**Abstract**

Birds are excellent subjects for studying the impacts of climate change. They have copious factors they must adapt to quickly in a rapidly changing climate. We used a long-term dataset to examine the effects of climate change on the breeding phenology of a population of white throated sparrows (*Zonotrichia albicollis*) by comparing timing of breeding and an array of different weather variables. We predicted that mean monthly precipitation and temperatures would advance hatch dates, the range of temperatures and precipitation has been narrowing over time, and that these results would differ between different morph-type mating pairs. We concluded that there were no changes in hatch dates over the years, but weather variables such as temperature range, precipitation range and the amount of precipitation in relation to hatch dates would be critical to analyze in future studies to keep track of the white throated sparrow’s plasticity. Furthermore, we found no significant differences in the results between different morph-type pairs.

**Introduction**

Since the Industrial Revolution, humans have been a the environment in vast ways, including releasing harmful greenhouse gasses into the atmosphere inducing climate change (Shaftel, 2019). In this world’s ever-changing climate, it is important to know what global warming and climate change will affect. Birds have been a noteworthy sensor of climate change due to changes in migration behavior and breeding habits, among other things.

It has been shown that reductions in bird abundance can have impacts that degrade ecosystem integrity, thus effecting important factors of our environment and economy (Rosenberg et al., 2019). Such environmental factors that would be effected include seed dispersal, pollination, and pest control (Rosenberg et al., 2019). Its effect on the United States economy would be heavily impacted, given 47 million people spend 9.3 billion U.S.D. per year on bird related activities (Rosenberg et al., 2019).

Overall, there has been a net loss of 2.9 billion bird abundance since 1970 (Rosenberg et al., 2019). Moreover, 90% of this loss applies to 12 bird families, which includes sparrows (*Emberizidae, Passerellidae*) (Rosenberg et al., 2019). It is also important to include that the two statements above are an overestimate, given this study’s estimated loss in only breeding populations (Rosenberg et al., 2019).

Birds can be excellent indicators of climate change for several factors, one central factor being their phenological cues (Visser et al., 2004). Increasing spring temperatures due to global warming has been shown to advance spring phenological events (Pudalov et al., 2017; Shutt et al., 2019). These events will be a key factor in determining the cues for migration and the timing of breeding seasons (Shutt et al., 2019; Visser et al., 2004; Visser & Both, 2005). The birds’ plasticity of these cues from changes brought by climate change will be an important factor in species’ ability to acclimate (Dunn & Winkler, 2010). Plasticity is defined as the ability of a genotype to change its phenotype after a change in environmental conditions (Dunn & Winkler, 2010). Some populations will be able to adapt to these changes in the environment by altering the timing or impact of these biological cues. It is detrimental to study these cues so that we may understand how adaptable certain species will be to an increasingly changing environment brought on by climate change.

An critical cue for many songbirds includes photoperiod, because it allows a standard time in which the breeding season will occur (Visser et al., 2004). Photoperiod is the change in how much daylight an organism interact with in a certain day. What is typical to many passerines, is in the spring when days get longer, a physiological response is triggered in these birds, whether it be gonadal development, follicular growth, or song development (Shutt et al., 2019). Since this exposure to light is the same every year, it isn’t an ideal indicator of how birds will adapt year to year to changes in climate (Visser et al., 2004). Because of this, these birds can be limited in their response to their timing of breeding amongst a changing climate (Townsend et al., 2013; Visser et al., 2004). Some cues that are best to look at, relative to adapting to climate change, includes certain secondary cues that involve food availability, migration, and weather conditions.

Several studies have shown certain passerines to follow a mismatch between the optimal time to raise chicks, and the time in which food is most abundant (Dunn & Winkler, 2010; Visser et al., 2004). Especially in insectivorous birds, increasing spring temperatures allow ectotherm insects to develop earlier in the season, causing a lag in homoeothermic nestlings (Dunn & Winkler, 2010; Pudalov et al., 2017; Visser et al., 2004). When this mismatch of timing occurs, a number of aspects to the timing of the reproduction cycle and chick survivability is changed. For example a study done on Blue Tits (*P. caeruleus*) demonstrated that parents found this kind of mismatching between nestling demands and food availability, and had to increase the amount of time foraging above their sustainable limit, causing potential damage to their survivability (Visser et al., 2004). This phenomenon is typically only observed in environments with scarcer resources (Dunn & Winkler, 2010; Shutt et al., 2019; Visser et al., 2004). This is not the case for all birds though. A trend seen in Song Sparrows (*Melospiza* *melodia*) in North America had revealed higher reproductive success when they bred earlier in warmer springs (Townsend et al., 2013). In environments that have more food available throughout the season and witness a more gradual peak during chick feeding, the need for species that have more than one brood per season to adapt to climate change is weaker than those species that have one brood per season (Visser et al., 2004). These species with only one brood per season will have higher fitness and should adjust their timing of reproduction accordingly (Visser et al., 2004). Weather and climate has a significant effect on timing of food availability, but can also affect bird phenology in different ways.

Another aspect that can effect breeding phonology is local and regional weather. In woodland passerines, average temperatures during spring has a negative correlation with clutch initiation (Shutt et al., 2019). For example one study showed in tit species, a gain of 1 degree Celsius causes an advancement of 3.5-5 days in clutch initiation (Shutt et al., 2019). Low local temperatures aren’t a cue, but appears to be more of a constraint that can limit the energy costly, physiologic processes involved in breeding, such as egg production and incubation (Shutt et al., 2019). There are different climactic scales that can be used to find phenological shifts (Grimm et al., 2015). Large scale climactic indices such as NAO (North Atlantic Oscillation) or ENSO (El Niño-Southern Oscillation) are found to predict ecological processes better than small scale indices (Grimm et al., 2015). Though several studies demonstrate that reproductive factors and nestling condition were more dependent on local temperature and rainfall (Grimm et al., 2015). For example, recent studies involving Danish colonial barn swallows (*Hirundo rustica*) showed that breeding phenology and brood size were affected by NOA and ecological processes on a small geographical scale (Grimm et al., 2015). The same studies also found that timing of breeding was more dependent on large scale NAO variations, and a reduction in breeding success was due to local scale climactic mismatches during breeding processes (Grimm et al., 2015). This reveals that both scales are valid and necessary factors to consider when observing climate’s effect on phenology. Another aspect of phenology that is affected by temperature and climate includes timing of migration.

Breeding phenology is affected by migration phenology, given the timing of migrating birds gives way to the timing in which they arrive at their breeding grounds and commence their breeding cycle. This is why it is imperative to note the differences in migration phenology in relation to temperature and climate changes in addition to observing the differences in breeding phenology. One effect observed by a change in migration timing is a mis-match in arrival dates of the breeding grounds and peak food abundance in that area (Both, 2010). For some species, early spring conditions put stress on birds to migrate early (MacMynowski & Root, 2007).

A study on Pied Flycatchers (*Ficedula hypoleuca*) observed how certain factors correlated with climate change affected their migratory timing. In previous works that were cited, trends in breeding dates due to local temperature changes within Europe were seen (Both, 2010). It was also mentioned that other works had found that photoresponsiveness and rainfall had an effect as well (Both, 2010). It mentioned previous works that implied this advance in migration date is because of an evolutionary response induced by climate change (Both, 2010). If an evolutionary response develops this quickly, the observed inadequate adjustments of the timing of arrival in accordance with climate change is a temporary problem, that will work itself out through this fast evolution (Both, 2010). The adaptive evolutionary response most likely exist too many factors simultaneously, so the previous statement seems hard to prove correct (Both, 2010). Within this study, it was found that median migratory recovery dates were heavily correlated with longitude and latitude of the area of birth (Both, 2010). Birds were able to migrate later when originating from more northern and eastern populations (Both, 2010). An analogous affect was found with the timing of arrival after migration and with time of laying (Both, 2010).

In this study, we are going to observe correlations between certain climate variables that may be altered due to climate change and trends in clutch one laying dates in the White Throated Sparrow. We are exploring if this certain population may be affected by certain climate variables, and if they are plastic enough to adapt to changes brought on by climate change. We hypothesize that certain climate variables such as average temperatures and precipitation are changing with climate change, and that White Throated Sparrows’ clutch one timing is changing as a result of that.

Based on other studies on the same subject, the following predications can be made:

1. Increases in mean temperatures will push the timing of the first clutch forward
2. Increases in mean, monthly precipitation will push hatch dates forward.
3. The range of hatch dates depending on mean monthly temperatures are decreasing
4. The range of hatch dates depending on mean monthly precipitation are decreasing
5. There will be variation in these trends depending on the mating pair’s morph type.

Correlative evidence has been adopted by scientists to link global warming patterns to upward movement of alpine-nival floras , earlier breeding by amphibian, northward range changes in butterflies, increased photo- synthesis, and changes in community composition (Brown et al., 1999). Utilizing correlation evidence can allow us to link factors of global climate change to certain aspects of white throated sparrows’ breeding phenology.

**Methods**

**Study Species**

This study utilizes the same data as the Tuttle research of White Throated Sparrow lab within Indiana State University, therefore methodology of data collection is the same (Tuttle et al., 2017). Bird data originates from a long term study of the White Throated Sparrow at the breeding grounds in Cranberry Lake Biological Station (State University of New York College of Environmental Science and Forestry, 44°150 N; 74°480 W) from 2000 to 2019. We looked at 490 nests from each mating pair’s first clutch, 258 nests of white morph males and tan morph females, 220 nests of white morph females and tan morph males, 5 nests with both mates having a tan morph, and 7 nests with both mates having the white morph. All of these nests were found in 131 different territories.

Blood was taken from the birds and processed in the lab for genetic testing of sex, lineage and morph. Adults and nestlings are banded with color bands and Fish and Wildlife bands for identification purposes. Newly banded adults and nestling are considered recruited into the population. Every summer, surveys are used to observe population density, breeding pairs, and morph composition of the pairs. During these summer breeding seasons, nests of breeding pairs were found and located using behavioral observation.

The nest cycle, nest contents, and nest success was observed closely by monitoring every two days. When the eggs hatch, all nestlings are marked with non-toxic marker on their tarsus for identification purposes. Also recorded are hatching failures and brood size decreases. When the chicks are 5 to 8 days old, they are banded, weighed, tarsus length is measured, and 80-200 μL of their blood is drawn from the brachial vein.

**Molecular data**

Using red blood cells, we derive DNA for genetic analysis of sex, lineage and morph. Dead nestlings were also collected for genetic analysis. Unhatched eggs were not genetically analyzed and at times, partial depredation reduced brood sizes before we could gather any samples. Because of this, results obtained from broods not reduced in size were compared with results obtained when using all broods where we gathered genetic data.

For molecular analysis, red blood cells are stored in lysis buffer at 4 degrees Celsius until we extract the DNA using the DNA IQ magnetic extraction system. Nestling sex is determined by amplifying conserved region of the chromo-helicase-DNA-binding gene that is on the avian sex chromosome (Tuttle et al., 2017).

**Weather data**

Weather data was collected from ncdc.noaa.gov. The data used was monthly summary reports of specific weather conditions from 1900 through 2020. The Weather Station from which the data was derived is at Indian Lake 2SW, NY US USC00304102. This set was used due to its proximity to our study site and the completeness of the data. Several stations were closer, but had large sections of missing data.

The specific weather factors we looked into were monthly values for the following:

Average temperature (TAVG), maximum temperature (TMAX), minimum temperature (TMIN), absolute maximum temperatures recorded (ABSMAX), Date ABSMAX occurred (ABSMAX\_DATE), Absolute minimum temperature recorded (ABSMIN), date ABSMIN occurred, (ABSMIN\_DATE), ABSMAX minus ABSMIN (ABS\_RANGE), number of days with maximum temperatures greater than or equal to 32 degrees Celsius (DX32), number of days with maximum temperatures less than than or equal to 0 degrees Celsius (DX0), number of days with minimum temperature less than or equal to 0 degrees Celsius (DT0), number of days with minimum temperatures less than or equal to -18 degrees Celsius (DT-18), total daily precipitation in millimeters (PRCP), maximum daily precipitation in millimeters (PRCPMAX), date PRCPMAX occurred (PRCPMAX\_DATE), total snowfall in millimeters (SNOW), maximum daily snowfall in millimeters (SNOWMAX), date SNOWMAX occurred (SNOWMAX\_DATE), days with precipitation greater than or equal to 0.25 millimeters (DP.25), days with precipitation greater than or equal to 2.5 millimeters (DP2.5), and days with precipitation greater than or equal to 25 millimeters (DP25X).

**Statistical Analysis**

Statistical Analysis involved running correlations with specific variables. For trends in laying dates we ran a linear regression with the Julian dates in which eggs hatched, and the Julian date by year.

For climatic correlations we ran correlations for weather variables and the months of April through May, since those months seem most critical for this population white throated sparrows to establish their breeding season once at Cranberry Lake.

We also looked at correlations between Julian date of eggs hatched and the previous years’ months to see if the previous year had an effect on the current previous seasons being looked at.

For trends in annual climate indicators we ran correlations between weather variables and years.

Trends in monthly climate variables were found by running correlations for weather variables and the months of April through May for each year.

We carried out correlations for average hatch dates for mating pairs with a white morph male and tan morph female against April and May of that breeding season. We ran correlations for average hatch dates for mating pairs with a tan morph male and white morph female against April and May of that breeding season.

In addition, we ran correlations for the earliest hatch dates for April and May of that breeding season over the years, and weather variables. We then ran correlations for the earliest hatch date of mating pairs with a white morph male and tan morph female, and weather variables for the months of April and May for that breeding season. Correlations were additionally run for the earliest hatch date of mating pairs with a tan morph male and white morph female, and weather variables for the months of April and May for that breeding season

We also ran correlations for all of the variables in the above paragraph, but instead of the months of April and May for that breeding season, we analyzed all of the months in the year previous to that breeding season.

**Results**

**Trends in Laying Dates**

Overall, there was no trends between laying dates over the years in this population of white throated sparrows. It is important to note, though, that even if there was no evidence of changes in laying dates over the years, it is still crucial to analyze potential factors that may be changing with weather conditions and hatch dates over the years.

**Climatic Correlates of Hatch Dates**

Trends between weather variables and the Julian hatch dates during May and April1

The three most notable correlations for this section were DP.25, ABS\_RANGE, TAVG, and TMAX, all for the month of May (P < 0.05; r ≥ 0.5)

Over the years, we are observing a trend in which the average temperatures and maximum temperatures for the month of May are decreasing over time. This could mean that May temperatures are getting cooler, and that the hottest days in May are decreasing in temperature as well. We can also see that ABS\_RANGE for the month of April is decreasing over time. Therefore, the variance of temperatures in the month of April is getting smaller. Finally, DP.25 is increasing for the month of May, meaning the days in which precipitation is greater than or equal to 0.25 millimeters is increasing and that May is seemingly getting more precipitation over the years.

Trends between weather variables and the Julian dates of the year previous to the current breeding season 2

The four strongest correlations for this section are ABS\_RANGE, ABSMIN, DP2.5, and PRCPMAX. (P < 0.05; r ≥ 0.5).

It seems the strongest correlations occur in spring in summer, contrary to the prediction of high winter correlations for previous years. For the month of July in the previous season, the range of absolute maximum and minimum temperatures increased As Julian hatch dates moved forward and vice versa. The absolute minimum temperatures recorded in July of the previous season decreased in occurrence as egg hatch dates progressed forward and vice versa. Days with precipitation greater than or equal to 2.5 mm in September of the previous season decreased as eggs hatched later in the year and vice versa. The maximum daily precipitation in August of the previous season decreased as hatch dates advanced and vice versa.

**Trends in Annual Climate Indicators**

The only significant correlation with this section was DP.25 (P < 0.05; r ≥ 0.5)3. Overall, the only weather variable to consistently change over the years was daily precipitation greater than or less than or equal to 0.25 millimeters. This value has been increasing over time.

**Trends in Monthly Climate Indicators**

The strongest correlations for this section was ABSMIN and DP.25(P < 0.05; r ≥ 0.5)4. Over the years, the absolute minimum temperatures for the month of May increased. In addition, the daily precipitation greater than or equal to 0.25 millimeters increased over the years for the month of April.

**Earliest Correlations**

Earliest across months5

For this section observed the weather variables correlated with the earliest Julian hatch dates for the months of April and May. We found a negative correlation between ABSMIN and the month of April. This means that when the minimum temperatures for April decrease, the earliest days in which eggs hatch move forward, and vice versa.

TxW earliest and months correlations6

For this study, we also wanted to see if there are any differences in the breeding timing due to certain weather conditions from different morph-type mating pairs. For this section, we ran correlations regarding the earliest hatch dates for mating pairs with a tan male and a white female, and certain weather variables for the months of April and May. Most of the morph-type pair data was insignificant, and the only moderate correlation found was with ABSMAX (P < 0.05; r ≥ 0.5). As the absolute maximum temperatures for the month of May increase, the earliest hatch dates for this type of mating pair decreases and vice versa.

**Discussion**

Overall, the purpose of this study was to detect a significant change between the white throated sparrow’s hatch dates, and the changing climate in the study area. We did not find a significant shift in this population’s hatching dates over the 19 years of this sample. Therefore, it seems so far, elements of climate change has not been effecting their reproductive phenology.

One explanation for this could be that there is a lack of phenotypic plasticity within this population. When climate changes we would predict that birds would adapt and change their timing of breeding to line up with optimal conditions, especially in songbirds (Dunn & Winkler, 2010). Some factors that could limit this ability to adapt could consist of phenotypic variables including their reaction to photoperiod, timing of migration, or hormones, for example (Dunn & Winkler, 2010) Alternative factors that could affect reproductive timing include food abundance, and breeding density. We likely would not expect these factors to change plasticity on this population of white throated sparrows, though, since their hatch dates have not changed over the years (Dunn & Winkler, 2010).

In a study Done by Both, Bouwhuis, Lessels, and Visser, they looked at the population declines in pied flycatchers, (*Ficedula hypoleuca*) as a product of mismatched reproductive timing due to climate change (Both et al., 2006). Populations declined by 90% over a twenty year span when food peaks did not line up with nestling peaks in the early breeding season (Both et al., 2006). If we witness a lack of plasticity in this population of white throated sparrows, we may note a similar fate. Further studies would be ideal to see how the white throated sparrows will react once the effects of climate grow even stronger.

We could assume that changes in weather and white throated sparrow breeding habits may occur in the future as climate change becomes more severe and has a larger impression on this area. If that is the case, we believe that the components we looked at within this study would be a simple, yet effective method of witnessing these changes. The results separate of the overall correlations between hatch dates and time can be good indicators of what to anticipate if their hatch dates do start to shift over the years.

The positive correlation found between hatch dates and precipitation above 0.25 mm for the month of May, the negative correlation found between precipitation above 0.25 mm and September of the previous breeding season, and the correlation between maximum precipitation and August of the previous breeding season could have an impact on breeding timing and success. Changes in precipitation may be related to timing of prey maturation (such as caterpillars that white throated sparrows eat during breeding season), or hinder the ability for white throated sparrows to attain their food or maintain egg/nest temperatures, which could affect the breeding timing and/or success (Irons et al., 2017). Wet conditions have also been shown to delay egg laying and incubation stages in tree swallow (*Tachycineta bicolor*) populations (Irons et al., 2017).

It seems that the most abundant correlations we have found had to do with the absolute range of temperatures. For several of the sections of the results, we found that the maximum temperatures were decreasing, and the minimum temperatures were increasing. This indicates that the variability of the temperatures within this area are decreasing. This isn’t commonly discussed in other related studies, so it could be a compelling novel metric to use in further studies related to climate and breeding. Furthermore, we have witnessed an increased in the absolute minimum temperatures, which demostrates that this population’s breeding months are getting “warmer” overall. Though it is important to note that it’s not getting “hotter” since there was no increased in maximum temperatures, therefore showing a decrease in the temperature range value, and could help predict where the white throated sparrow’s laying trends may be heading.

**Conclusion**

For this study, we predicted that an increase in mean temperatures would push the timing of egg laying forward, increases in mean monthly precipitation will push laying dates forward, the ranges of hatch dates based on mean monthly temperatures and mean monthly precipitation are becoming more narrow, and there would be variation of these trends based on the morph type of the mating pair. Overall, we did not find a significant difference in hatch dates over time, but noted some essential weather variables and hatch date correlations to keep in mind for further research. It is critical to continue this research to track the white throated sparrow’s breeding plasticity and ability to adapt in the world’s transitional climate.

**Appendix**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1Julian and Month Trends | |  |  |  |
|  | |  |  |  |
| **Weather Variable** | **Month** | **Correlation** | **P value** | **R value** |
| DP.25 | 5 | POS | 0.00141 | 0.6637 |
| ABS\_RANGE | 4 | NEG | 0.0244 | 0.5 |
| DP2.5 | 5 | POS | 0.038979 | 0.4647 |
| ABSMIN\_DATE | 4 | NEG | 0.0186 | -0.52 |
| PRCPMAX\_DATE | 4 | NEG | 0.0174 | -0.525 |
| ABSMAX | 5 | NEG | 0.0122 | -0.5487 |
| ABSMIN | 4 | NEG | 0.0126 | -0.597 |
| ABS\_RANGE | 5 | NEG | 0.0049 | -0.6 |
| TAVG | 5 | NEG | 0.0096 | -0.615 |
| TMAX | 5 | NEG | 0.0039 | -0.615 |

2Julian and Month Trends (previous)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Weather Variable** | **Month** | **Correlation** | **P value** | **R Value** |
| ABS\_RANGE | 7 | POS | 0.0214 | 0.5106 |
| PRCPMAX\_DATE | 3 | POS | 0.0302 | 0.4849 |
| ABSMIN\_DATE | 3 | POS | 0.03586 | 0.4715 |
| HTDD | 6 | POS | 0.0428 | 0.4569 |
| ABSMIN | 1 | POS | 0.05298 | 0.438716 |
| DT0 | 6 | POS | 0.05967 | 0.428 |
| DP2.5 | 5 | NEG | 0.0546 | -0.436 |
| DP2.5 | 4 | NEG | 0.0416 | -0.459 |
| PRCP | 3 | NEG | 0.0336 | -0.476 |
| PRCPMAX\_DATE | 8 | NEG | 0.0248 | -0.499 |
| ABS\_RANGE | 1 | NEG | 0.0245 | -0.5009 |
| DP.25 | 8 | NEG | 0.0226 | -0.5066 |
| DP.25 | 9 | NEG | 0.02103 | -0.5066 |
| ABSMAX\_DATE | 1 | POS | 0.054579 | -0.53915 |
| ABSMIN | 6 | NEG | 0.0141627 | -0.53915 |
| DP.25 | 4 | NEG | 0.0084 | -0.5717 |
| PRCPMAX | 3 | NEG | 0.0069 | -0.583 |
| PRCP | 8 | NEG | 0.0055 | -0.5967 |
| PRCP | 4 | NEG | 0.0052 | -0.5996 |
| ABSMIN | 7 | NEG | 0.003456 | -0.6213 |
| DP2.5 | 9 | NEG | 0.00275 | -0.63277 |
| PRCPMAX | 8 | NEG | 0.00182 | -0.6524 |

3Trends in annual climate indicators

|  |  |  |  |
| --- | --- | --- | --- |
| **Weather Variable** | **Correlation** | **P value** | **R value** |
| DP .25 | pos | 6.22E-94 | 0.51 |

4Trends in Monthly Climate Variables

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Weather Variabes** | **Month** | **Corelation** | **P value** | **R value** |
| ABSMIN | 5 | POS | 1.80E-14 | 0.629 |
| DP.25 | 4 | POS | 2.50E-09 | 0.52 |
| DP.25 | 5 | POS | 6.33E-07 | 0.445 |
| SNOWMAX\_DATE | 4 | NEG | 0.00123 | -0.482 |
| ABS\_RANGE | 5 | NEG | 1.88E-08 | -0.489 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 5EARLIEST ACROSS MONTHS CORRELATIONS | | |  |  |
| **Weather Variable** | **Month** | **Correlation** | **P value** | **R value** |
| TAVG | 5 | NEG | 0.0582 | -0.43 |
| ABSMIN | 4 | NEG | 0.021 | -0.51 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 6TxW\_EARLIEST AND Month Correlations | | |  |  |
| **Weather Variables** | **Months** | **Correlation** | **P value** | **R value** |
| ABSRANGE | 4 | POS | 0.0467 | 0.45 |
| ABSMIN | 4 | NEG | 0.0379 | -0.467 |
| ABSRANGE | 5 | NEG | 0.0308 | -0.483 |
| ABSMAX | 5 | NEG | 0.0152 | -0.534 |

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