Examining the effects of rising sea temperatures on the germination, growth and survival rate of *Enhalus acoroides.*

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Abstract:

The purpose of this study was to investigate the effect of increasing sea water temperature on the germination, growth, and survival rates of Enhalus acoroides in seedling stage by surveying two seagrass cultivation areas in Trang, namely Makham Bay and Boonkong Bay, to collect data on the salinity of sea water, temperature of sea water, and pH of sea water in that area. Experts and volunteers for seagrass restoration or fishermen in the area were interviewed to gather data for use in environmental simulations to create four experimental sets, each with four boxes. The box is then divided into three control units at room temperature, with temperature ranges of 30 - 32 ℃, 32 - 34 ℃, and 34 - 36 ℃.The innermost seeds of 32 seaweed seeds were then removed after they had been steeped in water for one night.

The experiments were carried out using approximately 160 suitable seaweed seeds. For the first four weeks, the sea grass seeds were divided into ten seed boxes, and the germination rate was measured every ten days. Following that, 16 seedlings at an early stage were chosen for the experimental set. Seedlings from that temperature range were placed in four experimental boxes. Leaf length and number of leaves were measured every 3 days, and the results for each set of experiments were obtained to measure growth and survival rates. The results showed that seaweed seeds germinated well at 34 - 36 ℃, which is consistent with Yi Zhou's (2016) research, and seaweed seedlings grew well and had a high survival rate in the temperature range of not more than 34 ℃, which is consistent with Chakrit Ruangsorn's research (2007).

Keyword *Enhalus acoroides Survival rate, growth rate and germination rate*

Research Question and Hypothesis:

Research questions

1. How does sea water temperature affect the germination rate of seagrass seeds?
2. How does sea water temperature affect the growth rate of seagrass at seedling stage?
3. How does sea water temperature affect the survival rate of seagrass seedlings?

Research hypothesis

1. Higher seawater temperature will lead to lower germination rate of seagrass seeds.
2. The increase of seawater temperature leads to the decrease of growth rate of seagrass at seedling stage.
3. The survival rate of seagrass seedlings decreased with the increase of seawater temperature.

Introduction

In Thailand, the coastal ecology still faces a significant problem with the decline or deterioration of seagrass. There are numerous consequences to this problem. This is due to the fact that the source of seagrass is crucial to the ecology; it serves as a spawning ground for marine species as well as a nursery for aquatic ones. In addition, some marine animals, such as large marine fish, shrimp, squid, and crabs, have economic significance. According to the Office of Environment and Pollution Control 13 (Chunwuli), 2017 seagrass is also a significant contributing factor to the decline in the number of creatures that are protected in the nation, such as dugongs and sea turtles. Seagrass also protects the earth's atmosphere and the water quality, which is crucial for aquatic life. The carbon storage that affects global warming (CAA), 2564, includes seagrass. There are numerous factors contributing to the decline of seagrass, but one of these factors is the warming of coastal seas. Global warming (Ministry of Natural Resources and Environment, Directorate of Marine and Coastal Resources, 2019).

We have developed a technique for transplanting protection since seagrass degradation is a problem with extensive effects. *Enhalus acoroides* is the type of seagrass that was seeded using accelerated protection. It is seagrass; thus, its leaves are quite long and rigid since seagrass is most likely to diminish owing to its physical qualities. until the leaves break or extend into the water, when the risk of being carried away by the waves is too great to accept (Ministry of Ocean and Coastal Resources, 2016).

Thus, the germination, development, and survival rates of *Enhalus acoroides* seeds at the seedling stage are of interest to researchers. To understand the significance of seagrass temperature variations, consider how the sea water temperature changes. Also, it offers instructions for growing substitute seagrass in case seagrass resources change in the future.

Research Methods and Materials

Materials

1.) Heater

2.) Thermometer

3.) Water pH meter

4.) Salinity meter

5.) 16 acrylic boxes, size 19x27x17 cm.

6.) Sand, shells and mud in Ratchamongkol beach

7.) Seawater

8.) *Enhalus acoriodes* fruit 32 fruit

9.) Aquarium oxygen

10.) LED bulb for aquatic plants

Research Methods:

1. Study area

Explore Makham Bay (7 37' 56.82 N and 99 14' 53.94 E), a region with a dense and robust seagrass population, and the area surrounding Boonkong Bay (37 25' 19.1 N and 122 05' 06 W), one of the seagrass transplant plots in Trang Province (Department of Marine and Coastal Resources, Ministry of Natural Resources and Environment, 2021). The staff's investigation will be combined with a survey of the seagrass species. Using the technology from GLOBE THAILAND and the program GLOBE Observer, the survey measured the salinity of the water, pH, and seawater temperature of that area. Landcover data were also recorded.

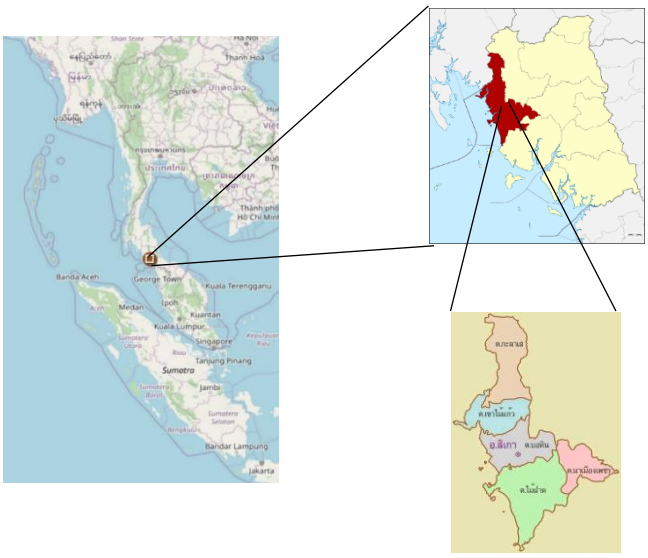

Figure 1 Areas around Boonkong Bay and Makham Bay.

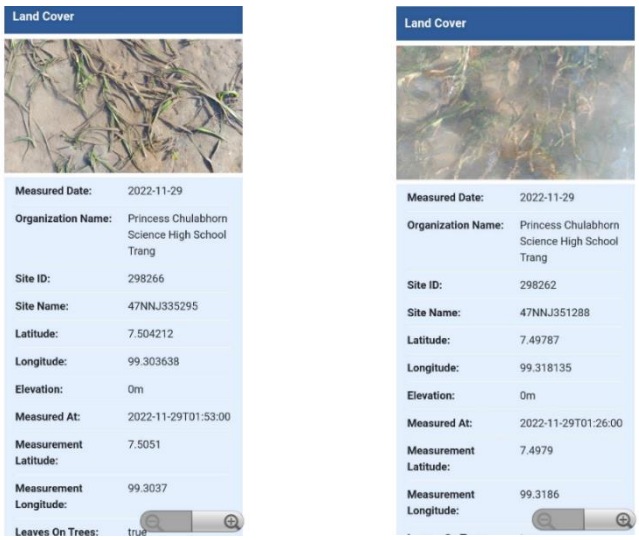

Figure 2 Recording Landcover Using Application GLOBE Observer.

From the survey area from both areas, the average data on seawater quality in that area is as follows in table 1

Table 1 Seawater quality at Boonkong Bay and Makham Bay.

Water quality	Boonkong Bay	Makham Bay	The average
Water salinity (ppt)	30	31	30.5
Water pH	7.5	7.6	7.55
Temperature (degrees Celsius)	28	27	27.5

2. Preparing equipment for growing *Enhalus acoroides*.

2.1 Preparing containers for *Enhalus acoroides* cultivation.

1. Prepare a seed container:16 acrylic boxes measuring 19x27x17 cm.

2. Put the soil in each box, 2 litres per box, which is sand mixed with 70% shells, 30% mud (Pornthep Wiratwong, 2016) and 5.6 litres of seawater.

3. Install every box of oxygenator.

4. A total of 12 temperature control heaters were installed and 4 boxes for laboratory temperature trials in seeding as a control unit.

5. Place the acrylic box in the prepared area where the LED lighting fixtures are installed.

2.2 Preparation of *Enhalus acoroides* seed.

1. Collect the *Enhalus acoroides* fruits. The fruits must be old, observe from the fruit must be fairly large, have a yellowish green colour and the appearance on the fruit will be clearly embossed. By collecting a total of 32 units.

2. Soak the *Enhalus acoroides* fruits in the sea water for 1 day so that the shell can be easily removed. One *Enhalus acoroides* fruit will get 5 - 7 seeds.

3. Wash and clean the seeds by removing the thin white pulp covering the seeds completely.

3. Seagrass culture and storage

1. Put the prepared *Enhalus acoroides* seeds in a seed container. Put 10 seeds per box with the right distance. Seeding is done by digging the soil into a small hole. Put the seeds into the hole and cover the soil so that it is not too tight.

2. Use a heater to heat the seawater. Box 1 - 4 is seeded at room temperature. Box 5 - 8 controls the temperature at 30 - 32 degrees Celsius. Box 9 - 12 controls the temperature at 32 - 34 degrees Celsius and the box 13 - 16 controls the temperature at 34 - 36 degrees Celsius.

3. Control the pH in seawater to be in the range of 7.5 - 8.4 Salinity in the water in the range of 30 - 35 ppt (Neonics Co., Ltd., 2021) and increase the seawater used to culture every

10 days. Turn on the LED at 8:00 a.m. and turn off the LED at 4:00 p.m. Every day to receive light similar to the actual environment and allow air to pass through the oxygen line.

4. Observe and record data by measuring seawater temperature, measuring seawater pH and measuring seawater salinity to stabilize every 3 day.

5. Study the germination rate of *Enhalus acoroides* seeds by collecting germination data in the first 4 weeks every 10 days, accounting for the following percentages: $\frac{Number\ of\ germinated\ seeds}{Initial\ number\ of\ seeds}$ x100 of each repetition of the trial set to come to average (World Vision Ethiopia, 2020). After that, bring the germination rate of each repetition of the experiment to the average.

6. Study the growth rate and survival rate of *Enhalus acoroides* in the seedling stage. By selecting from a total of 64 germination and strong seeds, put 4 *Enhalus acoroides* seedlings per box, placed in the form of squares and have the right distance. Seeding is done by digging the soil into a small hole. Put the seedling into the hole, leaving only the leaves of the seed

7. Growth rate measurement, measure the length of leaves and number of leaves every 3 days by using each set of results to find the difference and average (Andrew Carberry, 2022) and measure the survival rate as following percentages: $\frac{Number\ of\ surviving\ seedlings}{Initial\ number\ of\ seedlings}$ x100 (World Vision Ethiopia, 2020) After that, bring the survival rate of each repetition of the experiment to the average. If the seedling dies is 50% of the box, stop the experiment of that box.

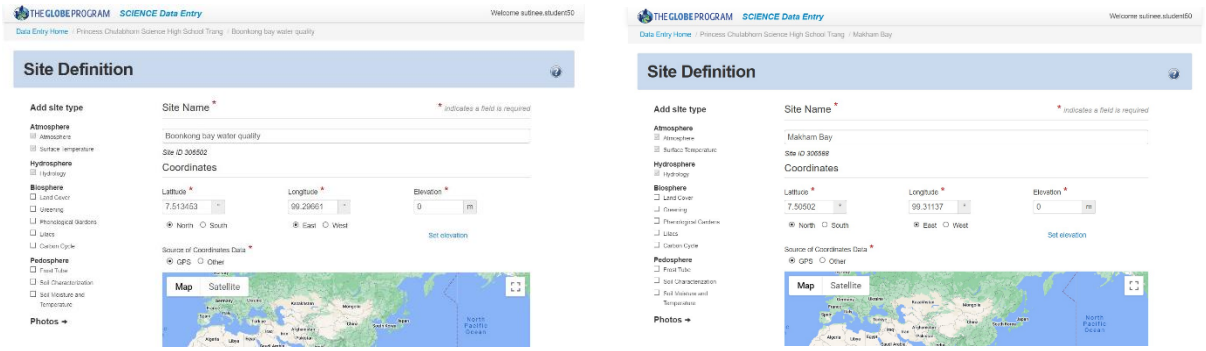

Figure 3 data entry in the Web page of GLOBE

4. Data analytics

Analyse the germination rate of *Enhalus acoroides* seed, growth rate and survival rate of *Enhalus acoroides* in the seedling phase using a one-way ANOVA record at a significant level of .05.

Results:

1. The results of the study of the germination rate of *Enhalus acoroides* seeds are as follows:

The germination rates at each temperature range were discovered to vary at a considerable level of.05. Figure 4 illustrates the temperature range between 34 and 36 degrees Celsius as having the maximum germination rate and being the closest to the typical temperature control unit.

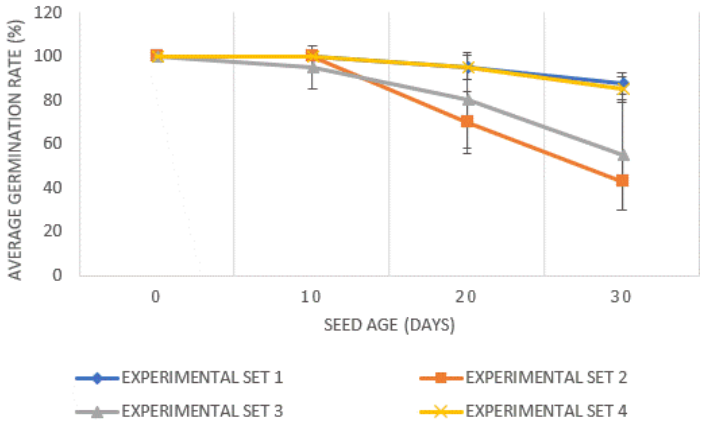

Figure 4 The graph shows the germination rate of *Enhalus acoroides* seed in each temperature range.

2. The results of the study of the growth rate of *Enhalus acoroides* in the seedling stage are as follows:

2.1 Leaf length.

As indicated in Figure 5, the temperature range between 32 and 34 degrees Celsius produces the highest growth rate for Enhalus acoroides seedlings. The leaf length fluctuates significantly at a level of.05.

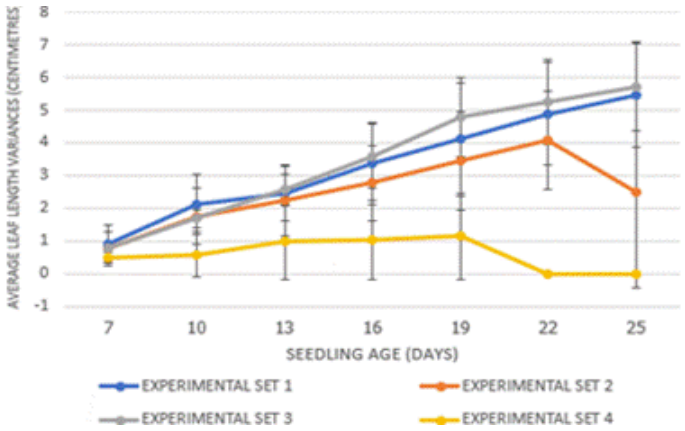

Figure 5 The graph shows the difference in the leaf length of *Enhalus acoroides* seedlings in each temperature range.

2.2 Number of *Enhalus acoroides* leaves.

In each temperature range, the number of Enhalus acoroides leaves that increase changes significantly at a level of.05. The temperature range of 32 to 34 degrees Celsius, as depicted in Figure 6, produces the greatest average number of Enhalus acoroides leaves.

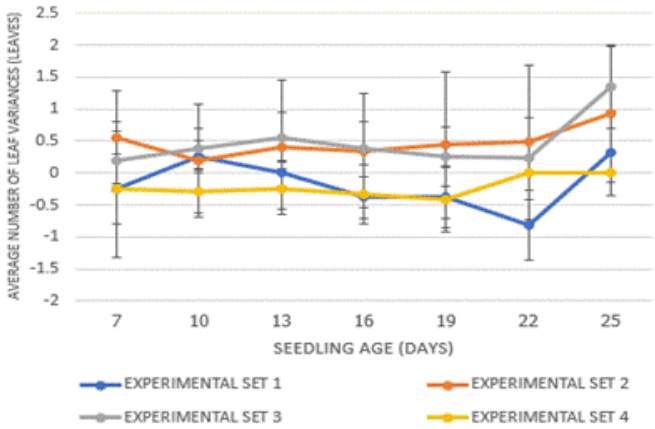

Figure 6 The graph shows the difference in the number of leaves of *Enhalus acoroides* seedlings in each temperature range.

3. The results of the survival rate of *Enhalus acoroides* in the seedling stage are as follows:

Each temperature range has a noticeable difference in the survival rate. 05. The temperature that gives Enhalus acoroides seedlings the highest survival rate and is the most similar to the standard temperature control unit. According to Figure 7, the temperature range is 32 to 34 degrees Celsius.

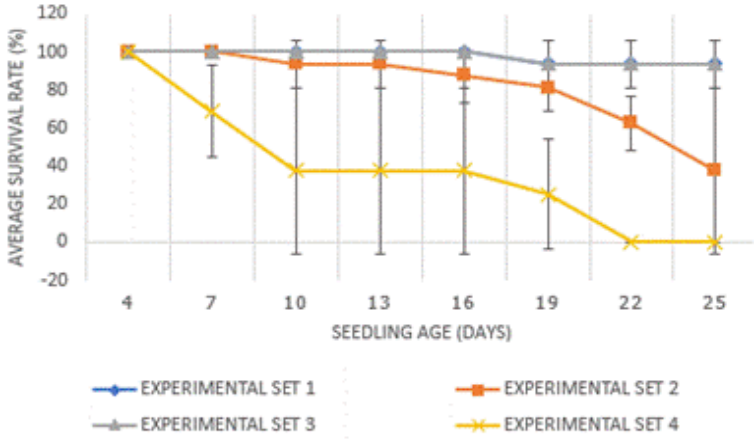

Figure 7 The graph shows the survival rate of *Enhalus acoroides* seedlings in each temperature.

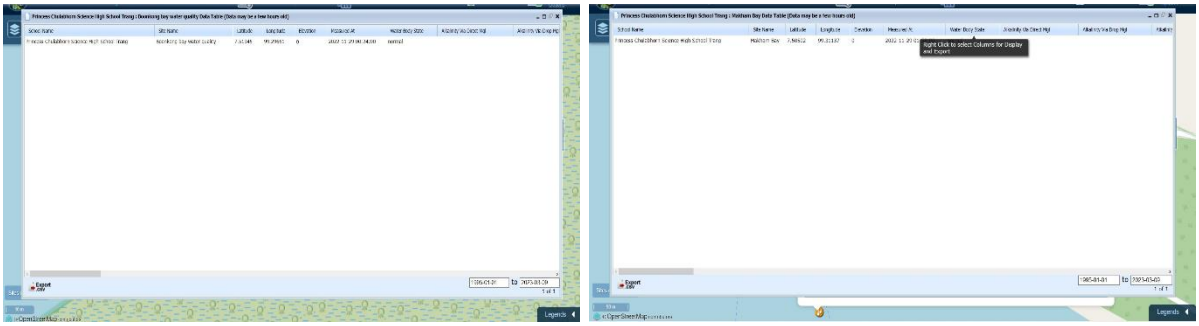

Figure 8 GLOBE Visualization page

Discussion:

The growth of seagrass was investigated in two survey areas, Boonkong Bay and Laem Sai Bay, Makham Bay. The researcher giving the data such an experimental design discovered that the water quality, the average salinity of the water was 30.5 ppt, the water pH was average, about 7.55, and the average water temperature was 27.5 degrees Celsius. The sowing phase and the seagrass seedling phase were the two sections of the experiment.

Early stages in agreement with Yi Zhou's (2016) study, which found that seed germination was considerably increased at high temperature (p 0.001) and at the seedling stage, the germination rate of seagrass seeds was significant in the temperature range of 34-36 °C. It was discovered that the growth rate of leaf length was used to gauge the rate of seagrass growth. *Enhalus acoroides* seedlings were shown to grow most effectively in the 32–34 °C temperature range, and tests of leaf number revealed that this is also the temperature range at which the leaf number differential was the largest. It was determined that the growth rate of *Enhalus acoroides* seedlings was highest between 32 and 34 degrees Celsius. The research of Chakrit Ruengsorn (2007), who claimed that the ideal temperature for seagrass growth in the tropics or subtropics will be in the range of 23.0 - 32.0 degrees Celsius, is consistent with the findings that the survival rate will be lowest in the temperature range of 34 - 36 degrees Celsius.

Conclusion:

The study's findings suggest that the temperature range is ideal for seagrass growth and survival. 32 - 34 ° C. The lowest rates of growth and survival are observed in the range of 34 to 36 ° C. The highest rate of seagrass germination occurs in the temperature range of 34 to 36 °C, which also shows that as seawater temperatures rise gradually in the future, seagrass germination rates would rise but growth and survival rates will fall. The result is that the seagrass resources will become more deteriorated in the future if the temperature rises more.

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including. Moreover we would like to thank Bohin's Farmstay and fisherman who give us more about the aquatic animal and seagrass.

Citations

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Badge

I am a collaborator: Our research was conducted in collaboration with our team. In our team we have 2 people who are Sutthini Rungcharoenpattanakit and Unda Bootliam. First, we brainstormed the title of the project from the problem in our community. Then we surveyed the studies site where are Makarm Bay and Boonkong bay. While surveying the Unda looked for physical appearances of the seagrasses and seawater and Sutthini collected the data and took pictures from everywhere went.After that, we tested the seawater. Unda measures seawater salinity, pH and temperature. While Suthini was collecting the data.Then we nursed Enhalus acoroides when we collected the data (length and number of leaves, pH, salinity and temperature of seawater) we also work together to collect the data all 16 boxes per person. When we were collecting data, we have one person measured and one person collected. We did every 3 days for 10 weeks.For the last, we also conclude all about our research together and prepare for presentation, research report by Unda, Power Point presentation by Sutthini and VDO clip by both of us.The advantages of collaboration are that we can spend less time working and have a higher quality of work than working alone because each person have different abilities. Our research was done in collaboration with Asst. Prof. Pornthep Weerawong from Rajamangala University of Technology Srivijaya To assist in making recommendations on research planning and data analysis. in order to plan more systematically and with more accurate information including cooperation with Bohinfarmstay In terms of information and space for planting plots for conservation in Trang Province, together with fishermen and local villagers to share knowledge and knowledge on the basics of seagrass and transplanting for conservation within the province.

I make an Impact: The reduction of seagrass in Thailand is still a major problem that is difficult to solve in the coastal ecosystem. There are many factors that cause this problem, but one interesting factor is the rise of sea water temperature caused by global warming. At present, the problem of seagrass reduction has a wide impact because seagrass is the nursery of various economic aquatic animals, including: Shrimps, shellfish, crabs or sea fish are also important food sources for protected animals such as dugongs and sea turtles. It is also an important factor in global warming, because seagrass is one of the major carbon dioxide reserves in the world. *Enhalus acoroides* is a popular protected species, because because of its physical characteristics, the risk of population reduction is the greatest. This study enables us to predict that if global warming continues to intensify, We must prepare for the degradation of seagrass. It is also a transplant database. After the end of the seed period, the seedlings may grow well at about temperature. 32 - 34 degrees Celsius. This information can be distributed to the community to help protect seaweed and prepare for the impact of this situation.

I am a Data Scientist: This study was obtained by collecting data from different sources. The source used for research planning and detailed analysis of data to summarize the results. The data obtained from the analysis can be used to predict the reduction of seagrass resources in the future and serve as the database of the plantation. Is the number of transplants increasing every year, or what is the future plan?