ReadMe File for

Bootstrap Mean Exit Time: Peter Lake 2013-2015

The scripts bootstrap mean exit time for Peter Lake as shown in the manuscript

Carpenter, S.R., Pace M.L., and Wilkinson G.M. 2022. Organic color and resilience of phytoplankton to enrichment.

Identical scripts were used for Tuesday Lake.

For mathematical details see Arani et al. (2021). For further details about application of the method to data from Paul, Peter, and Tuesday lakes see Carpenter et al. (2022)

Intermediate bootstrapped files are not included because the large files exceed storage limits.

Before bootstrapping, calculate the nominal point estimate of mean exit time using scripts in Carpenter & Arani (2021) and data in Pace et al. (2020).

Results of the nominal DLM model, a necessary input to the bootstrapping, are in **Peter1315_DLMresult.Rdata**

To calculate the bootstrap run the following 4 R scripts in sequence. Time required for 100 bootstrap cycles is roughly 10 minutes on a Dell Precision 3240 desktop computer running 10 cores.

Bootstrap_DLM_Peter1315_2021-12-09.R
(requires **ODLMAR_for_Bootstrap_2020-11-23.R**)
This script generates a large .Rdata file needed for the next step.

Bootstrap_DDbintau+xeq_2021-08-03.R
(requires **DDbintau+D4.R**)

BootALL_Step4_ET+Survival_Peter1315_2021-08-11.R
(this script also calculates median survival time of each state which is not used in the paper of Carpenter, Pace & Wilkinson)

Analyze_and_plot_ETbootstrap_Peter+Tuesday_bintau_2021-12-22.R
Before running this script it is necessary to provide the input file name in line 7 and the nominal exit times for each attractor on lines 13 and 14. Nominal values are used to correct bootstrap bias (Efron and Tibshirani 1993)

References

Arani, B. M. S., S. R. Carpenter, L. Lahti, E. H. van Nes, and M. Scheffer. 2021. Exit time as a measure of ecological resilience. Science **372**:eaay4895.

Carpenter, S. R., B. M. S. Arani, E. H. Van Nes, M. Scheffer, and M. L. Pace. 2022. Resilience of phytoplankton dynamics to trophic cascades and nutrient enrichment. Limnology and Oceanography **67**:S258-S265.

Carpenter Stephen, R., and B. M. S. Arani. 2021. Exit and survival time: New standard scripts. Zenodo. https://doi.org/10.5281/zenodo.6544226

Efron, B., and R. J. Tibshirani. 1993. An Introduction to the Bootstrap. Chapman and Hall, New York, NY.

Pace, M. L., J. J. Cole, and R. Carpenter Stephen. 2020. Cascade project at North Temperate Lakes LTER - High Frequency Data for Whole Lake Nutrient Additions 2013-2015 Environmental Data Initiative. https://doi.org/10.6073/pasta/cbe19041db41e720d84970f43156c042