



Science Project

A Study on the Effects of Salinity on Phytoplankton Community Structure
for Monitoring Algal Blooms in Coastal Areas of Mueang Chon Buri, Chon
Buri, Thailand.

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Chonburi



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Field of Study: Environmental Science

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Abstract

A Study of Salinity Effects on Phytoplankton Community Structure for Monitoring Plankton Blooms along the Coastal Areas of Mueang District, Chonburi Province. The objective of this scientific project was to investigate the relationship between salinity and the stability of phytoplankton community structures, and to compare the ecological dynamics between two study sites: Ang Sila and Wonnapha Beach. Water samples were collected and analyzed from August to November 2025.

The results demonstrate the critical role of salinity in maintaining ecological balance. Under conditions where salinity remained at moderate to high levels (23.00 – 30.00 ppt), the community structure exhibited high stability and biodiversity. Various species of diatoms, such as *Rhizosolenia spp.* and *Chaetoceros spp.*, coexisted harmoniously; this equilibrium effectively inhibited the rapid proliferation of any single species.

Conversely, a sharp decline in salinity (below 18.00 ppt) caused by freshwater runoff—particularly observed at Wonnapha Beach in early September led to an ecological imbalance. This triggered monodominance, where the dinoflagellate *Ceratium furca* rapidly replaced other species, reaching a peak density of 941,750 cells/liter.

In conclusion, salinity levels significantly influence phytoplankton community structures and serve as a key indicator of the transition from an ecological equilibrium to a bloom state. These findings are highly beneficial for monitoring and forecasting the risk of harmful algal blooms (red tides) in coastal environments.

Keywords: Salinity , Phytoplankton , Population Structure , Plankton Bloom

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Chapter 1

Introduction

Rationale and Significance of the Study

Climate change is currently reshaping global climatic systems, affecting precipitation patterns, the frequency of extreme rainfall, and the severity of droughts, alongside the variability of El Niño-Southern Oscillation (ENSO) events. These shifts directly impact freshwater runoff into coastal zones and disrupt the physicochemical balance of seawater most notably salinity, a fundamental environmental factor governing phytoplankton community structures. Increased freshwater runoff following heavy rain leads to significant seawater dilution (freshening) and water column stratification. Consequently, surface salinity in estuarine and coastal areas experiences higher fluctuations than under normal climatic conditions. Such instability directly affects phytoplankton populations, which serve as crucial primary producers, the foundation of the marine food web, and key drivers of global nutrient cycles

Phytoplankton population and community structures including species composition, diversity, and dominant groups exhibit high sensitivity to changes in salinity. This sensitivity stems from variations in osmotic stress tolerance and the optimal salinity ranges specific to each taxon. Sudden or extreme fluctuations in salinity can lead to a decline in sensitive species. Conversely, highly tolerant species or those with the potential for phytoplankton blooms may rapidly increase in density, leading to monodominance. Such shifts can adversely impact water quality, aquatic organisms, and human activities.

Bang Saen Beach in Chonburi Province is an estuarine-influenced coastal ecosystem, characterized by the interplay between seawater and freshwater runoff from

upstream watersheds. Consequently, the area experiences high salinity fluctuations driven by seasonal cycles and extreme rainfall events linked to climate change. As a vital hub for small-scale fisheries, coastal aquaculture, and tourism, changes in seawater quality and phytoplankton community structures have direct and significant implications for the local economy and the well-being of coastal communities.

Therefore, investigating the effects of salinity on phytoplankton population structures at Bang Saen Beach is of both ecological and resource management significance. Data regarding shifts in community composition and dominant groups under varying salinity levels can serve as a bioindicator for assessing coastal water quality. Furthermore, it provides an early warning signal for potential phytoplankton blooms that could jeopardize fisheries, aquaculture, and tourism. This database also establishes essential baseline data for monitoring the long-term impacts of climate change on the Bang Saen coastal ecosystem, enabling local authorities, fishing communities, and stakeholders to develop adaptive strategies and coastal management plans supported by scientific evidence.

Objectives

To study the effects of salinity on phytoplankton population structures along the Bang Saen coastal area in Mueang District, Chonburi Province.

Hypothesis

1. Seawater salinity levels along the coastal area of Mueang District, Chonburi Province, are significantly correlated with phytoplankton population structures.
2. There is a significant difference in salinity levels between Wonnapha Beach and Ang Sila.

Study Variables

Water quality assessment from selected sampling sites in Chonburi Province.

- 1.Independent Variable: Salinity
- 2.Dependent Variable: Phytoplankton population structure
- 3.Controlled Variable: Study period (Time of collection)

Scope of the Study

The objectives of this study are to investigate salinity as a key factor influencing changes in phytoplankton community structure and to predict the trends of Harmful Algal Blooms (HABs). Furthermore, this research examines the population dynamics of phytoplankton along Bang Saen Beach, Mueang Chon Buri, Chon Buri, to monitor the proliferation of toxic or pollution-inducing species that may impact the local coastal environment

Study Site

Two sampling stations located along the coast of Bang Saen, Mueang Chon Buri, Chon Buri Province: Wonnapha Beach Station and Ang Sila Station

Study Period

August 2025 to December 2025

Expected Benefits

1. Identification of phytoplankton species along Bang Saen Beach to provide early warnings for local fishermen and tourists in the event of toxic species that may affect humans or aquatic life.
2. Prediction of algal bloom trends based on the analysis of current biodiversity and community dynamics.

Chapter 2

Literature Review

A Study on the Effects of Salinity on Phytoplankton Community Structure for Monitoring Algal Blooms in Coastal Areas of Mueang Chon Buri, Chon Buri, Thailand

2.1 Harmful Algal Blooms (HABs)

2.2 Mechanisms of Salinity Affecting HABs Occurrences

2.2.1 Monodominance and its role in HABs

2.2.2 Direct Mechanisms: Salinity Stress and Environmental Filtering

2.2.3 Indirect Mechanisms: Water Column Stability and Resource

Competition

2.3 Related Research

2.1 Harmful Algal Blooms (HABs)

HABs, or "algae overgrowth phenomena," are conditions where certain types of algae or phytoplankton rapidly multiply in seawater or freshwater bodies, disrupting the natural balance. Some of these algae can produce toxins that are harmful to aquatic animals and humans. When these toxins accumulate in large quantities, they can cause mass mortality in aquatic animals due to oxygen deprivation. They can also accumulate in seafood consumed by humans, such as shellfish, shrimp, crabs, and fish, leading to food poisoning or serious neurological disorders. Furthermore, HABs have several economic impacts, affecting fisheries, tourism, and leading to decreased water quality. One of the major factors contributing to HABs is eutrophication, a condition where water sources have excessive amounts of nitrogen and phosphorus. These nutrients often originate from human activities such as agricultural fertilizer use, wastewater discharge from factories and communities, or the leaching of nutrient-rich soil into rivers and seas. When

these nutrients accumulate in the water excessively, algae and phytoplankton grow rapidly, covering the water surface and reducing light penetration, preventing other aquatic plants from photosynthesizing normally. The consequence is that when these algae die and decompose, they consume a massive amount of oxygen in the water, leading to oxygen deprivation and mass death of aquatic animals. This creates a condition called a Dead Zone, an area where living organisms can barely survive. In addition, the accumulation of toxins from some types of algae directly impacts the food chain and human health.

Therefore, HABs and eutrophication are closely related phenomena. Eutrophication is a major cause that triggers HABs, and HABs themselves further degrade water quality. Solving the problem must focus on controlling the amount of nutrients entering water sources, such as reducing the use of chemical fertilizers, efficiently treating wastewater, and conserving wetlands that can absorb excess nutrients.

2.2 Mechanisms of Salinity Affecting HABs Occurrences

2.2.1 Monodominance and its role in HABs

Monodominance, where a single species (or group) of phytoplankton proliferates to the point of dominating the population in an ecosystem (e.g., more than 80-90% of the total density), is directly related to and is a significant risk factor for Harmful Algal Blooms (HABs), or dangerous discoloration of seawater, through the following mechanisms:

2.2.1.1 Reduced Biodiversity Under normal conditions with high phytoplankton diversity, competition between species helps control populations, preventing any single species from overpopulating. However, when monodominance occurs, the dominant species monopolizes resources (such as nutrients and light), causing other species to decline or disappear. This unbalanced environment makes the ecosystem fragile and more susceptible to population blooms if environmental conditions are suitable.

2.2.1.2 Amplification of Harmful Effects When there is monodominance of

a harmful species (HAB Species), the effects are more severe and pronounced than when it is present in a smaller proportion. Toxic Production: If the dominant species is a toxic species (e.g., some dinoflagellates), the amount of toxins in the water will be very high, reaching levels that are dangerous to aquatic animals and humans (e.g., PSP, ASP toxins). Even if the cell density is not very high, if it is monodominance, the risk is higher. Oxygen Consumption: If a non-toxic species dominates to a high biomass, the simultaneous death and decomposition of a massive population will rapidly deplete the oxygen in the water (Hypoxia/Anoxia), leading to fish mortality.

2.2.1.3 Altered Food Webs Monodominance often occurs in species that are unpopular or inedible to predators (zooplankton or fish) (e.g., too large, spiny, or poisonous). When these species dominate, predators face food shortages, leading to the failure of natural population control (top-down control). This further exacerbates and prolongs blooms.

2.2.2 Direct Mechanisms: Salinity Stress and Environmental Filtration

Changes in salinity (osmotic pressure fluctuations) cause stress in planktonic cells. At low salinity (hypoosmotic stress), increased water inflow into the cells causes swelling, reducing photosynthetic efficiency (PSII reduction of 20-40%) and growth rate, especially in species with low tolerance (e.g., high-salinity marine diatoms). Conversely, more tolerant species (e.g., dinoflagellates tolerating 5-35 ppt) have improved ion pumps (e.g., Na⁺/H⁺ antiporters). This results in a decrease in the number of species (<20 species) and reduced uniformity, leading to dominance among tolerant groups due to lower competition for resources (energy is used to maintain salinity balance instead of reproduction). Tolerance varies among species. High salinity (hyperosmotic) reduces intracellular pressure and silica uptake in diatoms (resulting in increased frustule formation), thus reducing their numbers. While dinoflagellates are highly tolerant of organic osmolytes (e.g., DMSPs), resulting in a dominant ratio that changes from 30% to 70% at extreme salinity, by filtering out susceptible species, leaving only 1-2 dominant groups that have acquired physiological advantages under stress conditions.

2.2.3 Indirect Mechanisms: Water Column Stability and Resource Competition

Low salinity from surface water creates a halocline, increasing stratification and decreasing turbulent mixing. This results in a euphotic zone with high light but limited nutrients, favoring mobile/mixotroph species (dinoflagellates that can swim upstream to access nutrients) over submerged diatoms. Stratification also reduces upwelling, leading to high variance abundance and a 25-40% increase in monodominance, limiting resource access for sluggish groups. Salinity also affects nutrient patterns and abundance. Low salinity favors ammonium (NH_4) over nitrate (NO_3) from organically rich freshwater, which favors mixotrophs. Nutrients are also absorbed by suspended particles (e.g., kaolinite in low salinity that causes silica precipitation), reducing silica use by diatoms. Moderate salinity skews competition toward tolerant species, leading to monodominance during nutrient pulses from floodwaters. Moderate salinity facilitates water mixing and nutrient distribution, reducing the risk of dominant species.

2.3 Related Research

2.3.1. Yang, R., et al. (2021). "Salinity as a key driver of phytoplankton community structure in estuarine ecosystems."

This research, conducted in estuary ecosystems, indicates that salinity is a major factor determining the structure of phytoplankton communities, particularly during the rainy season when large amounts of freshwater flow in. Lower salinity causes a dominant group shift from diatoms to other, more salinity-tolerant groups, supporting the theory that salinity acts as the most important environmental filter in this type of ecosystem.

2.3.2. Li, X., et al. (2019). "Physiological adaptation of *Dunaliella salina* to hypersalinity in artificial and natural environments."

This study focuses on the physiological adaptation of the green algae *Dunaliella salina* under extremely high salinity (hypersaline) conditions. It found that this algae produces glycerol within its cells to balance osmotic pressure, allowing it to grow and dominate in

highly saline environments where other organisms cannot survive. This is a good example of monodominance in extreme conditions.

2.3.3. Yamada, S., et al. (2020). "Mechanisms of bloom formation and growth limitations of harmful dinoflagellates in estuarine environments."

This research studied the factors that promote the bloom of harmful dinoflagellates (HABs) in river mouths. It found that stratification, caused by freshwater inflow over saltwater (halocline), is a key mechanism that allows mobile dinoflagellates to accumulate and access nutrients more effectively than submerged diatoms. This provides evidence for an indirect mechanism of salinity in the formation of HABs.

2.3.4. Kumar, S., et al. (2022). "Effects of freshwater influx on phytoplankton community structure in the Bay of Bengal."

Studies on the effects of freshwater influx in the Bay of Bengal have shown that the mass of freshwater flowing into the sea creates a freshwater plume, which prevents nutrients from the deeper water from mixing. This condition allows picoplankton and some dinoflagellates to dominate, replacing the normally diverse planktonic communities, and increases the risk of oxygen minimum zones.

Chapter 3

Methodology

3.1 Materials and equipment

1. HANNA portable water quality testing instrument, model HI98194
2. Water transparency measuring device (Secchi disk)
3. Plankton filter bag, 20 micron mesh size
4. 10-liter water bucket with handle
5. 2-meter nylon rope
6. 250 ml plankton sample bottle
7. DO testing kit
8. pH testing kit
9. Phytoplankton counting slide (Sedgewick-Rafter Counting Chamber)
10. Light microscope (Compound Microscope)

3.2 Research Methods

3.2.1 Study Area

This research studied the effect of salinity on the population structure of fish in the Bang Saen beach area, Mueang District, Chonburi Province, at two locations: Station 1, Ang Sila Fishing Pier, Ang Sila Subdistrict, Mueang Chonburi District, which is closer to the Bang Pakong River than Station 2, Wonnapha Fishing Pier, Saen Suk Subdistrict, Mueang Chonburi District.

These two areas were chosen for this study because they are at different distances from the Bang Pakong River, which is freshwater, resulting in different salinity values.

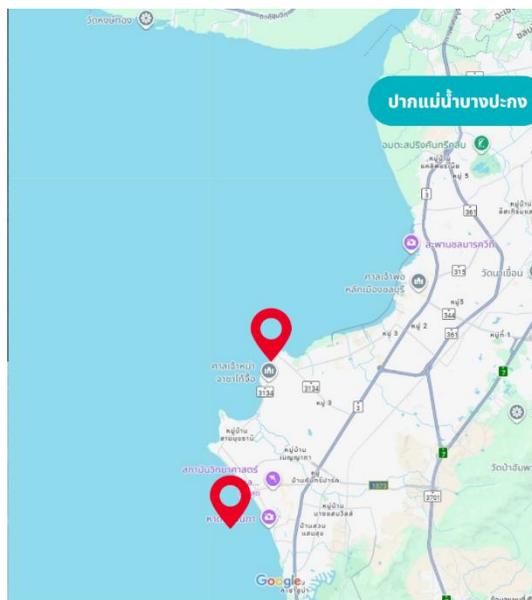


Figure 1 shows the water sampling point at Bang Saen Beach

3.2.2 Sampling timing

Data was collected a total of 8 times.

Month	Station	Temp.	pH	DO mg/L	TDS /ss	Density of Plankton	Salinity	transparent
August	Ang Sila							
	Wonnapha							
August	Ang Sila							
	Wonnapha							
September	Ang Sila							
	Wonnapha							
September	Ang Sila							
	Wonnapha							
October	Ang Sila							
	Wonnapha							
October	Ang Sila							
	Wonnapha							
November	Ang Sila							
	Wonnapha							
November	Ang Sila							
	Wonnapha							

3.3 Procedures

3.3.1 Collect a water sample using a 10-liter container.



Figure 2 Image of water sample collection.

3.3.2 Measure the DO and pH of the water collected in step 3.3.1 using a test kit.

3.3.3 Measure the various parameters of the water collected in step 3.3.1 using the HANNA HI98194 portable water quality testing instrument.

3.3.4 Pour the water collected in step 3.3.1 through a plankton filter bag with a 20-micron mesh size and collect 250 milliliters of the water in a sample bottle

3.3.5 Lower the water transparency measuring device (Secchi disk) into the water and read the value.

3.3.6 Repeat this process 3 times for both stations.

3.3.7 Submit data to GLOBE Data entry.

3.3.8 Study the type and quantity of phytoplankton in the water samples collected in step 3.3.4 in the laboratory under a microscope using a 1 ml Sedgewick-Rafter Counting Chamber. The phytoplankton quantity will be calculated using Ladda's method.

$$C = \frac{NV_2}{V_1}$$

when

C = Density of phytoplankton (cells or colonies)

N = Average number of phytoplankton counted in 1 milliliter (ml) of water
(cells/ml or colonies/ml)

V₁ = Volume of water filtered through the plankton net (Liters)

V₂ = Volume of the concentrated plankton sample in the collection bottle (Milliliters)

Chapter 4

Results

Recording of operational results

Collecting data on water quality and types of phytoplankton.

Date	Station	Temp	pH	DO mg/L	TDS /ss	Density of Plankton	Salinity	Translucent
7 Aug.	Ang Sila	32.8	8.13	6.75	11.91	19,540.00	14.26	1.00
7 Aug.	Wonnapha	31.8	8.60	9.00	15.09	14,140.00	18.53	1.30
2 Sept.	Ang Sila	31.53	9.00	12.75	96.58	338,025.00	11.55	1.20
2 Sept.	Wonnapha	31.09	8.50	8.50	14.46	941,750.00	17.72	1.40
9 Sept.	Ang Sila	32.09	8.55	6.70	18.32	3,750.00	22.93	1.00
9 Sept.	Wonnapha	32.00	8.50	7.00	17.60	3,520.00	21.97	1.80
28 Oct.	Ang Sila	29.20	8.00	7.50	21.50	27,083.00	29.00	0.90
28 Oct.	Wonnapha	29.70	8.40	5.00	24.27	14,375.00	31.00	1.70
5 Nov.	Ang Sila	30.83	8.00	8.37	23.21	19,333.00	29.95	1.10
5 Nov.	Wonnapha	30.42	8.50	8.50	24.55	6,375.00	31.91	1.50
12 Nov.	Ang Sila	32.65	9.00	12.50	18.99	52,125.00	23.88	1.00
12 Nov.	Wonnapha	32.12	8.81	10.00	20.51	48,125.00	26.05	1.30

The table shows water quality and types of phytoplankton.

Date	Genus	Species	Density (Cel/L)	Date	Genus	Species	Density (Cel/L)
7 Aug.	Dinoflagellates	Chaetoceros spp.	12,250	7 Aug.	Dinoflagellates	Ceratium furca	5,250
7 Aug.	Diatom	Rhizosolenia spp.	5,000	7 Aug.	Diatom	Coscinodiscus spp.	3,250
7 Aug.	Diatom	Coscinodiscus spp.	1,750	7 Aug.	Diatom	Rhizosolenia spp.	1,750
2 Sept.	Dinoflagellates	Ceratium furca	31,000	2 Sept.	Dinoflagellates	Ceratium furca	94,750
2 Sept.	Diatom	Coscinodiscus spp.	4,750	2 Sept.	Diatom	Coscinodiscus spp.	1,250
9 Sept.	Diatom	Rhizosolenia spp.	1,750	9 Sept.	Diatom	Coscinodiscus spp.	1,300
9 Sept.	Diatom	Thalassiosira spp.	1,750	9 Sept.	Dinoflagellates	Ceratium furca	500
9 Sept.	Diatom	Coscinodiscus spp.	1,000	9 Sept.	Diatom	Thalassiosira spp.	250
28 Oct.	Diatom	Navicula spp.	10,000	28 Oct.	Diatom	Navicula spp.	3,450
28 Oct.	Diatom	Surirella spp.	750	28 Oct.	Diatom	Surirella spp.	750
28 Oct.	Dinoflagellates	Chaetoceros spp.	750	28 Oct.	Diatom	Thalassiosira spp.	250
5 Nov.	Diatom	Rhizosolenia spp.	27,750	5 Nov.	Diatom	Rhizosolenia spp.	5,250
5 Nov.	Diatom	Thalassiosira spp.	875	5 Nov.	Diatom	Pleurosigma spp.	1,250
5 Nov.	Dinoflagellates	Ceratium furca	750	5 Nov.	Diatom	Thalassiosira spp.	500
12 Nov.	Diatom	Rhizosolenia spp.	26,875	12 Nov.	Diatom	Rhizosolenia spp.	29,375
12 Nov.	Dinoflagellates	Chaetoceros spp.	21,375	12 Nov.	Dinoflagellates	Chaetoceros spp.	17,250
12 Nov.	Dinoflagellates	Ceratium furca	3,875	12 Nov.	Dinoflagellates	Ceratium furca	1,500

The table shows the density of each type of phytoplankton.

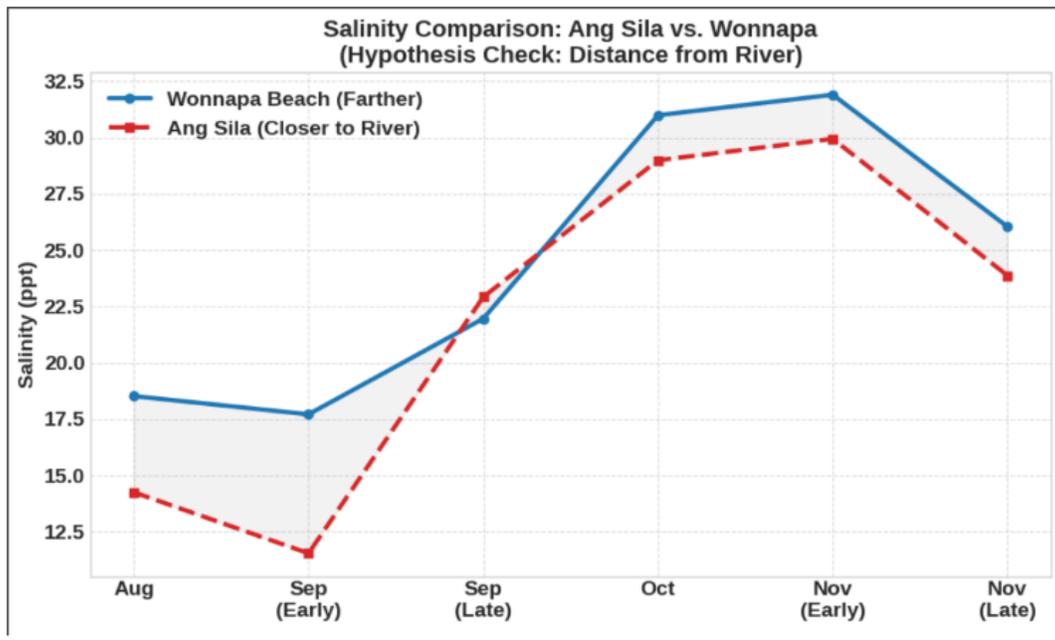
August	2 September	9 September	28 October	5 November	12 November
Ceratium furca Coccinodiscus spp. Rhizosolenia spp.	Ceratium furca Coccinodiscus spp.	Ceratium furca Coccinodiscus spp. Thalassiosira spp.	Chaetoceros spp. Ditylum spp. Navicula spp. Surirella spp. Thalassiothrix spp.	Ceratium furca Chaetoceros spp. Coccinodiscus spp. Navicula spp. Pleurosigma spp. Rhizosolenia spp. Thalassiosira spp.	Ceratium furca Chaetoceros spp. Rhizosolenia spp.

The table shows the genera of phytoplankton found at Wonnapha Beach from August to November 2025.

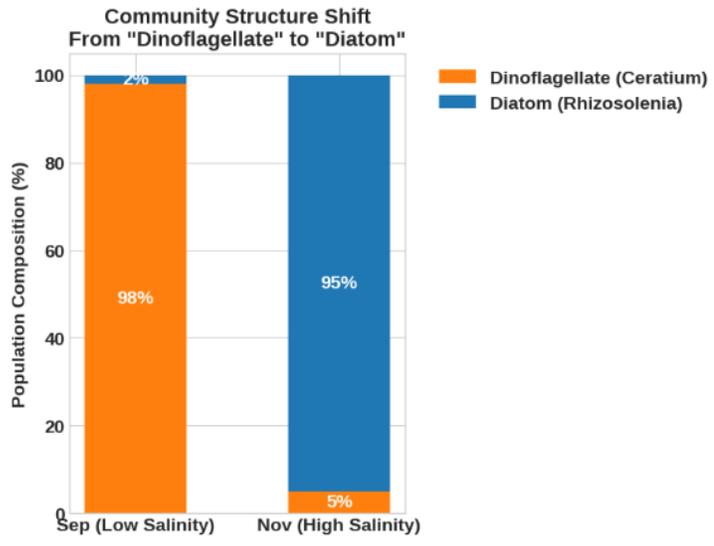
August	2 September	9 September	28 October	5 November	12 November
Chaetoceros spp. Coccinodiscus spp. Pleurosigma spp. Rhizosolenia spp.	Ceratium furca Coccinodiscus spp.	Chaetoceros spp. Coccinodiscus spp. Rhizosolenia spp. Surirella spp.	Chaetoceros spp. Navicula spp. Surirella spp.	Ceratium furca Chaetoceros spp. Thalassiosira spp. Rhizosolenia spp.	Ceratium furca Chaetoceros spp. Rhizosolenia spp.

The table shows the genera of phytoplankton found at Ang Sila from August to November 2025.

The chart shows the difference in salinity between Ang Sila Pier and Won Napha Beach Pier.



The chart shows the differences in population structure during periods of highest and lowest salinity.



Chapter 5

Conclusion and Discussion

Monitoring of water quality and phytoplankton population structure from August to December 2025 revealed that physical and chemical factors of the water, especially "salinity," play a role in determining the characteristics of the aquatic community in the study area. Water quality and seasonal changes during this period showed that the aquatic environment was suitable for marine life. Water temperature ranged from 29.2–32.8°C, which is conducive to phytoplankton metabolism, while pH was slightly alkaline (8.13–9.0). pH values exceeding 8.5 in some periods, such as September, were associated with increased photosynthesis rates, which correlated with the highest dissolved oxygen (DO) levels found during the same period at Ang Sila Station. However, the fluctuating factor with significant impact was "salinity" (11.55–31.91 PSU), which varies with rainfall and runoff, especially in September when salinity decreased significantly due to freshwater inflow into the water source. Phytoplankton's response to salinity fluctuations was also observed.

Ang Sila Station (Low Salinity/High Volatility Area): An environment experiencing stress from salinity changes and freshwater influences results in low species diversity and dominance among a few tolerant species, such as *Chaetoceros* spp., *Ceratium furca*, and *Rhizosolenia* spp. This aligns with the "monodominance" theory, which states that under stressful environmental conditions, only the strongest tolerant species will dominate the Won Napha Beach station area.

(High Salinity/More Stable Area): Higher plankton diversity was observed, with a succession of dominant species over time, ranging from *Ceratium furca* to *Coscinodiscus* and *Navicula*, reflecting a more resilient ecosystem.

I would like to claim IVSS badges

1. Data Scientist Badge

Our project adopts an Earth System Science approach by investigating the complex interactions between the Hydrosphere (salinity and water chemistry) and the Biosphere (phytoplankton community structure). By analyzing how freshwater runoff from the geosphere influences marine salinity, we documented the biological response of primary producers. This study illustrates the interconnectedness of Earth's systems, specifically how physical changes in water properties dictate the health and diversity of coastal life.

2. I Make an Impact

This research provides a direct benefit to the Chon Buri coastal community, where Algal Blooms frequently disrupt local fisheries and tourism. By identifying salinity thresholds and indicator species like *Ceratium furca*, our project acts as an early-warning framework. Our findings empower local stakeholders with the knowledge to predict and mitigate the impacts of 'red tides,' ultimately contributing to the sustainable management of our local marine resources and the protection of the coastal economy.

3. I Work with a STEM Professional

Throughout this study, we collaborated closely with STEM professionals and mentors who provided expertise in marine biology and environmental analysis. Under their guidance, we refined our taxonomic identification skills and learned to apply ecological theories, such as the 'monodominance' concept, to our field data. This mentorship ensured that our methodology met rigorous scientific standards and helped us bridge the gap between classroom theory and professional environmental research.