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Wildlife Disease Hazard Software

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Overview of the Wildlife Disease Hazard Software

The *Wildlife Disease Hazard Software* displays the hazards associated with the introduction and spread of Chronic Wasting Disease (CWD) in wild white-tailed deer (*Odocoileus virginianus*) in the eastern United States (US) and Canada (CAN). Disease hazards include any human activity that can result in the introduction of infectious prions into the environment or into live wild populations of cervids, but this software explicitly intakes data such as the presence of taxidermists, deer meat processing businesses, and captive cervid farms located amid wild deer populations (Schuler et al., *in preparation*). The *Wildlife Disease Hazard Software* further depicts areas for which local demographic parameters of the live deer population, such as fecundity, natural mortality, and harvest mortality, can influence the spread of CWD once infectious prions are introduced (Hanley et al., *in preparation*). Areas at high risk of novel CWD introduction and/or subsequent rapid spread of the pathogen through the live deer population are ranked using anthropogenic and demographic hazard combinations, then displayed in an interactive map. The *Wildlife Disease Hazard Software* includes (redacted) hazard data,

(redacted) deer demographic data, and example apps for use in Alabama, Arkansas, Connecticut, Florida, Georgia, Indiana, Iowa, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, New Hampshire, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Tennessee, Virginia, and Wisconsin, USA and Ontario, CAN, but the software is readily adaptable to depict conditions in other US states and Canadian provinces.

Because the *Wildlife Disease Hazard Software* displays data and modeling results for the state (or province) of interest and its contiguous neighbors, the R scripts of the *Wildlife Disease Hazard Software* are an interlinking network of commands that hinge on geography. The scripts create the geospatial files for the state (or province) of interest and its neighbors, prepare the surveillance (disease testing), hazard, and demographic data for the state (or province) of interest and its neighbors, and launch the user interface (UI) of the interactive software depicting the results in the state (or province) of interest.

Any data available from both the state (or province) of interest and adjacent (state and/or provincial) neighbors may be included in the *Wildlife Disease Hazard Software* interface. Missing data from adjacent states (or provinces) not included in this *Wildlife Disease Hazard Software* packet do not hinder the use of this software. Please see the **Instructions to Add an Additional State (or Province) to the Wildlife Disease Hazard Software** section below.

The *Wildlife Disease Hazard Software* contains four types of R scripts:

- “0_Hazard_Pre_Processing.R” script,
- “1_(state name)_Hazard_Data_Prep.R” script,
- “2_(state name)_Hazard_App.R” script,
- “3_(state name)_Hazard_Command_Center.R” script.

The 0_Hazard_Pre_Processing.R script of the *Wildlife Disease Hazard Software* creates, for each state (or province), the geospatial files containing administrative boundaries plus the administrative boundaries of contiguous neighbors “one administrative area deep”, as well as related files necessary for executing the UI. The outputs of the 0_Hazard_Pre_Processing.R script include the geospatial files and related files autosaved in the structural format needed for immediate upload into the 1_(state name)_Hazard_Data_Prep.R and 2_(state name)_Hazard_App.R scripts of the *Wildlife Disease Hazard Software*.

*Note that this script should be run before any other scripts in the Wildlife Disease Hazard Software and should only be run once, unless additional states are added to the software (see the **Instructions to Add an Additional State (or Province) to the Wildlife Disease Hazard Software** section below).*

The 1_(state name)_Hazard_Data_Prep.R script of the *Wildlife Disease Hazard Software* converts, for each state (or province) and its neighbors, the demographic (white-tailed deer) data, hazard (anthropogenic) data, and CWD surveillance (disease testing) data that has been preprocessed using the software in Mitchell et al. (2022). The outputs of the 1_(state name)_Hazard_Data_Prep.R script include the data autosaved in the structural format needed for immediate upload into the 2_(state name)_Hazard_App.R script of the *Wildlife Disease Hazard Software*.

The 2_(state name)_Hazard_App.R script of the *Wildlife Disease Hazard Software* intakes the autosaved geospatial files from the execution of the 0_Hazard_Pre_Processing.R script and the autosaved data from the execution of the 1_(state name)_Hazard_Data_Prep.R script and launches the interactive software that displays the results. Thus, the 0_Hazard_Pre_Processing.R, 1_(state name)_Hazard_Data_Prep.R, and 2_(state name)_Hazard_App.R scripts of the *Wildlife Disease Hazard Software* must run in sequence for each state (or province) of interest.

With one click, the 3_(state name)_Hazard_Command_Center.R script of the *Wildlife Disease Hazard Software* runs for each state (or province) the appropriate sequence and set of scripts of the *Wildlife Disease Hazard Software*:

1_(state name)_Hazard_Data_Prep.R and

2_(state name)_Hazard_App.R scripts.

*Note, however, that the 3_(state name)_Hazard_Command_Center.R script will not automatically run the 0_Hazard_Pre_Processing.R script and this script must be run separately before running the command center script (see the **Wildlife Disease Hazard Software User Tutorial** section below).*

We note that “(state name)” in all file names is a placeholder to depict the geographical entity of interest, regardless of whether the entity is a state, province, or otherwise. As well, the use of the word county is flexible to accommodate any mutually exclusive administrative area.

Inputs Needed to Run the Wildlife Disease Hazard Software

Data inputs necessary to run the 0_Hazard_Pre_Processing.R script of the *Wildlife Disease Hazard Software* include:

0-i. Raw geospatial files containing administrative boundaries for the US and Canada.

Note: The Cartographic Boundary and TIGER line files (US Census Bureau 2019; 2020) necessary to create the appropriate files for the US states are procured using command lines directly in the script. The files necessary for Canada (Statistics Canada 2019), however, require additional steps to procure from an outside source. See Steps 5-7 in the Wildlife Disease Hazard Software user tutorial section (below).

0-ii. A csv file containing a list of all participating state and province names in a single column (for more details see Step 8 below):

“All_states.csv”

Note: This script will automatically create a set of geospatial files and related files for each state (or province) included in “All_States.csv” and should only be run once, unless additional states are added to “All_States.csv” after the initial run.

Data inputs necessary to run the 1_(state name)_Hazard_Data_Prep.R script of the *Wildlife Disease Hazard Software* include:

1-i. Pre-processed surveillance (testing) data summaries of confirmed CWD positives by county (or other administrative area) and age/sex segment generated for years

(“XX”) 2013-2025 for the state (or province) of interest (created in Mitchell et al. 2022):

“(state name)CountySummary20XX.txt”

1-ii. Pre-processed surveillance (testing) data summaries of confirmed CWD positives by county (or other administrative area) and age/sex segment generated for years (“XX”) 2013-2025 for the state (or province) of interest and all participating neighbor(s) of the state (or province) of interest (created in Mitchell et al. 2022):

“(state name)CountySummary_Contig_20XX.txt”

1-iii. Summaries of anthropogenic hazards by county (or other administrative area) for the state (or province) of interest:

“Businesses_by_County_(state name).csv”

“Captive_by_County_(state name).csv”

1-iv. Summaries of anthropogenic hazards by county (or other administrative area) for the neighbor(s) of the state (or province) of interest:

“Businesses_by_County_(neighbor name).csv”

“Captive_by_County_(neighbor name).csv”

1-v. The hazard score that arises for each county (or other administrative area) from the model by Schuler et al. (*in preparation*) for the state (or province) of interest:

“Hazard_by_County_(state name).csv”

1-vi. Summaries of wild cervid demographic estimates by county (or other administrative area) for the state (or province) of interest:

“Density_by_County_(state name).csv”

“Fecundity_by_County_(state name).csv”

“Harvest_by_County_(state name).csv”

“Mortality_by_County_(state name).csv”

1-vii. Geospatial files *autosaved* during the execution of the 0_Hazard_Pre_Processing.R script containing the county (or other administrative area) boundaries of the state (or province) of interest:

“(state name)_counties.dbf”

“(state name)_counties.prj”

“(state name)_counties.shp”

“(state name)_counties.shx”

1-viii. Geospatial files *autosaved* during the execution of the 0_Hazard_Pre_Processing.R script containing the county (or other administrative area) boundaries “one layer deep” into contiguous states (or provinces):

“(state name)_ContigCounty.dbf”

“(state name)_ContigCounty.prj”

“(state name)_ContigCounty.shp”

“(state name)_ContigCounty.shx”

1-ix. A csv file containing a list of a list of all participating state and province names in a single column (for more details see **Step 8** below):

“All_states.csv”

1-x. A csv file containing a list of all state and province names with one or more rows of surveillance (testing) data in a single column (for more details see **Step 9** below):

“Data_States.csv”

Note: this list may differ from the one in “All_States.csv”.

The data (**1-i** through **1-vi**) are not included in this *Wildlife Disease Hazard Software* packet. Templates for data in (**1-i** and **1-ii**) can be created in Mitchell et al. (2022) and will be generated for years (“XX”) 2013-2025. Templates for data in (**1-iii** through **1-vi**) are included in this packet and can be modified to include real data by replacing the “999999” in all templates.

Data inputs necessary to run the 2_(state name)_Hazard_App.R script of the *Wildlife Disease Hazard Software* include:

- 2-i.** Geospatial files *autosaved* during the execution of the 0_Hazard_Pre_Processing.R script containing the county (or other administrative area) boundaries of the state (or province) of interest:
 - “(state name)_counties.dbf”
 - “(state name)_counties.prj”
 - “(state name)_counties.shp”
 - “(state name)_counties.shx”
- 2-ii.** Geospatial files *autosaved* during the execution of the 0_Hazard_Pre_Processing.R script containing the county (or other administrative area) boundaries “one layer deep” into contiguous states (or provinces):
 - “(state name)_ContigCounty.dbf”
 - “(state name)_ContigCounty.prj”
 - “(state name)_ContigCounty.shp”
 - “(state name)_ContigCounty.shx”
- 2-iii.** Data file outputs *autosaved* during the execution of the 1_(state name)_Hazard_Data_Prep.R script for the state (or province) of interest:
 - “County_Captive_(state name).txt”
 - “County_Taxidermy_(state name).txt”
 - “County_Processor_(state name).txt”
 - “County_Density_(state name).txt”
 - “County_Mortality_(state name).txt”
 - “County_Fecundity_(state name).txt”
 - “County_Harvest_(state name).txt”
 - “County_Hazard_(state name).txt”
 - “County_Load_(state name).txt”
- 2-iv.** Csv file outputs *autosaved* during the execution of the 1_(state name)_Hazard_Data_Prep.R script for the state (or province) of interest:
 - “Captive_by_County_(state name)_Contig.csv”
 - “Buisnesses_by_County_(state name)_Contig.csv”
 - “Load_by_County_(state name)_Contig.csv”
- 2-v.** Text files *autosaved* during the execution of the 0_Hazard_Pre_Processing.R script containing the geographic center of the state (or province) of interest:
 - “(state name)_Latitude.txt”
 - “(state name)_Longitude.txt”

Data inputs necessary to run the 3_(state name)_Hazard_Command_Center.R script of the *Wildlife Disease Hazard Software* include:

- 3-i.** Geospatial files *autosaved* during the execution of the 0_Hazard_Pre_Processing.R script containing the county (or other administrative area) boundaries of the state (or province) of interest:
“(state name)_counties.dbf”
“(state name)_counties.prj”
“(state name)_counties.shp”
“(state name)_counties.shx”
- 3-ii.** Geospatial files *autosaved* during the execution of the 0_Hazard_Pre_Processing.R script containing the county (or other administrative area) boundaries “one layer deep” into contiguous states (or provinces):
“(state name)_ContigCounty.dbf”
“(state name)_ContigCounty.prj”
“(state name)_ContigCounty.shp”
“(state name)_ContigCounty.shx”
- 3-iii.** Pre-processed surveillance (testing) data summaries of confirmed CWD positives by county (or other administrative area) and age/sex segment generated for years (“XX”) 2013-2025 for the state (or province) of interest (created in Mitchell et al. 2022):
“(state name)CountySummary20XX.txt”
- 3-iv.** Pre-processed surveillance (testing) data summaries of confirmed CWD positives by county (or other administrative area) and age/sex segment generated for years (“XX”) 2013-2025 for the state (or province) of interest and all participating neighbor(s) of the state (or province) of interest (created in Mitchell et al. 2022):
“(state name)CountySummary_Contig_20XX.txt”
- 3-v.** Summaries of anthropogenic hazards by county (or other administrative area) for the state (or province) of interest:
“Businesses_by_County_(state name).csv”
“Captive_by_County_(state name).csv”
- 3-vi.** Summaries of anthropogenic hazards by county (or other administrative area) for the neighbor(s) of the state (or province) of interest:
“Businesses_by_County_(neighbor name).csv”
“Captive_by_County_(neighbor name).csv”
- 3-vii.** The hazard score that arises for each county (or other administrative area) from the model by Schuler et al. (*in preparation*) for the state (or province) of interest:
“Hazard_by_County_(state name).csv”
- 3-viii.** Summaries of wild cervid demographic estimates by county (or other administrative area) for the state (or province) of interest:
“Density_by_County_(state name).csv”
“Fecundity_by_County_(state name).csv”
“Harvest_by_County_(state name).csv”
“Mortality_by_County_(state name).csv”
- 3-ix.** A csv file containing a list of a list of all participating state and province names in a single column (for more details see **Step 8** below):
“All_states.csv”
- 3-x.** A csv file containing a list of all state and province names with one or more rows of surveillance (testing) data in a single column (for more details see **Step 9** below):

“Data_States.csv”

Note: this list may differ from the one in “All_States.csv”.

3-xi. Text files *autosaved* during the execution of the 0_Hazard_Pre_Processing.R script containing the geographic center of the state (or province) of interest:

“(state name)_Latitude.txt”

“(state name)_Longitude.txt”

The data in (**3-iii** through **3-viii**) are not included in this *Wildlife Disease Hazard Software* packet. Templates for data in (**3-iii** and **3-iv**) are in Mitchell et al. (2022) and will be generated for years (“XX”) 2013-2025. Templates for data in (**3-v** through **3-viii**) are included in this packet and can be modified to include real data by replacing the “999999” in all templates.

Variables in the templates are defined as:

Businesses: the number of wild deer meat processing and taxidermist businesses that are known to exist in each county (or other administrative area);

Captive: the number of captive cervid facilities that are known to exist in each county (or other administrative area);

Hazard: the hazard score that arises for each county (or other administrative area) from the model by Schuler et al. (*in preparation*);

Density: the estimated number of deer (per sq. kilometer) that occur in each county (or other administrative area);

Fecundity: the average number of fawns born to each doe per year in each county (or other administrative area);

Harvest: the average number of deer harvested by hunters via legal hunting activities per year in each county (or other administrative area);

Mortality: the average mortality of deer per year in each county (or other administrative area). Mortality is equal to one over survival.

Wildlife Disease Hazard Software User Tutorial

Preparing and Running the Wildlife Disease Hazard Software

Step 1: Open R and verify that you are running the appropriate version of the R Software (R Core Team 2020). The appropriate version is 4.0.2 (2020-06-22) -- "Taking Off Again" Copyright (C) 2020 The R Foundation for Statistical Computing Platform: x86_64-w64-mingw32/x64 [64-bit].

Step 2: Install the appropriate versions of the dependencies (R packages) in R. Packages include:

“datasets” version 4.0.2

“devtools” version 2.3.2

“dplyr” version 1.0.2

“leaflet” version 2.0.3

“leaflet.extras” version 1.0.0

“leafpop” version 0.0.6

“RColorBrewer” version 1.1-2

“rgdal” version 1.5-18

“rgeos” version 0.5-5

“rgl” version 0.100.54
“raster” version 3.4-5
“rmapshaper” version 0.4.4
“maptools” version 1.5-2
“shiny” version 1.5.0
“shinyBS” version 0.61
“shinycssloaders” version 1.0.0
“shinydashboard” version 0.7.1
“sf” version 0.9-6
“spdep” version 1.1.8
“sp” version 1.4-4
“stringr” version 1.4.0
“tidyr” version 1.1.2
“tigris” version 1.0

To install a particular version of an R package, run the code:
library(devtools)
devtools::install_version("package name", version = "#.#.#").

- Step 3:** Create a folder on your computer that will function as your working directory.
- 3-a:** Create a folder, then name it in accordance with your project. This folder will be your working directory.
 - 3-b:** Set the path to the working directory in R by clicking the R Console, clicking “File”, clicking “Change dir...”, then navigating through the file paths to your working directory. Click “OK”.
 - 3-c:** Verify that R has the correct path to your working directory by clicking the R console, typing “dir()”, and hitting enter. The file names of the contents of your working directory will print in the R console.
- Step 4:** Prepare the *Wildlife Disease Hazard Software* on your machine.
- 4-a:** Download, unzip, and save *Wildlife Disease Hazard Software* contents in your working directory.
 - 4-b:** To double check all contents are in your working directory, click the R console, type “dir()”, and hit enter. The file names of the contents of your working directory will print in the console.
- Step 5:** Download and prepare the provincial boundary shapefiles for Canada.
- 5-a.** Download the 2016 Provincial Boundary Shapefiles from Statistics Canada by going to <https://www12.statcan.gc.ca/census-recensement/2011/geo/bound-limit/bound-limit-2016-eng.cfm>.
 - 5-b.** Select the following options: Language: "English"; Format: "ArcGIS"; Boundary files: "Provinces/territories" under "Cartographic Boundary File", then click "Continue" to be directed to the download page.
 - 5-c.** Download the zipped folder (lpr_000b16a_e.zip).
 - 5-d.** Unzip the downloaded folder into the working directory.

Step 6. Download and prepare the census division units shapefiles from Statistics Canada.

6-a. Go to <https://www12.statcan.gc.ca/census-recensement/2011/geo/bound-limit/bound-limit-2016-eng.cfm>.

6-b. Select the following options: Language: "English"; Format: "ArcGIS"; Boundary files: "Census division" under "Cartographic Boundary File"; then click "Continue" to be directed to the download page.

6-c. Download the zipped folder (lcd_000b16a_e.zip).

6-d. Unzip the downloaded folder into the working directory.

Step 7. Download and prepare the geographic attribute file for the 2016 census year for Canada.

7-a. Go to <https://www12.statcan.gc.ca/census-recensement/2011/geo/ref/att-eng.cfm>.

7-b. Select the following options: Census year: 2016; Format: "Comma-separated values (.csv)"; then click "Continue" to be directed to the download page.

7-c. Download the zipped folder (2016_92-151_XBB_csv.zip).

7-d. Unzip the downloaded folder into the working directory.

Step 8. Create a csv file titled "All_States" with a list of all participating state and province names in a single column named "All_States". This list is used by the *Wildlife Disease Hazard Software* to create the sets of geospatial files necessary to run the application as well as read in and collate hazard data for each participating state and province listed.

Note: States or provinces with spaces, such as "New York" should be written with the space. Do not include the country in the name. For example, type "New York" as "New York", not as "New York, USA". States and provinces should be listed in ascending alphabetical order (from A at top to Z at bottom).

Step 9. Create a csv file titled "Data_States" with a list of all state and province names with one or more rows of surveillance (testing) data in a single column named "Data_States". This list is used by the *Wildlife Disease Hazard Software* to collate CWD environmental prion load totals for states (or provinces) with such data.

Note: States or provinces with spaces, such as "New York" should be written with the space. Do not include the country in the name. For example, type "New York" as "New York", not as "New York, USA". States and provinces should be listed in ascending alphabetical order (from A at top to Z at bottom).

Note: this list may differ from the one in "All_States.csv".

Step 10: Run the "0_Hazard_Pre_Processing.R" script.

10-a. Open the "0_Hazard_Pre_Processing.R" script in R.

10-b. Click "Edit" then "Run all" to run all lines of code in the script.

Note: This script will automatically create a set of geospatial files and related files for each state (or province) included in "All_States.csv" and should only be run once, unless additional states are added to "All_States.csv" after the initial run.

Step 11: For the state (or province) of interest, run the *Wildlife Disease Hazard Software*.

11-a. Open the “3_(state name)_Hazard_Command_Center.R” script for the state (or province) of interest in R.

11-b. Click “Edit” then “Run all” to run all lines of code in the script.

*Note: From this moment in **Step 11-b**, your script will automatically call the appropriate libraries, then begin running the series of scripts of the Wildlife Disease Hazard Software for that state (or province). Several lines of code will be executed without any further interaction from you. Your script will automatically load the geospatial files, initiate projections, crunch data, and sort data. This computational process is normal. All files are autosaved to your working directory. Finally, the script will open the interactive app for your state (or province) of interest.*

Step 12: Once done interacting with the UI, close the tab depicting the UI, stop the R code, and close the R program.

Step 13: Repeat **Steps 11-12** for additional states (or provinces) of interest.

Instructions to Add an Additional State (or Province) to the Wildlife Disease Hazard Software

The *Wildlife Disease Hazard Software* was developed to accommodate the needs of a consortium of state and provincial wildlife agencies that opted to participate in the Surveillance Optimization Project for Chronic Wasting Disease (SOP4CWD; CHWL 2021). Accordingly, the list of states and provinces included in this packet reflect the current list of partnering agencies, but other states and provinces are welcome to join.

In the event additional states or provinces join, this software can accommodate their inclusion with ease. To add a state or province to the *Wildlife Disease Hazard Software*:

Step i: Open the “All_States.csv” file.

i-a: Enter the name of the new state (or province) in the alphabetically appropriate row.

Note: States or provinces with spaces, such as “New York” should be written with the space. Do not include the country in the name. For example, type “New York” as “New York”, not as “New York, USA”. States and provinces should be listed in ascending alphabetical order (from A at top to Z at bottom).

i-b. Save the updated “All_States.csv” file to your working directory.

Step ii. If the new state (or province) has one or more rows of surveillance (testing) data, open the “Data_States.csv” file, and enter the name of the new state.

ii-a. Enter the name of the new state (or province) in the alphabetically appropriate row.

Note: States or provinces with spaces, such as “New York” should be written with the space. Do not include the country in the name. For example, type “New York” as “New York”, not as “New York, USA”. States and provinces should be listed in ascending alphabetical order (from A at top to Z at bottom).

Step iii: Run the “0_Hazard_Pre_Processing.R” script with the new list of states.

iii-a. Follow **Steps 1-10** (above).

Note: If you previously completed Steps 2-7 for another state (or province) (i.e., installed the appropriate packages, setup your working directory, prepared the Wildlife Disease Hazard Software, and downloaded and added the Canadian provincial boundary shapefiles, census division unit shapefiles, and geographic attribute file to your working directory), you may skip Steps 2-7.

Step iv: Create a “1_(state name)_Hazard_Data_Prep.R” script for the new state (or province) to add to the *Wildlife Disease Hazard Software*.

iv-a. Make a copy of the “1_(state name)_Hazard_Data_Prep.R” of any previously existing state.

Note: For new states or provinces with spaces in the name, such as South Carolina, choose an existing state with spaces in the name, such as New York.

iv-b. Rename the copy to reflect the name of the new state (or province).

Note: States or provinces with spaces in the name should be named without the space, nor the country. For example, to add South Carolina, the file name should be “1_SouthCarolina_Hazard_Data_Prep.R”.

iv-c. Open the script created in **iv-b**, click “Edit” then “Replace...”, and in the box that pops up, fill in the appropriate fields with the existing state (or province) name and the new state (or province) name, then click “Replace All”.

Note: For states or provinces with spaces in the name, repeat this process both with a space and without. For example, perform “Replace All” for both:

find: New York, replace: South Carolina

find: NewYork, replace: SouthCarolina

Step v: Create a “2_(state name)_Hazard_App.R” script for the new state (or province) to add to the *Wildlife Disease Hazard Software*.

v-a. Make a copy of the “2_(state name)_Hazard_App.R” of any previously existing state.

Note: For new states or provinces with spaces in the name, such as South Carolina, choose an existing state with spaces in the name, such as New York.

v-b. Rename the copy to reflect the name of the new state (or province).

Note: States or provinces with spaces in the name should be named without the space. For example, to add South Carolina, the file name should be “2_SouthCarolina_Hazard_App.R”.

v-c. Open the script created in **v-b**, click “Edit” then “Replace...”, and in the box that pops up, fill in the appropriate fields with the existing state (or province) name and the new state (or province) name, then click “Replace All”.

Note: For states or provinces with spaces in the name, repeat this process both with a space and without. For example, perform “Replace All” for both:

find: New York, replace: South Carolina

find: NewYork, replace: SouthCarolina

Step vi: Create a “3_(state name)_Hazard_Command_Center.R” script for the new state (or province) to add to the *Wildlife Disease Hazard Software*.

vi-a. Make a copy of the “3_(state name)_Hazard_Command_Center.R” of any previously existing state.

Note: For new states or provinces with spaces in the name, such as South Carolina, choose an existing state with spaces in the name, such as New York.

vi-b. Rename the copy to reflect the name of the new state (or province).

Note: States or provinces with spaces in the name should be named without the space, nor the country. For example, to add South Carolina, the file name should be “3_SouthCarolina_Hazard_Command_Center.R”.

vi-c. Open the script created in **vi-b**, click “Edit” then “Replace...”, and in the box that pops up, fill in the appropriate fields with the existing state (or province) name and the new state (or province) name, then click “Replace All”.

*Note: For states or provinces with spaces in the name, repeat this process both with a space and without. For example, perform “Replace All” for both:
find: New York, replace: South Carolina
find: NewYork, replace: SouthCarolina*

Step vii: Use Mitchell et al. (2022) to create the “(new state name)CountySummary20XX.txt” and “(new state name)CountySummary_Contig_20XX.txt” files, then add those files to the *Wildlife Disease Hazard Software*.

Step viii: Create a blank “Businesses_by_County_(new state name).csv” file, then add the file to the *Wildlife Disease Hazard Software*.

viii-a. Make a copy of the “Businesses_by_County_(state name).csv” of any previously existing state.

viii-b. Rename the copy to reflect the name of the new state (or province).

Note: States or provinces with spaces in the name should be named without the space, nor the country. For example, to add South Carolina, the file name should be “Businesses_by_County_SouthCarolina.csv”.

viii-c. Open the file created in **viii-b**, then replace the old county (or other administrative area) names with names for the new state.

Note: County (or other administrative area) names should be capitalized and listed in ascending alphabetical order (from A at top to Z at bottom).

viii-d. Replace the “999999” with the real data for each county (or other administrative area).

Note: These data are the number of wild deer meat processing and taxidermist businesses that are known to exist in each county (or other administrative area).

Step ix: Create a blank “Captive_by_County_(new state name).csv” file, then add the file to the *Wildlife Disease Hazard Software*.

ix-a. Make a copy of the “Captive_by_County_(state name).csv” of any previously existing state.

ix-b. Rename the copy to reflect the name of the new state (or province).

Note: States or provinces with spaces in the name should be named without the space, nor the country. For example, to add South Carolina, the file name should be “Captive_by_County_SouthCarolina.csv”.

ix-c. Open the file created in **ix-b**, then replace the old county (or other administrative area) names with names for the new state.

Note: County (or other administrative area) names should be capitalized and listed in ascending alphabetical order (from A at top to Z at bottom).

ix-d. Replace the “999999” with the real data for each county (or other administrative area).

Note: These data are the number of captive cervid facilities that are known to exist in each county (or other administrative area).

Step x: Create a blank “Hazard_by_County_(new state name).csv” file, then add the file to the *Wildlife Disease Hazard Software*.

x-a. Make a copy of the “Hazard_by_County_(state name).csv” of any previously existing state.

x-b. Rename the copy to reflect the name of the new state (or province).

Note: States or provinces with spaces in the name should be named without the space, nor the country. For example, to add South Carolina, the file name should be “Hazard_by_County_SouthCarolina.csv”.

x-c. Open the file created in **x-b**, then replace the old county (or other administrative area) names with names for the new state.

Note: County (or other administrative area) names should be capitalized and listed in ascending alphabetical order (from A at top to Z at bottom).

x-d. Replace the “999999” with the real data for each county (or other administrative area).

Note: These data are the hazard scores that arise for each county (or other administrative area) from the model by Schuler et al. (in preparation).

Step xi: Create a blank “Density_by_County_(new state name).csv” file, then add the file to the *Wildlife Disease Hazard Software*.

xi-a. Make a copy of the “Density_by_County_(state name).csv” of any previously existing state.

xi-b. Rename the copy to reflect the name of the new state (or province).

Note: States or provinces with spaces in the name should be named without the space, nor the country. For example, to add South Carolina, the file name should be “Density_by_County_SouthCarolina.csv”.

xi-c. Open the file created in **xi-b**, then replace the old county (or other administrative area) names with names for the new state.

Note: County (or other administrative area) names should be capitalized and listed in ascending alphabetical order (from A at top to Z at bottom).

xi-d. Replace the “999999” with the real data for each county (or other administrative area).

Note: These data are the estimated number of deer (per sq. kilometer) that occur in each county (or other administrative area).

Step xii: Create a blank “Fecundity_by_County_(new state name).csv” file, then add the file to the *Wildlife Disease Hazard Software*.

- xii-a.** Make a copy of the “Fecundity_by_County_(state name).csv” of any previously existing state.
- xii-b.** Rename the copy to reflect the name of the new state (or province).
Note: States or provinces with spaces in the name should be named without the space, nor the country. For example, to add, South Carolina, the file name should be “Fecundity_by_County_SouthCarolina.csv”.
- xii-c.** Open the file created in **xii-b**, then replace the old county (or other administrative area) names with names for the new state.
Note: County (or other administrative area) names should be capitalized and listed in ascending alphabetical order (from A at top to Z at bottom).
- xii-d.** Replace the “999999” with the real data for each county (or other administrative area).
Note: These data are the average number of fawns born to each doe per year in each county (or other administrative area).

Step xiii: Create a blank “Harvest_by_County_(new state name).csv” file, then add the file to the *Wildlife Disease Hazard Software*.

- xiii-a.** Make a copy of the “Harvest_by_County_(state name).csv” of any previously existing state.
- xiii-b.** Rename the copy to reflect the name of the new state (or province).
Note: States or provinces with spaces in the name should be named without the space, nor the country. For example, to add South Carolina, the file name should be “Harvest_by_County_SouthCarolina.csv”.
- xiii-c.** Open the file created in **xiii-b**, then replace the old county (or other administrative area) names with names for the new state.
Note: County (or other administrative area) names should be capitalized and listed in ascending alphabetical order (from A at top to Z at bottom).
- xiii-d.** Replace the “999999” with the real data for each county (or other administrative area).
Note: These data are the average number of deer harvested by hunters via legal hunting activities per year in each county (or other administrative area).

Step xiv: Create a blank “Mortality_by_County_(new state name).csv” file, then add the file to the *Wildlife Disease Hazard Software*.

- xiv-a.** Make a copy of the “Mortality_by_County_(state name).csv” of any previously existing state.
- xiv-b.** Rename the copy to reflect the name of the new state (or province).
Note: States or provinces with spaces in the name should be named without the space, nor the country. For example, to add South Carolina, the file name should be “Mortality_by_County_SouthCarolina.csv”.
- xiv-c.** Open the file created in **xiv-b**, then replace the old county (or other administrative area) names with names for the new state.
Note: County (or other administrative area) names should be capitalized and listed in ascending alphabetical order (from A at top to Z at bottom).
- xiv-d.** Replace the “999999” with the real data for each county (or other administrative area).

Note: These data are the average mortality of deer per year in each county (or other administrative area). Mortality is equal to one over survival.

Step xv: Run the command code for the new state (or province) (i.e., **Steps 11-12** above).

Technical Details

0_Hazard_Pre_Processing.R script of the *Wildlife Disease Hazard Software* was written under R version 4.0.2 (2020-06-22) -- "Taking Off Again" Copyright (C) 2020 The R Foundation for Statistical Computing Platform: x86_64-w64-mingw32/x64 (64-bit) and requires the packages: (1) "devtools" version 2.3.2 (Wickman et al. 2020), (2) "rgdal" version 1.5-18 (Bivand et al. 2020), (3) "tigris" version 1.0 (Walker 2020), (4) "stringr" version 1.4.0 (Wickman 2019), (5) "spdep" version 1.1.8 (Bivand et al. 2013; Bivand and Wong 2018), (6) "maptools" version 1.0-2 (Bivand and Lewin-Koh 2021), (7) "raster" version 3.4-5 (Hijmans 2020), (8) "dplyr" version 1.0.2 (Wickman et al. 2021), (9) "rmapshaper" version 0.4.4 (Teucher and Russell 2020), and (10) "rgeos" version 0.5-5 (Bivand and Rundel 2020).

1_(state name)_Hazard_Data_Prep.R script of the *Wildlife Disease Hazard Software* was written under R version 4.0.2 (2020-06-22) -- "Taking Off Again" Copyright (C) 2020 The R Foundation for Statistical Computing Platform: x86_64-w64-mingw32/x64 (64-bit) and requires the packages: (1) "devtools" version 2.3.2 (Wickman et al. 2020), (2) "rgdal" version 1.5-18 (Bivand et al. 2020), (3) "datasets" version 4.0.2 (R Core Team 2020), and (4) "stringr" version 1.4.0 (Wickman 2019).

2_(state name)_Hazard_App.R script of the *Wildlife Disease Hazard Software* was written under R version 4.0.2 (2020-06-22) -- "Taking Off Again" Copyright (C) 2020 The R Foundation for Statistical Computing Platform: x86_64-w64-mingw32/x64 (64-bit), and requires the packages: (1) "devtools" version 2.3.2 (Wickman et al. 2020), (2) "shinydashboard" version 0.7.1 (Chang and Borges Ribeiro 2018), (3) "shiny" version 1.5.0 (Chang et al. 2020), (4) "leaflet" version 2.0.3 (Cheng et al. 2019), (5) "dplyr" version 1.0.2 (Wickman et al. 2021), (6) "leaflet.extras" version 1.0.0 (Karambelkar and Schloerke 2018), (7) "rgl" version 0.100.54 (Adler et al. 2020), (8) "shinyBS" version 0.61 (Bailey 2015), (9) "RColorBrewer" version 1.1-2 (Neuwirth 2014), (10) "sp" version 1.4-4 (Pebesma and Bivand 2005; Bivand et al. 2013), (11) "sf" version 0.9-6 (Pebesma 2018), (12) "rgdal" version 1.5-18 (Bivand et al. 2020), (13) "leafpop" version 0.0.6 (Appelhans and Detsch 2020), (14) "tidyr" version 1.1.2 (Wickman 2020), (15) "shinycssloaders" version 1.0.0 (Sali and Attali 2020), and (16) "rmapshaper" version 0.4.4 (Teucher and Russell 2020).

The 3_(state name)_Hazard_Command_Center.R script of the *Wildlife Disease Hazard Software* was written under R version 4.0.2 (2020-06-22) -- "Taking Off Again" Copyright (C) 2020 The R Foundation for Statistical Computing Platform: x86_64-w64-mingw32/x64(64-bit)and requires all the packages listed for the other scripts.

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