

Guide to the Northern Highlands Adaptive Management Game

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The Northern Highlands Adaptive Management game allows the player to make decisions about the future of a social-ecological system based on the Northern Highland Lake District (NHLD) of Wisconsin. The social-ecological model that underlies the game was described by Carpenter and Brock (2004). The scenarios that are simulated by the game are available at the URL <http://lakefutures.wisc.edu>. A preliminary version of the scenarios and a social-ecological description of the NHLD were presented by Peterson et al. (2003). The game was programmed by Brad Grzesiak and Steve Carpenter in Matlab.

This guide first explains how to launch the program. Then the functions of the 6 main buttons on the main menu are explained. Then we present an explanation of the various graphical results calculated by the program.

Launching the Program

The program runs on Windows (95 or higher). Two versions are available. One requires Matlab 6.x or higher. The other version is executable from Windows, even if you do not own a separate copy of Matlab.

Matlab version: From the run window in Matlab 6.x or higher, type “rungame” to start the program. Matlab code is provided in a zip file on <http://limnology.wisc.edu/ecogame>.

Compiled version: Run the installer, found on <http://limnology.wisc.edu/ecogame>. The installer will prompt you to choose a folder in which the game will be installed. To start the game from Windows Explorer, click on the “ecogame” icon in that folder. Note that an “un-installer” is also provided in case you want to remove the game from your hard drive.

Ending the Program

Matlab version: For the scenario simulations (see below) the program will terminate automatically. For the simplified and complex versions of the game (see below), click the “quit” button on the control panel to end the game.

Compiled version: For the scenario simulations (see below), close the black text window to close the game. For the simplified and complex versions of the game (see below), click the “quit” button on the control panel to end the game.

Main Menu

When the program first starts, you will see a main menu. The main menu has 7 buttons. The lower button, “quit”, stops the program. The other 6 buttons run various versions of the program. These 6 buttons are discussed in the following 6 sections of this guide.

Simulate the Anaheim North Scenario

47
 48 The program is run with a set of parameters selected to resemble the Anaheim North scenario
 49 presented at <<http://lakefutures.wisc.edu>>.

50
 51 **Simulate the Northwoods Quilt Scenario**

52
 53 The program is run with a set of parameters selected to resemble the Northwoods Quilt scenario
 54 presented at <<http://lakefutures.wisc.edu>>.

55
 56 **Simulate the Walleye Commons Scenario**

57
 58 The program is run with a set of parameters selected to resemble the Walleye Commons scenario
 59 presented at <<http://lakefutures.wisc.edu>>.

60
 61 **Simulate the Refugee Revolution Scenario**

62
 63 The program is run with a set of parameters selected to resemble the Refugee Revolution
 64 scenario presented at <<http://lakefutures.wisc.edu>>.

65
 66 **Play the Simplified Game**

67
 68 The simplified version of the game is designed so it can be learned and played rapidly.
 69 However, the game player has relatively few policy options from which to choose.

70
 71 Graphic outputs are explained below under “Explanation of Program Outputs”.

72
 73 Buttons across the top of the window are used to select the different levels of output display.
 74 Buttons across the bottom of the window are used to simulate one year at a time, simulate a
 75 specified number of years, or simulate the remaining years of the run. All runs are 30 years,
 76 corresponding to the scenario exercise described at <<http://lakefutures.wisc.edu>>.

77
 78 Controls on the left side of the window are used to select policies for governing the landscape
 79 Prior to each time step, the game player makes the following choices:

80
 81 Sprawl controls: “Low” selects for policies that place few limitations on locations of new
 82 buildings. “High” selects for policies that limit locations of new buildings to a few regions of the
 83 landscape.

84
 85 Purchase of information: The player chooses among three levels of information for the
 86 landscape. Costs are associated with choosing more information. The information provided at
 87 the three levels is as follows. Variables are explained under “Explanation of Program Outputs”.

88
 89 *Minimum*: Population versus time; Infrastructure versus time; Management costs versus
 90 time.

91

92 *Moderate*: The “minimum” information plus: Commerce versus time; Fishing effort
 93 versus time; Population versus landscape position; Infrastructure versus landscape position.

94
 95 *Maximum*: The “minimum” and the “moderate” information plus: Satisfaction index
 96 versus time; Forest condition versus landscape position; Forest condition versus time; Fish
 97 population versus landscape position; Fish population versus time.

98
 99 Buttons across the top of the window are used to display the different levels of information. If
 100 the game player did not select a particular level of information, it is not displayed.

101
 102 Stocked lakes: The player chooses not to stock lakes (“no”) or to stock the most heavily-fished
 103 lakes (“yes”). There is an economic cost of stocking.

104
 105 Habitat regulations: The game player chooses the level of regulation of lakeshore habitat. If
 106 regulation is low, then property owners have great flexibility to alter lakeshore habitat. If
 107 regulation is high, then property owners are encouraged to maintain lakeshore habitat by
 108 regulations and incentives. These regulations and incentives have economic costs.

109
 110 Fishing policy: The game player chooses the level of fishing policy. If regulation is low, then
 111 fishers have relatively few restrictions on harvest. If regulation is high, then there are more
 112 restrictions on the number of fish that can be harvested. These restrictions have economic costs.

113 114 **Play the Complex Game**

115
 116 The complex game was designed to provide the game player with a richer set of policy options.
 117 As a result, however, the game is more complicated to learn, and can take a longer time to play.

118
 119 Graphic outputs are explained below under “Explanation of Program Outputs”.

120
 121 Buttons across the top of the window are used to select the different levels of output display.
 122 Buttons across the bottom of the window are used to simulate one year at a time, simulate a
 123 specified number of years, or simulate the remaining years of the run. All runs are 30 years,
 124 corresponding to the scenario exercise described at <<http://lakefutures.wisc.edu>>.

125
 126 Controls on the left side of the window are used to select policies for governing the landscape
 127 Prior to each time step, the game player makes the following choices:

128
 129 Escapement on co-managed lakes: Lakes at positions 11-14 are co-managed for both tribal
 130 harvest and angling using an escapement system, as described in Carpenter and Brock (2004).
 131 The slider sets the escapement level on these lakes.

132
 133 Sprawl control: The degree of control on sprawl of development is set by the slider.

134
 135 Purchase information: The player chooses among three levels of information for the landscape.
 136 Costs are associated with choosing more information. The information provided at the three
 137 levels is as follows. Variables are explained under “Explanation of Program Outputs”.

138
 139 *Minimum:* Population versus time; Infrastructure versus time; Management costs versus
 140 time.

141
 142 *Moderate:* The “minimum” information plus: Commerce versus time; Fishing effort
 143 versus time; Population versus landscape position; Infrastructure versus landscape position.
 144

145 *Maximum:* The “minimum” and the “moderate” information plus: Satisfaction index
 146 versus time; Forest condition versus landscape position; Forest condition versus time; Fish
 147 population versus landscape position; Fish population versus time.
 148

149 Stocked lakes: Select lakes for stocking. There is a cost for stocking each lake.
 150

151 Habitat regulation: For each lake, the game player chooses the level of regulation of lakeshore
 152 habitat. If regulation is low, then property owners have great flexibility to alter lakeshore
 153 habitat. If regulation is high, then property owners are encouraged to maintain lakeshore habitat
 154 by regulations and incentives. These regulations and incentives have economic costs.
 155

156 Fishing policy: For each lake, the game player chooses the fishing regulations. If regulation is
 157 low, then fishers have relatively few restrictions on harvest. If regulation is high, then there are
 158 more restrictions on the number of fish that can be harvested. These restrictions have economic
 159 costs.
 160

161 Investment policy: For each lake, the game player chooses the degree to which investment in
 162 new construction is favored by residents of each watershed. Capital for investment tends to flow
 163 toward watersheds that favor new construction.
 164

165 **Explanation of Program Outputs**

166
 167 The current year and ending year of the simulation are printed in the upper right corner of the
 168 game window.
 169

170 Depending on the amount of information purchased by the game player, various graphics are
 171 available in the game window. The X-axis and Y-axis variates are as follows.
 172

173 X-axis: Two variates are used on the X-axis. One is time in years since the start of the game.
 174 The other is lake position (or landscape position) measured as distance from the main highway.
 175 Low distances correspond to lakes that have very low travel cost from the highway. High
 176 distances correspond to lakes that have high travel costs from the highway. The most distant
 177 lakes (above distance = 22) are wilderness lakes where no development is permitted.
 178

179 Y-axis variates are as follows, starting with the minimum level of information and moving
 180 through moderate to maximum.
 181

182 *Population:* number of people on the whole landscape (when plotted against time) or
 183 population density in the watershed of each lake (when plotted against lake position).

184
185 *Infrastructure*: capital value of buildings on the whole landscape (when plotted against
186 time) or in the watershed of each lake (when plotted against lake position).

187
188 *Management Cost*: annual expenditures on all resource management by government
189 (includes costs of controlling sprawl, buying information, regulating habitat, regulating
190 fishing, and fish stocking).

191
192 *Commerce*: index of total commercial activity.

193
194 *Fishing effort*: index of total fishing activity by people.

195
196 *Satisfaction index*: index of the extent to which people can obtain the experiences that they
197 want from the lakes and forests. This index goes up if lake and forest resources are
198 abundant relative to peoples' wants, and goes down if resources are limited (due to rarity or
199 regulation) relative to peoples' wants.

200
201 *Forest reserve*: index of the amount of lakeshore forest that is set aside for natural forest
202 dynamics, versus development.

203
204 *Fish*: index of game fish population on the whole landscape (when plotted against time) or
205 in each lake (when plotted against lake position).

206
207 At the end of each run, a series of summary graphics are plotted. These summarize conditions
208 over the entire run. All information is displayed, even if only limited information was purchased
209 by the game player. Variates in these graphics were described above.

210
211 A Sustainability Score is printed at the end of each run. This score is the sum of six indicators:
212 number of fish populations far from the threshold of collapse; number of lakes with habitat that
213 creates high resilience for fish populations; degree of aggregation of the human population;
214 satisfaction index for people (explained above); degree to which resource use is self-regulated by
215 people, versus regulated by government intervention; and cost of the government resource
216 management as a proportion of the total economy.

217
218 **References**

219
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