**Data report for ‘Testing thermal tolerance limits as proxies for climate change vulnerability’**

EC Contract No. 3000703027

Last updated by Joey Bernhardt

March 31, 2020

4.1. Data extraction and statistical analyses to be completed no later than March 1, 2020.

4.1.1. A copy of the data used to inform all analyses including:

All of the code and data to reproduce these analyses are available here:

<https://github.com/JoeyBernhardt/intra-therm>

The Intratherm database, in its current form is available here:

<https://github.com/JoeyBernhardt/intra-therm/blob/master/data-raw/intratherm-merged-nikkis-traits.csv>

4.1.1.1. Population change data and /or IUCN vulnerability metrics for each species (by population where relevant).

**1.** [**Global Population Dynamics Database**](http://www3.imperial.ac.uk/cpb/databases/gpdd)**: (population data for 25 species in Intratherm)**

The population data for Intratherm species from the GPDD are here: <https://github.com/JoeyBernhardt/intra-therm/blob/master/data-processed/intratherm-gpdd.csv>

../figures/gpdd-taxon.pdf

**2.** [**Living Planet Index**](http://www.livingplanetindex.org/home/index)**: (population data for 103 species in Intratherm)**

Population data for Intratherm species in the LPI are here: <https://github.com/JoeyBernhardt/intra-therm/blob/master/data-processed/lpi-intratherm-overlap.csv>

Here is an example for Alewife (a species in LPI, but not at the same locations as Intratherm):

../figures/lpi-examples-alewife.pdf

**3.** [**IUCN Redlist**](https://www.iucnredlist.org/) (180 Intratherm species, not location-matched):

<https://github.com/JoeyBernhardt/intra-therm/blob/master/data-processed/intratherm-species-redlist.csv>

../figures/redlist-categories.pdf

**4.1.1.2. Exposure metrics.**

We haven’t calculated exposure metrics yet, but have made progress on how to do so. Our plan is to compare time series of population abundances from the sources listed above with time series of temperatures at each of the locations for which we have population abundance data. Then, we will able to evaluate the extent to which time spent within 2°C of the population’s CTmax is associated with population trajectory. If populations can maintain stable population abundances, even when temperatures are within 2°C of CTmax, or exceed that threshold, then we would conclude that thermal stress is not sufficient to endanger populations. This will require us to get temperature data from the locations where we have population data (i.e. these populations will not be the same as those in Intratherm, so this will be a new data extraction task). We will extract data from “Daily Land (Experimental; 1880 – Recent) - Average high temperature TMAX)” datasets from <http://berkeleyearth.org/data/>. Then we will estimate those populations CTmax by fitting a predictive model to our Intratherm population’s CTmax, their traits and a metric of temperature from their collection locations. The model will take the form of something like:

CTmax ~ mean\_max\_temperature\*dispersal\_ability +  mean\_max\_temperature\*other\_traits + acclimation\_offset, data = intratherm, random = species

Note that this model will draw on species’ trait data that we have collected (i.e. body size, lifespan etc) as well as the thermal regimes at the collection locations for each of the populations in Intratherm. We intend to use this model to ‘fill in the gaps’ on our CTmax data, so we can have (predicted) CTmax data and population abundances from the same locations.

**4.1.1.3. R code and outputs, including figures and explanations of outcome of statistical analyses.**

All of the R code to reproduce these analyses are available here: <https://github.com/JoeyBernhardt/intra-therm/tree/master/R>

Note: as we further develop the statistical analyses, more explanations will be available. Right now we are still in the exploratory phase, so most analyses have involved visualizations. The figures we have produced are available to view here:

<https://github.com/JoeyBernhardt/intra-therm/tree/master/figures>

**4.1.2. Documentation of the methods for the data extractions and statistical analyses to ensure reproducibility and transparency.**

**1. Methods for the data extraction**

**Thermal tolerances:**

We obtained thermal tolerance data by searching for papers using Google Scholar (over a period between June 2018 and August 2019), with the search terms:

population, CTmax, acclimation temperatures, thermal limits, heat tolerance, critical thermal maximum, critical thermal minimum, upper thermal tolerance, lower thermal tolerance, thermal tolerance breadth, heat tolerance, cold tolerance, upper lethal temperature limit, lower lethal temperature limit, thermal tolerance window, species temperature tolerance, thermo-neutral zone

**Population abundance data:**

We obtained population abundance data using the Global Population Dynamics Database (using the R package rgpdd), the Living Planet Index (using the R package rlpi) and the IUCN redlist (data downloaded from <https://www.iucnredlist.org/search>). We also searched for data in the COMADRE and COMPADRE datasets (<https://compadre-db.org/>, which we accessed using the R package Rcompadre).