# Growth and mortality of lobster larvae at different temperatures for lobster larvae from Gulf of Maine near Boothbay Maine from 2021 and 2022 (Lobster Thermal Thresholds project)

**Website**: https://www.bco-dmo.org/dataset/939825
**Data Type**: experimental
**Version**: 1
**Version Date**: 2025-03-21

**Project**
» RUI: Collaborative Research: Linking physiological thermal thresholds to the distribution of lobster settlers and juveniles (Lobster Thermal Thresholds)


| Contributors | Affiliation | Role |
|---|---|---|
| Annis, Eric R. | Hood College | Principal Investigator |
| Frederich, Markus | University of New England - Marine Science Center (UNE-MSC) | Co-Principal Investigator |
| Rasher, Douglas B. | Bigelow Laboratory for Ocean Sciences | Co-Principal Investigator |
| Newman, Sawyer | Woods Hole Oceanographic Institution (WHOI BCO-DMO) | BCO-DMO Data Manager |


**Abstract**
We used the American lobster (Homarus americanus lsid:marinespecies.org:taxname:156134) in the Gulf of Maine as a model system to define thermal tolerance in larvae and establish mechanistic linkages between thermal tolerance of the individual larva and the patterns of settlement in the field. We assessed and compared the thermal tolerances of larvae reared in the laboratory using conventional methods with larvae captured in the wild, and examined ontogenetic changes in thermal tolerance. The upper and lower thermal thresholds larval stages I-IV and the first juvenile stage were defined in part by growth and mortality when subjected to chronic exposure to different treatment temperatures until they either molted to the next developmental stage or died. This data set includes individuals dying, the size after molting and the amount of time elapsed between the start of the treatment and either molting or death. These data were collected between 2021-2022 at Bigelow Laboratory for Ocean Sciences, led by Eric Annis.

## Table of Contents



## Coverage

**Location**: Bigelow Laboratory for Ocean Sciences
**Temporal Extent**: 2021-06-01 - 2022-12-31

### Methods & Sampling

*Homarus americanus* (lsid:marinespecies.org:taxname:156134) lobster larvae were reared to the appropriate stage in lab under several different conditions. Most larvae were reared individually in an environmental control room at 18°C in 400 ml glass jars in 0.45 µm filtered seawater and fed fresh hatched brine shrimp ad

libitum. Water changes were made every 2-3 days. Alternative rearing conditions included 14°C and fed fresh hatched brine shrimp, ambient seawater temperature (jars were held in a water bath of flow through seawater) fed fresh hatched brine shrimp, and 18°C and fed a diet of live, freshly collected zooplankton from local waters. We also conducted trials on wild caught stage IV larvae. Larvae were collected using a neuston net (0-0.5 m depth) in the vicinity of Boothbay, Maine, USA. Wild larvae were held in individual jars at ambient seawater temperature until trials could be conducted.

To assess growth and mortality, larvae were transferred from their rearing condition to the treatment temperature and maintained at the treatment temperature until they either molted to the next developmental stage or died. Larvae were transferred in their jar at the rearing temperature to the treatment temperature without exchanging the water, which allowed for a gradual temperature change. Feeding and water changes continued as described for rearing conditions. When larvae molted to the next developmental stage, they were photographed for carapace length measurements and frozen individually. Measurements of carapace length were made from the posterior edge of the ocular cavity to the midline of the posterior edge of the carapace using ImageJ. Frozen larvae were subsequently dried for 24 hours at 60 °C and weighed. Larvae dying during the experiment were not measured or weighed.

#### BCO-DMO Processing Description

- Data from 2021 and 2022 were merged from two original data files into one data table represented by the primary data file of this dataset. Year data is still retained within the HATCH_OR_CAPTURE_DATE column of this data file.
- Units were removed from column names (unit information can be found in the parameters section of the BCO-DMO metadata page).
- Spaces in column names replaced with underscores ("_").
- Standardized bit character representation of blank values within the data file.
- Removed "1 claw" note from dry weight field and added this to the notes column.

#### Problem Description

Data have been checked and potentially problematic readings have been deleted by the data authors.

[ table of contents | back to top ]

## Data Files

| File | |
|---|---|
| **939825_v1_lobster_larvae_growth_and_mortality_data .csv** | (Comma Separated Values (.csv), 79.22 KB) MD5:d0a2aa8c885e26bb870d862e40e5f593 |
| Primary data file for dataset ID 939825, version 1 | |

[ table of contents | back to top ]

## Related Publications

Annis, E. R., Jane, A., Frederich, M., Waller, J., Fecteau-Volk, C. D., O'Loughlin, H., Larkin, R., & Rasher, D. B. (2025). Laboratory-reared lobster larvae yield inaccurate estimates of thermal tolerance. Global Change Biology, 31, e70154. https://doi.org/10.1111/gcb.70154
*Results*

Waller, J. D., Wahle, R. A., McVeigh, H., & Fields, D. M. (2016). Linking rising pCO2 and temperature to the larval development and physiology of the American lobster (Homarus americanus). ICES Journal of Marine Science, 74(4), 1210–1219. https://doi.org/10.1093/icesjms/fsw154
*Methods*

[ table of contents | back to top ]

## Parameters

| Parameter | Description | Units |
|---|---|---|
| LARVA_ID | Larva ID consists of the following terms from left to right: Treatment temperature; Rearing temperature (14 degrees C, 18 degrees C, Ambient, Wild); Developmental Stage (1, 2, 3, 4, 5); Experiment (Respirometry, Growth, Molecular); Sequential Number (1, 2, 3...n OR CTRL Testing or CTRL Active). | unitless |
| TREATMENT_TEMPERATURE | Temperature of experimental trial in °C. | degrees C |
| DIET | Diet larvae were fed during rearing. Z = zooplankton, B = brine shrimp. | unitless |
| REARING_CONDITION | Rearing conditions; L= lab, w = wild. | unitless |
| REARING_TEMPERATURE | Rearing temperature; 14 = 14°C, 18 = 18°C, A = Ambient , W = Wild Caught | degrees C |
| DEVELOPMENTAL_STAGE | The developmental stage at which the larva was placed in the temperature treatment (stage 1-5). | unitless |
| INDIVIDUAL_LARVA_NUMBER | Sequential numbers assigned to individuals in each treatment. | unitless |
| HATCH_OR_CAPTURE_DATE | Date that larva was hatched for lab reared larvae or caught for wild larvae. | unitless |
| TRANSFER_DATE | Date that the larva was transferred to the temperature treatment. | unitless |
| MOLT_DATE | Date that the larva molted to the next developmental stage (only recorded if it molted). | unitless |
| TIME_UNTIL_MOLT | Number of days from transfer date to molting to the next developmental stage (only recorded if it molted). | unitless |
| DEATH_DATE | Date that the larva died (only recorded if the larva died). | unitless |
| TIME_UNTIL_DEATH | Number of days from transfer to death (only recorded if the larva died). | days |

| | | |
|---|---|---|
| CARAPACE_LENGTH | Measured in mm from the posterior edge of the ocular cavity too the the midline of the posterior edge of the carapace. | millimeters (mm_ |
| DRY_WEIGHT | Measured in g after the larvae were died for 24 hours at 60°C. | grams (g) |
| NOTES | Additional comments on individual larvae | unitless |
| Source_File | Original file name from which the corresponding row of data was sourced. Originally, the 2021 and 2022 data were stored in two separate files merged to create the primary data file published through BCO-DMO. | unitless |

[ table of contents | back to top ]

## Instruments

| | |
|---|---|
| **Dataset-specific Instrument Name** | Nikon SMZ745T |
| **Generic Instrument Name** | Camera |
| **Dataset-specific Description** | A Nikon SMZ745T with an AmScope HD205-WU camera, ImageJ was used to take photographs and make the larval measurements. |
| **Generic Instrument Description** | All types of photographic equipment including stills, video, film and digital systems. |

[ table of contents | back to top ]

## Project Information

**RUI: Collaborative Research: Linking physiological thermal thresholds to the distribution of lobster settlers and juveniles (Lobster Thermal Thresholds)**

**Coverage**: Gulf of Maine

*NSF Award Abstract:*
Temperature is one critical factor that determines the distribution of marine organisms. However, in many cases temperature ranges (thermal tolerances) are only known for adults, but not for the immature stages that transition from the plankton to the bottom. This study is testing how temperature affects where larvae are settling. The American lobster (Homarus americanus) in the Gulf of Maine is serving as a model system to measure the thermal tolerance of the larvae and link this to the distribution of young lobsters in the field. Presently, lobster larvae are more likely to experience relatively cold temperatures than heat stress and larval settlement appears to be restricted to warmer shallow waters by a sensitivity to temperatures below 12°C. As water temperature has increased, settlement and juvenile distribution have expanded into deeper waters suggesting a release from cold stress. This project is advancing the understanding of shifting species distributions in response to increasing ocean temperatures by exploring thermal sensitivity in wild-caught larvae for the first time. This information is providing thermal thresholds for modeling larval viability in response to climate change scenarios. Understanding the larvae?s responses to temperature is fundamental to predicting the impact of climate change on one of the most valuable commercial fisheries in North America. The project is supporting training of undergraduate interns and a master?s student from small colleges (Hood College and University of New England) and connecting them with a research institution (Bigelow Laboratory

for Ocean Sciences). Teacher training is occurring in collaboration with the Marine Science Center at the University of New England. Results from this study are being shared with stakeholders and contributing to science-based management of the lobster fishery.

This project is the first to examine how thermal stress on a larval stage determines juvenile distributions using a combination of correlative and experimental approaches that includes measuring biochemical stress indicators in larvae deployed in natural field habitats. The central hypothesis is that the physiology of individual planktonic larvae controls meso-scale settlement patterns in the field. The goal is to ascertain if there is a causal relationship between the underlying physiology and thermal sensitivity of the organism and the distribution of early life stages. Larval supply, settlement and juvenile abundances will be assessed at different depths with temperatures above and below the proposed minimum temperature threshold of 12°C for larvae. Laboratory experiments using conventional methods are determining thermal tolerances in wild-caught larvae and how they change with ontogeny. The upper and lower thermal optima are being resolved using multiple physiological parameters such as measurements of oxygen consumption and aerobic scope, and biochemical assays of thermal stress (HSP70, AMPK, and SIRT). To link physiology to settlement patterns, caged stage IV larvae and V juveniles are being deployed in the field at sites with temperatures above and below 12°C. Lethal and sub-lethal effects on caged lobsters are being evaluated through measures of growth, mortality and biochemical markers of thermal stress. This is the first study to focus on the thermal tolerance of wild larvae, which has broad implications for understanding settling in marine invertebrate larvae.

[ table of contents | back to top ]

## Funding


| Funding Source | Award |
|---|---|
| NSF Division of Ocean Sciences (NSF OCE) | OCE-1948146 |
| NSF Division of Ocean Sciences (NSF OCE) | OCE-1947639 |
| NSF Division of Ocean Sciences (NSF OCE) | OCE-1948108 |


[ table of contents | back to top ]