## LIST OF FIGURES AND TABLES\_

## List of Figures

| Executive Summary   |    |
|---|----|
| Figure 1. Process and outcomes of the Statewide Conservation and Preservation Plan  | 8  |
| Figure 2. Natural resource values assessment of policy and action recommendations   | 9  |
| Figure 3. Strategic framework for integrated resource conservation and preservation | 10 |
| Introduction  |    |
| Figure 4. Assessment of recommendations' effect on drivers of change                | 18 |
| Strategic Framework for Recommendations   |    |
| Figure 5. Strategic framework for integrated resource conservation and preservation | 26 |
| Figure 6. Natural resource values assessment of recommendations                     | 28 |
| Habitat Recommendations   |    |
| Table H1. Input data sets and weightings for terrestrial habitat analyses           | 35 |
| Table H2. Input data sets for aquatic habitat analyses                              | 36 |
| Table H3. Input data sets for aquatic environment stressors                         | 37 |
| Figure H1. Minnesota Ecological Subsections   | 38 |
| Figure H2. MCBS sites of biodiversity   | 39 |
| Figure H3. Potential species richness based on habitat                              | 40 |
| Figure H4. Land status.   | 41 |
| Figure H5. Road density index by township   | 42 |
| Figure H6. Population (housing density) stress                                      | 43 |
| Figure H7. Integrated terrestrial value score                                       | 44 |
| Figure H8. Integrated aquatic habitat quality index                                 | 45 |
| Figure H9. Integrated aquatic habitat score   | 46 |
| Figure H10. Housing density index   | 47 |
| Eiguna U11 Dood dansity index   | 10 |

| Figure H12. Agricultural land use  | 49 |
|--|----|
| Figure H13. Urban land use   | 50 |
| Figure H14. Lakeshed invasives   | 51 |
| Figure H15. Aquatic habitat quality vs. environmental stress   | 52 |
| Figure H16. Vulnerable key habitat by township   | 53 |
| Figure H17. Locations of terrestrial and aquatic focus areas   | 57 |
| Figure H18. Summary of ecological values and stresses around Grand Marais along the North Shore  | 58 |
| Figure H19. Summary of ecological values and stresses in the Red Lake River watershed  | 59 |
| Figure H20. Summary of ecological values and stresses in western Minnesota   | 60 |
| Figure H21. Summary of ecological values and stresses in the Twin Cities metropolitan area   | 61 |
| Figure H22. Ownership of land by entity  | 62 |
| Figure H23. Marschner's map of vegetation around the time of European settlement   | 64 |
| Figure H24. Land cover change, 1890–1990   | 65 |
| Figure H25. Surface waters in Minnesota  | 68 |
| Figure H26. Aerial photographs show the same shore of a Minnesota lake 64 years apart  | 69 |
| Figure H27. Development around north-central Minnesota lakes, as dock sites per mile   | 70 |
| Figure H28. Increasing size of the arrows indicate increasing volume of runoff and nutrients as shorelines   | 71 |
| Figure H29. Lake Christina, shallow lake with good habitat   | 72 |
| Figure H30. State and federal recreation resources available in Minnesota  | 75 |
| Figure H31. Access to parks and low mobility, Minneapolis  | 77 |
| Figure H32. Example of poor shallow lake habitat   | 79 |
| Figure H33. Cross-section of two-stage channel constructed within a channelized stream   | 83 |
| Figure H34. Two-stage channel just after construction.   | 83 |
| Figure H35. Floating, emergent, and natural vegetation along the shoreline provides habitat  | 85 |
| Figure H36. Stream without riparian buffer of vegetation; stream with riparian buffer of vegetation  | 87 |
| Figure H37. Degraded shoreline revegetated to prevent erosion and provide habitat  | 90 |
| Figure H38: What Minnesota vegetation cover might look like if average temperatures in the state rise 10 degrees F and precipitation increases 13% at double historical CO <sub>2</sub> levels | 93 |
| Figure H39. Wild rice bed in Lake Onamia   | 95 |

| T 1  | 1 T T | T    |     | -   | 1 ,•    |
|------|-------|------|-----|-----|---------|
| Land | Use   | Reco | mme | ena | lations |

| Figure L1. Minnesota county population change, 1990–2000   | 98  |
|--|-----|
| Figure L2. Impervious acres change 1990–2000   | 100 |
| Figure L3. Projected impervious acres change 2020  | 101 |
| Figure L4. Minnesota inventory of impaired waters  | 115 |
| Table L1. Pollutants grouped by affected designated use category   | 116 |
| Figure L5. Potential soil erosion by water   | 117 |
| Figure L6. Comparison of economic and emission growth factors in Minnesota from 1985 to 2005   | 117 |
| Figure L7. Impervious surface increase by watershed 1990–2000  | 118 |
| Figure L8. Acreages planted to hay, row crops, pasture and other annual crops  | 119 |
| Figure L9. Minnesota agro-ecoregions differ significantly in suitability for perennial species   | 120 |
| Transportation Recommendations   |     |
| Figure T1. Fragmentation effects of transportation infrastructure  | 136 |
| Figure T2. An overview of some of the elements of the "carbon footprint" of vehicular transportation   | 137 |
| Figure T3. Population density  | 138 |
| Figure T4. VMT growth factors by county  | 139 |
| Figure T5. Policy areas and levels—resource impacts  | 140 |
| Figure T6. Conventional cul-de-sac low, density development in context of road networks and land cover - same number of dwellings in compact, connective street system | 152 |
| Figure T7. Road construction alters runoff speed, patterns, and volumes, and directs contaminants to the valley floor of a stream system                               | 154 |
| Figure T8. Current practices in road design to filter and slow runoff from paved surfaces  | 155 |
| Figure T9. Conservation green corridors in the Sherburne County Multimodal Plan (2007)   | 156 |
| Figure T10. Alternative to minimize the impacts of proposed upgrades at Sherburne National Wildlife Refuge   | 157 |
| Table T1. Buffer distances for road functional classes   | 158 |
| Table T2. Road lengths (mi) in current and future functional classes   | 158 |
| Figure T11. Critical habitat   | 159 |
| Figure T12. Critical habitat adjacent to road functional classes   | 160 |
| Figure T13. Critical habitat adjacent to future road functional classes  | 161 |
| Figure T14. Critical habitat adjacent to road functional classes   | 162 |

| Figure T15. Critical habitat adjacent to future road functional classes  | 163 |
|--|-----|
| Figure T16. Critical habitat adjacent to road functional classes   | 164 |
| Figure T17. U.S. Census housing density  | 165 |
| Energy Recommendations   |     |
| Figure E1. Trends in Minnesota population growth, energy consumption, vehicle miles traveled, and greenhouse gas emissions | 170 |
| Figure E2. Historical and projected electricity production from renewable sources  | 171 |
| Table E1. Per capita energy consumption by country for 2005.   | 172 |
| Figure E3. Energy consumption in Minnesota by economic sector, 1970–2004   | 173 |
| Figure E4. Minnesota's wind resource potential   | 173 |
| Figure E5. Historical and projected Minnesota ethanol production under future scenarios                                    | 174 |
| Table E2. Summary of woody biomass resources   | 175 |
| Figure E6. Average soil-based crop productivity index values for Minnesota counties  | 177 |
| Figure E7. Change in Minnesota corn acreage between 2006 and 2007  | 178 |
| Figure E8. Percent change in Minnesota corn acreage between 2006 and 2007  | 178 |
| Figure E9. Water erosion rates for cultivated cropland in Minnesota  | 179 |
| Figure E10. Wind erosion rates for cultivated cropland in Minnesota  | 179 |
| Figure E11. Areas of high acetochlor leaching risk on Minnesota corn-soybean land  | 180 |
| Figure E12. Areas of high atrazine leaching risk on Minnesota corn-soybean land  | 180 |
| Figure E13. CRP acres in Minnesota   | 181 |
| Figure E14. Acres of Minnesota CRP land with contracts expiring in different time intervals                                | 181 |
| Figure E15. Average soil-based crop productivity index and acres of expiring CRP land                                      | 182 |
| Appendix I   |     |
| Figure 1. Conceptual hierarchy of drivers  | 210 |
| Appendix III   |     |
| Figure 1. Biogeochemical cycle of mercury in the environment   | 227 |
| Figure 2. Sources of atmospheric mercury deposition to Minnesota   | 228 |
| Figure 3. Annual mercury flux at mercury deposition network (MDN) sites in Minnesota                                       | 228 |

| List of Figures | Final Pla |
|-----------------|-----------|
|                 |           |

| Table 1. Regional differences in land cover and water quality   | 229   |
|---|-------|
| Table 2. Median mercury concentrations for northern pike and walleye collected from 1970 to 2002  | . 229 |
| Table 3. Estimated anthropogenic mercury emissions in Minnesota for 2005, 2010, and 2018  | 231   |
| Table 4. Baseline fish concentrations in Minnesota for northern pike and walleye  | 234   |
| Table 5. Electrical generation options and their impact on mercury emissions  | 238   |
| Table 6. National statistics for acres of crop harvested and resulting biomass production   | 239   |
|   |       |
| Appendix IV   |       |
| Figure 1. Predicted changes in average annual temperature and precipitation by 2039 and 2069  | . 244 |
| Figure 2. Migrating climate analogs for eight Minnesota landscape regions   | 245   |
| Table 1. Summary of protected areas of ecosystems within designated landscape regions   | 246   |
|   |       |
| Appendix V  |       |
| Table 1. Summary of potential costs and benefits from acquisition of high-priority shoreland  | 255   |
| Table 2. Summary of potential costs and benefits from wetland and wetland-associated restoration  | 262   |
| Figure 1. Minnesota rural land: median sale price per acre  | 267   |
| Table 3. Summary of potential costs and benefits protecting large blocks of forested land in the first five years of project implementation.                          | 268   |
| Table 4. Summary of potential costs and benefits from a perennial crop payment program in the first five years of project implementation, all adjusted to 2007 values | 275   |
| Table 5. Summary of potential costs and benefits from a perennial crop payment program for expiring CRP land in the first five years of project implementation        | 276   |
| Table 6. Summary of potential costs and benefits from an HEV tax rebate program in the first five years of project implementation                                     | 283   |
| Appendix VI   |       |
| Table 1. Relative costs of implementing recommendations statewide   | 292   |
| Appendix VII  |       |
| Figure 1. St. Paul Public Outreach Forum  | 298   |
| Figure 2. Morris energy tour. Photograph by Les Everett   | 300   |