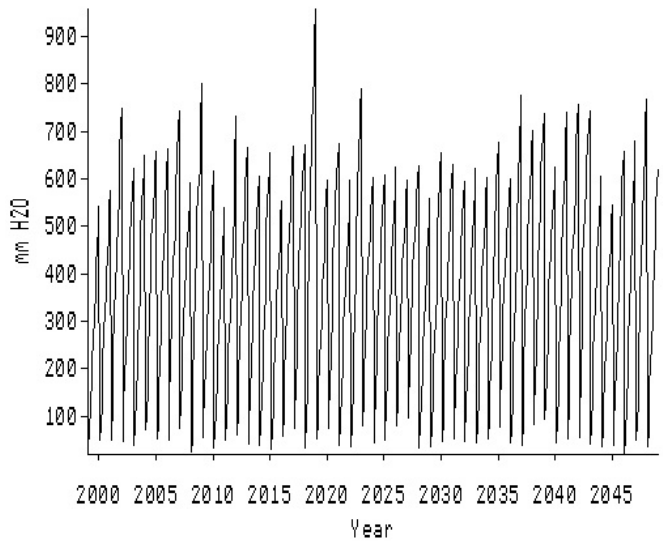
A)



B)

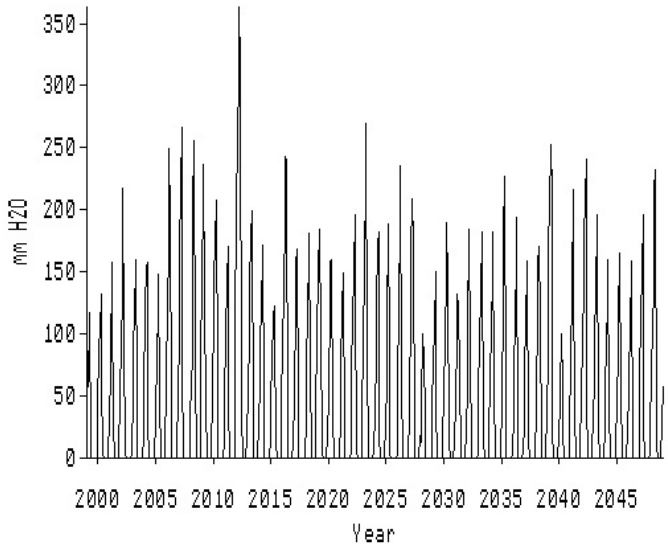
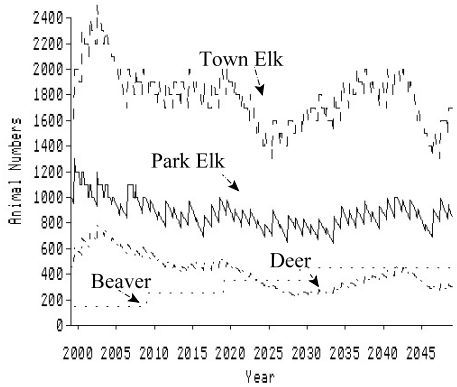
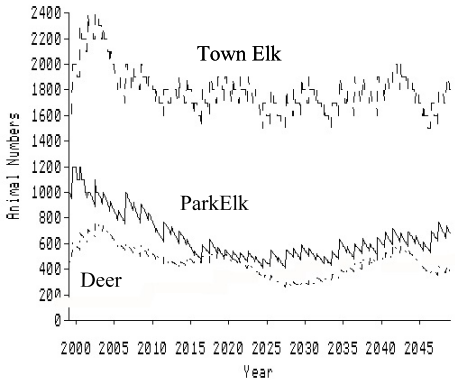


Figure 96. A) Annual precipitation in the future management scenarios. B) Snow water equivilent in the future management scenarios. Weather drawn at random from data for 1949-1998.

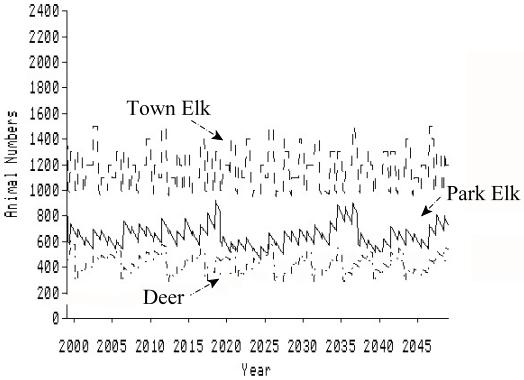
A)



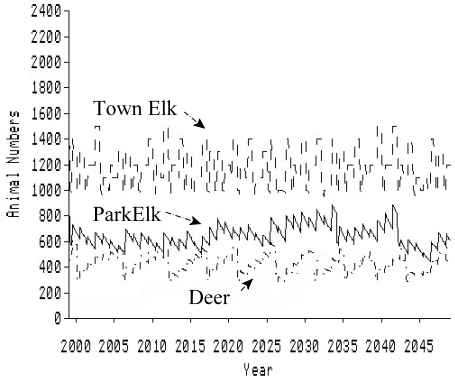
B)



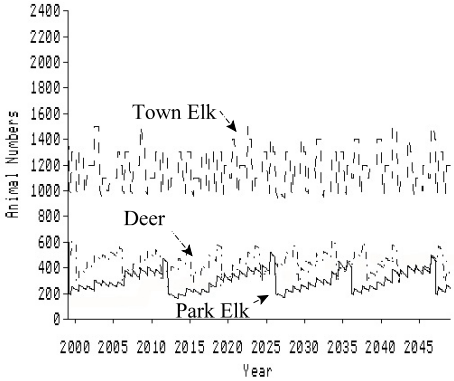
C)



D)



E)



F)

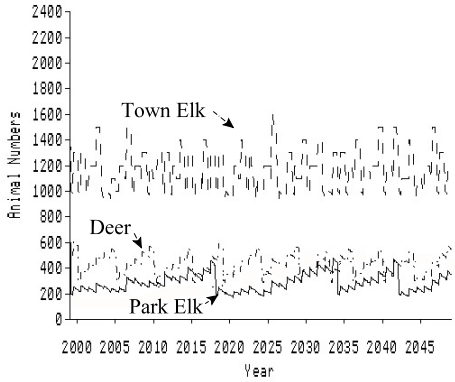
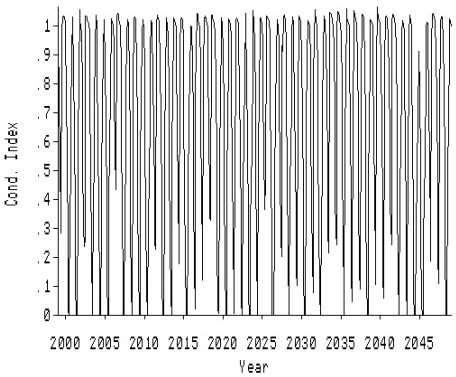
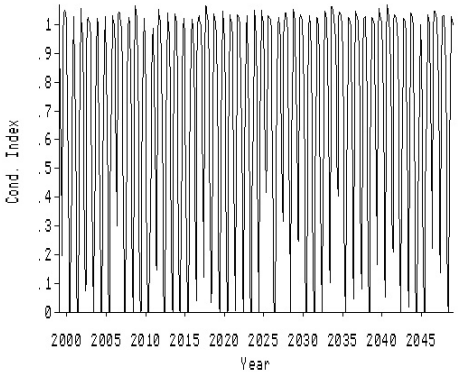


Figure 97. Elk, deer, and beaver population dynamics under different management scenarios. Beaver population dynamics are prescribed, and the same in all runs. A) No elk removals. B) No elk removals, but fence all willow and aspen for first 25 years. C) Cull elk to 600-800. D) Cull elk to 600-800, and fence all willow and aspen for first 25 years. E) Cull elk to 200-400. F) Cull elk to 200-400 and fence willow and aspen for first 25 years. Town elk were culled to 1000-1300 in runs C,D,E,F.

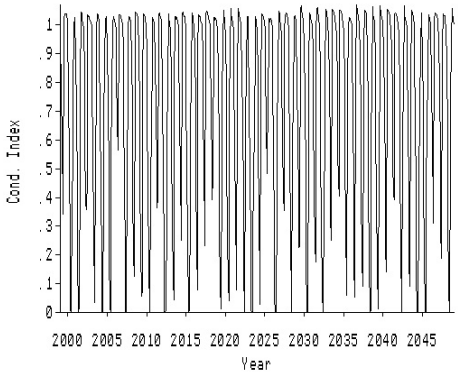
A)



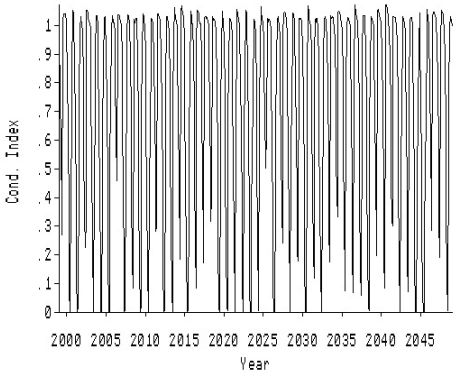
B)



C)



D)



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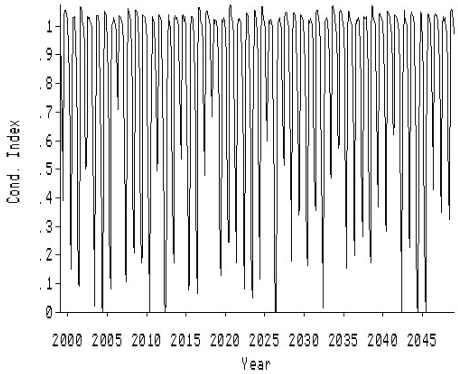


F)

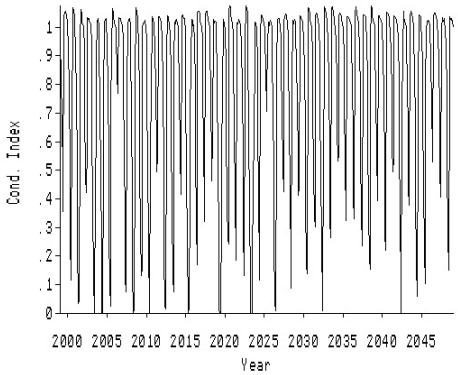


Figure 98. Responses of the body condition of the park elk herd to alternative management scenarios. A) No elk removals. B) No elk removals, but fence all willow and aspen for first 25 years. C) Reduce elk to 600-800. D) Reduce elk to 600-800, and fence all willow and aspen for first 25 years. E) Reduce elk to 200-400. F) Reduce elk to 200-400 and fence willow and aspen for first 25 years.

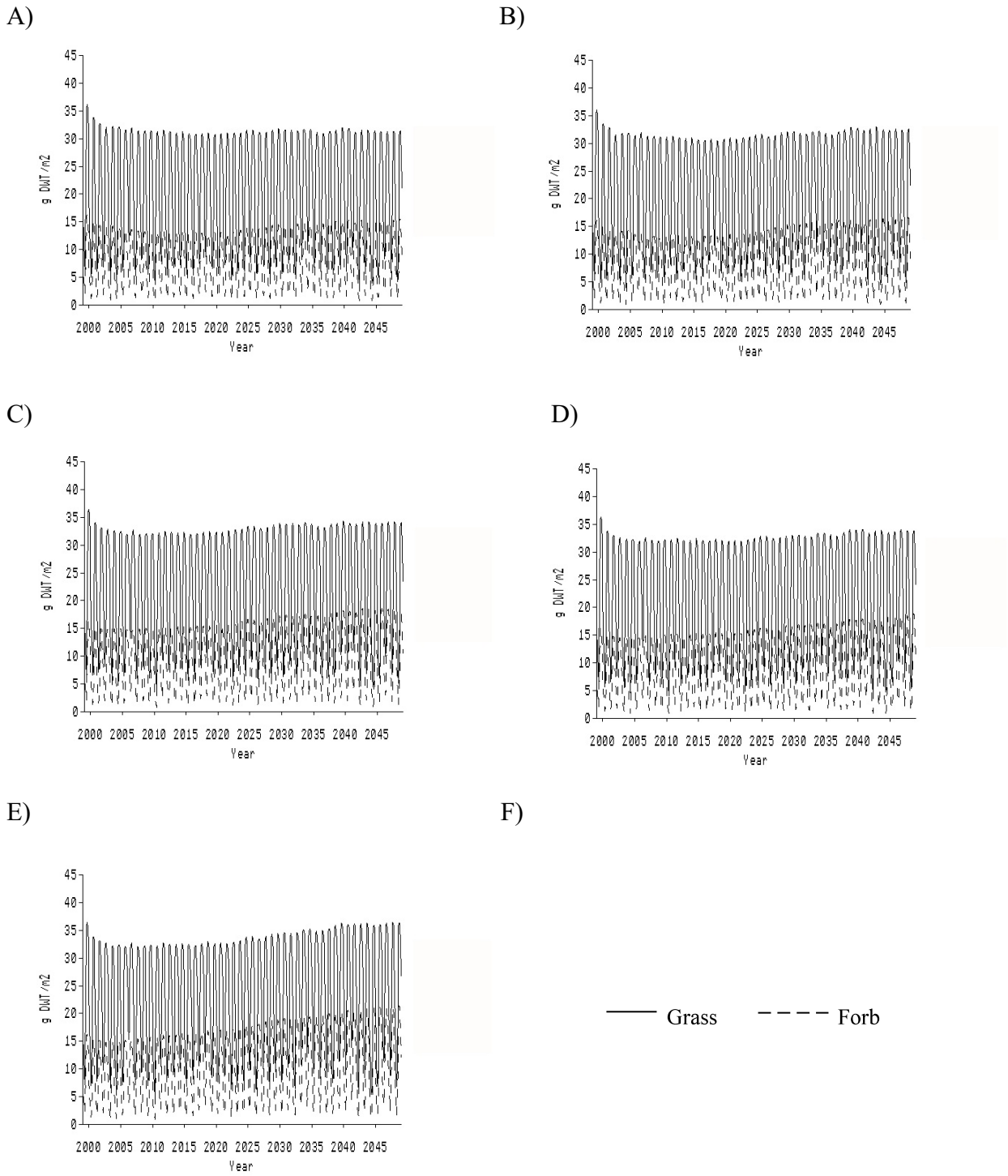


Figure 99. Responses of dryland herbaceous aboveground biomass (grasses and forbs) to alternative management scenarios, using randomly selected weather from 1949-1998, for 50 years. A) No elk removals. B) No elk removals, but fence all willow and aspen for first 25 years. C) Reduce elk to 600-800. D) Reduce elk to 600-800, and fence all willow and aspen for first 25 years. E) Reduce elk to 200-400. F) Reduce elk to 200-400 and fence willow and aspen.

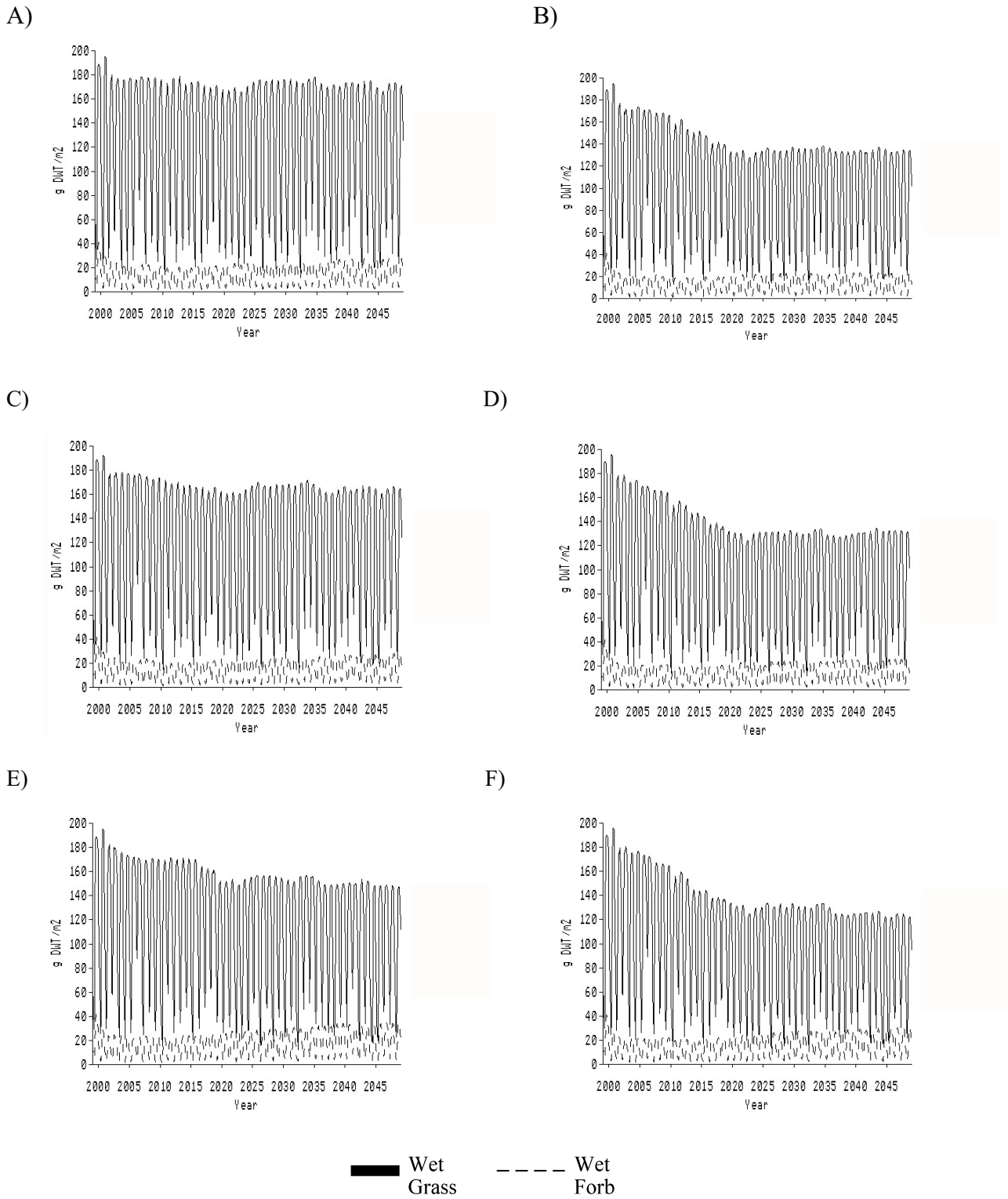


Figure 100. Responses of mesic herbaceous aboveground biomass (grasses and forbs) to alternative management scenarios. A) No elk removals. B) No elk removals, but fence all willow and aspen for first 25 years. C) Reduce elk to 600-800. D) Reduce elk to 600-800, and fence all willow and aspen. E) Reduce elk to 200-400. F) Reduce elk to 200-400 and fence willow and aspen for first 25 years.

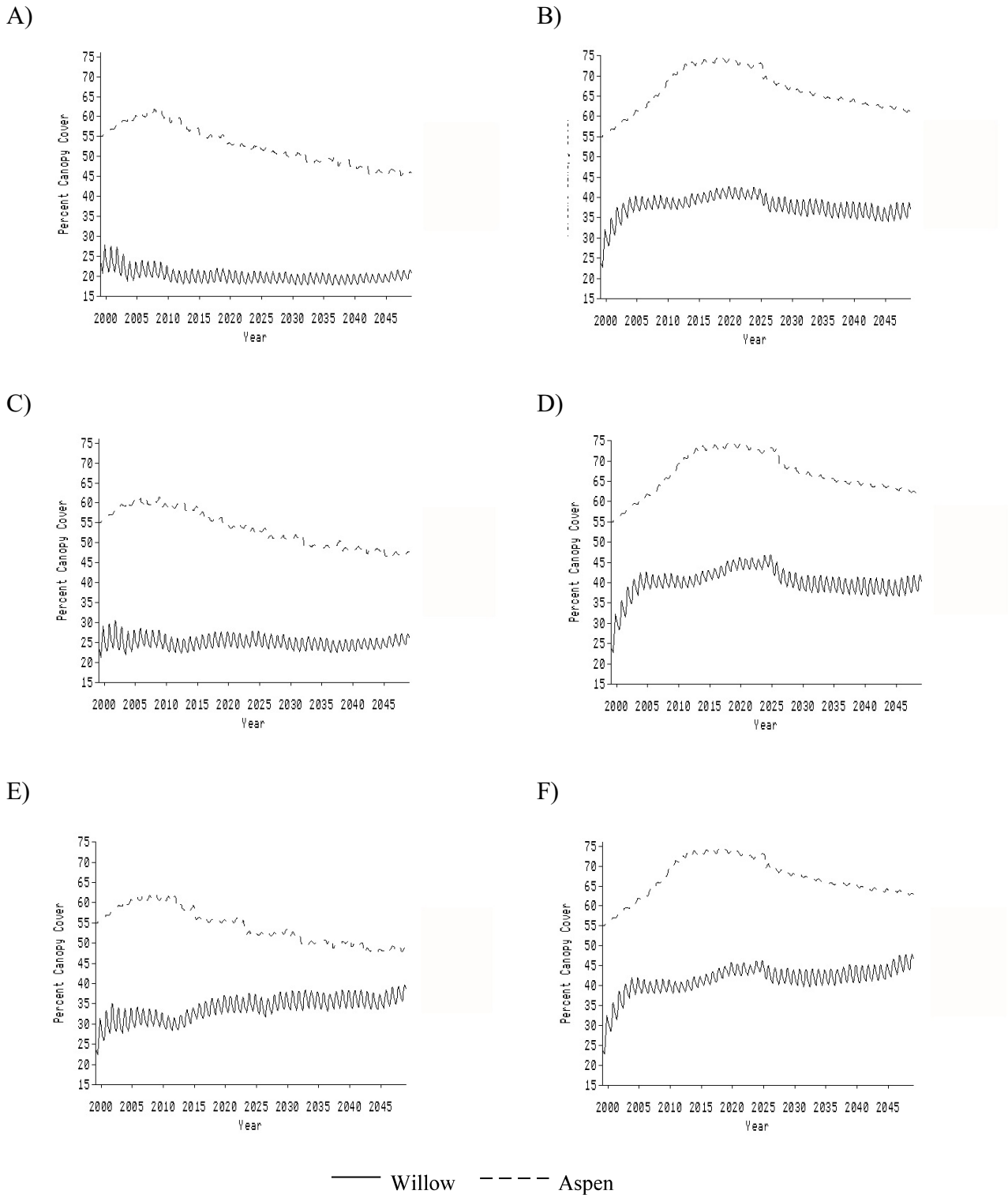


Figure 101. Responses of willow and aspen to management scenarios, using randomly selected weather from 1949-1998, for 50 years as mean canopy cover within grid-cells of that vegetation type. A) No elk removals. B) No elk removals, but fence all willow and aspen for first 25 years. C) Reduce elk to 600-800. D) Reduce elk to 600-800, and fence all willow and aspen for first 25 years. E) Reduce elk to 200-400. F) Reduce elk to 200-400 and fence willow and aspen.

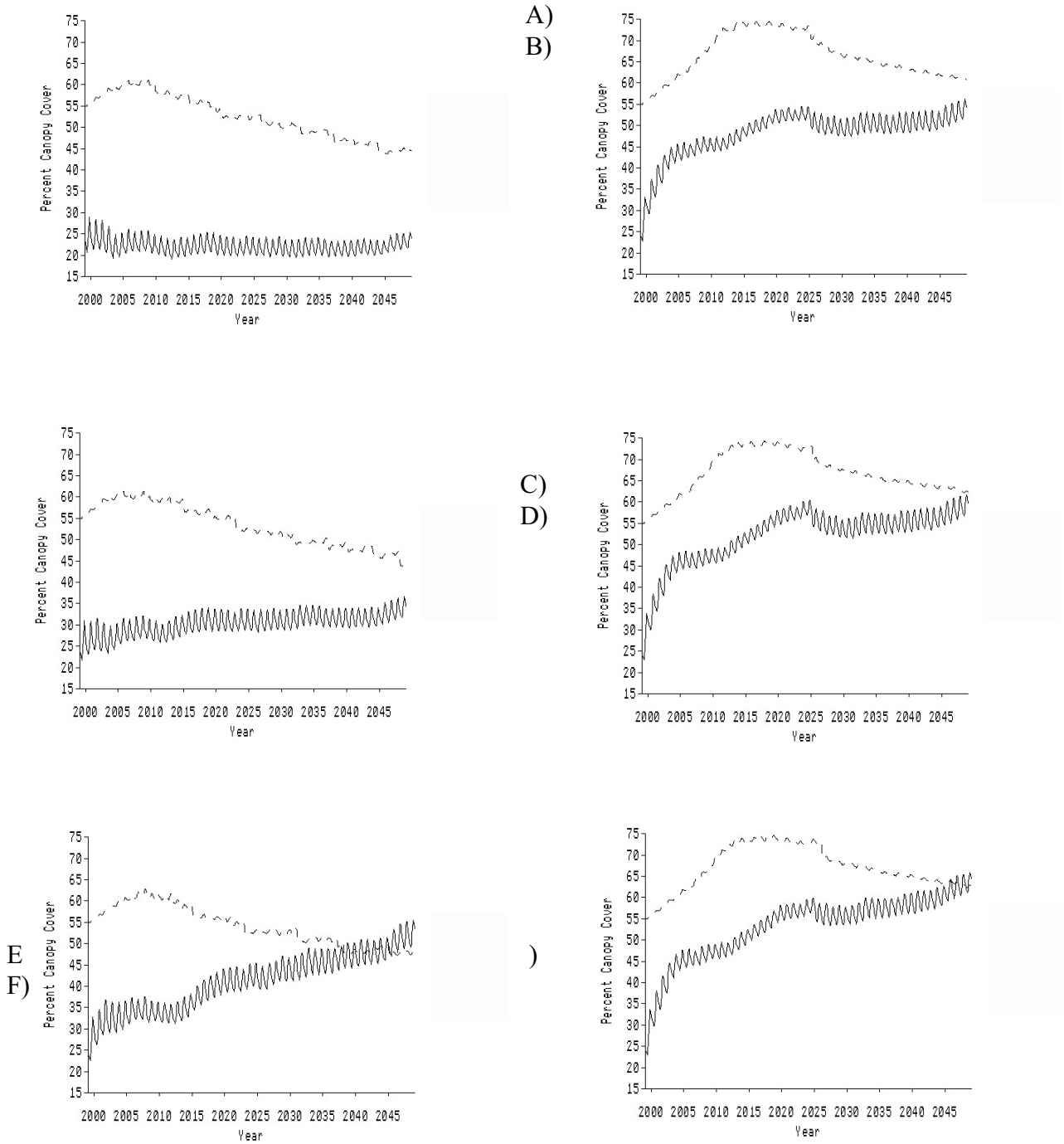
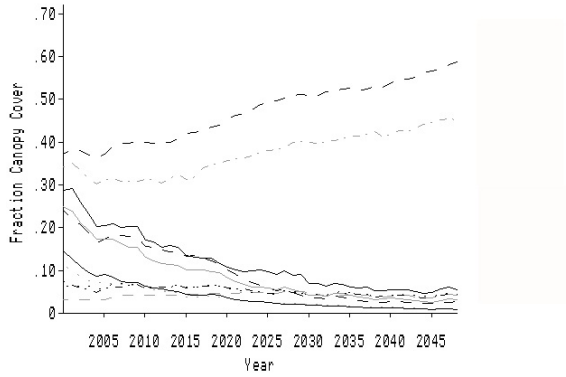
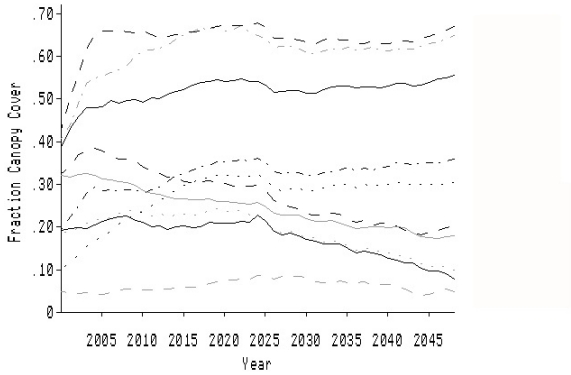


Figure 102. Responses of willow and aspen to alternative management scenarios, with higher water tables reported as mean canopy cover within the grid-cells having that vegetation type. A) No elk removals. B) No elk removals, but fence all willow and aspen for first 25 years. C) Reduce elk to 600-800. D) Reduce elk to 600-800, and fence all willow and aspen for first 25 years. E) Reduce elk to 200-400. F) Reduce elk to 200-400 and fence willow and aspen.

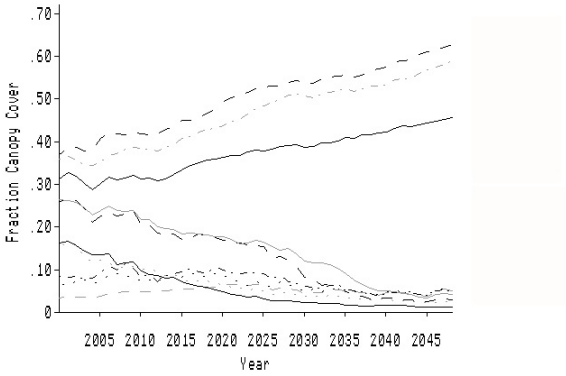
A)



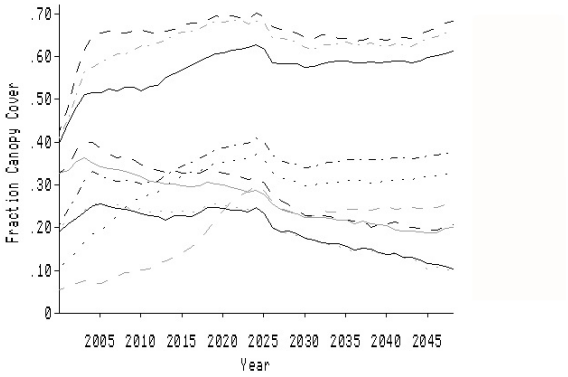
B)



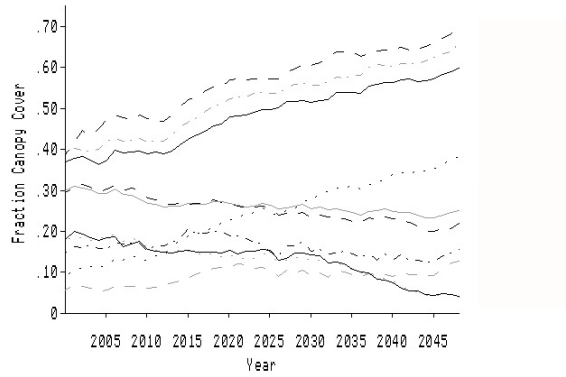
C)



D)



E)



F)

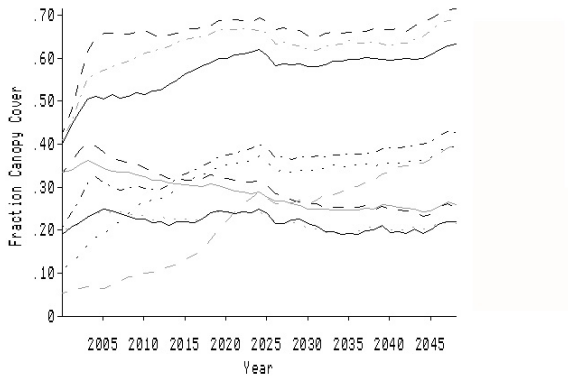
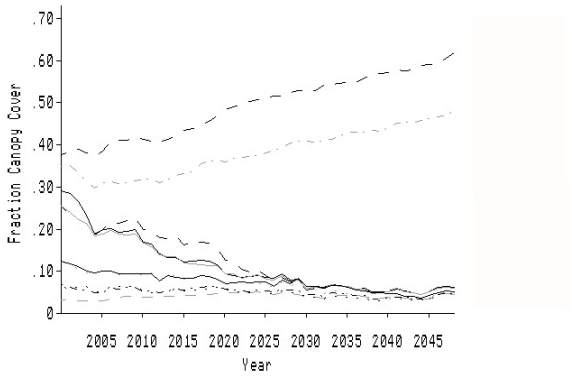
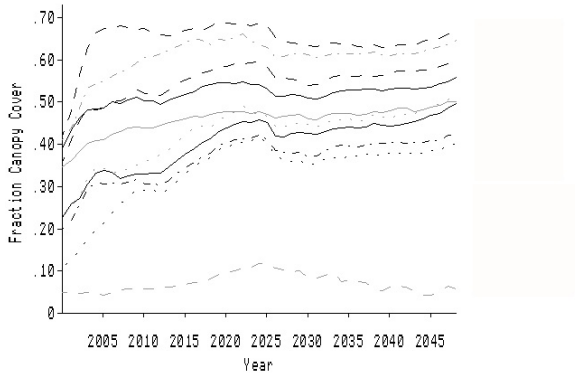


Figure 103. Responses of willow cover in individual grid-cells to alternative management scenarios, using randomly selected weather from 1949-1998, for 50 years. A) No elk removals. B) No elk removals, but fence all willow and aspen for first 25 years. C) Reduce elk to 600-800. D) Reduce elk to 600-800, and fence all willow and aspen for first 25 years. E) Reduce elk to 200-400. F) Reduce elk to 200-400 and fence willow and aspen.

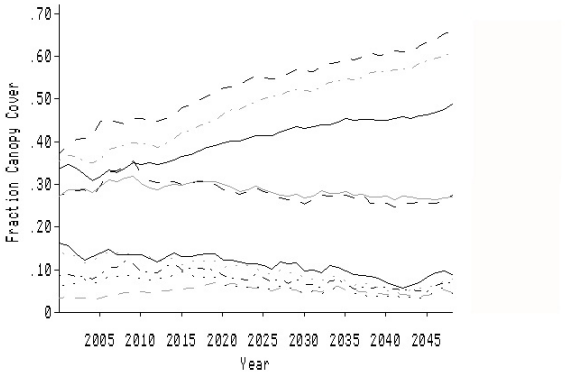
A)



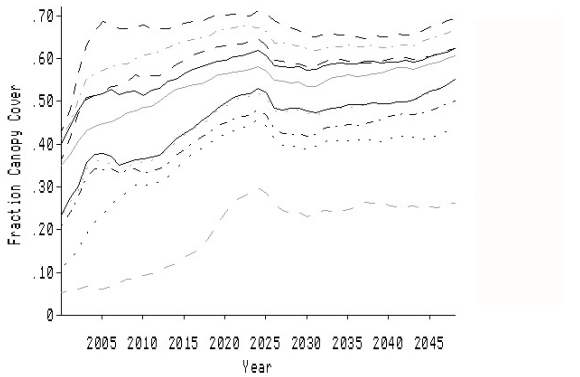
B)



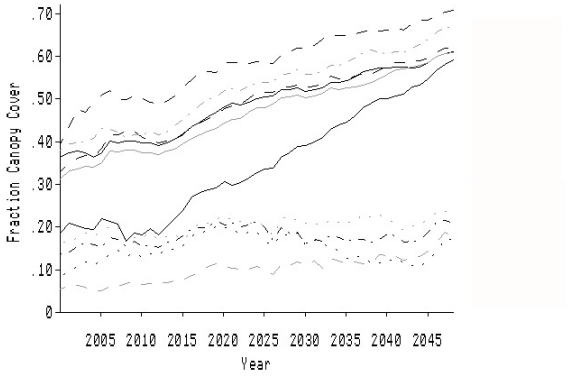
C)



D)



E)



F)

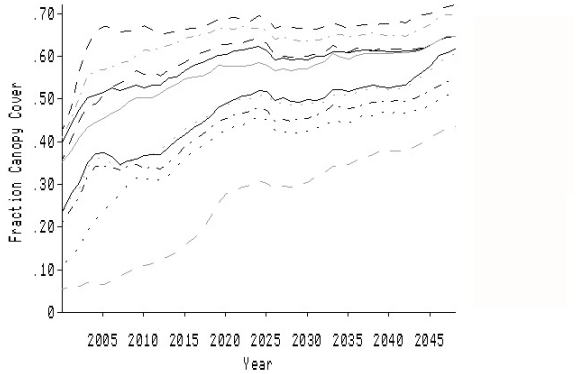
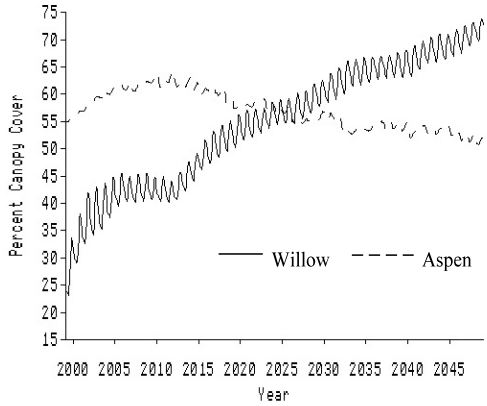


Figure 104. Responses of willow cover in individual grid-cells to alternative management scenarios, with elevated water tables. A) No elk removals. B) No elk removals, but fence all willow and aspen for first 25 years. C) Reduce elk to 600-800. D) Reduce elk to 600-800, and fence all willow and aspen for first 25 years. E) Reduce elk to 200-400. F) Reduce elk to 200-400 and fence willow and aspen.

A)



B)

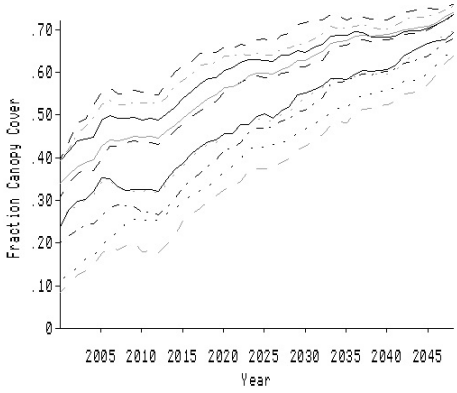
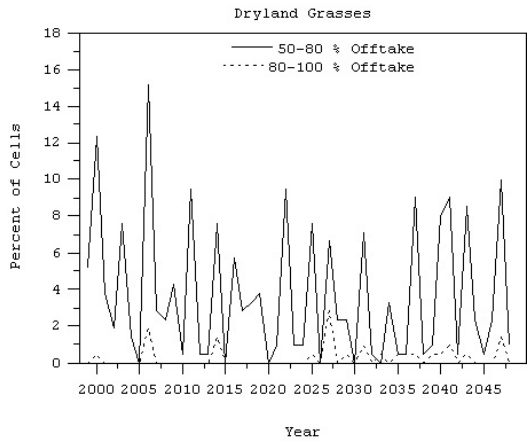
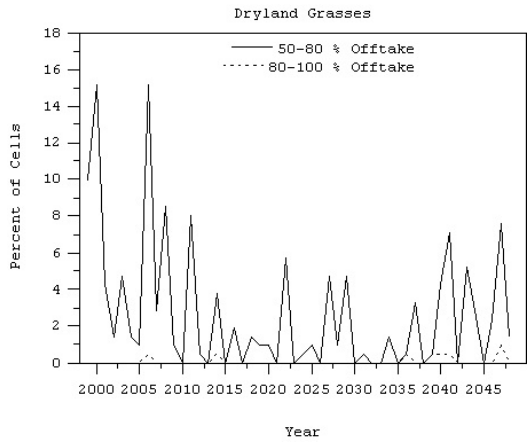


Figure 105. A) Willow and aspen cover and B) willow cover in individual grid-cells, with removals of elk to 200, fencing willow and aspen for the first 25 years, elevated water tables, and no beaver. (Compare to Fig. 104f, 105f).

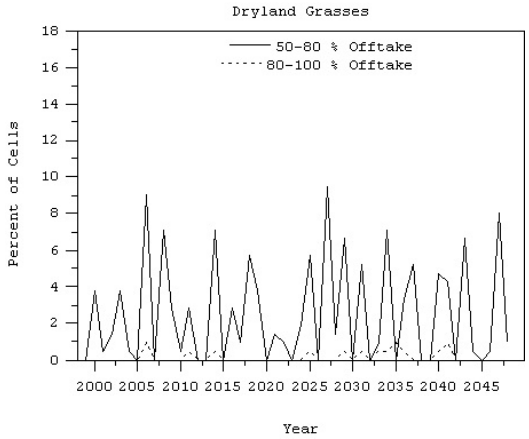
A)



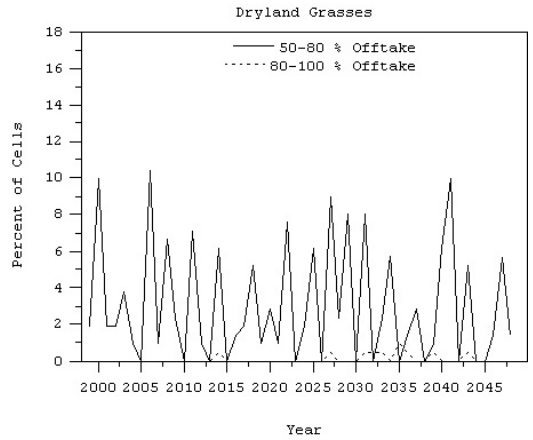
B)



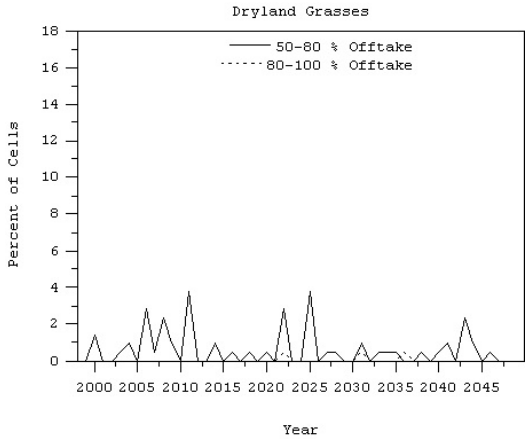
C)



D)



E)



F)

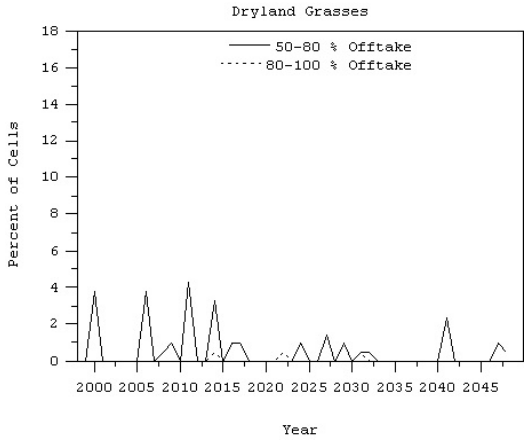


Figure 106. Percentages of grid-cells on the winter range with upland grass offtake >50% in A) no cull, B) no-cull, fence willow and aspen in yrs 1-25, C) cull to 600-800, D) cull to 600-800 and fence years 1-25. E) Cull to 200-400. F) Cull to 200-400 and fence years 1-25.

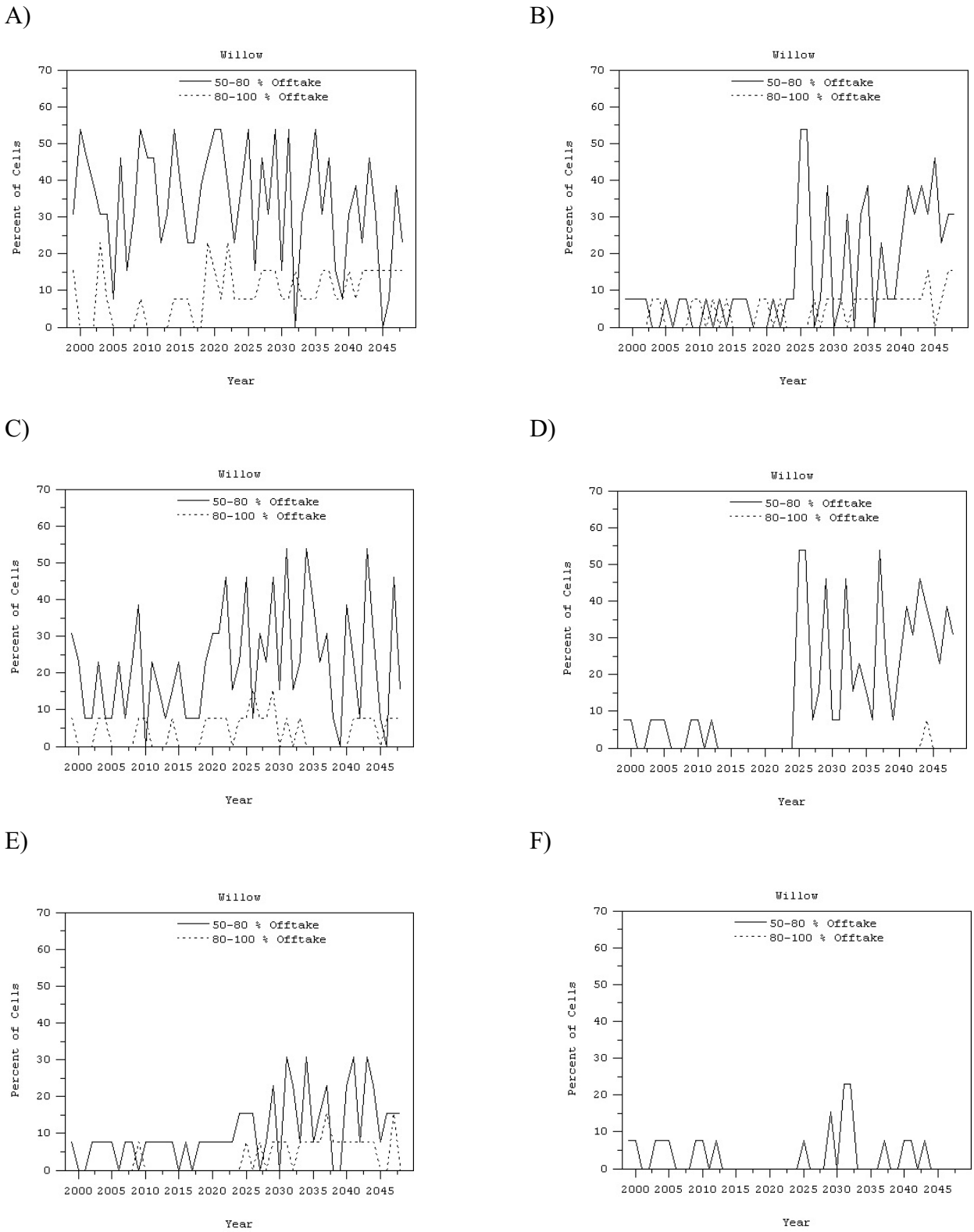
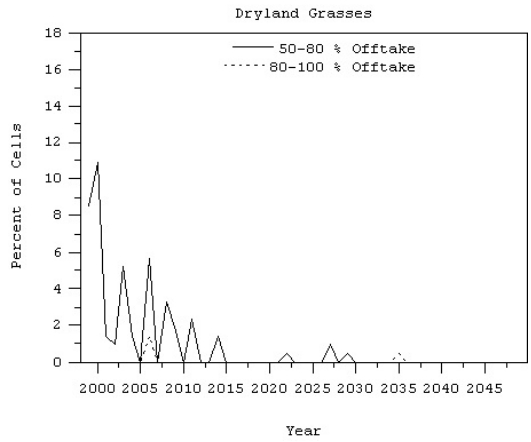
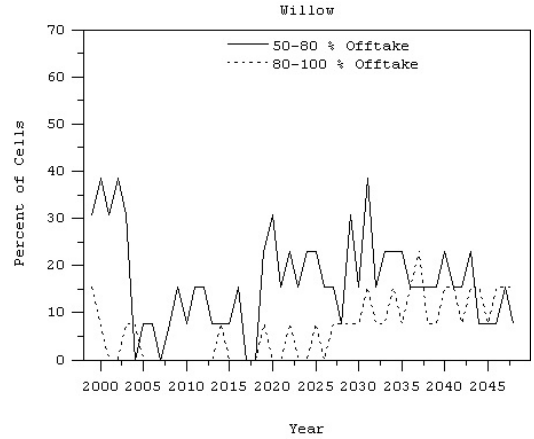


Figure 107. Percentages of grid-cells on the winter range with willow offtake >50% in A) no cull, B) no-cull, fence willow and aspen in yrs 1-25, C) cull to 600-800, D) cull to 600-800 and fence years 1-25. E) Cull to 200-400. F) Cull to 200-400 and fence years 1-25.

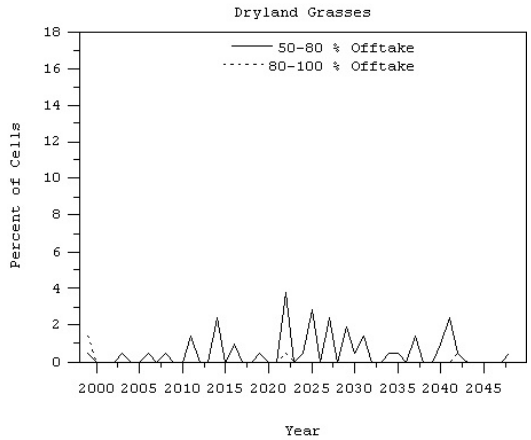
A)



B)



C)



D)

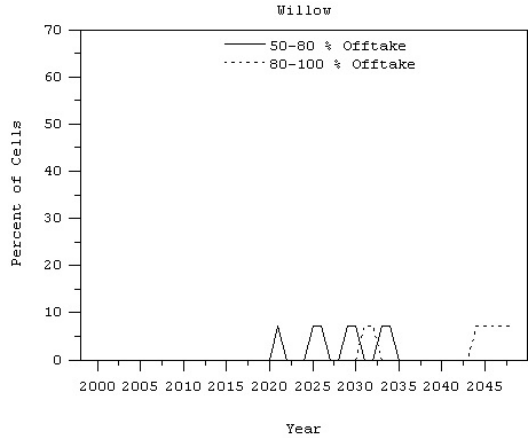
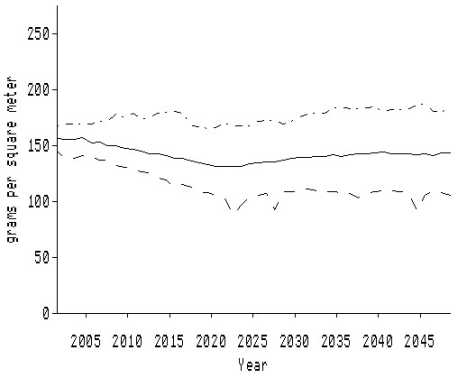
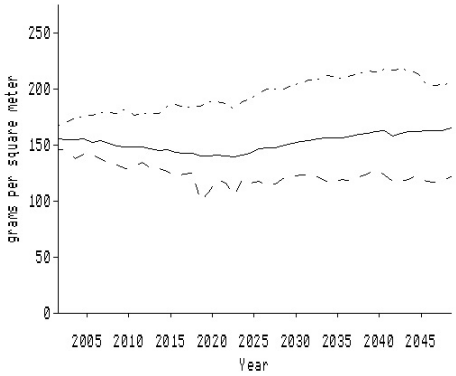


Figure 108. Percentages of grid-cells where dryland grasses and willow offtake is > 50% A) and B) in simulations with current vegetation and ungulates and with a hypothesized wolf reintroduction, and C) and D) in simulations with undisturbed vegetation and initial ungulate numbers as in the undisturbed 1912-1948 run.

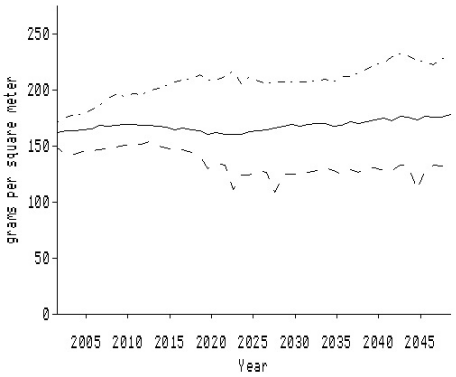
A)



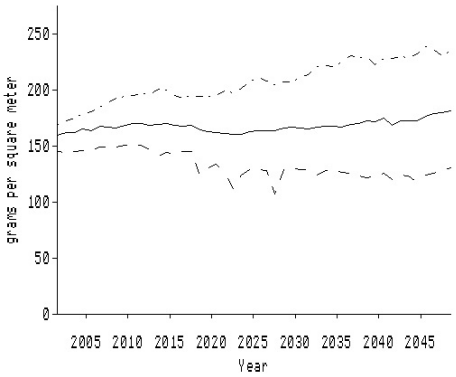
B)



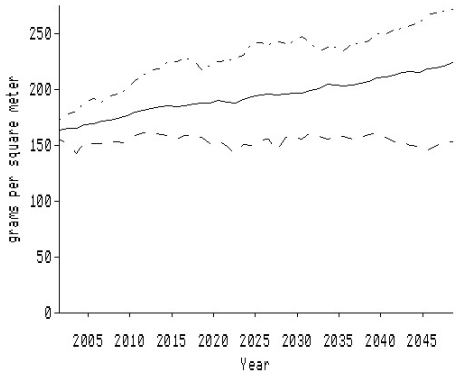
C)



D)



E)



F)

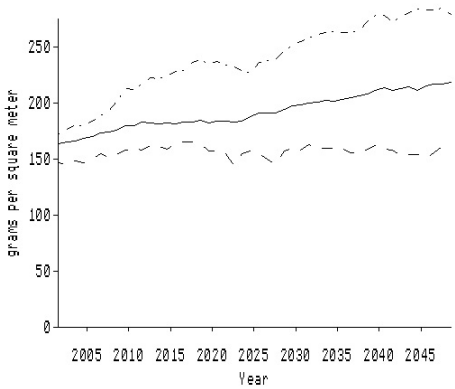
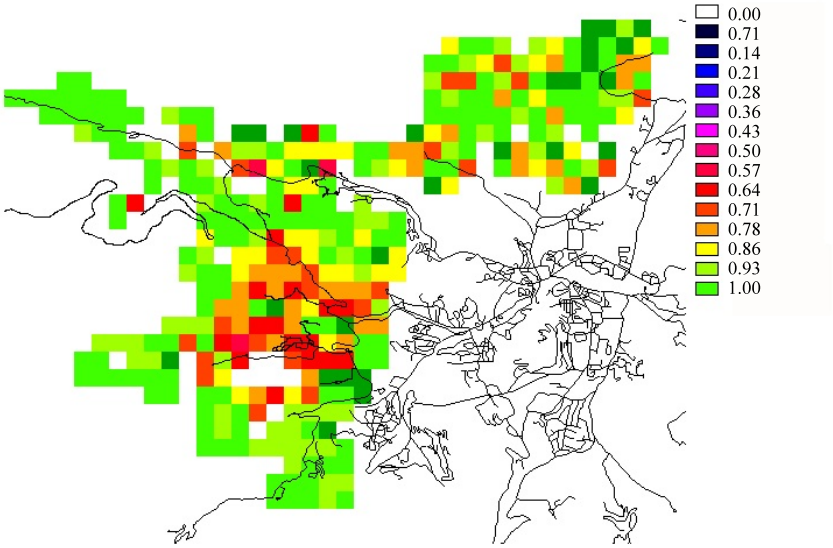


Figure 109. Herbaceous root biomass on grassland vegetation types in the park range in July. A) No elk culling. B) No elk culling, but fence all willow and aspen for first 25 years. C) Cull elk to 600. D) Cull elk to 600, and fence all willow and aspen for first 25 years. E) Cull elk to 300. F) Cull elk to 300 and fence willow and aspen for 25 years.. Minimum, maximum, and average values among grid-cells illustrate the range of spatial variation.

A)



B)

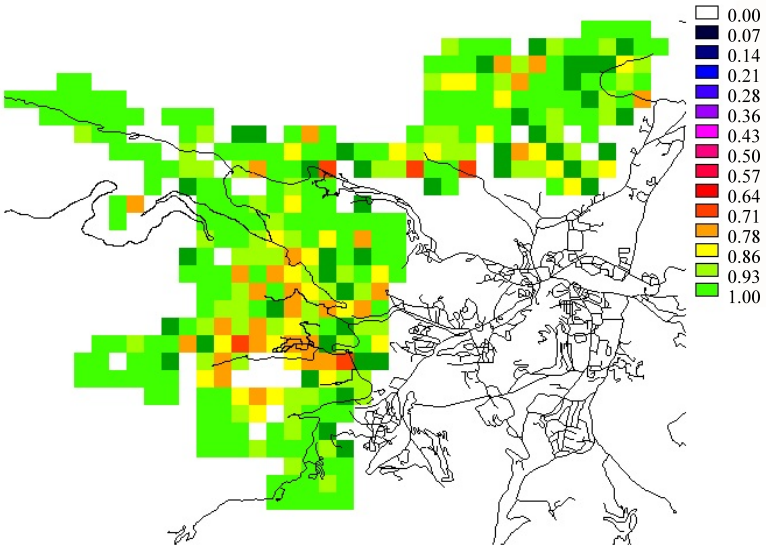
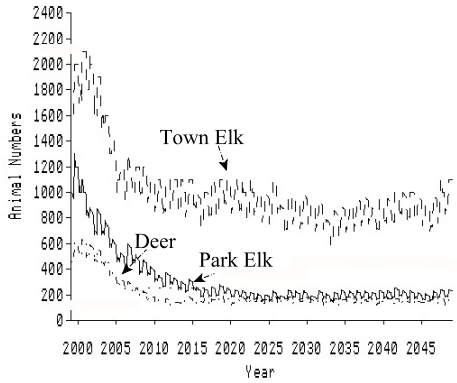
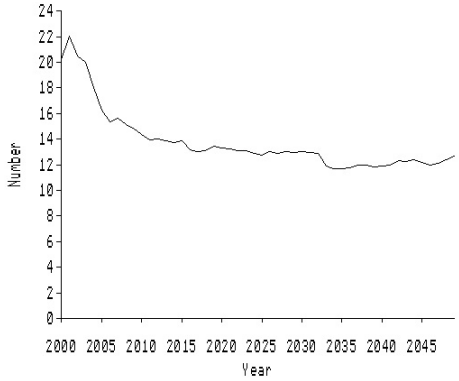


Figure 110. A) Ratio of dryland herbaceous root biomass in the last 10 years of the no-cull simulation 1999-2048 to that with elk culled to 20-4000. B) Ratio of root biomass with elk culled to 400-600 to that with elk culled to 200-400.

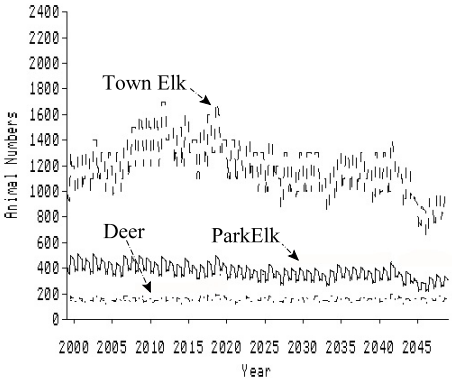
A)



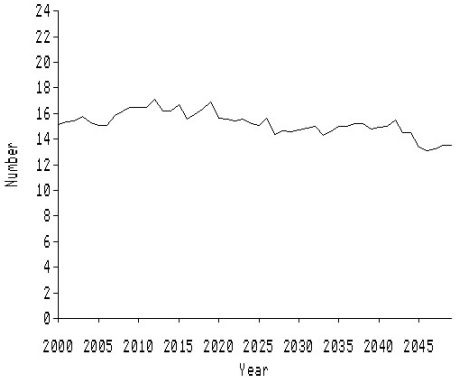
B)



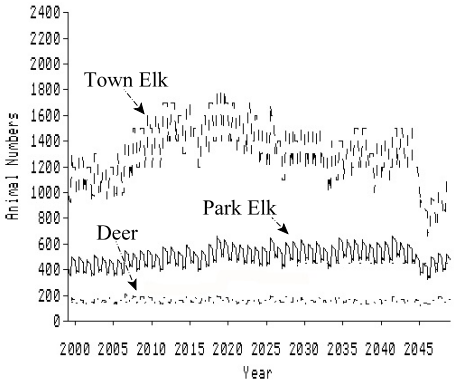
C)



D)



E)



F)

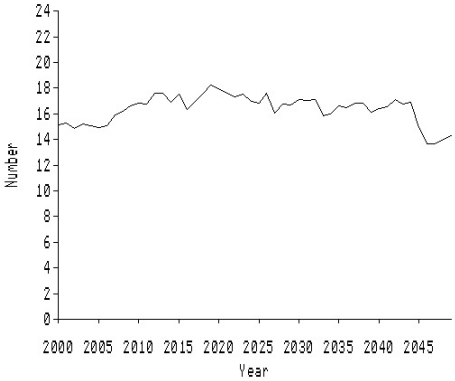
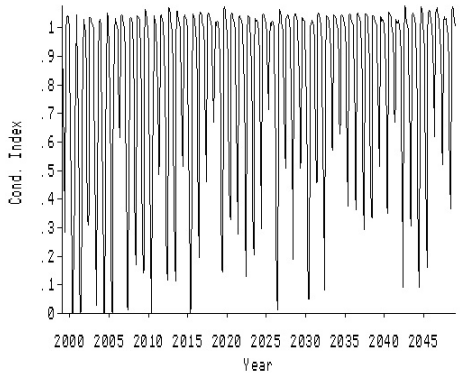
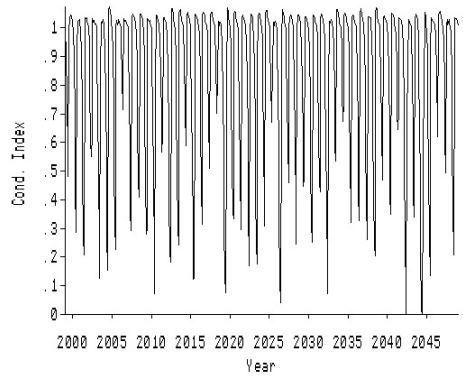


Figure 111. Herbivore and wolf populations in hypothetical scenarios with wolves. A) Herbivores and B) wolves with current vegetation and soil water tables, starting with current plant and animal abundances . C) Herbivores and D) wolves with current vegetation and soil water tables, starting with plants and ungulates at end of the 1949-1998 run with wolves. E) Herbivores and F) wolves with undisturbed vegetation and soil water tables, starting with undisturbed 1949-98 final results.

A)



B)



C)

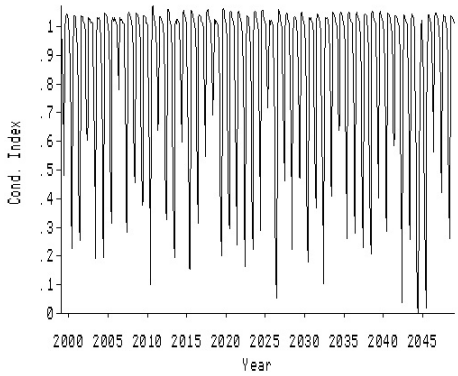


Figure 112. Elk condition in simulations with wolves. A) With current vegetation and soil water tables, starting with current plant and animal conditions. B) With current vegetation and soil water tables, starting with plants and ungulates at end of the 1949-1998 run with wolves. C) With pre-1900 soil water tables, starting with plants and ungulates at end of run 1949-1998 run with wolves.

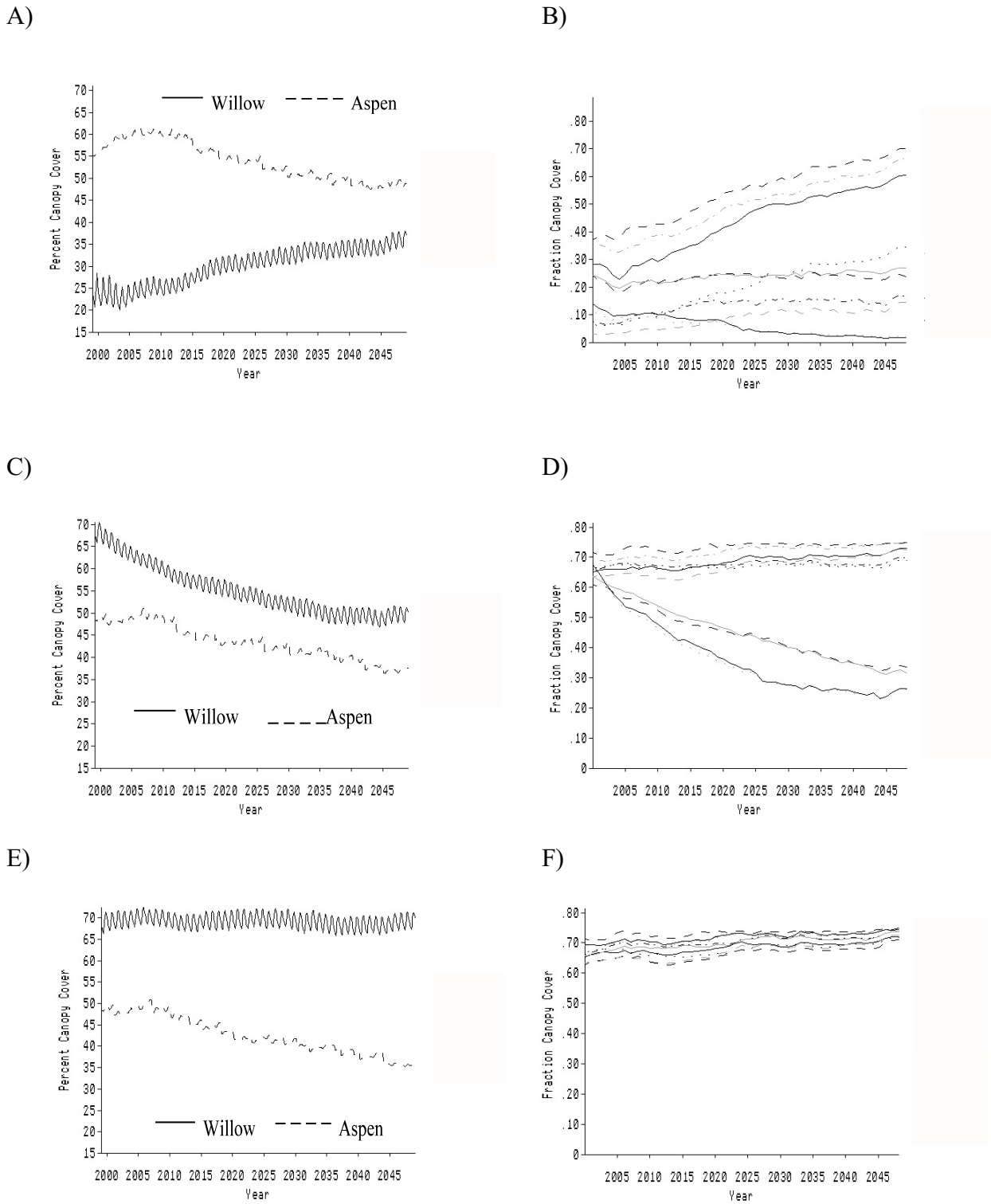


Figure 113. A,C,E) Willow and aspen cover in simulations with wolves. B,D,F) Aspen cover in 10 individual grid-cells. A,B) With current vegetation and soil water tables, starting with current plant and animal conditions. C,D) With current vegetation and soil water tables, starting with plants and ungulates at end of the 1949-1998 run with wolves. E,F) With pre-1900 soil water tables, starting with plants and ungulates at end of run 1949-1998 run with wolves.

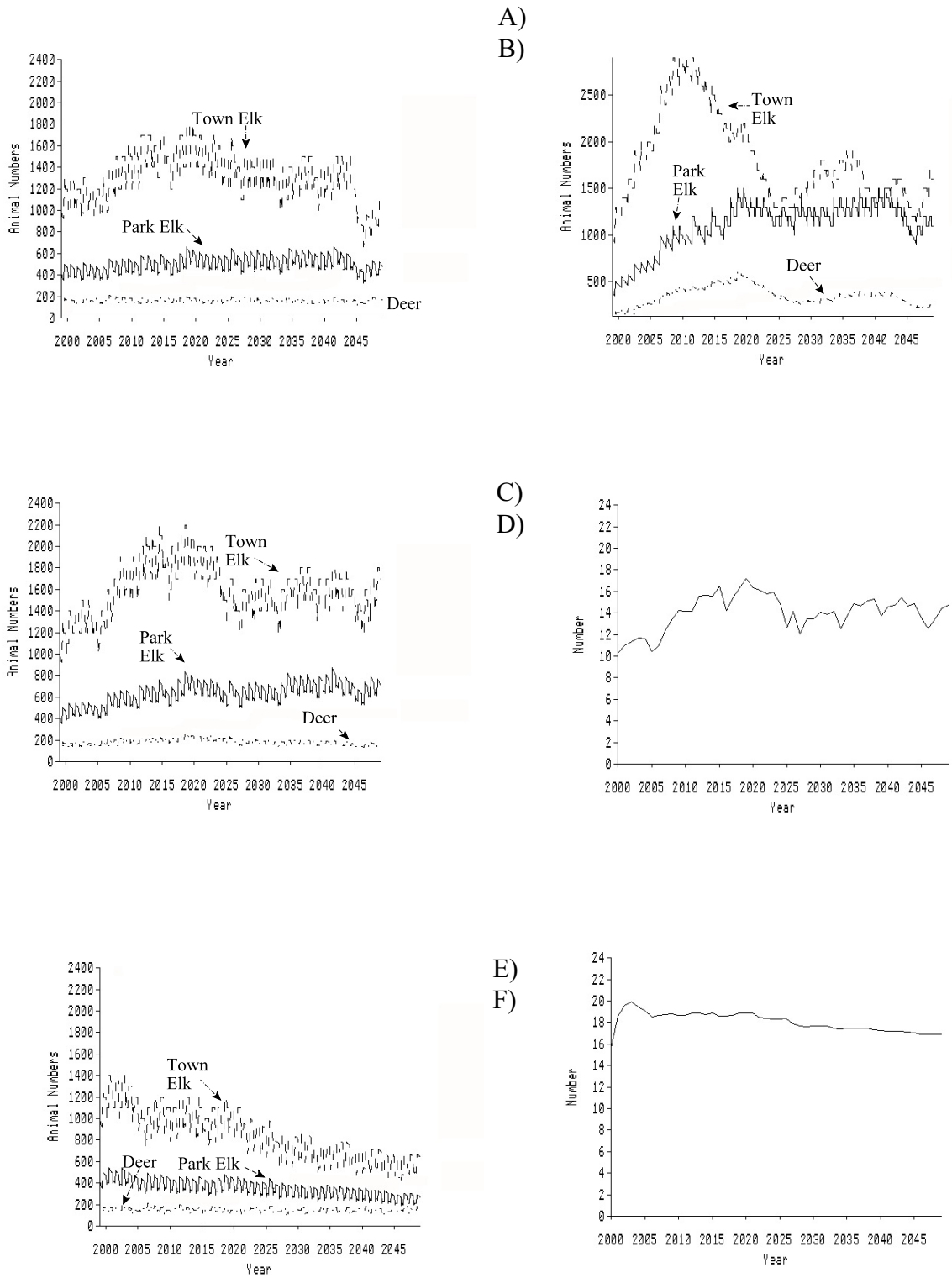
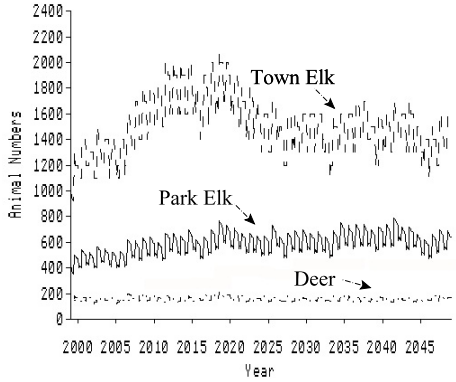
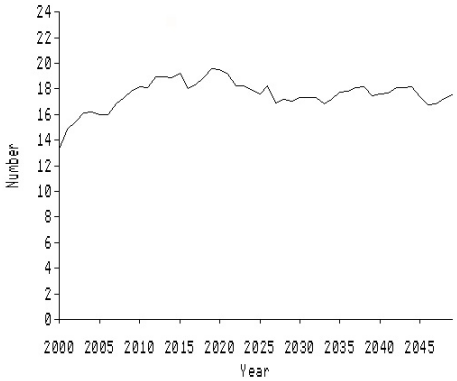


Figure 114. Sensitivity analysis of wolf model parameters. A) The control run (as Figure 111e), with wolf parameters in Table 9 and wolf numbers in Figure 111f. B) No wolves., C) and D) use wolf density vs. prey function giving minimal wolf densities at a given prey density. E) and F) use the wolf density vs. prey function giving maximal wolf densities. All runs are a continuation of the 1949-1998 undisturbed run.

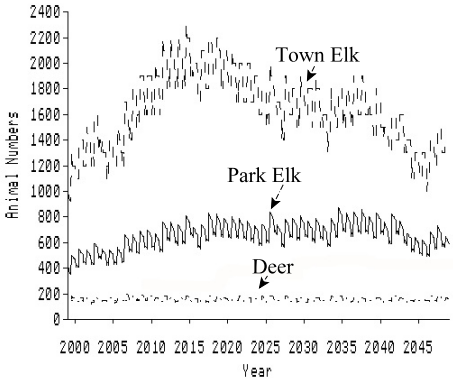
A)



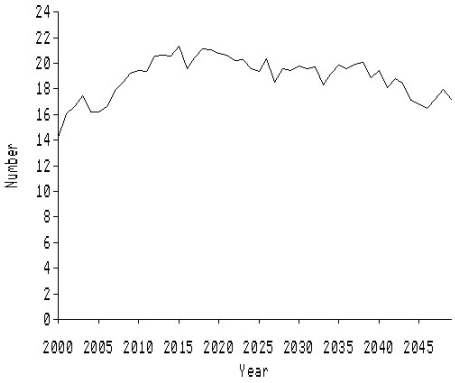
B)



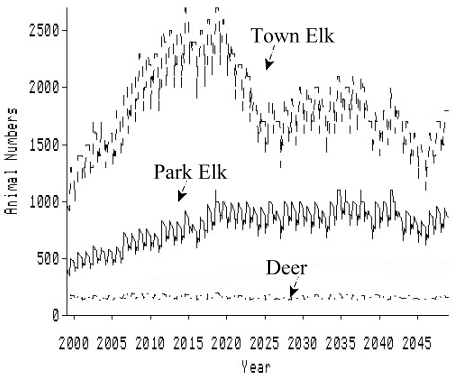
C)



D)



E)



F)

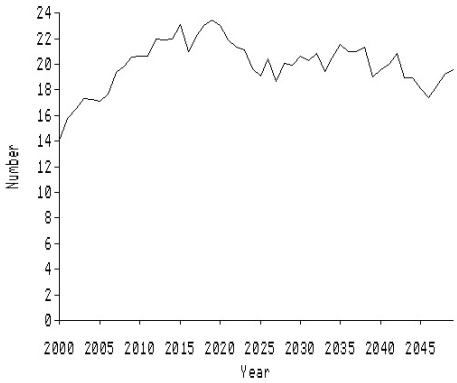


Figure 115. Sensitivity analysis of wolf model parameters. A) elk, and B) wolves, use a w0 value of 5.5 rather than 3.5, C) elk and D) wolves use an Fmax of 18.0 rather than 25.0, E) elk and F) wolves use a uniform vulnerability value among all sex and age classes, instead of making calves and older animals more vulnerable. All runs are a continuation of the 1949-1998 run using undisturbed vegetation.

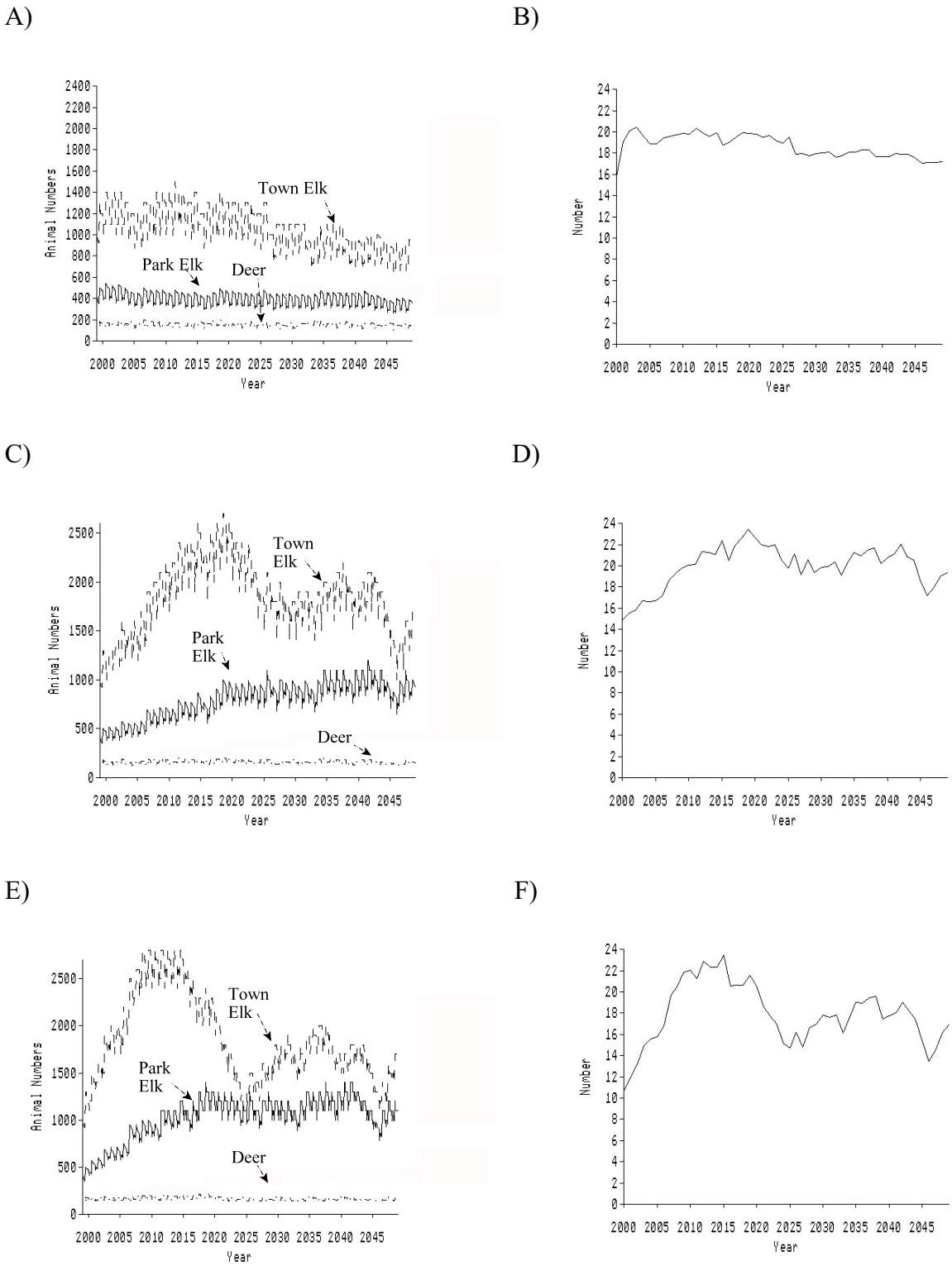


Figure 116. Sensitivity analysis of wolf model parameters. A) elk and B) wolves assume all prey are in the wolve's range year-around, instead of assuming some are out of range in winter. C) elk and D) wolves with compensatory elk mortality of 0.8 instead of 0.3. E) elk and F) wolves use a combination of parameters that are least effective for predator control of prey (see text).