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Inventory and Stock Assessment of *Sargassum* Spp. in Ilocos Sur

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ABSTRACT

Sargassum, one of the country's seaweed exports, abounds in the coastal barangays of Ilocos Sur. Although dominant in most months of the year, no published report has been made in the area prior to this study.

Taxonomic and standing crop studies were performed for a period of two years. Environmental parameters like temperature, salinity, and water movement were also monitored as they affect Sargassum biomass production.

Four species were observed in the area: Sargassum crassifolium, S. cristaefolium, S. polycystum, and S. siliquosum. All four species showed different growth patterns and seasonal dominance. Data on biomass production show that Sargassum is abundant in the coastal towns of Ilocos Sur. The reefs which extend several meters seaward in most coastal municipalities support algal blooms anytime of the year.

Temperature and water movement affect Sargassum biomass production. Greater production occurs during colder months and in areas with moderate water movement. Consideration of these two ecological factors are important for proper management of the resource.

Introduction

The shallow coastal areas of the province of Uocos Sur support well-developed seaweed communities. Most of the coastal towns and barangays have reefs which extend up to several hundred meters seaward where seaweeds abound. Only a few have sandy beaches not suited for benthic algae. In a previous study conducted, Corrales-Domingo (1988) reports that a total of 103 species of algae belonging to 58 genera, 28 families, and 16 order are found in the area. Of this number, one species belongs to Cyanophyta, 43 to Chlorophyta, 17 to Phaeophyta, and 42 to Rhodophyta.

Sargassum (aragan, Ilk.) is one of the seaweeds that abound in the coastal barangays of the province. This brown alga is dominant in most months of the year, an indication of its abundance in the area. No report, however, has been made on the assessment of the resource.

Considering the fact that *Sargassum* is one of our country's seaweed exports and that no adequate information on the resource is available, the researchers deemed this study necessary. The information and data from this study are necessary for the proper development and management of the resource. It provides baseline information necessary for *Sargassum* production through gathering of natural stocks and *Sargassum* product formulation as alternate source of livelihood of the people. Moreover, it will add to the existing knowledge of the algal flora of the province.

Objectives

The purpose of this research work was to inventory and assess the *Sargassum* spp. in llocos Sur. In particular, it aimed to:

1. Undertake taxonomic studies of the *Sargassum* spp. in Ilocos Sur.
2. Study the structure of *Sargassum* spp. communities in the areas in terms of biomass and spatial distribution.
3. Observe the effects of different ecological factors like temperature, salinity, and water movement on the growth of *Sargassum*.
4. Identify areas where *Sargassum* spp. may be further developed.
5. Determine the relationship between *Sargassum* biomass production and each of the following environmental parameters: temperature, salinity, and water movement.

Review of Related Literature

The first reports citing seaweeds found in the province of Ilocos Sur and the neighboring provinces of Ilocos Norte and La Union were made by foreign authors (Corrales-Domingo, 1988). The earliest Filipinos to do taxonomic and ecological investigations on the seaweeds of Northwestern Luzon were Domantay (1961), Menez (1961), and Galutaria and Velasquez (1963). Domantay (1961) reports different types of algal vegetation in different types of habitats in Hundred Islands, Pangasinan. In the same year, Menez made a study on some ecological factors affecting their occurrence. Galutaria and Velasquez (1963) identified 19 species of edible seaweeds in Ilocos Norte and added data on their preparation, distribution, and seasonal occurrence.

In Ilocos Sur, *Sargassum* is one of the country's seaweed species which abound along its coasts (Corrales-Domingo, 1988). A brown alga (Phaeophyta) belonging to order Fucales, *Sargassum* is one of the country's seaweed exports. It is a raw material in the mufacture of seaweed meal. It is abudant along Northwestern and Northern Luzon where these form contiguous beds (Trono, 1986). No data, however, has been reported on *Sargassum* biomass in the area. Harvesting of natural stocks for commercial used in feed manufacture or for export has not been done in the area. The gathering of this seaweed is presently limited to Central Visayas and the northern coast of Mindanao.

There are at present no policy guidelines to develop the seaweed industry. It is important that reforms be initiated to push vigorously the development of the seaweed resource. One major concern is the diversification of the industry through the development of the resource bases, products, and the markets (Trono et. al., 1988).

Hypothesis

Sargassum biomass production is significantly related to each of the following environmental paramaters: temperature, salinity, and water movement,

Methodology

Establishment of sampling stations. Three sampling stations were determined based on the results of a study on species dominance conducted by Corrales-Domingo (1988). The areas selected were: Salomague, Cabugao; Nalvo, Santa Maria; and Gabao, Santiago.

Taxonomic studies. Collection of *Sargassum* for taxonomic studies was done bi-monthly. In each collection period, four samples for each species were taken. These were brought to the laboratory of the University of Northern Philippines (UNP) College of Arts and Sciences for identification. Identification was done up to the species level using available algal literature.

Standing crop studies. Standing crop studies were done monthly for a period of two years in *Sargassum* beds through random quadrat sampling. A 1 x 1 m iron quadrat was used in the sampling. The *Sargassum* spp. present in each quadrat were collected and the wet-weight recorded. Twenty quadrats in each station were recorded every sampling period. The data taken in each of the quadrats were expressed in grams/sq meter (g/sq m) to represent the biomass.

Environmental factors. Data on environmental parameters like temperature, salinity, and water movement were recorded every sampling period.

a. Water temperature. Surface water temperature was measured using an ordinary laboratory thermometer at nine o'clock A.M. A series of five readings was made in each station and the average temperature was computed and recorded.

b. Salinity. Salinity in parts per thousand (ppt) was determined using a salinometer. A series of five readings was made in each station and the average salinity was computed and recorded.

c. Water movement. The relative amount of water movement was measured using clodcards (Doty, 1971) arranged in pairs and placed at 10-meter interval along the Sargassum beds and submerged for 24 hours. The diffusion index factor (DIF) was calculated using the formula:

$$DIF = \frac{\text{Weight loss of clodcard in field}}{\text{Calibrated value in the laboratory}}$$

where the weight loss in the field was the difference between the initial and the final weights of the clodcards after exposure in water for 24 hours

Statistical treatment of data. Means were used in the presentation of data. To determine the correlation of variables, the Pearson product-moment coefficient of correlation and I-tests were used at .05 level of significance.

Results and Discussions

Taxonomic Studies

Based on external features, four species of *Sargassum* were observed:

Key to four species:

1. Branches muricate with protuberances –2
1. Branches smooth without protuberances– **3**
    2. Holdfast small and disk-shaped – ***S.*** *polycystum*
    2. Holdfast shield-shaped to massive – *S. siliquosnm*
3. Blades with duplicated margins, horizontally attached - S. *cristaefolium*
3. Blades with duplicated margins, vertically attached – *S. crassifolium*

All the four species occurred in the collecting stations at different months of the year which shows that they have different growth patterns. They also differ in seasonal dominance, the difference of which was beyond the scope of this research.

Standing Crop/Biomass Studies

The biomass of the *Sargassum* spp. in the three stations for a two-year period, from July 1996 to June 1997 and July 1997-June 1998 is shown in Tables 1 and 2.

Table 1. Mean monthly biomass of *Sargassum* spp. expressed in g/m? from **July 1996 to June 1997.**

YEAR	MONTHS	STATION I	STATION II	STATION III	MEAN
1996	July	700.3	637.8	478.2	605.4
	August	1552.6	860.0	1125.9	1179.4
	September	1466.6	1617.5	1280.1	1454.7
	October	1203.6	1441.2	720.5	1121.8
	November	1357.1	1338.3	1117.3	1270.9
	December	1960.4	986.1	1196.6	1381.0
1997	Januarv	2046.6	1184.6	1128.4	1453.2
	Februarv	1893.3	1137.8	1072.2	1367.8
	March	1860.1	1348.8	972.1	1396.6
	April	1548.3	984.1	696.0	1076.1
	Mav	1060.7	868.2	576.2	835.0
	June	819.1	788.6	472.1	693.3
	Mean	1339.1	1099.4	903.0	1152.9

Table 2. Mean monthly biomass of *Sargassum* spp. expressed in g/m? **from July 1997 to June 1998.**

YEAR	MONTHS	STATION I	STATION II	STATION III	MEAN
1997	July	862.2	722.4	412.3	665.6
	August	1392.5	894.6	698.2	995.1
	September	1322.6	1238.6	824.6	1128.6
	October	1238.6	1184.2	672.8	1031.9
	November	1312.5	1172.6	786.6	1090.6
	December	1216.3	1210.3	986.3	1137.6
1998	Januarv	1376.4	1284.2	1152.4	1271.0
	February	973.8	1421.0	1087.2	1160.6
	March	1174.0	1239.4	1497.5	1303.6
	Aoril	891.2	943.2	1073.1	969.2
	Mav	764.3	804.1	965.3	844.6
	June	783.6	605.8	839.8	743.0
	Mean	1109.0	1060.0	916.3	1028.4

Based on spatial biomass, the data show that the alga is most abundant in Station I (Salomague, Cabugao) with a mean biomass of 1339.1 g/sq m during the first year and 1109 g/sq m for the second year of the study. This is followed by Station II (Nalvo, Santa Maria) with a mean biomass of 1099.4 g/sq m during the first year of the study and 1060 g/sq m during the second year. It is least abundant in Station III (Gabao, Santiago) with a mean biomass of 903.0 g/sq m during the first year of the study and 916.3 sq m during the second year. Within the two-year period of the study, *Sargassum* biomass was higher during the first year (1152.9 g/sq m) than during the second year (1028.4 g/sq m).

Figures 1 and 2 show the graphical presentation of Sargassum biomass in the three stations. The abundance of *Sargassum* spp. in Station I is clearly evident, followed by Station II, and Station ill is shown to have the least biomass.

The preceding data on biomass show that *Sargassum* spp. is abundant in the coastal towns of Ilocos Sur. From the three collecting stations, an average of 1152.9 g/sq m was collected during the first year of the study and 1028.4 g/sq m was collected during the second year . For the two years of study an average of 1090.6 g/sq m of *Sargassum* was collected.

Considering that most of the coastal towns have wide reef areas where *Sargassum* spp. abound, this algal species can be considered as a potential resource of the province.

Environmental Parameters

Water temperature. The monthly variation in water temperature in the three study areas is presented in Tables 3 and 4 and Figures 3 and **4.** Generally, the colder months in the three stations were from December to April (mean temperature of 28.2%C-31.2%C) during the first year of the study and from December to May (mean temperature of 28.3%C-31.2°C) during the second year. The wanner months were from May to November (mean temperature of 31.7%C-35C) during the first year of the study and from June to November (mean temperature of 32.2C-34.5C) during the second year. In Station I, temperature ranged from 28%C-36C; in Station II, from 28%C-33.5C; and in Station III, from 28%C-35.5O.

Salinity. Salinity readings in the three study areas were not uniform. Fluctuations in salinity values ranged from 27.5-36 ppt (Tables 3 and 4, Figures 5 and 6). In Station I, salinity ranged from 27.5 - 35 ppt. In Station II, salinity ranged from 30-36 ppt and in Station III, from 29-35.5 ppt. Salinity values were lower from July to November and higher from February to May.

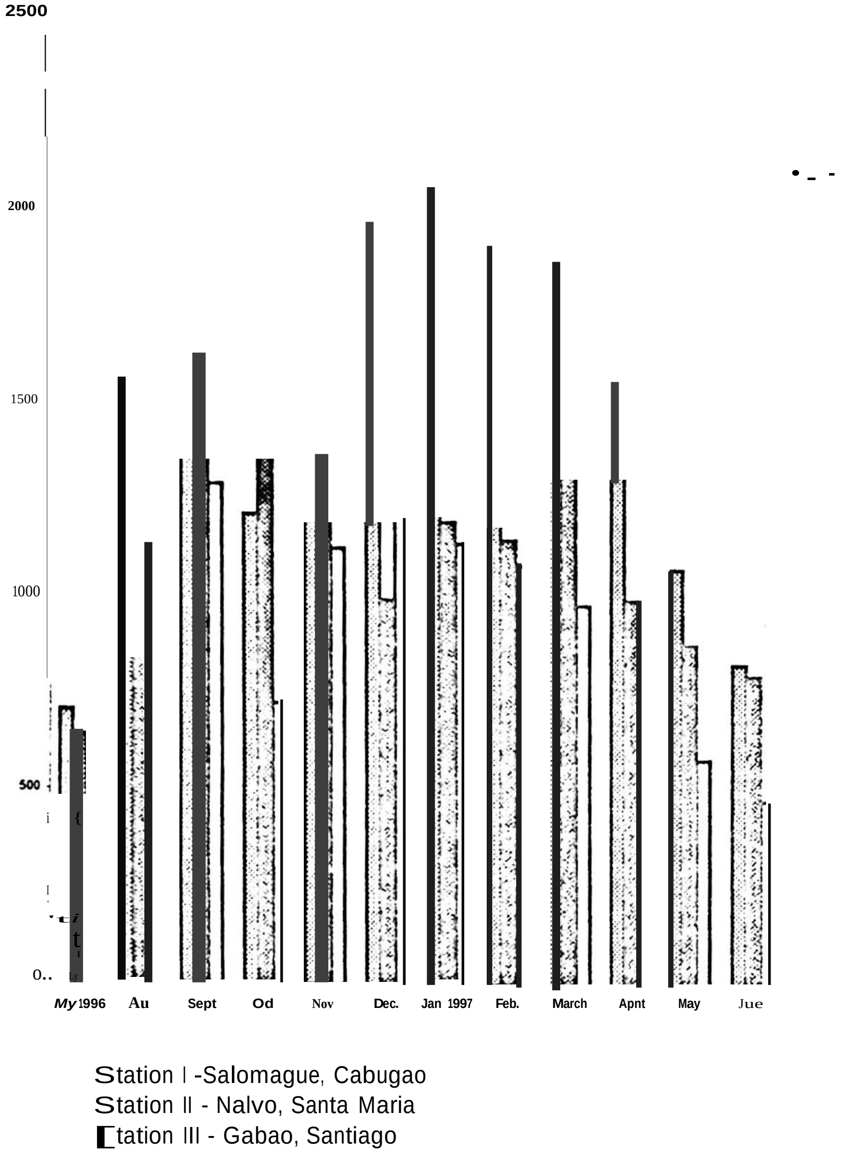


Figure 1. Mean monthly biomass of *Sargassum* spp. expressed in g/sq m from July 1996 to June 1997,

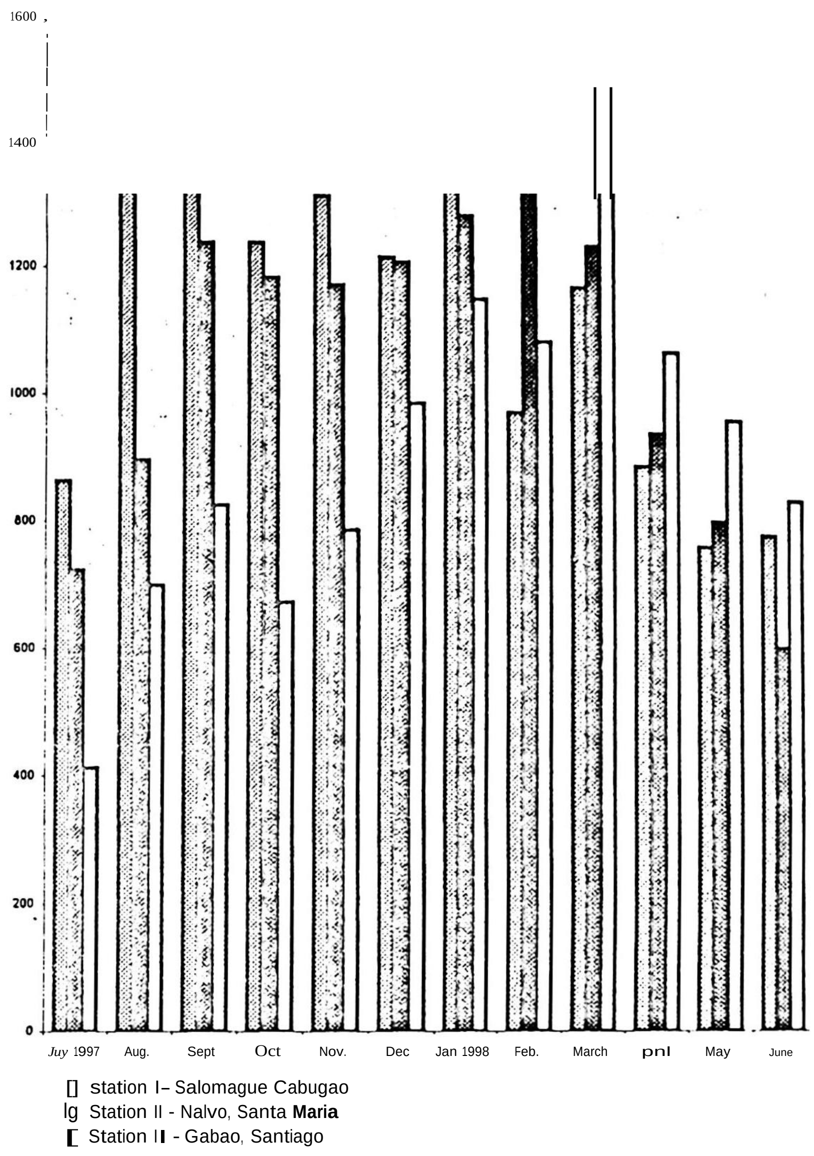


Figure 2. Mean monthly biomass of *Sargassum* spp. in g/m' from July 1997 to June 1998.

Table 3. Monthly variation in water temperature, salinity and water movement from July 1996 to June 1997.

	TEMPERATURE				SALINITY				WATER MOVEMENT			
Month/Year	I	I	III	M	I	II	DI	M	I	II	III	M
July 1996	34.0	33.0	33.5	33.5	28.0	31.0	30.0	29.7	3.2	10.2	6.2	6.53
Aug.	35.5	33.5	35.0	34.7	28.0	31.0	30.0	29.7	5.4	14.6	5.6	8.53
Sept.	36.0	33.5	35.5	35.0	27.5	31.5	31.0	30.0	5.6	16.2	6.4	9.40
Oct.	32.0	32.0	33.0	32.3	27.5	32.0	31.0	30.2	5.8	14.2	8.4	9.47
Nov.	31.5	31.5	32.0	31.7	28.0	32.5	32.0	30.8	S.6	8.2	10.1	7.97
Dec.	31.5	30.0	31.5	31.0	30.0	33.S	33.0	32.2	S.1	10.4	S.8	7.10
Jan. 1997	28.0	29.0	29.0	28.7	33.0	34.S	3S.0	34.2	4.6	10.2	S.2	6.67
Feb.	28.S	28.0	28.0	28.2	34.0	3S.O	3S.0	34.7	4.4	7.4	S.0	5.60
March	30.0	29.0	29.0	29.3	34.0	35.0	35.0	34.7	4.2	2.6	4.8	3.87
April	31.S	31.0	31.0	31.2	35.0	36.0	35.0	35.3	4.8	8.1	5.6	6.17
May	32.0	31.5	31.5	31.7	·34.0	35.0	34.0	34.3	6.6	10.S	7.2	8.10
June	33.0	32.0	32.0	32.3	33.0	34.0	34.0	33.7	10.2	14.0	11.2	11.80

Table 4. Monthly variation in water temperature, salinity and water movement from July 1997 to June 1998.

	TEMPERATURE				SALINITY				WATER MOVEMENT			
Month/Year	I	II	m	M	I	II	m	M	I	II	III	M
July 1997	34.0	32.5	33.0	33.2	31.0	32.0	33.0	32.0	12.1	22.1	14.2	16.10
Aug.	34.S	33.0	34.0	33.8	30.0	31.0	31.0	30.7	10.1	18.0	12.2	13.40
Sept.	35.0	33.S	35.0	34.5	29.0	30.0	29.0	29.3	6.2	16.2	8.1	10.20
Oct.	33.0	33.0	34.0	33.3	28.0	31.0	30.0	29.7	6.4	16.0	7.8	9.73
Nov.	32.0	31.5	33.0	32.2	28.0	32.5	32.0	30.8	7.2	12.2	7.6	9.00
Dec.	31.5	31.0	31.0	31.2	30.0	33.0	32.5	31.8	7.4	10.1	8.0	8.50
Jan. 1998	28.5	29.0	28.0	28.5	32.0	34.0	33.0	33.0	7.1	10.2	8.2	8.50
Feb.	29.0	28.0	28.0	28.3	34.0	35.5	35.5	3S.0	6.6	8.2	8.1	5.70
March	29.5	28.5	28.5	28.8	34.0	35.0	35.0	34.7	6.4	7.8	7.1	7.10
April	29.5	29.0	29.0	29.2	35.0	36.0	35.0	35.3	6.2	8.2	6.6	7.00
May	32.0	30.0	31.0	31.0	33.0	34.0	33.0	33.3	6.4	9.2	6.6	7.40
June	34.0	31.5	32.0	32.5	31.0	32.0	32.0	31.7	6.6	12.0	7.2	8.60
Mean	31.9	31.0	31.6	31.5	31.1	33.2	32.8	32.4	6.2	11.S	7.6	8.44

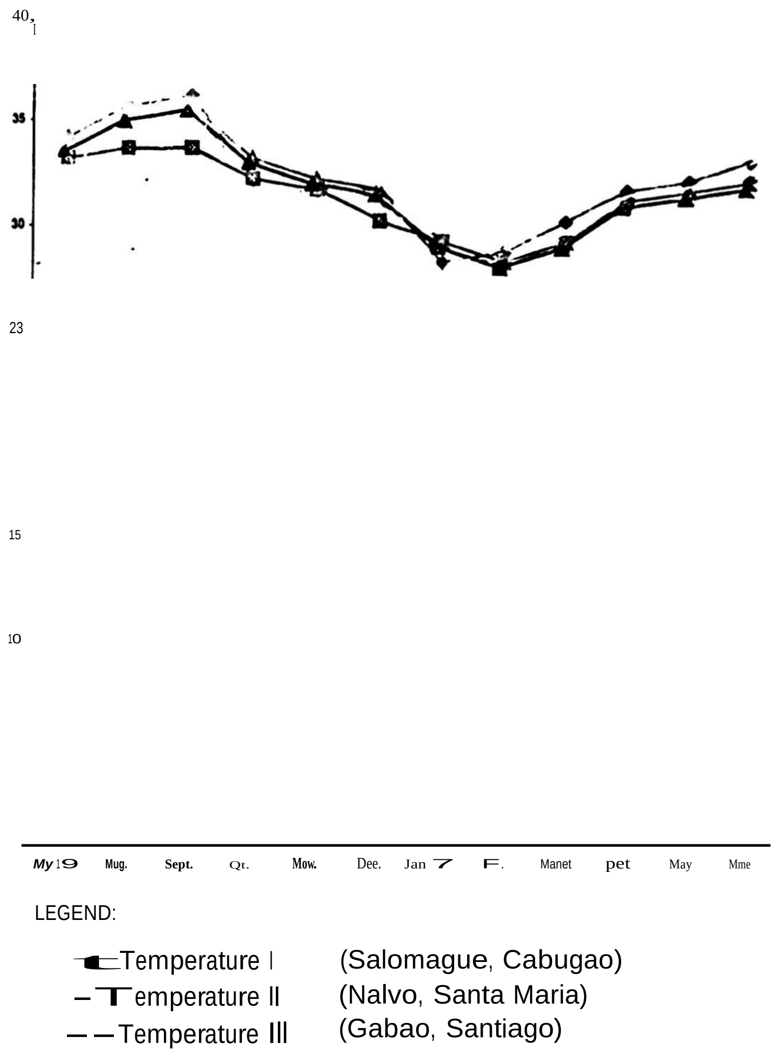
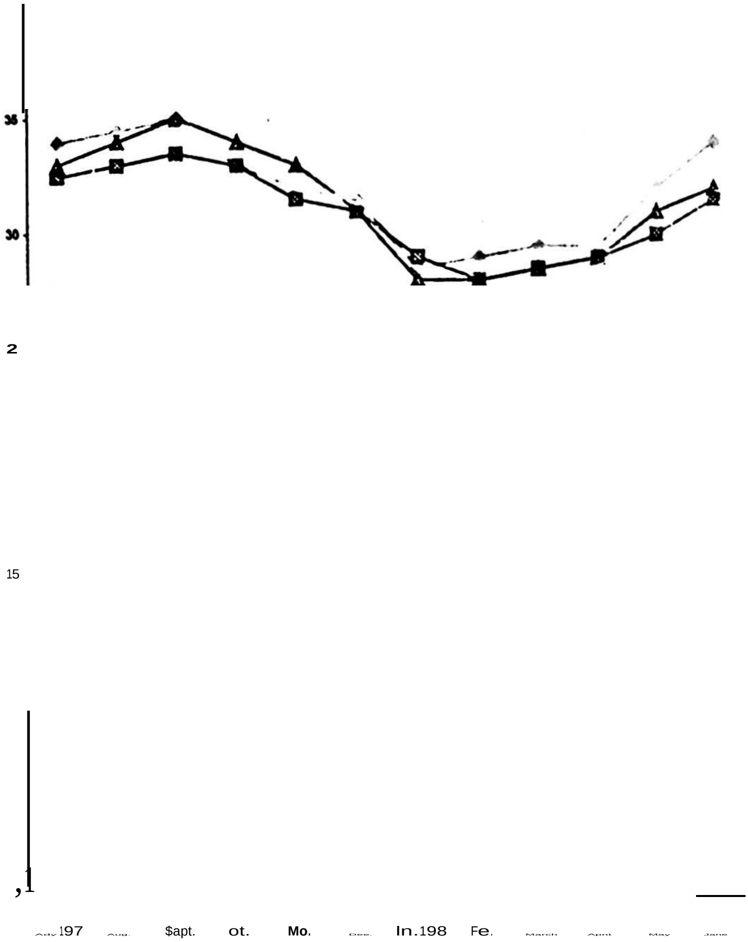


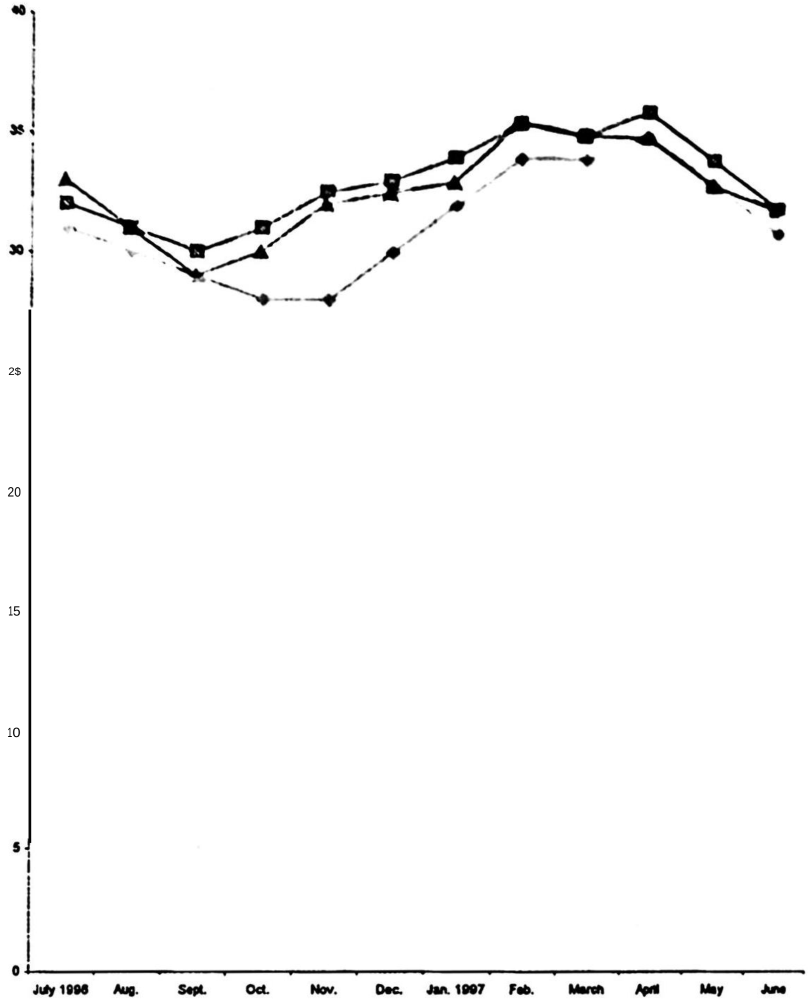
Figure 3. Monthly variation in water temperature from July 1996 to June 1997.



LEGEND:

— Temperature I (Salomague, Cabugao)
– – Temperature II (Nalvo, Santa Maria)
▪ — Temperature III (Gabao, Santiago)

Figure 4. Monthly variation in water temperature from July 1997 to June 1998.



LEGEND:

- - Salinity I Salomague, Cabugao
— — Salinity II Nalvo, Santa **Maria**
Salinity III Gabao, Santiago

Figure 5. Monthly variation in salinity from July 1997 to June 1998.

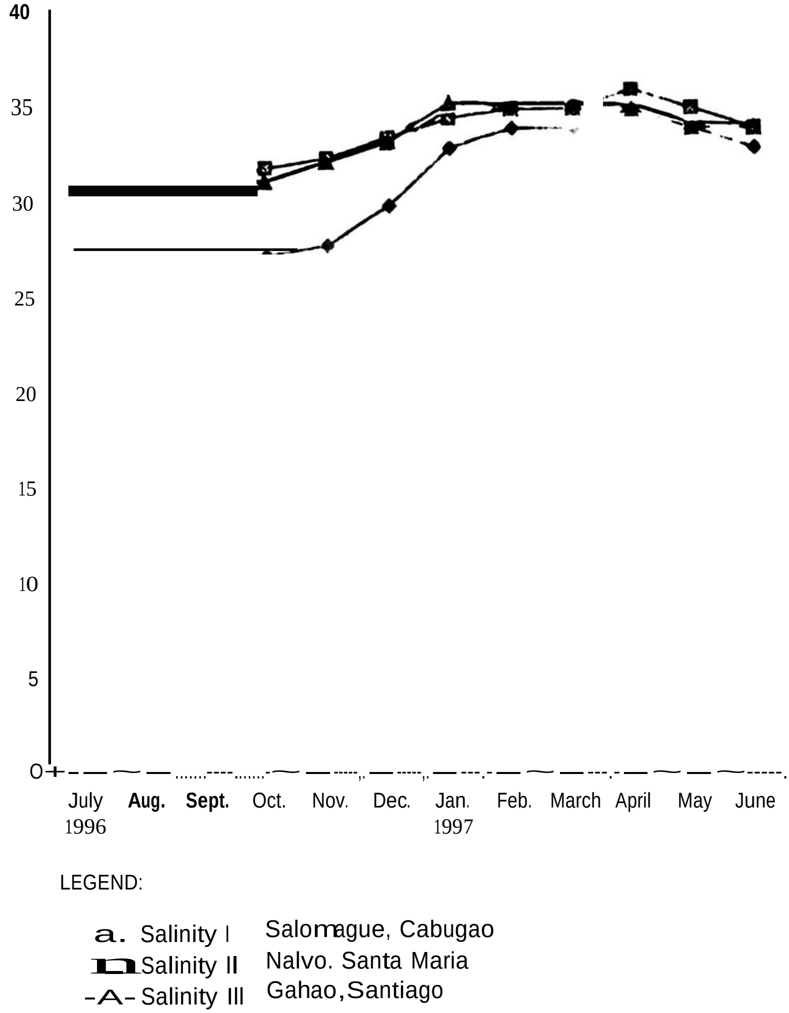


Figure 6. Monthly variation in salinity from July 1996 to June 1997

Water movement. Tables 3 and 4 and Figures 7 and 8 show the trend in water movement. In the three stations, the mean water movement was lowest in March (3.87) during the first year and in February (5.7) during the second year. It was highest in June (11.8) during the first year and July (16.1) during the second year of the study.

Correlation of Variables

To determine whether or not relationships exist between biomass production and each of the three environmental parameters monitored, Pearson r, and t-tests were used. Results are presented in Table 5.

Table 5. Relationship between *Sargassum* biomass and changes in environmental parameters as determined by t-tests.

PARAMETER	t-COMPUTED	t-TABULAR	RELATIONSHIP
Temperature	1.8874 (r=-0.3733)	1.717	Significant
Salinity	0.5799 (r = 0.1227)	1.717	Not Significant
Water Movement	2.4169 (r– 0.458)	1.717	Significant

Significant at .05 level

The data show that significant relationship exists between biomass production and temperature. This is shown by the computed t-value of 1.8874 which was higher than the tabular t-value of 1.717 at .05 level of significance. Since r= -0.3733, this implies that negative relationship exists. This means that higher biomass production occurred during months of lower temperature or during colder months.

The observed higher biomass production of *Sargassum* spp. during colder months indicate the enhancement of algal blooms during this period. Though *Sargassum* is a persistent dominant species (Castro, 1986), observations from this study imply that more species of *Sargassum* attain their peak of development during the colder months. This supports the observation of Ang (1982) that *Sargassum siliquosum* attain its highest thallus length at the onset of the cold months.

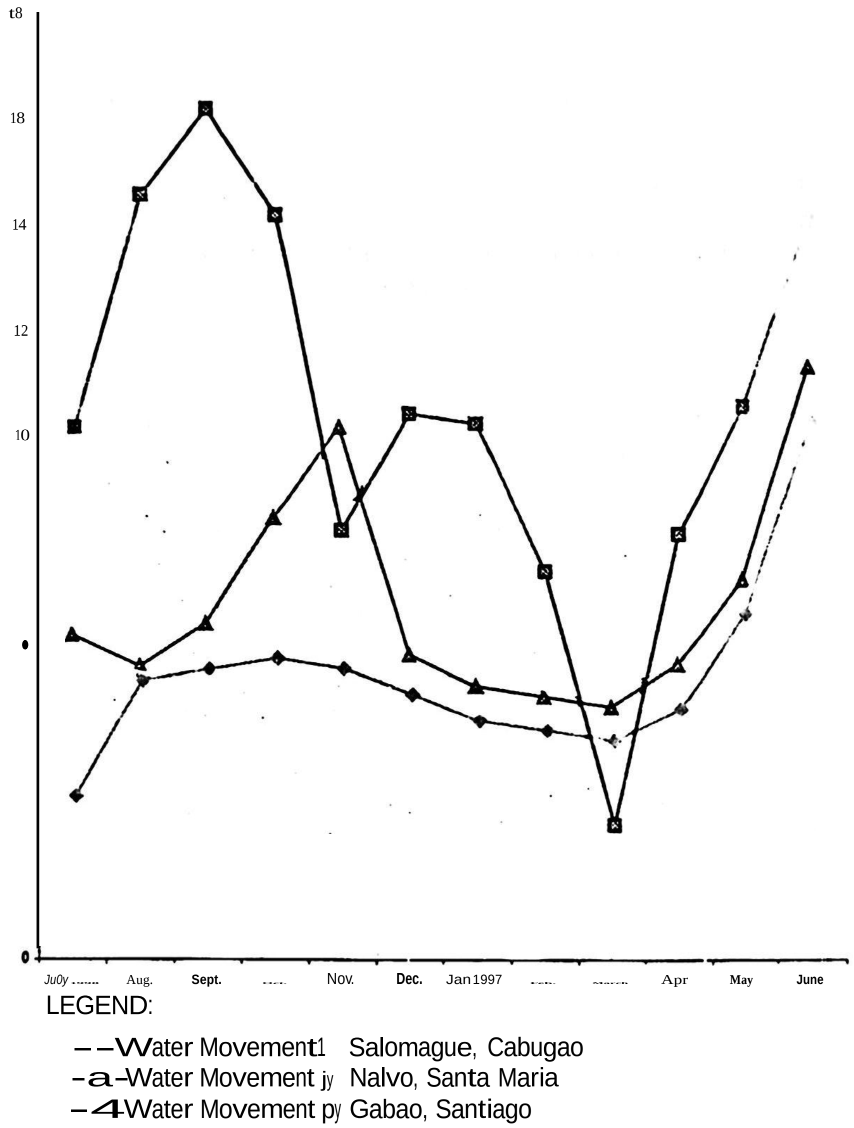
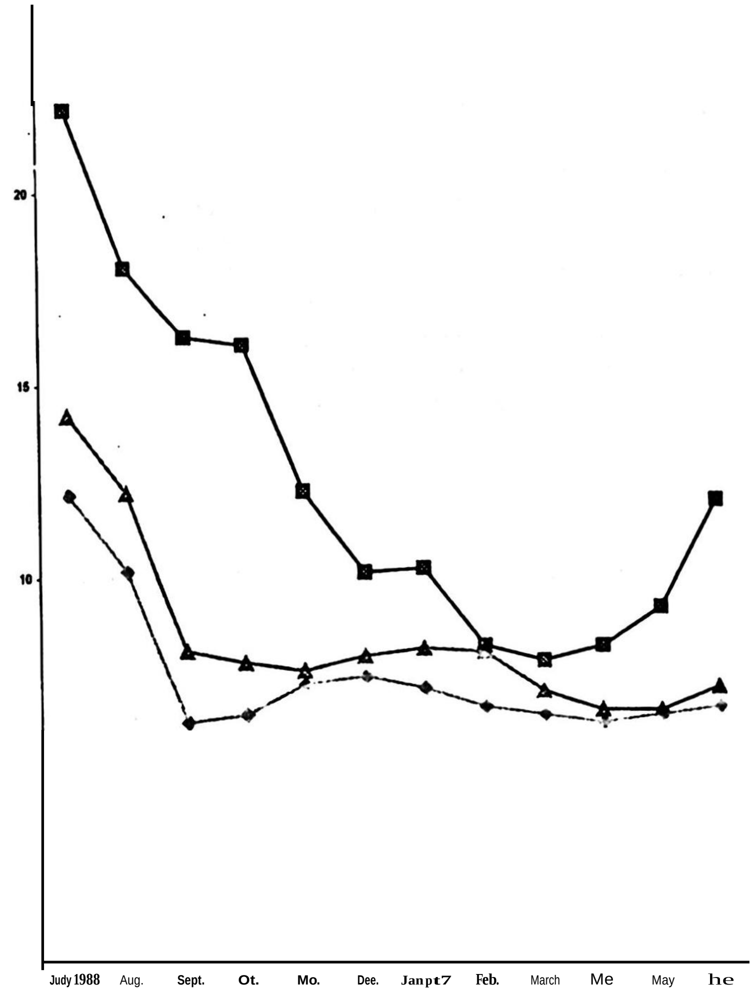


Figure 7. Monthly variation in water movement from July 1996 to June 1997.



LEGEND:

-»--Water Movement I Salomague, Cabugao
-n-Water Movement II Nalvo, Santa Maria
–t–Water Movement III Gabao, Santiago

Figure 8. Monthly variation in water movement from July 1997 to June 1998.

Salinity was not found significantly related to *Sargassum* biomass. This is due to the slight changes in salinity in the study areas which are within the range suited for *Sargassum* growth. Added to this is the fact that observation was done in *Sargassum* beds where growth of *Sargassum* spp. is already established.

Water movement was found significantly related to *Sargassum* biomass. As shown in Table 5, the computed t-value was 2.4169, which was higher than the tabular t-value of 1.717. Since r—-0.458, it implies that negative relationship exists. This means that higher production occurred in areas where water movement was less strong than in areas with strong water movement. Strong water movement washes away algal species. Although *Sargassum* spp. is a flexible and resilient algal species, too strong water currents can detach their holdfasts or a portion of the algal thalli, thus decreasing algal biomass. On the other hand, areas with moderate water movement support the enhancement of algal growth, hence an increase in biomass.

Summary of Findings and Recommendations

Stock assessment of economically important seaweeds is a necessary undertaking for the proper management of these resources. It provides infonnation necessary in the stabilization of the seaweed industry and in the diversification of the industry through research and development of equally important seaweed species and products.

Sargassum spp. is a potential resource in the province of Ilocos Sur. Gathering of natural stocks is a possible alternate source of Iivelihood of the people. Due to the presence of several species in the area, collection can be made possible anytime of the year. Toe reefs which extend up to several meters seaward in most coastal municipalities support algal blooms anytime of the year. The biomass production results of this study show high *Sargassum* yield in the collecting stations representing the possible *Sargassum* collecting areas of the province. Hence, *Sargassum* can be further developed in all these areas.

Changes in environmental conditions must be taken into account in the gathering of natural stocks in the future. Having been found out to affect biomass production, temperature changes and water movement must be considered before planning any management or development strategy of the resource.

Considering the great bulk of *Sargassum* biomass collectible in the province, seaweed processing plants must be established in the area. Product fonnulation studies through collaboration with other agencies such as the Department of Science and Technology (DOST) should be undertaken to enable the people of Ilocos Sur to benefit from these resources to the fullest. Further research must be conducted to determine the other products that can be extracted from this resource.

Community-based coastal resources management is deemed necessary in the province of Ilocos Sur. It should, therefore, be a priority program of everybody – the local government, the private sector, and the community.

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