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ClosedCounterPOPd Web Interactive: Software to investigate the population scale impacts of lead in hypothetically closed bald eagle populations

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## **Overview of the software application**

We integrated veterinary data on lead toxicosis with baseline population dynamics to explore the differences in population dynamics that arise in the presence and absence of lead toxins in hypothetically closed bald eagle populations.

This ClosedCounterPOPd interactive application allows the user to view and compare the algorithm-predicted asymptotic and transient population properties for male and female bald eagles when losses or gains from dispersal is nil. Comparisons include: (1) current (Pb) scenario (“Northeast, USA”), (2) a hypothetical scenario with the removal of Pb poisoning cases (“Exper.I”), and (3) a hypothetical scenario with the removal of Pb exposure cases (“Exper.II”).

Comparative demographic properties include:

- 1) Life table
- 2) Predicted annual abundances
- 3) Predicted bi-annual abundances
- 4) Predicted bi-annual hatchling abundances
- 5) Predicted bi-annual immature and non-breeding adult abundances

- 6) Predicted bi-annual breeding adult abundances
- 7) Predicted abundances during the breeding period
- 8) Predicted abundances during the non-breeding period
- 9) Migration and dispersal
- 10) Asymptotic growth rates
- 11) Survival rates
- 12) Stable stage distribution
- 13) Reproductive value
- 14) Sensitivities
- 15) Elasticities
- 16) Damping ratio and convergence time
- 17) Cumulative growth
- 18) Stochastic growth rate
- 19) Transient growth rate
- 20) Harmonic vs. arithmetic mean abundances
- 21) Loss of genetic diversity
- 22) Population inertia
- 23) Reactivity
- 24) Maximum amplification
- 25) Maximum attenuation

## **Interactive Software User Tutorial**

### ***Preparing and running the software for female and male bald eagles:***

#### **Running the app for female bald eagles:**

**Step 1:** Download the “ClosedCounterPOPd for Females” folder.

**Step 2:** Inside the folder, you will find four .R files and several pre-saved .txt files:

“BestAlgorithmPredictedModelsNORTHEAST”,  
 “BestAlgorithmPredictedModelsCOUNTERFACTUAL\_PAIN\_A.txt”,  
 “BestAlgorithmPredictedModelsCOUNTERFACTUAL\_PAIN\_C.txt”,  
 “NEW\_AA\_NORTHEAST”,  
 “NEW\_AA\_COUNTERFACTUAL\_PAIN\_A.txt”,  
 “NEW\_AA\_COUNTERFACTUAL\_PAIN\_C.txt”,  
 “NEW\_PA\_NORTHEAST”,  
 “NEW\_PA\_COUNTERFACTUAL\_PAIN\_A.txt”,  
 “NEW\_PA\_COUNTERFACTUAL\_PAIN\_C.txt”,  
 “NEW\_SA\_NORTHEAST”,  
 “NEW\_SA\_COUNTERFACTUAL\_PAIN\_A.txt”,  
 “NEW\_SA\_COUNTERFACTUAL\_PAIN\_C.txt”,  
 “NEW\_PS\_NORTHEAST”,  
 “NEW\_PS\_COUNTERFACTUAL\_PAIN\_A.txt”,  
 “NEW\_PS\_COUNTERFACTUAL\_PAIN\_C.txt”,  
 “NEW\_Adults\_January\_NORTHEAST”,  
 “NEW\_Adults\_January\_COUNTERFACTUAL\_PAIN\_A.txt”,  
 “NEW\_Adults\_January\_COUNTERFACTUAL\_PAIN\_C.txt”,

“NEW\_Adults\_June\_NORTHEAST”,  
“NEW\_Adults\_June\_COUNTERFACTUAL\_PAIN\_A.txt”,  
“NEW\_Adults\_June\_COUNTERFACTUAL\_PAIN\_C.txt”,  
“NEW\_Subadults\_January\_NORTHEAST”,  
“NEW\_Subadults\_January\_COUNTERFACTUAL\_PAIN\_A.txt”,  
“NEW\_Subadults\_January\_COUNTERFACTUAL\_PAIN\_C.txt”,  
“NEW\_Subadults\_June\_NORTHEAST”,  
“NEW\_Subadults\_June\_COUNTERFACTUAL\_PAIN\_A.txt”,  
“NEW\_Subadults\_June\_COUNTERFACTUAL\_PAIN\_C.txt”,  
“NEW\_Juveniles\_June\_NORTHEAST”,  
“NEW\_Juveniles\_June\_COUNTERFACTUAL\_PAIN\_A.txt”,  
“NEW\_Juveniles\_June\_COUNTERFACTUAL\_PAIN\_C.txt”,  
“NEW\_AdultsAbsorbPercent\_NORTHEAST”,  
“NEW\_AdultsAbsorbPercent\_COUNTERFACTUAL\_PAIN\_A.txt”,  
“NEW\_AdultsAbsorbPercent\_COUNTERFACTUAL\_PAIN\_C.txt”,  
“NEW\_AdultsPurgePercent\_NORTHEAST”,  
“NEW\_AdultsPurgePercent\_COUNTERFACTUAL\_PAIN\_A.txt”,  
“NEW\_AdultsPurgePercent\_COUNTERFACTUAL\_PAIN\_C.txt”,  
“NEW\_SubadultsAbsorbPercent\_NORTHEAST”,  
“NEW\_SubadultsAbsorbPercent\_COUNTERFACTUAL\_PAIN\_A.txt”,  
“NEW\_SubadultsAbsorbPercent\_COUNTERFACTUAL\_PAIN\_C.txt”,  
“NEW\_SubadultsPurgePercent\_NORTHEAST”,  
“NEW\_SubadultsPurgePercent\_COUNTERFACTUAL\_PAIN\_A.txt”,  
“NEW\_SubadultsPurgePercent\_COUNTERFACTUAL\_PAIN\_C.txt”,  
“NEW\_TIMESERIES\_NORTHEAST”,  
“NEW\_TIMESERIES\_COUNTERFACTUAL\_PAIN\_A.txt”,  
“NEW\_TIMESERIES\_COUNTERFACTUAL\_PAIN\_C.txt”,  
“TIMESERIES\_NORTHEAST”,  
“TIMESERIES\_TIMESERIES\_COUNTERFACTUAL\_PAIN\_A.txt”,  
“TIMESERIES\_TIMESERIES\_COUNTERFACTUAL\_PAIN\_C.txt”.

**Step 3:** Save these text files in a specific location on your computer.

**Step 4:** Open R Studio.

**Step 5:** In R Studio, install the appropriate versions of the six packages: “shinyBS”, “shiny”, “popdemo”, “rgl”, “FSA”, and “rmarkdown”. The appropriate versions are listed below.

**Step 6:** Open the FemaleClosedCounterPOPd.R file in R studio and set the working directory to the location where you saved the .txt files in Step 3.

**Step 7:** Click “Run All”.

**Step 8:** Begin interacting with the FemaleClosedCounterPOPd software application.

**NOTE:** The above 8-step process requires the use of all the pre-saved files that are listed in Step 2. However, you may generate the .txt files yourself using the three algorithm files. The “...NORTHEAST.txt” files are generated using “Algorithm Northeast.R”, the “...COUNTERFACTUAL\_PAIN\_A.txt” are generated using “Algorithm – Exper.I.R” and the “...COUNTERFACTUAL\_PAIN\_C.txt” files are generated using the “Algorithm - Exper.II.R” file. If you wish to modify and run

your altered algorithms on your own machine (to overwrite the .txt files with new versions):

**Step i.** Conduct Step 2-3 (above),

**Step ii.** Open the appropriate “Algorithm...R” file in R,

**Step iii.** Set the working directory to the folder in Step i.

**Step iv.** Select “Run all”. ***Beware, the runtime of the unmodified algorithms is a minimum of 6 hours, so ensure your computer is plugged in and will not go to sleep, and then turn off your screen to save the backlight from burnout.*** The algorithm will run and automatically save the new .txt files into the folder that you specified in Step iii.

### **Running the app for male bald eagles:**

**Step 1:** Download the “ClosedCounterPOPd for Males” folder.

**Step 2:** Inside the folder, you will find four .R files and several pre-saved .txt files:

“BestAlgorithmPredictedModelsNORTHEAST”,

“BestAlgorithmPredictedModelsCOUNTERFACTUAL\_PAIN\_A.txt”,

“BestAlgorithmPredictedModelsCOUNTERFACTUAL\_PAIN\_C.txt”,

“NEW\_AA\_NORTHEAST”,

“NEW\_AA\_COUNTERFACTUAL\_PAIN\_A.txt”,

“NEW\_AA\_COUNTERFACTUAL\_PAIN\_C.txt”,

“NEW\_PA\_NORTHEAST”,

“NEW\_PA\_COUNTERFACTUAL\_PAIN\_A.txt”,

“NEW\_PA\_COUNTERFACTUAL\_PAIN\_C.txt”,

“NEW\_SA\_NORTHEAST”,

“NEW\_SA\_COUNTERFACTUAL\_PAIN\_A.txt”,

“NEW\_SA\_COUNTERFACTUAL\_PAIN\_C.txt”,

“NEW\_PS\_NORTHEAST”,

“NEW\_PS\_COUNTERFACTUAL\_PAIN\_A.txt”,

“NEW\_PS\_COUNTERFACTUAL\_PAIN\_C.txt”,

“NEW\_Adults\_January\_NORTHEAST”,

“NEW\_Adults\_January\_COUNTERFACTUAL\_PAIN\_A.txt”,

“NEW\_Adults\_January\_COUNTERFACTUAL\_PAIN\_C.txt”,

“NEW\_Adults\_June\_NORTHEAST”,

“NEW\_Adults\_June\_COUNTERFACTUAL\_PAIN\_A.txt”,

“NEW\_Adults\_June\_COUNTERFACTUAL\_PAIN\_C.txt”,

“NEW\_Subadults\_January\_NORTHEAST”,

“NEW\_Subadults\_January\_COUNTERFACTUAL\_PAIN\_A.txt”,

“NEW\_Subadults\_January\_COUNTERFACTUAL\_PAIN\_C.txt”,

“NEW\_Subadults\_June\_NORTHEAST”,

“NEW\_Subadults\_June\_COUNTERFACTUAL\_PAIN\_A.txt”,

“NEW\_Subadults\_June\_COUNTERFACTUAL\_PAIN\_C.txt”,

“NEW\_Juveniles\_June\_NORTHEAST”,

“NEW\_Juveniles\_June\_COUNTERFACTUAL\_PAIN\_A.txt”,

“NEW\_Juveniles\_June\_COUNTERFACTUAL\_PAIN\_C.txt”,

“NEW\_AdultsAbsorbPercent\_NORTHEAST”,

“NEW\_AdultsAbsorbPercent\_COUNTERFACTUAL\_PAIN\_A.txt”,

“NEW\_AdultsAbsorbPercent\_COUNTERFACTUAL\_PAIN\_C.txt”,  
“NEW\_AdultsPurgePercent\_NORTHEAST”,  
“NEW\_AdultsPurgePercent\_COUNTERFACTUAL\_PAIN\_A.txt”,  
“NEW\_AdultsPurgePercent\_COUNTERFACTUAL\_PAIN\_C.txt”,  
“NEW\_SubadultsAbsorbPercent\_NORTHEAST”,  
“NEW\_SubadultsAbsorbPercent\_COUNTERFACTUAL\_PAIN\_A.txt”,  
“NEW\_SubadultsAbsorbPercent\_COUNTERFACTUAL\_PAIN\_C.txt”,  
“NEW\_SubadultsPurgePercent\_NORTHEAST”,  
“NEW\_SubadultsPurgePercent\_COUNTERFACTUAL\_PAIN\_A.txt”,  
“NEW\_SubadultsPurgePercent\_COUNTERFACTUAL\_PAIN\_C.txt”,  
“NEW\_TIMESERIES\_NORTHEAST”,  
“NEW\_TIMESERIES\_COUNTERFACTUAL\_PAIN\_A.txt”,  
“NEW\_TIMESERIES\_COUNTERFACTUAL\_PAIN\_C.txt”,  
“TIMESERIES\_NORTHEAST”,  
“TIMESERIES\_TIMESERIES\_COUNTERFACTUAL\_PAIN\_A.txt”,  
“TIMESERIES\_TIMESERIES\_COUNTERFACTUAL\_PAIN\_C.txt”.

**Step 3:** Save these text files in a specific location on your computer.

**Step 4:** Open R Studio.

**Step 5:** In R Studio, install the appropriate versions of the six packages: “shinyBS”, “shiny”, “popdemo”, “rgl”, “FSA”, and “rmarkdown”. The appropriate versions are listed below.

**Step 6:** Open the MaleClosedCounterPOPd.R file in R studio and set the working directory to the location where you saved the .txt files.

**Step 7:** Click “Run All”.

**Step 8:** Begin interacting with the MaleClosedCounterPOPd software application.

**NOTE:** The above 8-step process requires the use of all the pre-saved files that are listed in Step 2. However, you may generate the .txt files yourself using the three algorithm files. The “...NORTHEAST.txt” files are generated using “Algorithm Northeast.R”, the “...COUNTERFACTUAL\_PAIN\_A.txt” are generated using “Algorithm - Exper.I.R” and the “...COUNTERFACTUAL\_PAIN\_C.txt” files are generated using the “Algorithm - Exper.II.R” file. If you wish to modify and run the altered algorithms on your own machine (to overwrite the .txt files with new versions):

**Step i.** Conduct Step 2-3 (above),

**Step ii.** Open the appropriate “Algorithm...R” file in R,

**Step iii.** Set the working directory to the folder in Step i.

**Step iv.** Select “Run all”. ***Beware, the runtime of the unmodified algorithms is a minimum of 6 hours, so ensure your computer is plugged in and will not go to sleep, and then turn off your screen to save the backlight from burnout.*** The algorithm will run and automatically save the new .txt files into the folder that you specified in Step iii.

## **The Validation Results**

The Validation Bundle provides the code to simulate the dynamics of a random bald eagle population, run the algorithms to estimate the dynamics, and then compare the outcomes. The results of the algorithm performances are found on the Validation Results document.

## **Technical Details**

This app 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 R packages: “devtools (Version 2.3.2)”, “shinyBS (Version 0.61)”, “shiny (Version 1.3.2)”, “rgl (Version 0.100.26)”, “popdemo (Version 1.3-0)”, “FSA (Version 0.8.25)” and “rmarkdown (Version 1.14)”.

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Hanley, B., Dhondt, A., Bunting, E., Pokras, M., Hynes, K., Forzán, M., & Schuler, K. 2019. ClosedCounterPOPd Web Interactive: Software to investigate the population scale impact of lead in bald eagles in hypothetically closed populations [Software]. Cornell University Library eCommons Repository. doi: <https://doi.org/10.7298/q4t7-1y54>.

### **Package Updates:**

2019-11-22. B. Hanley uploaded the a modified version of the ClosedCounterPOPd software (FemaleClosedCounterPOPd.R and MaleClosedCounterPOPd.R) and the validation bundle. The modified software includes additional narratives on the reliability of the parameter estimation that were attained from the validation software. All other aspects of this software, including the original results of the parameter estimates remain unchanged. B. Hanley also included the code that was used to validate the algorithm estimations given this assumption of a closed system.

2020-10-24. Changes made at the request of formal peer reviewers to the ClosedCounterPOPd eCommons include: (1) the alteration from the terms “acute” to “Exper.I” and “chronic” to “Exper.II” in the code and readme files, (2) the alteration of .txt files names from “...PAIN.ACUTE” and “...PAIN.CHRONIC” to “...\_PAIN\_A” and “...\_PAIN\_C” in the code and readme files, (3) the removal of the interpretation boxes in the software, (4) the correction of typos in the narratives, (5) the addition of the Validation graphics parameter to the packet, (6) the alteration of the code and readme to include R and package versioning information, (7) the renaming of “Algorithm Acute Pain Observed Only” to “Algorithm – ExperI” and “Algorithm Chronic Pain Observed Only” to “Algorithm-ExperII”, and (8) an update of names in the acknowledgements.

2022-01-04. Changes made include (1) the correction of remaining A and C to “Exper.I” and “Exper.II” in locations that were missed in the previous round of corrections, and (2) the organization of all boxplots to have data displayed (from left to right) as “Northeast”, “Exper.I”, and “Exper.II”.