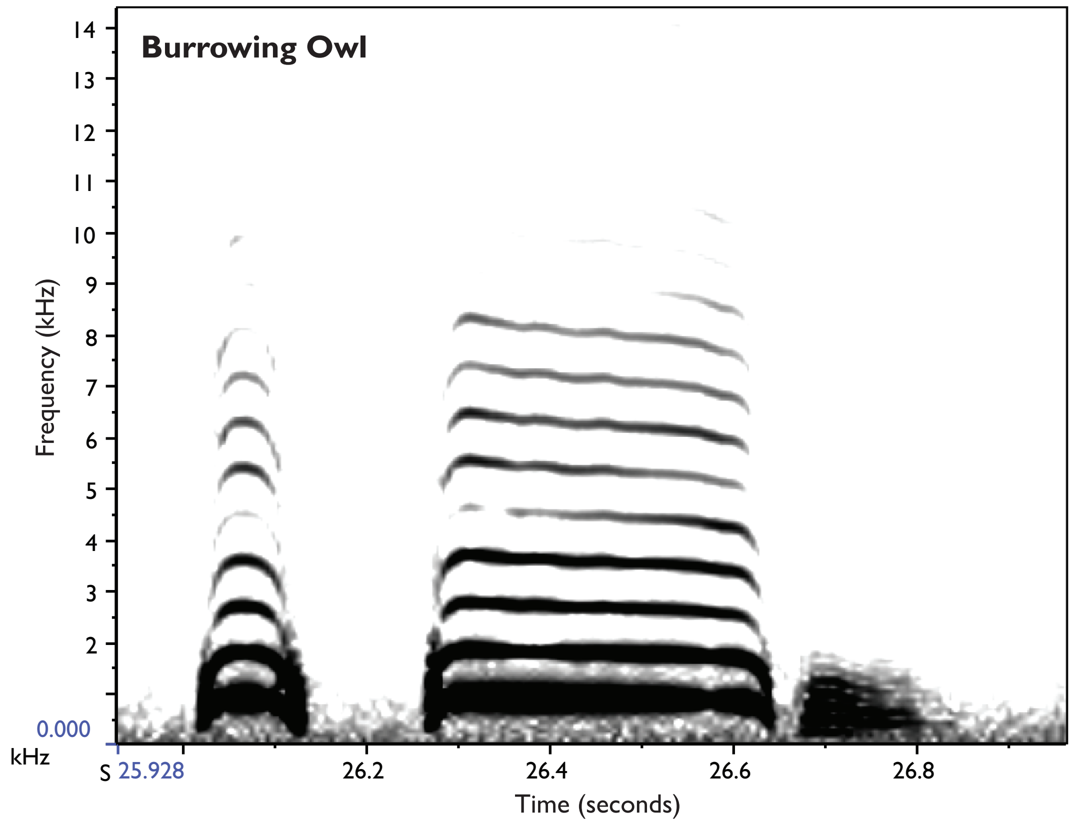
Figure 3-26c
Bird Vocalization Sonograms
Short-Eared Owl



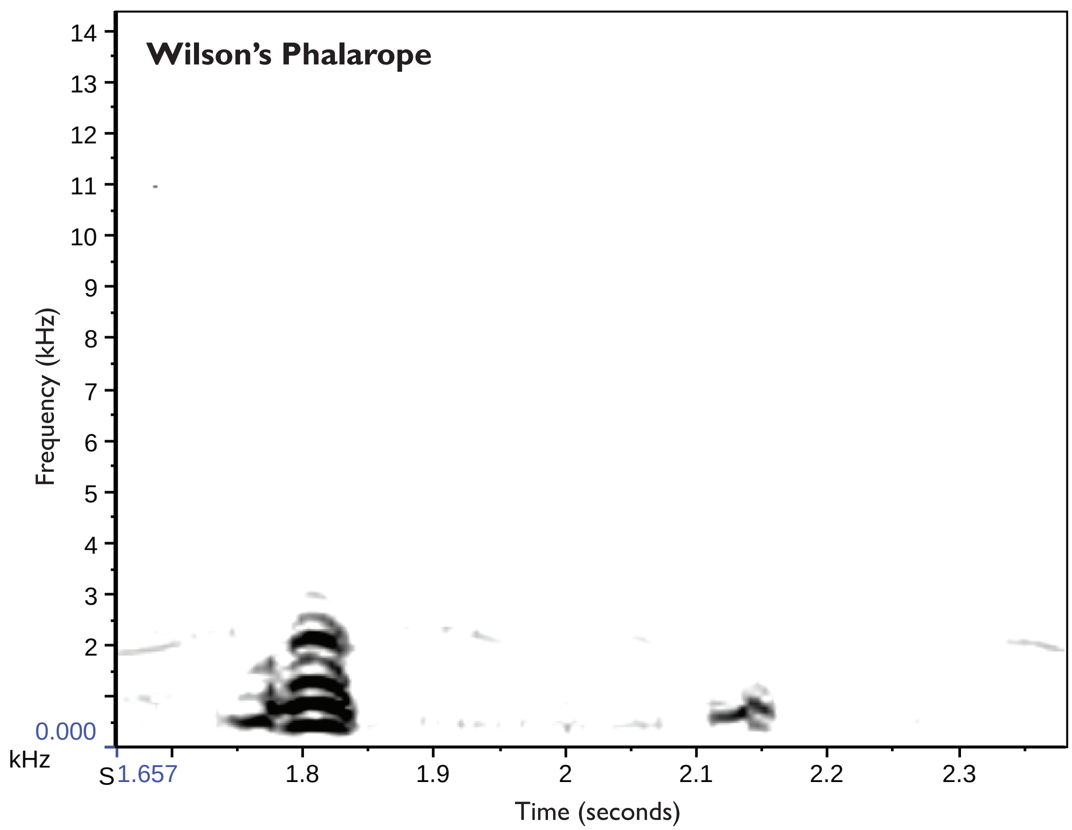
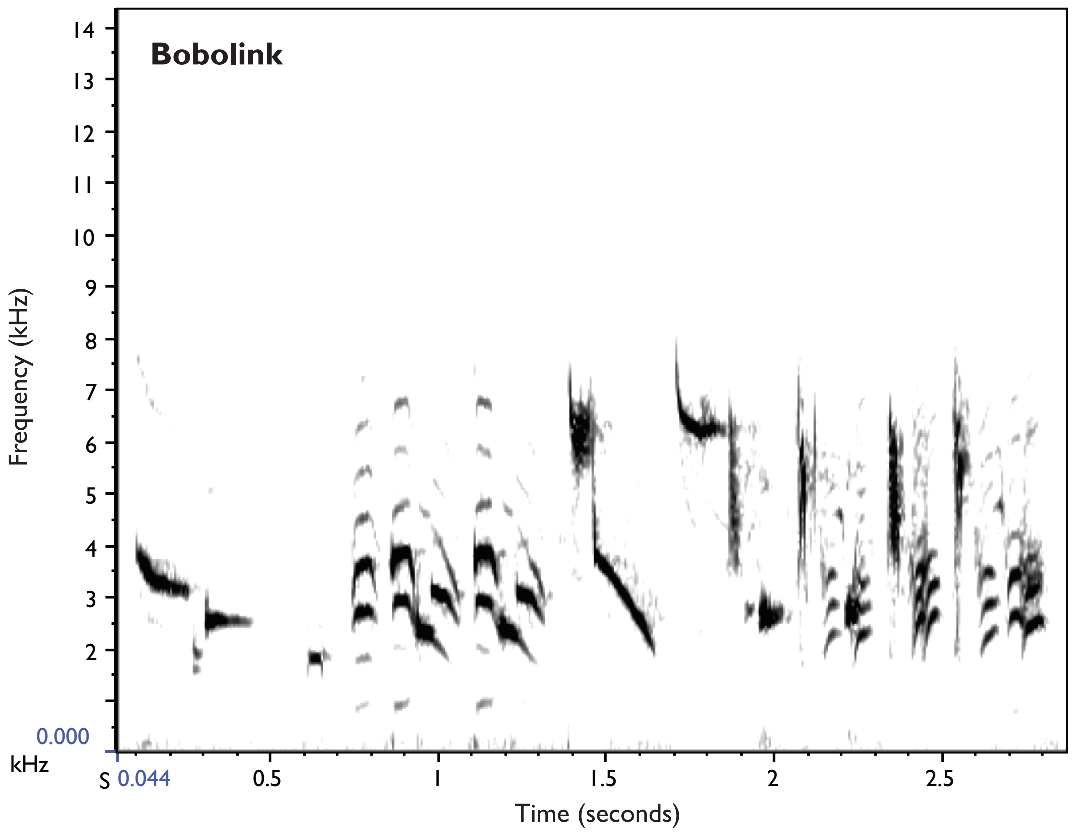


Figure 3-26d
Bird Vocalization Sonograms
Burrowing Owl and Wilson's Phalarope



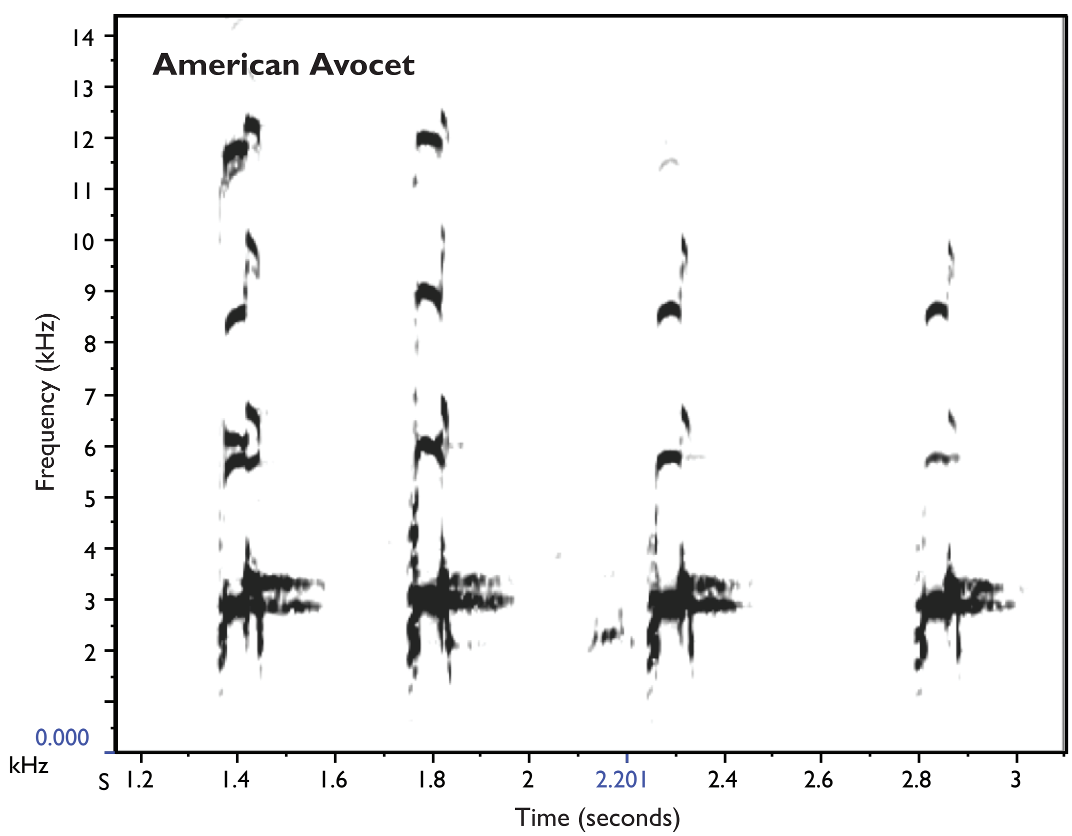


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Figure 3-26e
Bird Vocalization Sonograms
Bobolink and American Avocet

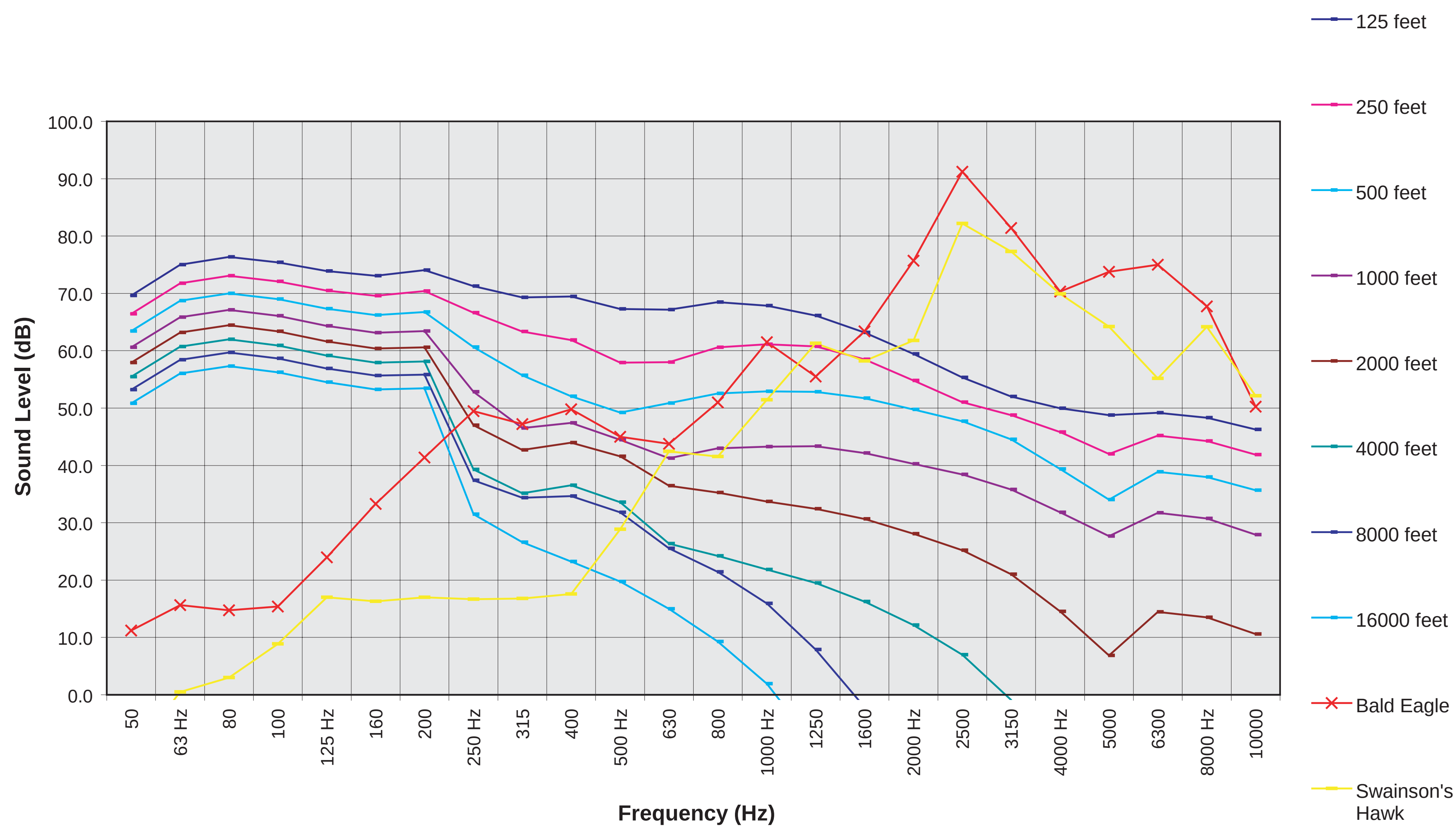

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Figure 3-27a
Traffic Noise Masking Thresholds and Vocal Signal Profiles at 50 Feet
Bald Eagle and Swainson's Hawk

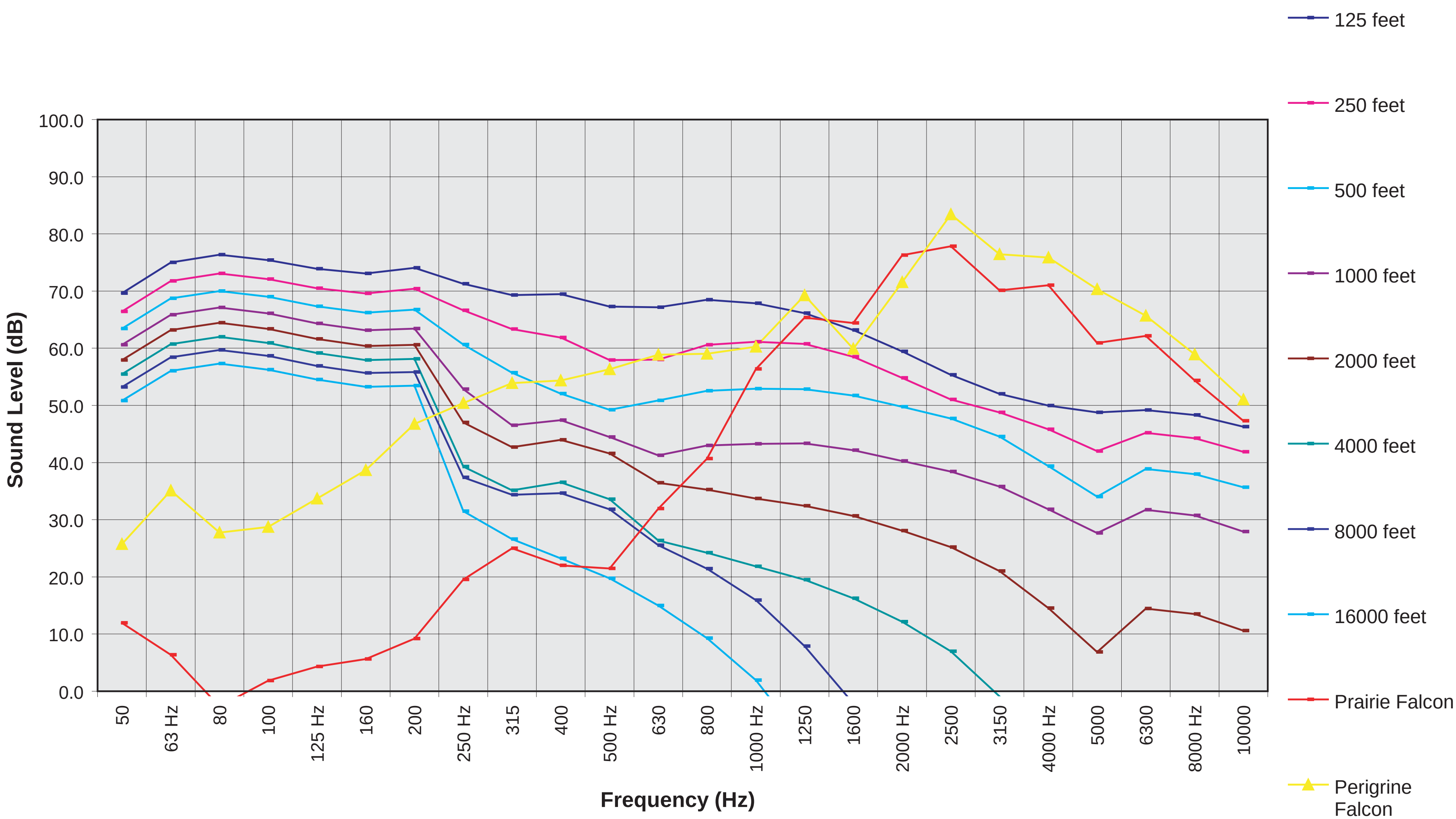

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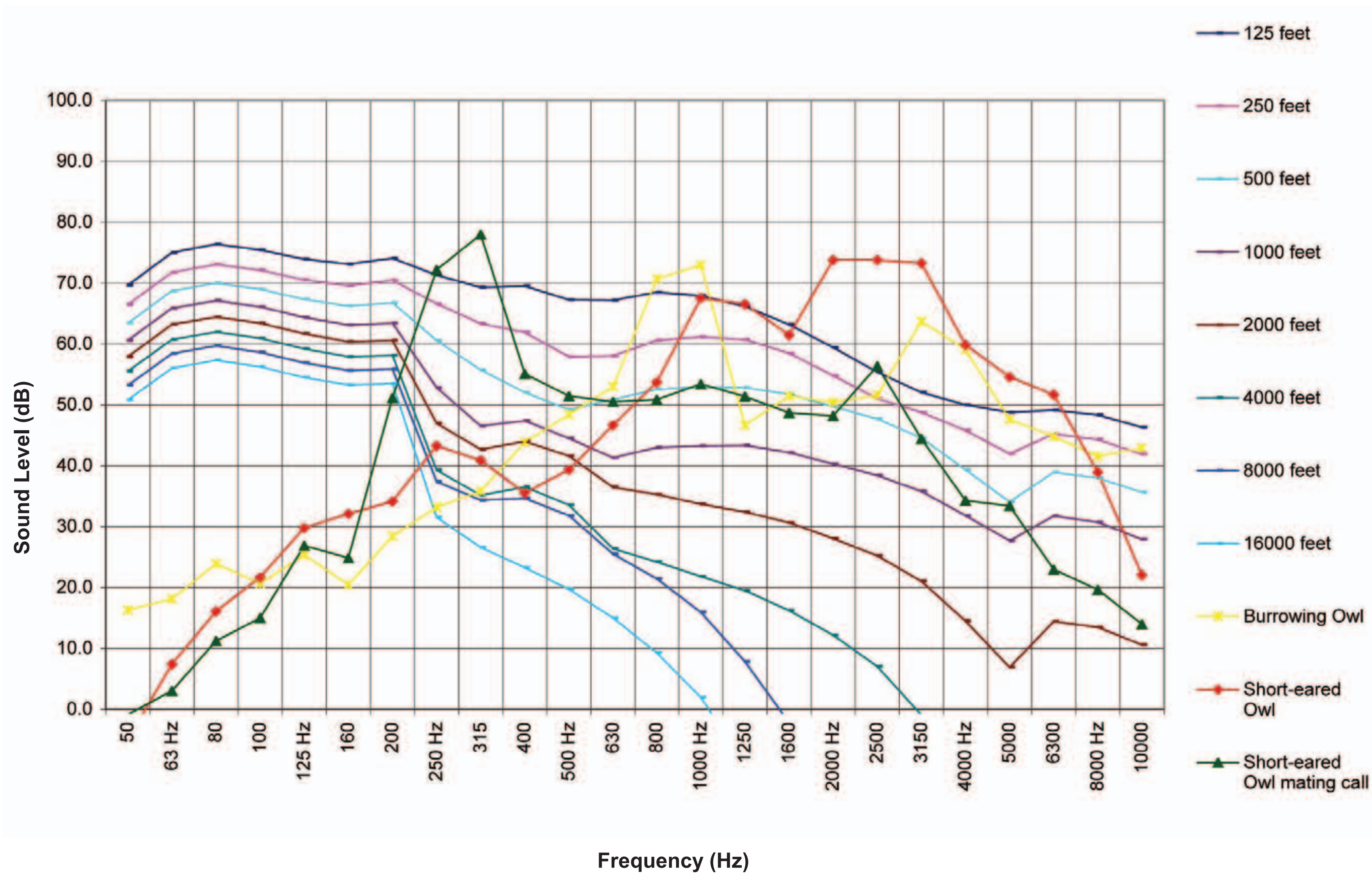
Figure 3-27b
Traffic Noise Masking Thresholds and Vocal Signal Profiles at 50 Feet
Peregrine Falcon and Prairie Falcon



Jones & Stokes

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

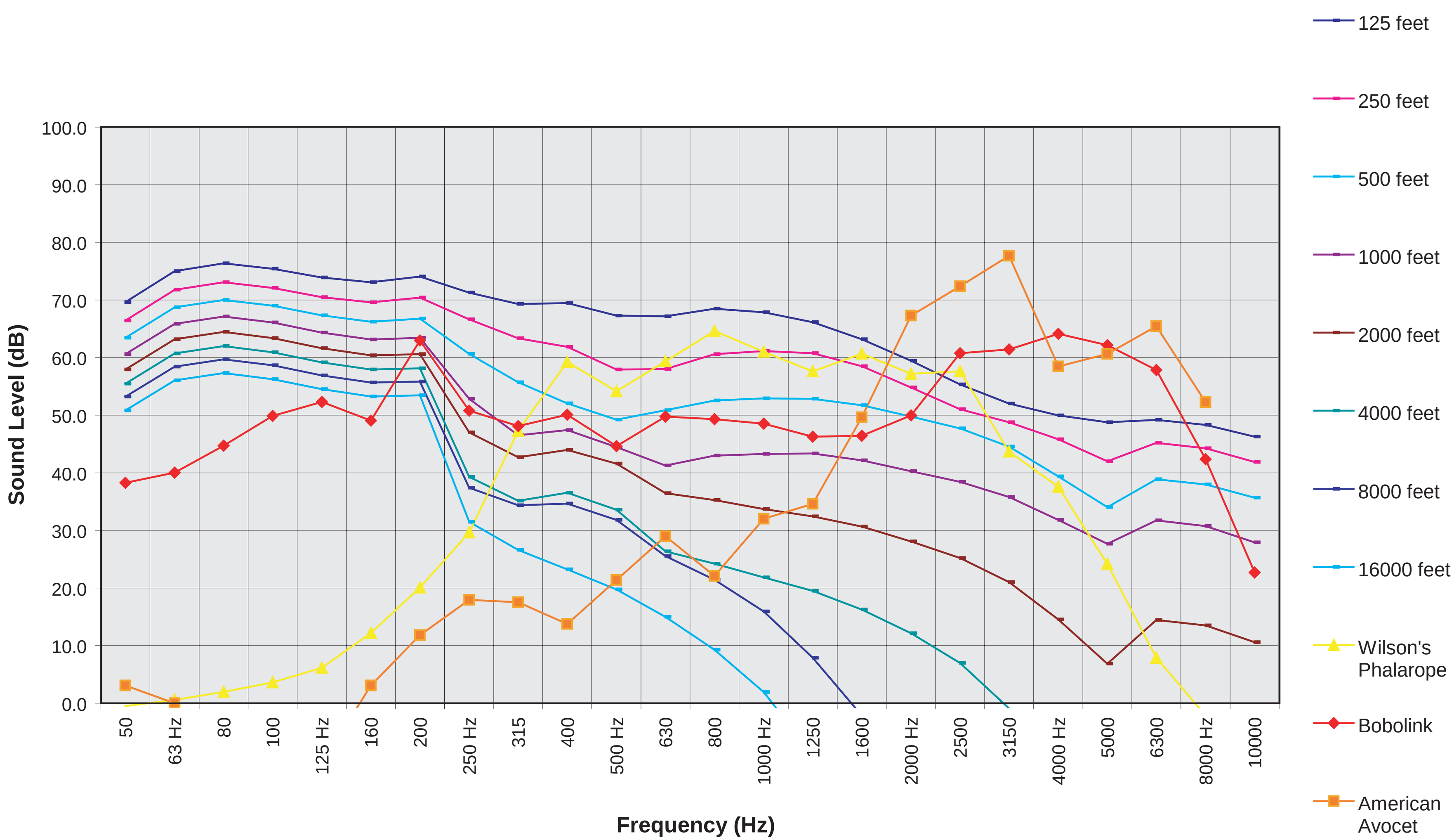


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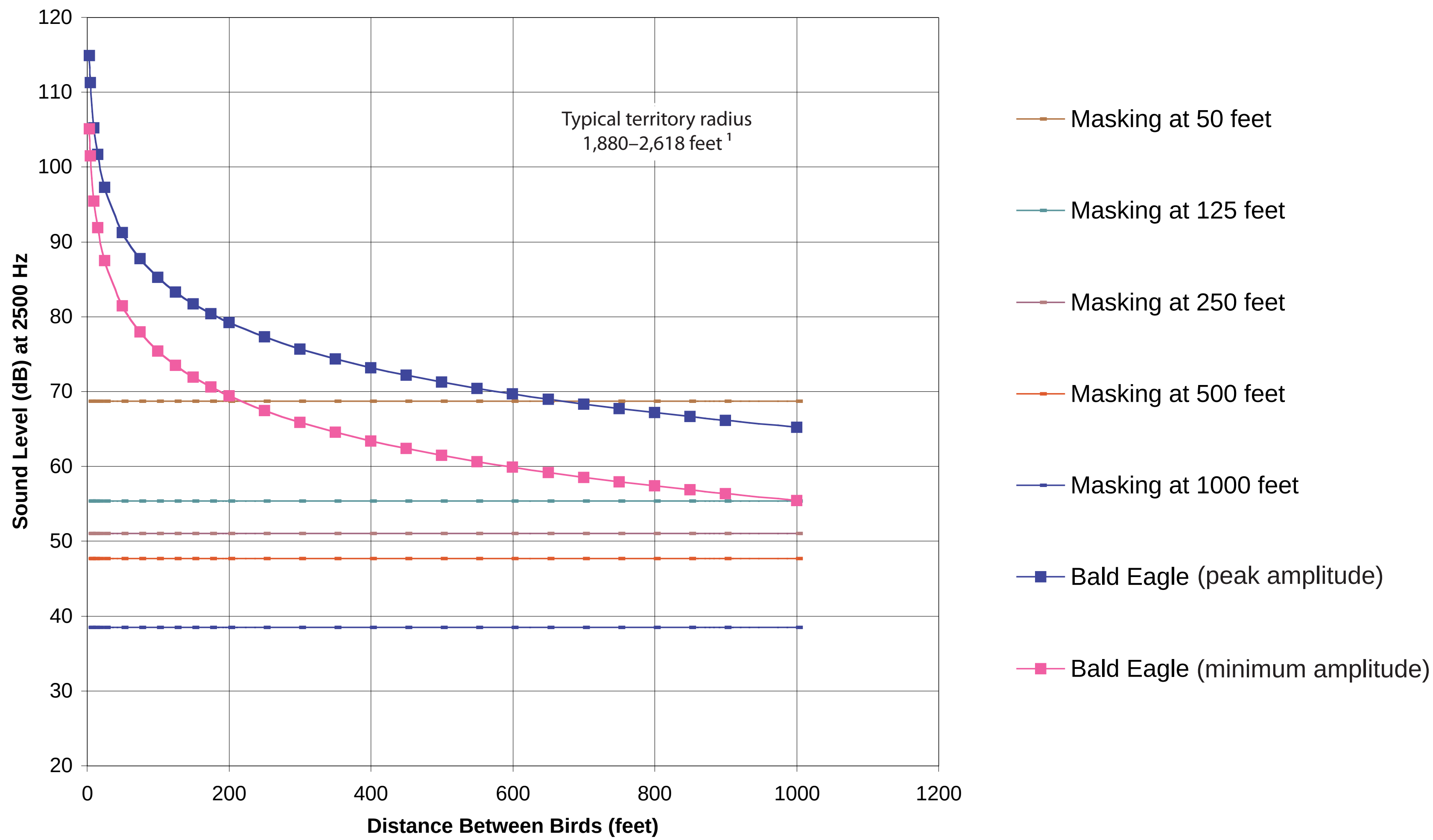
Figure 3-27d
Traffic Noise Masking Thresholds and Vocal Signal Profiles at 50 Feet
Wilson's Phalarope, Bobolink and American Avocet



[1] Buehler 2000

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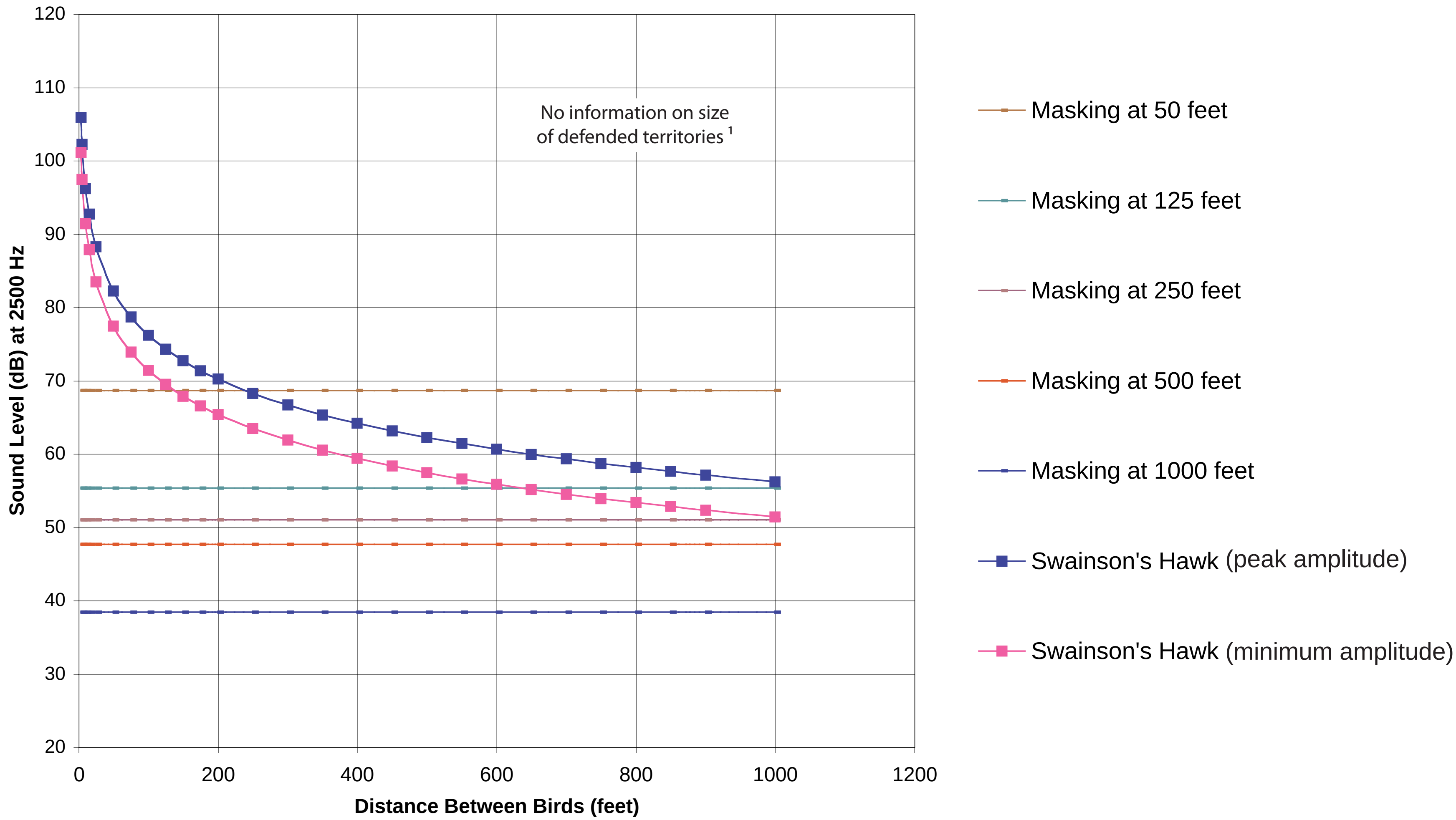
Figure 3-28a
Bald Eagle Masking Distance



[1] England et al. 1997

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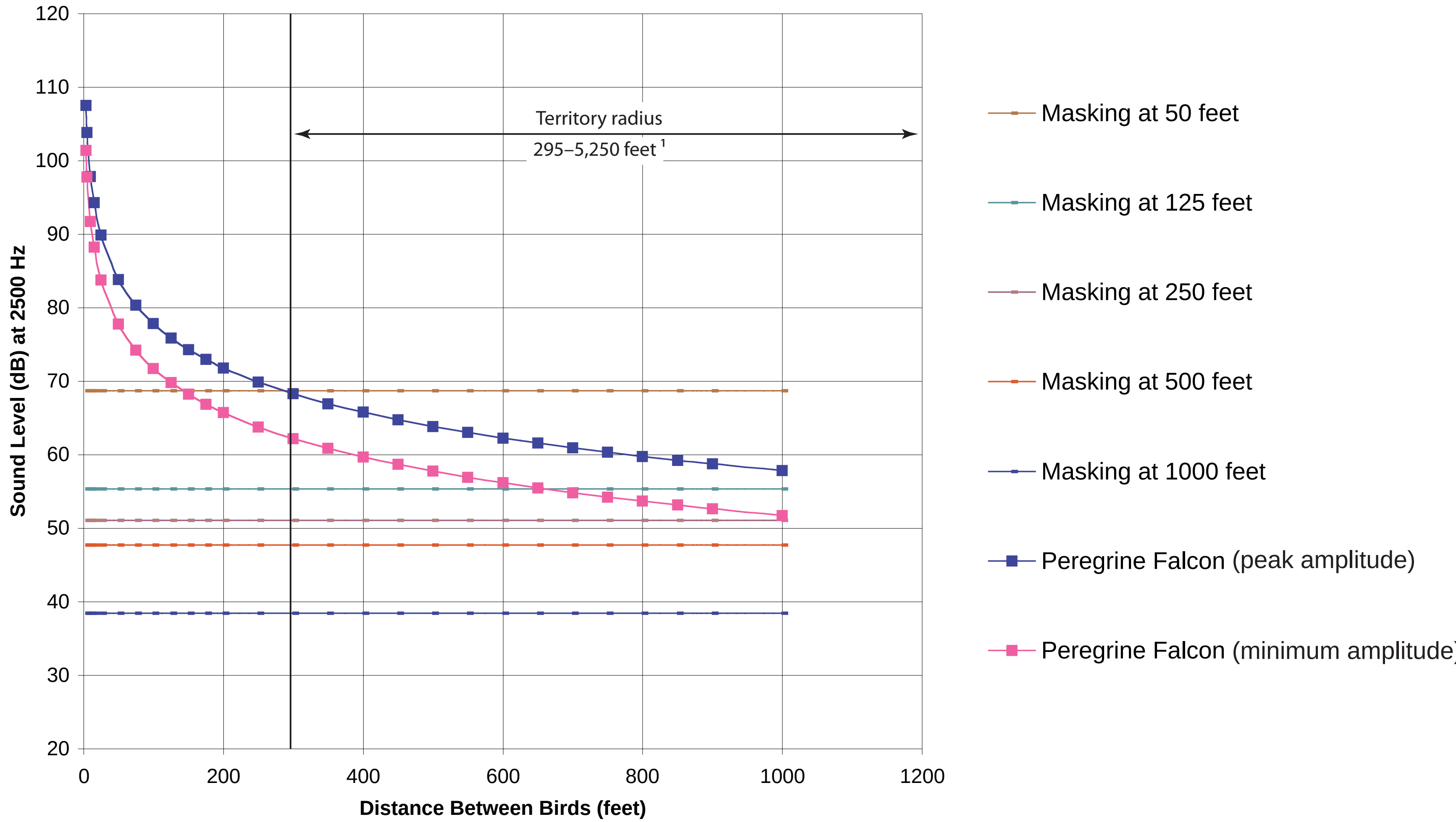
Figure 3-28b
Swainson's Hawk Masking Distance



[1] Johnsgard 1990

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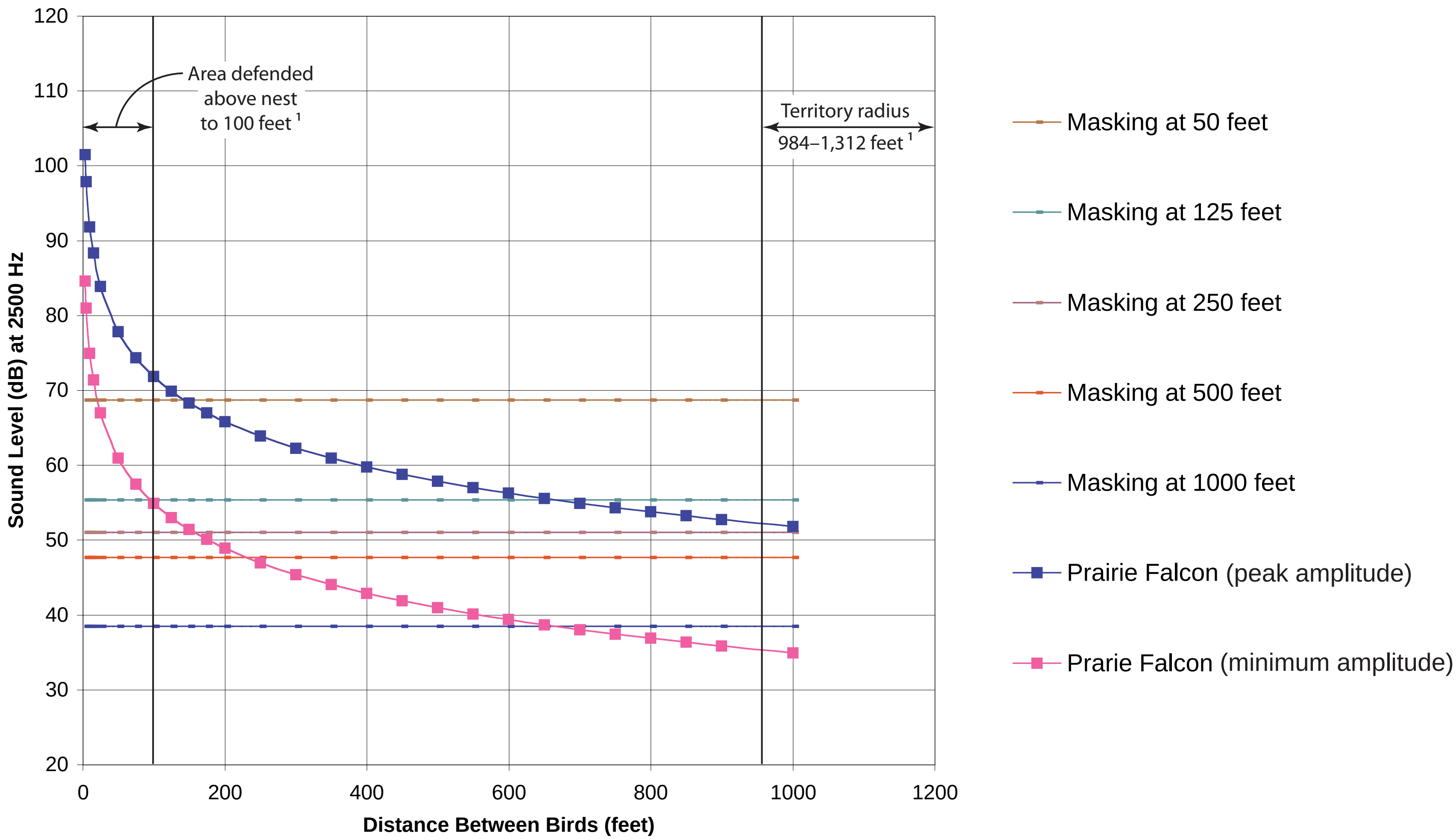
Figure 3-28c
Peregrine Falcon Masking Distance



[1] Steenhof 1998

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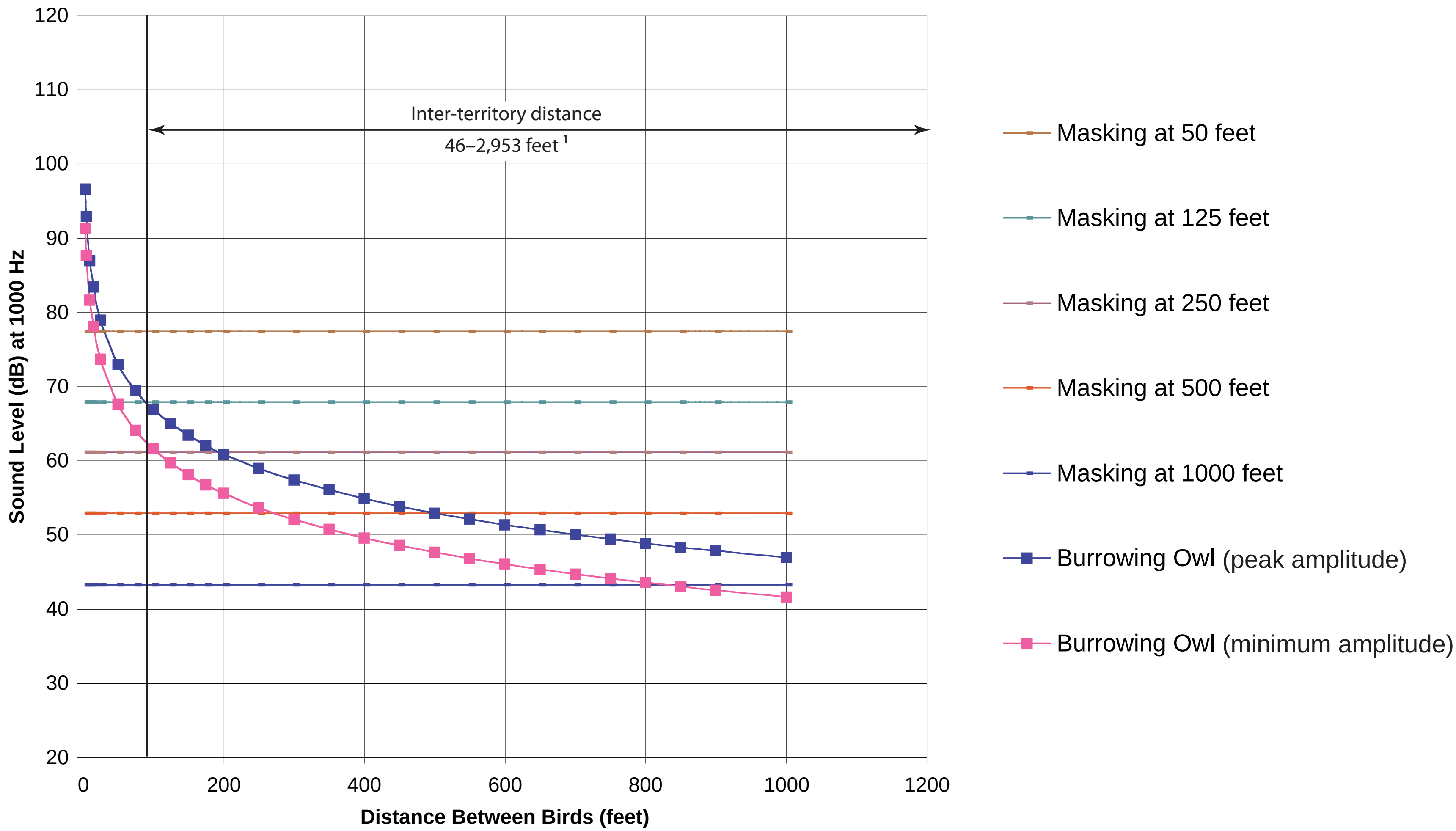
Figure 3-28d
Prairie Falcon Masking Distance



[1] Haug et al. 1993

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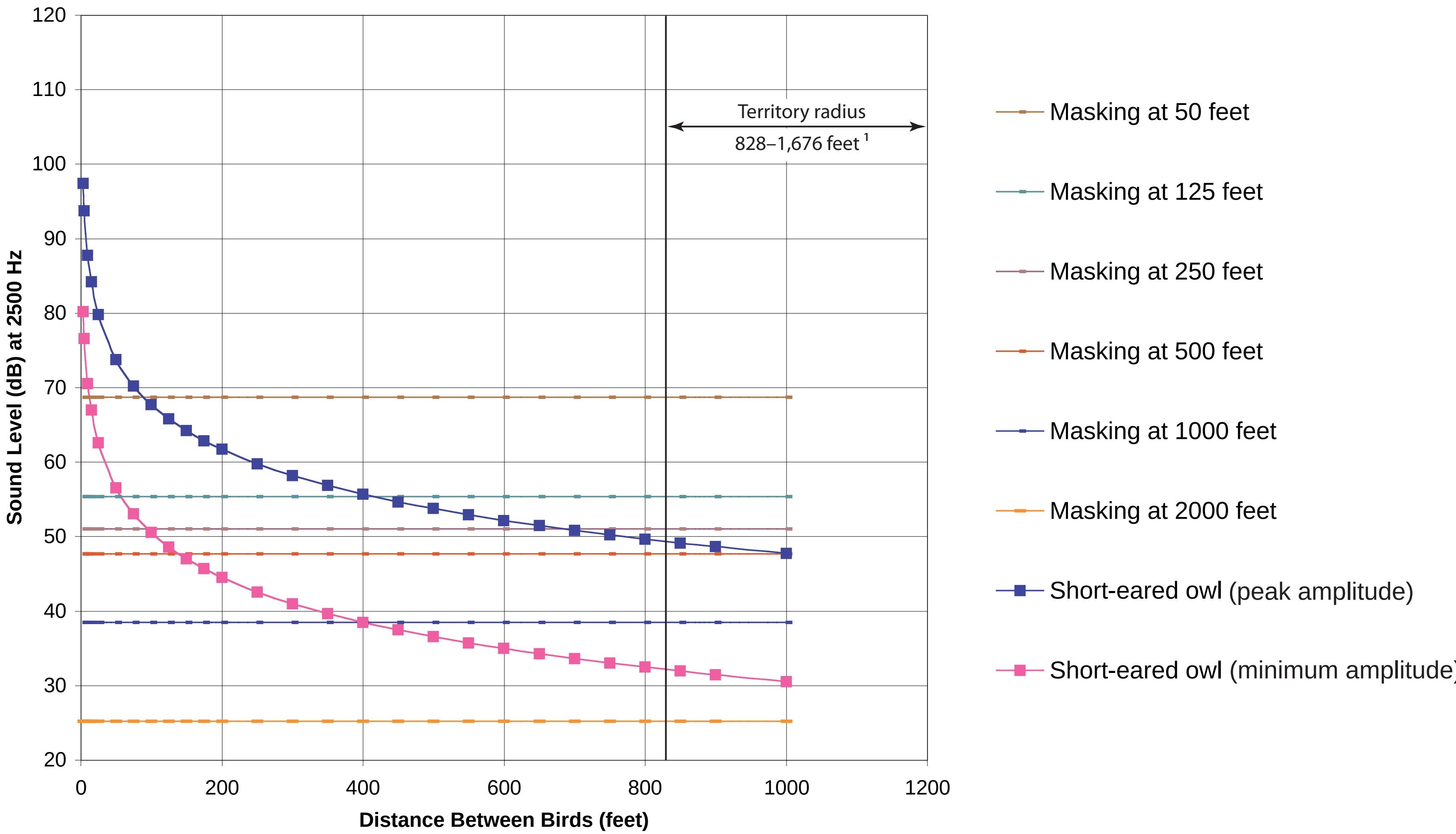
Figure 3-28e
Burrowing Owl Masking Distance



[1] Holt and Leasure 1993

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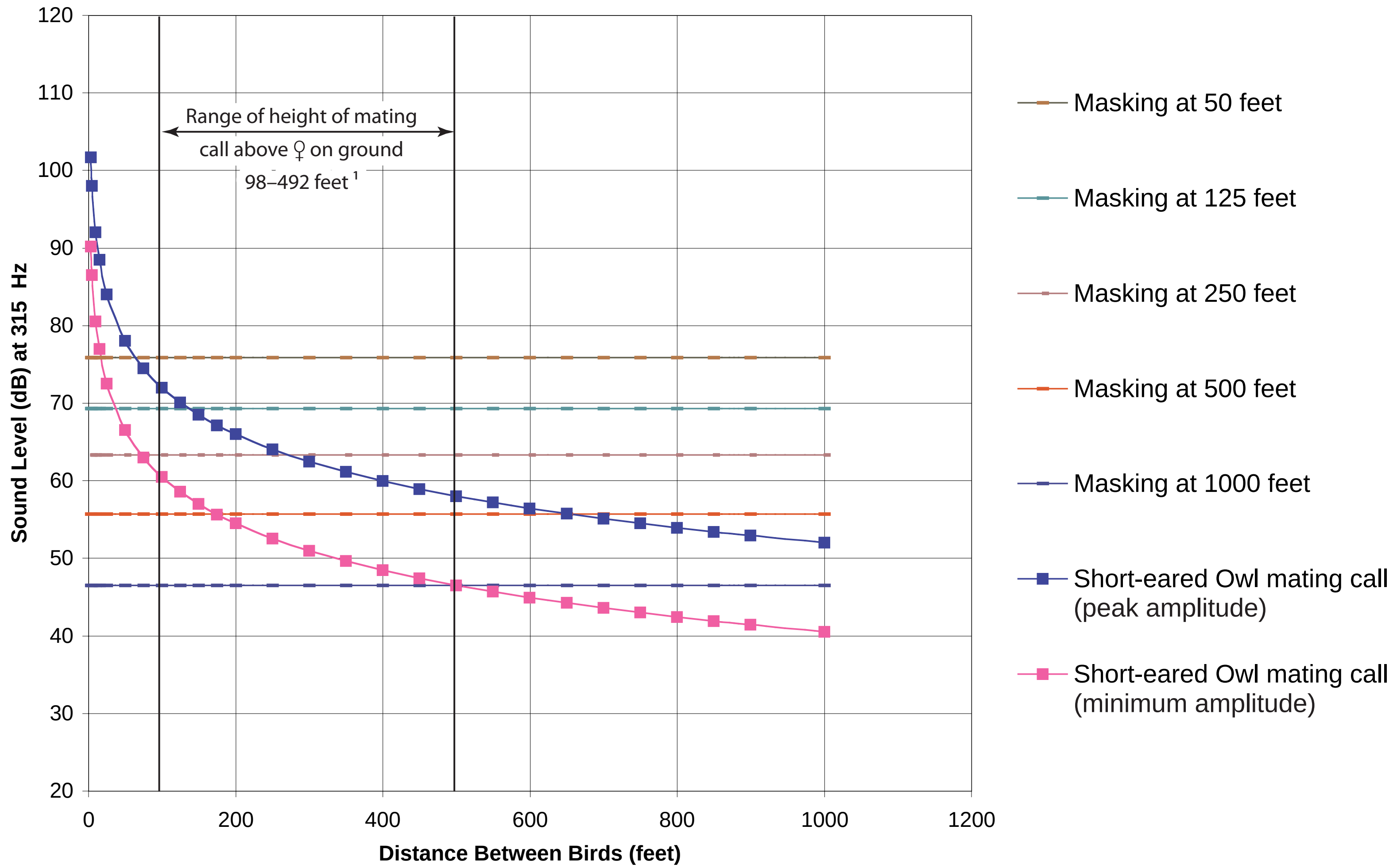
Figure 3-28f
Short-Eared Owl Masking Distance



[1] Holt and Leasure 1993

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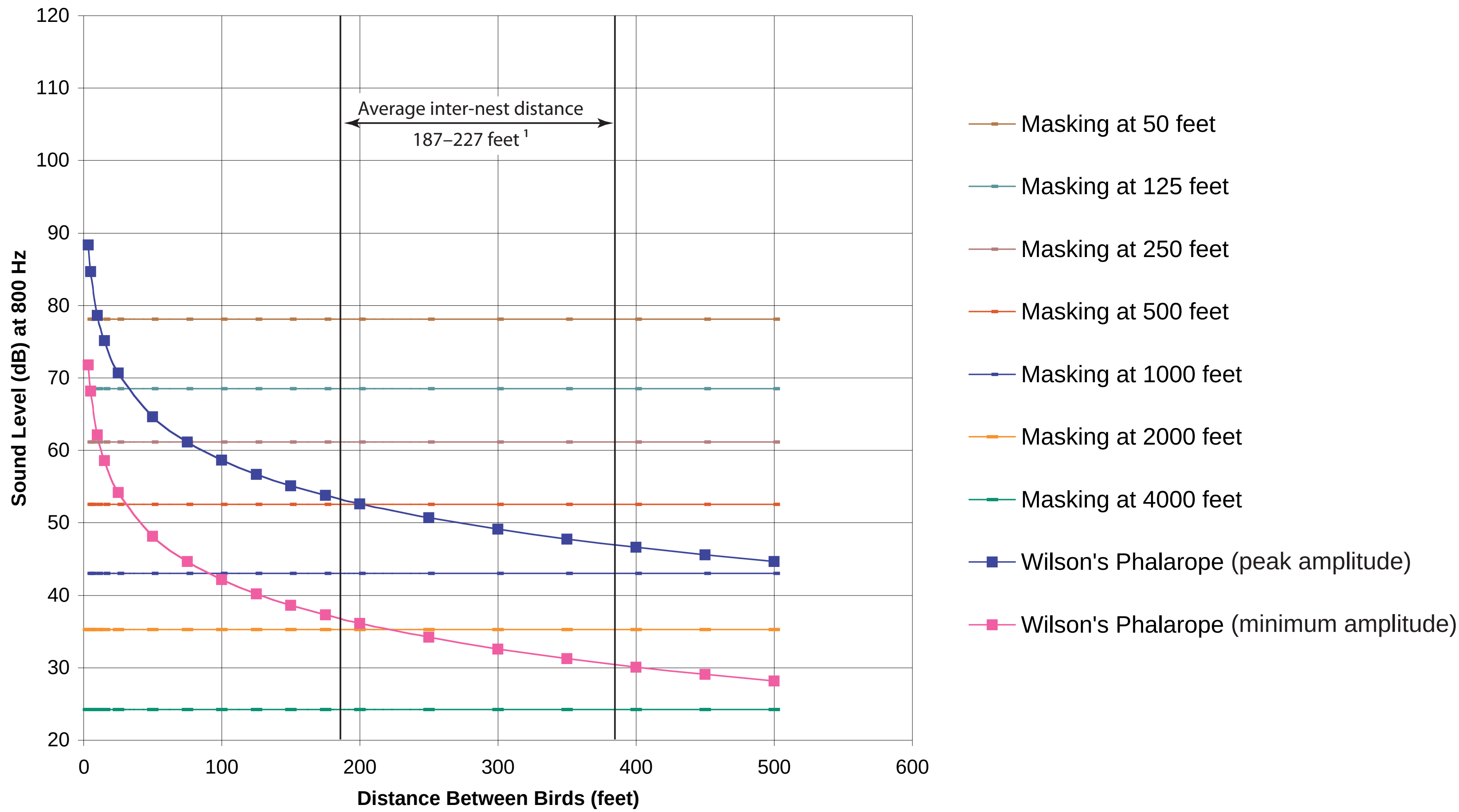
Figure 3-28g
Short-Eared Owl (Mating Call) Masking Distance



[1] Colwell and Jehl 1994

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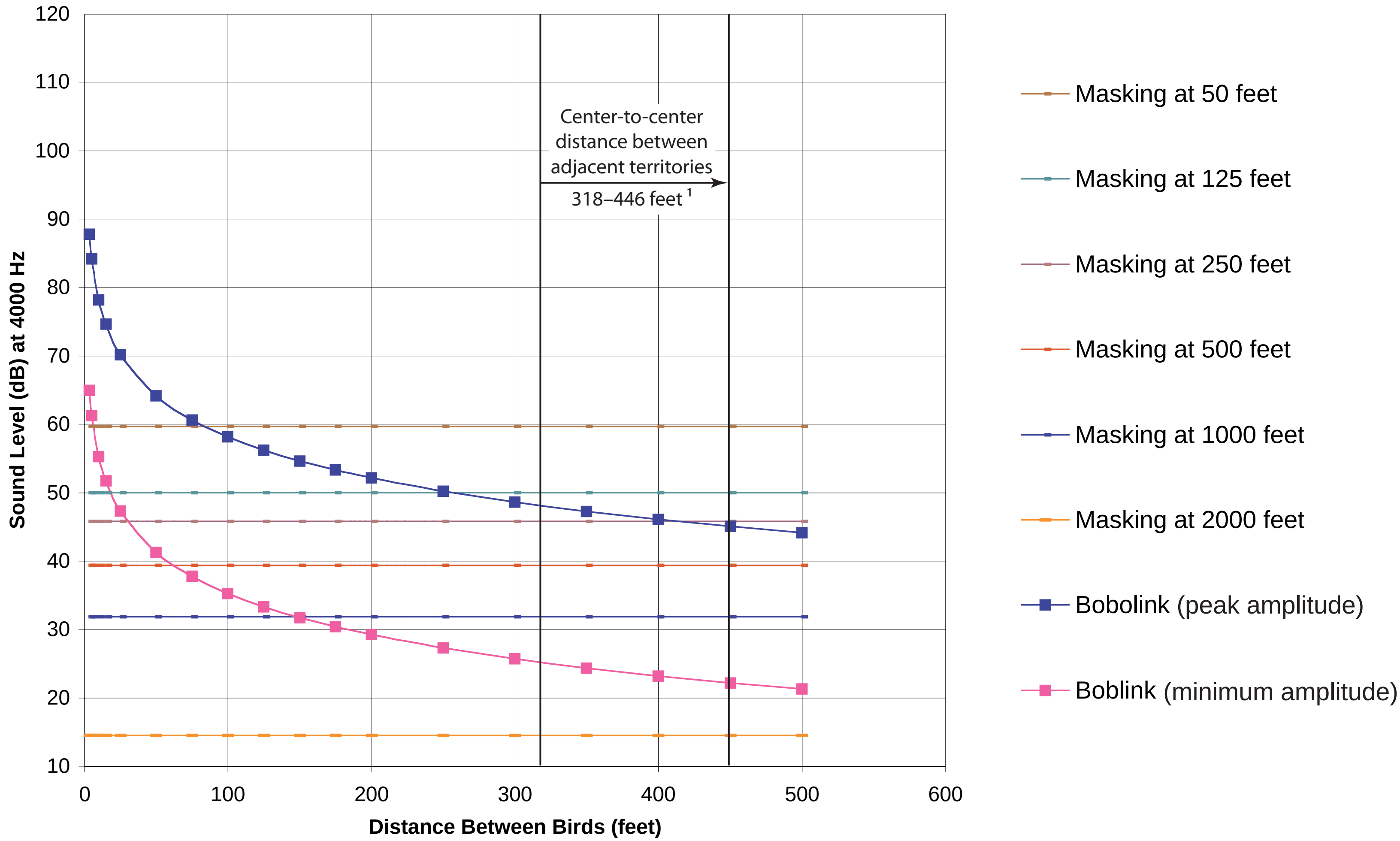
Figure 3-28h
Wilson's Phalarope Masking Distance



[1] Martin and Gavin 1995

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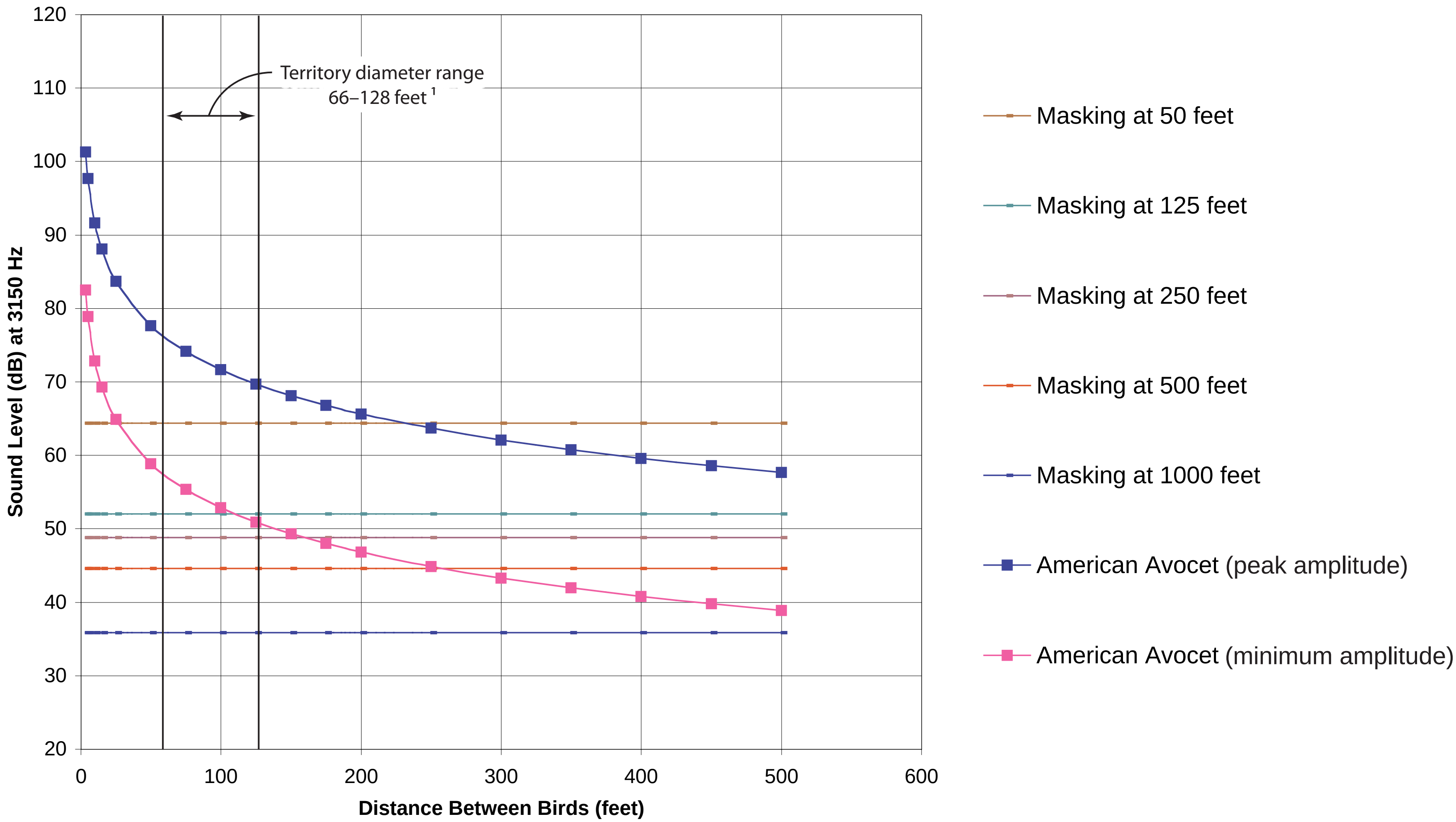
Figure 3-28i
Bobolink Masking Distance



[1] Robinson et al. 1997

Figure 3-28j
Avocet Masking Distance

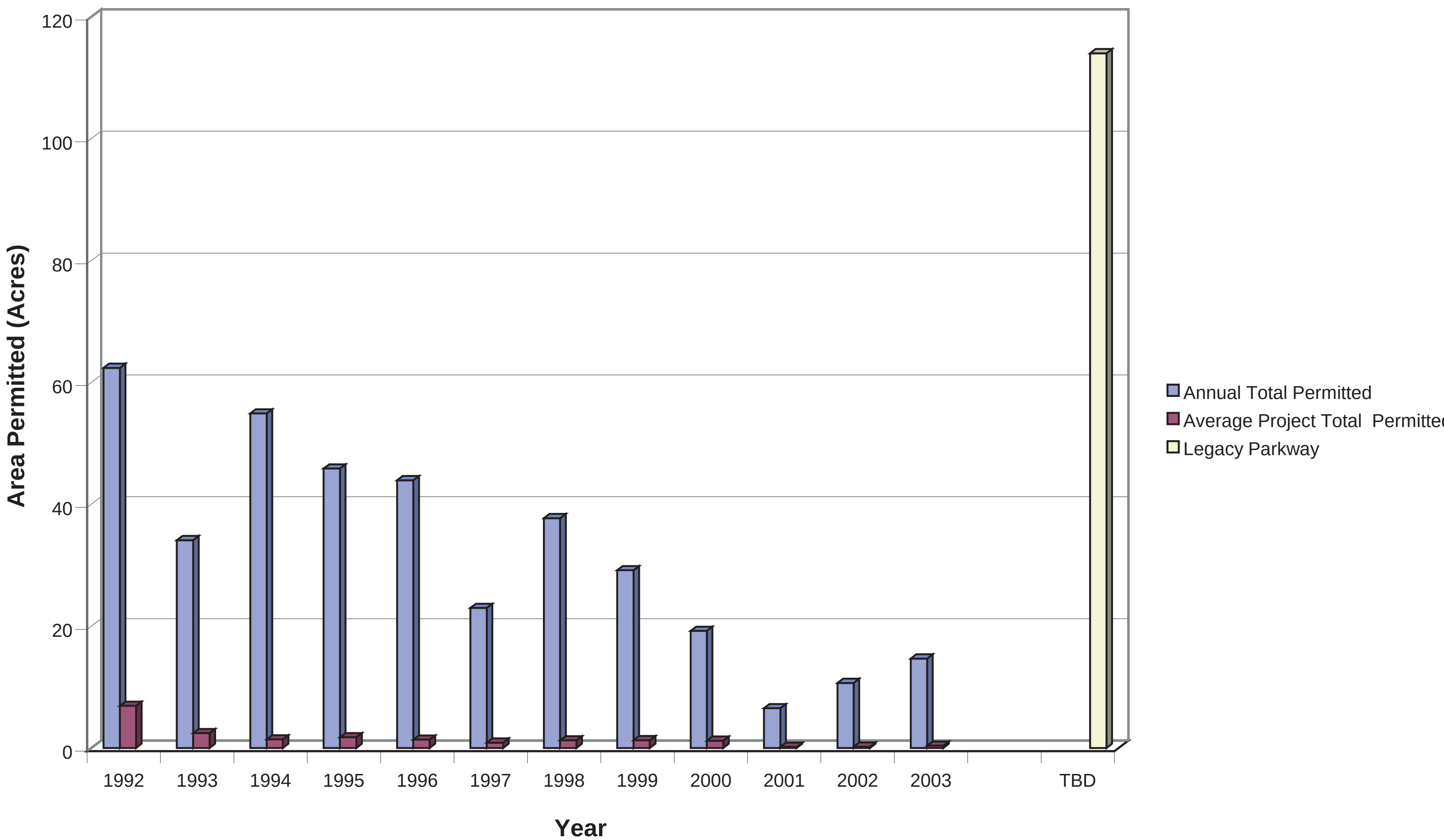


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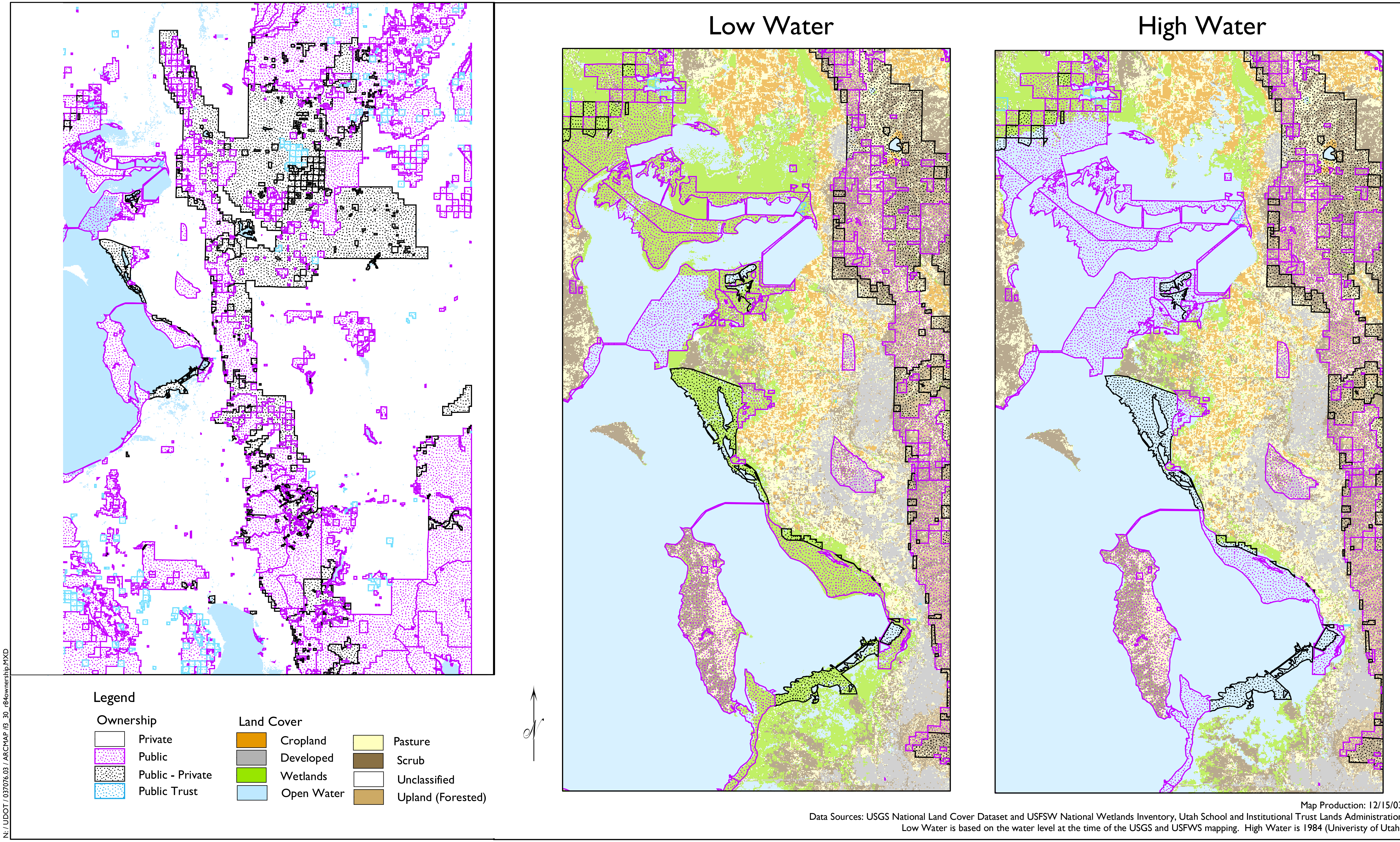
Figure 3-29
Extent of Permitted Actions in Wetlands in Salt Lake and Davies Counties (1992–2003)



N: / UDOT / 037076.03 / ARCMAP /f3_30_r84ownership.MXD

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Figure 3-30
Land Cover, Ownership Status, and Lake Level Change