Investigation of a unique population of Chondrus Crispus in Basin Head Harbour, Prince Edward Island: final report under contract CS155-0-6302, 080-005

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INVESTIGATION OF A UNIQUE POPULATION OF *CHONDRUS CRISPUS* IN BASIN HEAD HARBOUR, PRINCE EDWARD ISLAND

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FINAL REPORT UNDER CONTRACT CS155-0-6302, 080-005

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ABSTRACT

A unique free-living population of Chondrus crispus Stackhouse exists at Basin Head Harbour, P.E.I., and the ecology of this barrachois was briefly studied. The estimated biomass of this Chondrus population appeared to decrease from 154,500 kg in June 1980 to 127,290 kg in August 1980; however no statistically significantly difference existed between these values. Specimens of Basin Head Chondrus were transplanted by attachment to screens to 15 other locations in Prince Edward Island. These grew an average of 2.5% per day in July and early August, but generally decreased in weight in August. A "foliose" morphology of Basin Head Chondrus showed the best overall growth, while Basin Head specimens generally exhibited larger weight gains than co-transplanted NRCC T4 and offshore Chondrus.

INTRODUCTION

The coastline of Prince Edward Island is indented with many estuaries which typically have high nutrient levels, warm water temperatures and good tidal flushing, factors favourable for growth of many organisms. A population of Chondrus crispus (Irish moss) at Basin Head Harbour exemplifies how a species may be modified in such an environment. The plants are unattached and exhibit a large, robust, generally spherical habit with broad, thickened thalli. Blue mussels (Mytilus edulis) attach to the fronds, their byssal fibres often joining together several plants and the resulting weight and volume help to anchor the population.

With the potential economic importance of this population as an impetus, a Summer Job Corps project was created in 1979 to undertake an ecological study of the Basin Head barrachois and determine what factors established and now sustain this unique growth of Chondrus. The group investigated benthos, plankton, nutrient levels and species associated with the Chondrus population. As well, various physical parameters (oxygen, temperature, salinity, pH) were monitored on a weekly basis from May until December 1979. Other research that has been conducted in the Basin Head area includes Griffin (1973) who examined the ecology of the Basin Head sand dune system and Palmer (1978) who traced the recent geological history of the harbour by diatom stratigraphy. J. Murchison, of the Prince Edward Island Department of Fisheries, has conducted growth rate experiments with Basin Head Chondrus and has attempted transplants to several locations.

A three-point objective was established for this project. First, the biomass of the Chondrus population at the Basin Head barrachois would be determined in both May and August, giving a measurement of growth over the summer months. Second, the growth potential of Basin Head Chondrus and T4 Chondrus in this and other estuaries and embayments of P.E.I. would be investigated. Third, baseline data would continue to be monitored at Basin Head Harbour. These data include temperature, salinity, turbidity, nutrients and benthos, and would be measured selectively at other transplant sites whenever possible.

If it were possible to transplant Basin Head Chondrus to other environments and obtain a good growth rate, a commercially viable aquaculture would develop. This report should provide baseline data for managing the Basin Head Chondrus resource, and for selecting appropriate transplant sites which could support a profitable Irish moss population.

STUDY AREA

Basin Head Harbour is a barrachois located in eastern Kings County, P.E.I., 12 km east of Souris. The body of water covers 0.52 km^2, with the harbour proper being about 760 m long and 380 m wide and having a channel 500 m long connecting it to the Northumberland Strait (Figs. 1, 2). This channel is relatively deep, about 2.5 m, and was formed some forty years ago when the former channel at the eastern end of the system filled in. The harbour proper is shallow, from 1.0 to 1.5 m deep at high tide, with extensive eel grass beds and a very soft bottom, probably formed when the area was the head of the system.

A long narrow arm extends for 3.0 km east of the harbour, separating a large sand dune system from agricultural land to the north. This arm, about 50 to 130 m wide, is a sheltered area protected by the dunes to the south and steep treed banks to the north. The fields above the barrachois support a variety of crops including potatoes, clover and oats. A salt marsh dominated by Spartina spp. borders the system to the south and in pockets to the north. The sand dunes, dominated by Ammophila breviligulata and Corema conradii, are from 400 to 800 m wide and extend the length of the arm.

The Basin Head barrachois is dominated by eel grass (Zostera mariana), sea lettuce (Ulva lactuca) and Irish Moss (Chondrus crispus). Zostera is ubiquitous throughout the system while large sheets of Ulva are found piled several layers deep at the head, completely covering the substrate. A Chondrus bed occurs 1.0 km up the arm and extends for about 800 m (from T1 to T4, Fig. 2). This mat is up to 0.4 m thick

over the substrate, and is interrupted periodically by variously sized holes or bare patches both naturally occurring and caused by transplanting activities. Common fish species include the eel (Anguilla rostrata), mummichog (Fundulus heteroclitus) and flounder (Pseudopleuronectes americanus). Major invertebrates inhabiting the system include Mytilus edulis, which are found associated with Chondrus, periwinkles (Littorina spp.), the crab Cancer irroratus, the amphipod Gammarus oceanicus and the polychaete Nereis diversicolor. The clam Mya arenaria occurs in the sandy intertidal mud flats of the harbour and lower arm and has supported a small fishery (McCurdy, 1979).

EXPERIMENTAL PROCEDURE

Biomass

The following biomass sampling procedure was initiated after consultation with Dr. Don Tosh, Department of Mathematics, Acadia University.

The dense bed of Chondrus crispus was found to occur in an 800 m segment of the barrachois, with only small scattered patches of plants found outside these limits (Fig. 2). Parallel transects were then established at 1 m intervals across this portion of the barrachois. A stake was driven into the ground of the north shore of the barrachois every 10 m along a parallel baseline, while the corresponding stake for the south shore was positioned by sighting with a surveyor's transit on a constant compass bearing from the northern stakes. Thus, 801 parallel transects, numbered 0 through 800, were established with labeled reference stakes every 10 metres.

Transects to be sampled each day for the first biomass estimate in late May and June were selected in the following manner. Using CRC random number tables (Beyer, 1968), forty numbers between and including 0 and 800 were chosen, then placed in ascending order. Again using random numbers, forty more numbers between 0 and 115 were chosen to complement the previously selected set. Thus, forty paired coördinates resulted, the first number representing a transect between 0 and 800 as previously established, and the second (or cross) number representing a position along this transect. The widest point of the area of the barrachois being sampled was 115 m and this was chosen as the

theoretical length of each transect so that every position along each transect would have an equal chance of being randomly chosen.

For a given coördinate pair, a person was situated on both shores of the barrachois at the appropriate transect position and a rope marked in metres was stretched taut across the water along the particular transect from mean high water on the north shore to the lower edge of the salt marsh on the south shore and the resulting width recorded. If the width was less than the value for the cross number, this was noted as "ashore" and the next pair of coördinates investigated. If, however, the cross number on the rope was situated over water, a pair of divers checked and determined if a sample would be taken. A "hit" occurred when the area directly under a given value was covered completely with Chondrus whereas a "miss" constituted any other situation. In the latter case, it was recorded whether there was no vegetation or whether the substrate was covered with Ulva, Zostera, Spartina or any combination thereof. If there were a few Chondrus plants amongst other vegetation but less than 100% cover by Chondrus, this was noted but no sample was taken.

Sampling was achieved using a circular metal hoop, 30 cm deep, having an enclosed area of 0.25 m^2 and an attached buoy to facilitate location in turbid water. By driving the sharp lower edge of the hoop into the substrate with a twisting motion, plants within the hoop were severed from those without, and a plant mostly outside the prescribed area was thus not falsely included by being pulled under the hoop. If the area directly under the cross value occurred on the edge of a

Chondrus bed partly over a hole, the hoop was situated slightly to one side to obtain 100% Chondrus coverage. Because sampling occurred only in areas of 100% Chondrus coverage, the resulting mean biomass would apply only to such areas and not to the barrachois as a whole.

Everything within the hoop was gathered into nylon mesh bags, numbered to keep samples distinct. Visibility was obscured by clouds of silt when the Chondrus plants were disturbed so it was necessary to determine by touch whether or not all plants had been collected; lower water temperatures in May and June hampered this operation somewhat by necessitating the use of neoprene mitts.

To determine the wet weight of Chondrus per 0.25 m^2 plot, all samples were sorted of non-Chondrus material (mostly mussels, eel grass and Ulva), washed with fresh water to remove mud, shaken to a uniform dryness and weighed. These plants were then sun-dried and stored. For conversion to dry weight, all of one day's samples were weighed wet in the normal manner, dried at 70°C for 48 hours and a dry weight obtained. As the samples were chosen randomly, a true average percent dry weight, incorporating data from all areas of the barrachois, was procured.

The second biomass estimate, conducted in mid-August, followed the same procedure with two exceptions. As time was short, sixty coördinates were chosen and sampled each day of the August trial. Also, because of the warmer water temperature, neoprene mitts were not required thereby facilitating accurate sampling.

Results

Wet weights and converted dry weights per 0.25 m^2 plot for each sampling day for both biomass estimate trials are found in Table 1. In all, 76 samples were taken in late May and June, and 35 in mid-August for a total of 111 samples. The ratio of dry weight to wet weight was calculated from the data in Table 2; these weights were representative of the entire Chondrus bed.

Appendix I contains a brief statement of the various statistical methods used.

The area of the 800 m segment of the barrachois investigated for biomass was 60,008 m^2; this figure was derived from the widths of the 680 transects measured during biomass sampling. This agrees well with the area of 59,592 m^2 obtained using a planimeter and an orthophotograph of Basin Head Harbour with a scale of 1:5000.

The area of the above portion of the barrachois covered with Chondrus beds was derived by comparing hits with misses along those transects which had cross numbers falling over water (i.e. not ashore) (Table 3). Thus, the fraction covered with Chondrus for the first trial was 0.26 ± 0.05 and 0.23 ± 0.07 for the second trial (95% confidence interval). It follows that in late May and June, the Chondrus bed was between 12,600 m^2 and 18,600 m^2 with a mean of 15,600 m^2 whereas in August the Chondrus bed was between 9600 m^2 and 18,000 m^2 with a mean of 13,800 m^2 (Table 3).

The mean biomass per 0.25 m^2 for areas of 100% Chondrus coverage was calculated as follows. A 90% confidence interval was used as the number of samples was too low with the inherent standard deviation for a 95% confidence interval. For the first trial, the mean wet weight per 0.25 m^2 was determined to fall between 2273 g and 2679 g (average 2476 g). Similarly, for the second trial, the mean weight fell between 2135 g and 2477 g with an average of 2306 g (Table 4).

The biomass of Chondrus at Basin Head Harbour can be determined by converting wet weight per 0.25 m^2 to wet weight per m^2, and multiplying by the area of Chondrus beds. The resulting mean value was 154,500 kg for early summer and 127,290 for late summer. Table 4 shows the upper and lower biomass limits.

The average Chondrus densities of 9.9 kg per m^2 in June and 9.2 kg per m^2 in August were not significantly different ($Z = 1.05$), while the standard deviations of these means for the two periods showed a highly significant difference ($F = 3.05$). The area of the Chondrus bed was not significantly different ($Z = 1.38$) between June and August. Therefore, despite the apparent decrease by 17% in total Chondrus biomass from June to August at Basin Head Harbour, the mean biomass per m^2 and the area of Chondrus bed did not differ significantly and no conclusions can be made about any actual reduction in biomass.

Transplants

Basin Head Chondrus plants were introduced into other areas (Fig. 1) by attachment to screens which were then anchored to the substrate. The screens were made from vinyl-coated fencing material,

mesh 2.5 cm by 2.5 cm, cut 0.9 m by 0.3 m. The outer 0.15 m of each piece was bent perpendicularly to form an anchoring mechanism, leaving a surface area of about 0.2 m^2 for plant attachment (Fig. 3). The screen was tagged on the upper right corner and divided into 8 reference positions as shown in Figure 3.

Sites for transplanting were chosen according to several criteria. Locations having clear, shallow water with a moderate current were considered suitable, while other qualifications were ready access to the site and ease of relocating the screen. Two locations, Covehead and Oyster Hole Bridge, were estuaries with an already established natural population of Chondrus; thus the comparative growth potential of Basin Head Chondrus at these sites seemed valuable information. The native plants had broadened thalli but were much smaller and had more abrupt dichotomies near the apices than Basin Head Chondrus, and were attached by holdfasts to empty mussel or oyster shells embedded in mud and not free-living as at Basin Head Harbour. In addition, these Chondrus plants were yellow-green as opposed to the deep purple-red of Basin Head specimens.

Several kg of NRCC T4 Chondrus crispus, both red and green varieties, were obtained from culture tanks at Sandy Cove, Halifax County, N.S., on 1 July 1980 and on the same day about 5 kg Basin Head Chondrus were collected. These plants were transported in styrofoam ice chests and stored overnight in sea-water tanks at the University of Prince Edward Island. The following day, Chondrus from an offshore population at North Rustico was collected from a depth of about 6 m

using SCUBA equipment and transported along with the previously collected Basin Head and T4 Chondrus to the Covehead site. On screens 1 through 6 all three varieties were attached to one screen with the Basin Head specimens occupying positions 1, 2, 7 and 8, T4 occupying positions 3 and 4 and shore moss from North Rustico occupying positions 5 and 6. The remaining screens were composed entirely either of 8 plants of the Basin Head variety, each occupying a reference position, or of a known quantity of T4 plants attached in random order. Specimens of T4 transplanted on 8 July had been stored one week in sea water tanks at U.P.E.I. whereas those transplanted on 29 July were brought from Sandy Cove the same day. Other than the above cases, all specimens were collected from Basin Head Harbour and transplanted the same day. Plants were transplanted in all instances in styrofoam ice chests and kept moist and cool.

Each specimen to be transplanted was cleaned of epiphytes and debris, blotted to a uniform dryness with paper towels, weighed, and then attached to its position on the screen with nylon twine, taking care to maintain natural orientation. The screens were then anchored in the water of the transplant site at depths of 0.5-2.0 m (relative to low water) by pushing the perpendicular end portions of the screen 10 to 15 cm into the substrate. The positions of the screens were marked for ease of relocation by driving an orange stake into the substrate adjacent to the screen.

Three easily discernable morphologies of Basin Head Chondrus occur at the barrachois. The most abundant type, "ordinary" Basin Head (BH)

type, has typically broad thalli, numerous apices and a rubbery texture. Another morphology, referred to a "foliose" BH Chondrus, features very wide, thick thalli with few apices and generally has buds of new fronds growing from the margins and surfaces of the broad thalli. A third type, known as "spriggy" BH Chondrus has narrower thalli and numerous apices, is somewhat brittle in texture and generaly takes a spherical form. At least one specimen of each type was included among the 8 plants for each screen in order to determine any differences in growth rates.

Plants were reweighed after 3 to 4 weeks and again in the last week of August. The same weighing procedure was followed in each case, and usually the entire plant was retied on the screen. However, if the plant had fragmented into 2 or more pieces, generally only one piece was replaced and the new weight noted.

Results

Appendix II summarizes the results of transplanting at each site, and gives a brief description of the physical environment and location of screens. Salinity and temperature of these sites on 28 July is found in Table 5. Growth of Basin Head Chondrus plants, expressed as % increase in weight (relative to the initial weight for the period) per day, on each screen and for each morphological type, is presented in Table 6. Similarly expressed growth rates for red and green T4 and offshore Chondrus are found in Table 7. No growth is indicated by a "0", whereas a loss in weight is indicated by a "-". Absence of any notation means the plants were not reweighed for that period.

Nearly all Basin Head plants exhibited some growth upon initial reweighing, after 3 to 4 weeks. Except at Graham Pond and Basin Head Harbour, all Basin Head Chondrus bleached to varying shades of green, at the tips, while the lower portions mostly remained purple-red. Many screens and plants had mussels or mussel spat attached to them. In this time period, the best growth was exhibited by the "foliose" morphology, which averaged 3.1% increase in weight per day, with values as high as 6.8%. "Ordinary" BH morphology averaged 2.1% per day growth, with values as high as 4.5%, while "spriggy" averaged 1.9% per day growth, with one value of 9.8%. The latter type was somewhat brittle and fragile, and prone to breakage which may have accounted for the lower average growth rate.

The second reweighing, at the end of August revealed much poorer growth for BH Chondrus. With the exception of one screen at Basin Head, several at Covehead and those at Graham Pond and Eglington Bay, the plants generally had a necrotic appearance with ragged apices and fragmentation evident. This was reflected in the poor growth shown by most specimens; about 40% of the plants displayed no apparent growth or lost weight.

Upon initial reweighing, individual red T4 plants at Covehead (Screens 1-6) increased in weight an average of 2.2% per day, while the green T4 plants grew faster at a rate of 2.8% per day. Growth was virtually nil in the second growth period for green T4, while red T4 did little better with a rate of 0.3% per day. The screens entirely of T4 Chondrus at Oyster Hole Bridge and Covehead showed similar results

with green T4 exhibiting better growth than red for both growth periods; however, better growth resulted in the second growth period for these plants than individual ones. At Basin Head, only one screen of T4 plants showed an increase in weight. This is likely due to fragmentation of these specimens, possibly a result of being kept in sea water tanks at U.P.E.I. for a week. The plants did not appear healthy.

Offshore Chondrus growth rates at Covehead were similar to those of other Chondrus varieties, but a little slower at 1.8% per day for the first period and a much slower rate of 0.6% per day for the second growth period.

Overall, Basin Head Chondrus showed a greater mean increase in weight at transplant sites that did T4 or offshore Chondrus, although green T4 exhibited the greatest growth rate. However, fewer plants of green T4 than of BH Chondrus were transplanted. In addition to overall superior growth, BH Chondrus is much more robust and rugged, and seems most able to survive transplant activities.

Sites showing an average growth rate of BH Chondrus greater than 2.25 per cent per day for the first growth period were Covehead, South Lake, Midgell, Savage Harbour, Bay Fortune and Oyster Hole Bridge, whereas significant growth occurred only at Covehead, Eglington, South Lake and Basin Head Harbour for the second growth period. Overall, Covehead and South Lake appeared to grow BH Chondrus best, while this strain fared relatively poorly on the control screens at Basin Head Harbour. This could indicate a sampling error, or generally poor

growth conditions at the site during this summer, as manifested in the apparent lack of increase in Chondrus biomass from June to August.

Physical Data

The five sampling transects at Basin Head Harbour used in 1980 were those established in 1979 (McCurdy, 1979) with the addition of three occasional sampling stops (Fig. 2). Salinity and temperature data were collected weekly from these transects from 7 May to 27 August 1980. To ascertain diurnal changes in physical parameters, temperature, salinity and water depth data were collected hourly from Transect 3 (T3) on 6 August 1980 from 1100 to 2300 h. On 28 July, salinity and temperature data were collected from various transplant sites to determine any such differences in these areas.

Salinity and temperature data collected weekly along the Basin Head transects are presented in Table 8, while the results of the August hourly sampling at T3 are shown in Table 9. Data collected from transplant sites are found in Table 5. Temperature increased throughout the summer from 4.0°C in early May to 20.9°C in early August with a subsequent gradual decline. The water at the head of the system was generally warmer than that nearer the mouth. Salinity ranged from 15.9°/$_{oo}$ to 28.2 °/$_{oo}$ and was lower at the head and higher near the mouth with values dependent upon tidal height. Hourly data for 6 August show that water temperature and salinity are affected by tidal height, with incoming tide raising salinity and lowering water temperature. The tidal regime was somewhat irregular on 6 August, with

rather low water all day. The following morning, depth was 0.95 m at 0900 h. Temperature and salinity data were collected from south shore transplant sites (Hillsborough to South Lake) on a full tide ebbing, whereas they were obtained at low tide for north shore sites (Midgell to Covehead).

Light penetration was measured as an indicator of turbidity. A quantum meter (model LI-185, Li-Cor) equipped with an underwater probe was used to measure radiation at the water surface, 1 cm below the surface and just above the substrate. Triplicate measurements were taken at each position and the amount of light reaching the bottom of the water column expressed as a percentage of incident light at the water's surface. These results are presented in Table 10. Water depth and turbidity are critical factors in light penetration, as shown at Graham Pond where only 5% of incident light reached the bottom when the water was muddied as compared to 48% in clear water, and also at Basin Head where only 16% of incident light reached the bottom of a 1.5 m deep hole as compared to 44% in 0.75 m deep water. No difference in light reaching plants and light reaching bare substrate at a similar depth was found.

Water samples were collected and frozen throughout the summer to be analyzed later for nitrate and nitrite. These were unfortunately lost due to inadvertent thawing.

Benthos was quantitatively sampled using a 15 cm by 15 cm Eckman grab (Ward's). Duplicate samples were taken from the middle of each transect and were sieved sequentially through a 850 μm mesh screen and

a 425 µm mesh screen. This procedure prevented the coarse vegetative material from clogging the fine screen. Once washed, the contents of both sieves were put in jars containing 4% formalin-seawater. The preserved samples were sorted in the lab and stored in 70% ethanol. Organisms were identified to species and enumerated. Invertebrate keys used included Gosner (1971), Bousfield (1973), Morris (1973), Linkletter (1976) and Appy et al (1979).

Benthic sampling took place at Basin Head Harbour on 21 May and 11 July 1980, but only the specimens from 21 May have yet been identified. These organisms, together with numbers per m^2 for each transect are presented in Table 11. An unidentified species of oligochaete was the most abundant invertebrate, followed by the gastropod Hydrobia minuta. The polychaete Nereis diversicolor was ubiquitous throughout the barrachois and contributed significantly to the invertebrate biomass, while other numerous polychaetes included Streblospio benedicti and Polydora ligni. Several species are associated with the Chondrus population in the Basin Head barrachois. Littorina spp. and Gammarus oceanicus are found clinging to the fronds, while Cancer irroratus is commonly seen scurrying over the firm substrate provided by the Chondrus plants. Mytilis edulis forms an association with Chondrus, anchoring the plants with byssal fibres, and often attaching several plants together. The weight and volume of the resulting biculture helps to hold the population in place in swiftly flowing current, although some drifting does occur.

DISCUSSION

Although no significant difference was found between the June and August total Chondrus biomass, several factors were noted which could explain an apparent decrease in biomass. Between biomass samplings, quantities of Chondrus were exported from the barrachois by P.E.I. Dept. of Fisheries for transplanting activities. This activity left large holes particularly in the lower portion of the Chondrus bed. Ulva may also have decreased the size of the bed. Large sheets of this species floated down the barrachois from the head waters during summer and occasionally settled on the Chondrus, particularly in the upper part of the bed. These sheets of Ulva seemed to kill the Chondrus plants, perhaps by blocking light penetration or gas exchange. Plants under these Ulva sheets had rotted into fragments with white edges, and in some cases had completely disappeared except for some small white pieces or a white film over the substrate. Later, the Ulva sheets floated away leaving a hole; this could be the cause of some of the gaps in the Chondrus bed. This summer, the Ulva "kill" happened most often near the edge of the Chondrus bed where the slower currents would allow settling to occur.

In addition to attrition of the Chondrus bed, it seems apparent that a cessation of, or decrease in, Chondrus growth occurred at Basin Head Harbour during the late summer. This is not likely due to a lack of nutrients, as the barrachois has had high levels of nitrate and phosphorus in past years (McCurdy, 1979), although no nutrient testing was completed this year. An abundance of nutrients could result in

overdevelopment of pigmentation at the expense of structural strength, resulting in fragmentation of the resulting brittle thalli (Bird, pers. com.).

A biomass study conducted by P.E.I. Dept. of Fisheries in July, 1977, estimated the Basin Head barrachois to have 95,000 kg of Chondrus, with an average density of 2.8 kg per m^2 (Murchison, 1977). This latter figure is the density of Chondrus for the whole area of the barrachois from T1 to T5 including patches with no Chondrus, whereas the figure calculated in this report was for density in areas of 100% Chondrus coverage. Also, in the 1977 study, the estimate of the area of the barrachois was smaller than in this study. A figure for Chondrus biomass at Basin Head Harbour in August, 1979, was estimated by McCurdy (1979), however too few samples were taken. In the 1979 study, the average density of Chondrus per 0.25 m^2 was also much higher than in the 1977 study.

The overall slow growth shown by Basin Head Chondrus transplants in August was partly due to fragmentation, resulting in pieces of plant drifting away and not being included in the reweighing procedure, and partly due to a cessation of growth from some of the apices which had a ragged appearance, although the proportional effect of each factor is unknown. In an unattached culture system, breakage of larger plants into smaller ones may actually increase growth by increasing surface area available for photosynthesis, whereas damaged apices would halt production of new plant material.

Generally, the "foliose" morphology showed a faster growth rate, probably because the plants were tougher and more resistant to fragmentation. New growth was generally from buds along the broad thallus as well as from established apical regions. This could cause the large, spherical form of many Basin Head Chondrus plants. "Spriggy" plants occasionally did very well as might be expected because of their many apices but often fragments appeared to become detached and drift away. Growth rates of plants in a confined culture system might be expected to be higher.

Growth rates of about 2 to 3% per day were exhibited during the first period, in July. J. Murchison (pers. com.) obtained a growth rate of about 1% per day over 3 wk periods for Basin Head Chondrus on screens at South Lake, Eglington Bay, Howe Bay, Brudenell River and St. Mary's Bay in 1979. Good growth was also reported in previous years from Hillsborough and Elliot Rivers. Several kg of Basin Head Chondrus were inoculated into a hectare plot at South Lake in summer of 1979. These plants survived the winter, with those in shallow water growing much better than those in deeper areas, likely owing to high turbidity causing a severe reduction in available light in deeper areas.

The bleaching of Basin Head Chondrus at other sites, particularly shallow ones, while remaining red-purple at Basin Head Harbour suggests a nutrient deficiency in these areas, which may have contributed to the general poor growth and fragmentation in August. In shallow areas, a moderately swift current is necessary to prevent water from becoming

turbid and the bottom from being inundated with growth of Ulva and other green and blue green algae which would limit Chondrus growth. Too swift a current, however, could cause abrasion and result in the plants being swept away. Any transplant site ought not to freeze over completely in winter as ice could raft the plants away in spring, particularly in areas exposed to wind. Screens were left in deep (1.5 m), swift flowing water at Covehead to determine what effect overwintering has on Basin Head Chondrus at this site.

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Table 1. Wet and converted dry weights of Chondrus per 0.25 m^2 collected from Basin Head Harbour, summer 1979.

Date	Wet Weight (g)	Dry Weight (g)	Date	Wet Weight (g)	Dry Weight (g)
22 May 80	1661	271.6		1940	317.2
	1316	215.2		3181	520.1
	1193	195.1		2177	355.9
	3194	522.2		2845	465.2
	995	162.3		2876	470.2
	4046	661.5		2919	477.3
	981	160.4		1644	268.8
	2305	376.9			
	714	116.7	12 June 80	2632	430.3
				1722	281.5
26 May 80	2506	409.7		1148	187.7
	1792	293.0		2157	352.7
	1685	275.5			
			17 June 80	1989	325.2
28 May 80	1985	324.5		1803	294.8
	2946	481.7		1031	168.6
	2241	366.4		3323	543.3
	2887	472.0		1967	321.6
	1682	275.0		3107	508.0
	1455	237.9		1023	167.3
	1036	169.4		3268	534.3
	3400	555.9		2444	399.6
	2112	345.3			
			18 June 80	4563	746.1
29 May 80	2625	429.2		1917	313.4
	2225	363.8		2316	378.7
	2516	411.4		1850	302.5
	2773	453.4		3806	622.3
				883	144.4
10 June 80	2525	412.8		2064	337.5
	4285	700.6		2472	404.2
	2781	454.7			
	2097	342.9	19 June 80	2965	484.8
				3950	645.8
11 June 80	3546	579.8		3415	558.4
	2662	435.2		1849	302.3
	2072	338.8		6920	1131.4
	2910	475.8			
	848	138.6	25 June 80	2290	374.4
	2615	427.6		4002	654.3

Table 1. (Cont'd)

Date	Wet Weight (g)	Dry Weight (g)	Date	Wet Weight (g)	Dry Weight (g)
	4725	772.5	21 Aug. 80	3162	517.0
	3866	632.1		2459	402.0
	3341	546.3		3451	564.2
	1164	190.3		2252	368.2
	3787	619.2		2482	405.8
	2230	364.6		1281	209.4
14 Aug. 80	1702	278.3			
	2582	422.2			
	3356	548.7			
	1168	191.0			
	2352	384.6			
	3217	526.0			
	2313	378.2			
18 Aug. 80	2252	368.2			
	2892	472.8			
	2280	372.8			
	2724	445.4			
	2424	396.3			
	1656	270.8			
	2566	419.5			
	2264	370.2			
	2742	448.3			
	3553	580.9			
	1885	308.2			
20 Aug. 80	1351	220.9			
	2815	460.3			
	1924	314.6			
	1992	325.7			
	1885	308.2			
	2133	348.7			
	1396	228.2			
	2237	365.7			
	2360	385.9			
	1536	251.1			
	2067	338.0			

Table 2. Actual wet and dry weights of Chondrus per 0.25 m^2 collected at Basin Head Harbour on 25 June 1980.

Wet Weight	Dry Weight	Dry Weight/Wet Weight	Conversion Factor
1164	209.5	18.0 %	5.6
3341	559.0	16.7	6.0
3787	615.3	16.2	6.15
4725	781.0	16.5	
2230	348.0	15.6	
4002	639.0	16.0	
3866	641.5	16.6	
2290	348.0	15.2	

$\bar{x}$ = 16.35 ± 0.84

Table 3. Data for calculating area of Chondrus bed at Basin Head Harbour for June and August 1980.

	June	August
number transects	440	240
no. ashore	144	86
no. in water	296	154
no. hits	76	35
area (total) m^2	60,000	60,000
% Chondrus	0.26 ± 0.05	0.23 ± 0.07
area Chondrus m^2	15,600 ± 3000	13,800 ± 4200

Table 4. Data for calculating mean Chondrus weight per m^2 and biomass at Basin Head Harbour for June and August 1980.

	June	August
no. samples (n)	76	35
mean weight (wet) per 0.25 m^2 (g)	2476.1	2306.0
standard deviation	1074.6	615.5
minimum no. samples for 95% CI	290	109
minimum no. samples for 90% CI	51	19
90% CI mean weight per 0.25 m^2 (g)	2476.1 ± 202.8	2306 ± 171.1
90% CI mean weight per m^2 (kg)	9.9 ± 0.8	9.2 ± 0.6
lower limit biomass (kg)	114,560	81,980
mean biomass (kg)	154,500	127,290
upper limit biomass (kg)	199,320	178,340

Table 5. Temperature and salinity data collected from various transplanting sites on 28 July 1980. Tide was ebbing on the south shore, and very low on the north shore of P.E.I. at sampling time.

Site	Water °C	Salinity °/₀₀
Hillsborough Bridge	19.2	22.9
Keppoch	21.5	27.5
Oyster Hole Bridge	21.3	19.3
	22.0	20.3
Graham Pond	22.7	19.0
Panmure Island	21.0	22.8
Spry Cove	21.9	24.2
Eglington Bay	21.5	24.3
Howe Bay	22.5	26.3
Bay Fortune	20.9	24.1
South Lake	20.1	21.2
Midgell	24.1	15.2
Savage Harbour	24.6	17.1
Winter Bay	25.1	15.0
Covehead	23.2	18.7

Table 6. Growth of Basin Head Chondrus plants, expressed as % increase in weight per day for two consecutive growth periods in July and August, 1980, at various transplant sites.

A dash, "-", indicates a loss in weight.

Screen and Location	Days in Period 1	Days in Period 2	% increase in weight per day Spriggy 1	Spriggy 2	Foliose 1	Foliose 2	Ordinary 1	Ordinary 2
1 Covehead	29	24	2.2	2.5	3.7	2.4	4.5	3.3
							2.8	1.0
2 Covehead	29	24	0.2	-	-	0.6	2.8	0.2
			9.5	0.3				
3 Covehead	30	24					1.8	1.1
							1.6	1.9
							0.4	2.4
							1.8	2.4
4 Covehead	30	24			3.1	0.5	4.2	1.5
							1.8	1.7
							3.1	2.1
5 Covehead	29	24			4.0	-	1.4	0.8
							2.5	0.4
							2.3	1.2
6 Covehead	29	24					2.5	1.8
							3.2	1.8
							2.9	1.9
							1.1	1.4
10 South Lake	27	21	2.1	-	3.2	0.7	4.4	0.2
					3.0	-	4.9	-
					4.5	-	3.5	0.6
							1.1	8.9
11 Midgell	27	21	1.4	-	3.5	-	1.8	-
			3.5	-			1.9	-
			1.2	-			2.8	0.8
			2.8	-				

Table 6. (Cont'd)

Screen and Location	Days in Period 1	Days in Period 2	% increase in weight per day Spriggy 1	Spriggy 2	Foliose 1	Foliose 2	Ordinary 1	Ordinary 2
12 Savage Harbour	27	21	2.5 2.7 2.8 3.6	- 0.4 - -	2.9	2.2	4.1 1.0	- 1.3
13 Winter Bay	27	21	1.2 2.3	0 -	3.4	1.4	2.4 3.2 4.4 0	- 0.2 3.0 -
14 Spry Cove	28						3.4 2.0	
15 Eglington Bay	28	19	3.0 0.1 0 4.0	0 2.4 2.3 0.4	4.0 2.4 -	1.2 - 6.4	2.7	0.8
16 Bay Fortune	28	19	1.7 2.7 2.4 2.3	0.4 0 - 0	2.7	0.8	3.0 2.9 2.8	0 - -
18 Basin Head	26	21	0.8 0 1.4	0 0 -	0	0	1.1 2.0 0.2 1.5	0.2 0 0 0
19 Basin Head	26	21	1.3 1.5 1.9	0.5 0 3.7	3.4	3.2	1.4 3.3 2.8 1.0	0.8 1.7 2.1 0.9
20 Basin Head	26	not found	1.4 2.0 1.6 1.5		1.6 1.9		1.9 1.4	

Table 6. (Cont'd)

Screen and Location	Days in Period 1	Days in Period 2	% increase in weight per day Spriggy 1	Spriggy 2	Foliose 1	Foliose 2	Ordinary 1	Ordinary 2
21 Graham Pond	28	16	1.6 1.9	0.5 0	2.8 2.6	1.8 0	2.9 1.5 2.8 1.7	- 0.1 0.5 2.8
22 Oyster Hole Bridge	not found	44		0.3 1.1 0.4		- 4.7		1.6 2.4 -
23 Panmure Island	28	16	1.3 2.6 1.6 1.3	0 0 0 0	1.5 2.2 2.0	- 0.1 0	1.2	0.3
24 Oyster Hole Bridge	28	not found	1.6 1.8 0 1.7		2.7 6.2		2.6 2.5	
25 Covehead	27	12	0.5 1.4 0.8	0.5 0.1 -	3.2 3.0	1.8 1.3	0.3 0.9 1.9	0 0 0.7
26 Covehead	27	12	1.5 2.3 0 1.0	0.5 0.4 0 0.6	2.4	0.7	2.5 1.7 2.7	1.1 0 0.9
27 Keppoch	28		1.6 1.8 1.3		2.1		3.8 1.9 2.5 1.4	
28 Hillsborough	28		1.9 0.8 1.3		-		0.1 1.4 2.1 0	
29 West River	24		2.2 2.1 0		3.6 1.4		2.2 2.0 3.8	

Table 7. Growth of red T4, green T4 and offshore Chondrus plants, expressed as % increase in weight per day for two consecutive growth periods in July and August, 1980, at various transplanting sites.

A dash, "-", indicates a loss in weight.

Screen and Location	Days in 1	Days in 2	% increase in weight per day: Red T4 1	Red T4 2	Green T4 1	Green T4 2	Offshore (North Rustico) 1	Offshore (North Rustico) 2
1 Covehead	29	24	2.3	1.1	0.8	-	2.5	0.2
2 Covehead	29	24	3.7	0.7	7.3 3.8	0 0	1.8 4.3	- -
3 Covehead	30	24	1.0	-	- 1.0	- 0	2.1	0
4 Covehead	30	24	-	-	2.0	0	1.4 -	- 0.6
5 Covehead	29	24	2.1	0.6	2.1	-	1.9 1.7	0.9 0
6 Covehead	29	24	1.8	0.3	2.8	0.3	- 1.9	0 0
7 Basin Head	29	21	-	-				
8 Basin Head	29	21	2.0	0				
9 Basin Head	29	21	-	-				
30 Oyster Hole Bridge	14	16	1.8	0.1	3.0	1.2		
31 Covehead	15	12	2.0	0.9	2.3	1.2		

Temperature and salinity data collected weekly along 5 transects (T1-T5) and three sampling stops (S1-S3) at Basin Head Harbour from 7 May to 27 August 1980.

Temperature								
Ambient	T5	T4	T3	T2	T1	S1	S2	S3
4.8	6.1	6.0	5.9	5.9	5.2			
4.2	5.0	4.5	5.2	4.2	4.0	4.4	4.3	3.5
7.4	9.1	9.0	8.3	7.5	7.0			
6.5	8.1	8.0	7.5	7.0	6.8	6.2	6.0	5.1
7.5	10.9	10.7	10.7	10.6	10.2	10.0	10.0	8.9
9.1	11.0	11.5	10.1	10.0	9.1			
10.5	14.0	13.6	13.1	13.0	12.5			
16.8	20.4	19.1	19.0	17.2	16.2	16.0	15.1	10.5
11.1	13.0	12.9	13.0	12.9	13.0			
13.2	14.0	14.0	14.1	13.9	14.0			
18.1	18.5	18.3	17.6	17.2	16.9	16.5	16.4	15.0
17.4	19.1	19.0	18.4	18.1	18.0			
21.1	20.5	20.1	19.2	19.2	19.0	19.0	21.0	16.3
18.8	20.9	20.9	20.7	20.7	20.2			
15.5	17.3	17.3	17.1	17.1	17.3	17.1	17.3	17.0
16.0	19.2	19.1	19.0	18.9	18.1			
18.2	18.8	18.6	17.8	17.2	17.0	17.1	18.1	16.5

Table 8. (Cont'd)

Date	Tide Condition	Salinity T5	T4	T3	T2	T1	S1	S2	S3
7 May	almost high	20.4	20.3	20.3	21.0	21.8			
15	high & ebbing	20.5	23.5	23.5	23.5	24.2	24.5	25.2	25.1
21	incoming	17.8	18.6	20.4	21.0	20.0			
28	ebbing	20.2	20.5	20.6	20.5	19.8	20.5	21.0	24.9
6 June	low	20.3	23.8	22.1	21.8	22.0	23.0	24.5	26.0
12	incoming	25.5	25.1	25.5	24.2	26.0			
19	high	17.8	18.2	19.0	19.0	17.8			
25	ebbing	18.3	22.1	19.2	20.0	20.2	20.8	21.2	25.0
1 July	incoming	24.2	24.1	23.5	23.5	22.7			
11	high	23.0	23.0	24.5	25.2	25.2			
18	high	16.8	16.3	19.9	20.1	22.2	23.0	23.8	27.2
24	high & ebbing	21.9	21.1	22.5	21.9	22.3			
31	incoming	21.6	22.1	24.3	24.9	25.1	24.5	24.3	25.1
7 Aug.	ebbing	19.9	20.4	21.6	21.8	22.3			
14	incoming	16.2	16.5	15.9	17.2	18.6	19.2	20.5	26.0
21	ebbing	16.0	16.5	18.5	19.2	20.0			
27	incoming	19.3	19.8	20.8	20.8	20.1	21.4	22.3	28.2

Table 9. Salinity, temperature and water depth data collected hourly on 6 August 1980 at Basin Head Harbour, P.E.I.

Time (hours)	Water °C	Air °C	Salinity	Depth (m)
1100	22.3	18.2	18.4	.53
1200	23.3	19.3	18.2	.48
1300	24.1	19.3	18.8	.44
1400	25.2	18.4	17.2	.41
1500	25.8	19.0	20.6	.38
1600	26.0	18.6	18.9	.36
1700	26.0	20.0	18.0	.38
1800	25.5	20.0	17.8	.46
1900	25.4	18.6	17.1	.59
2000	25.3	18.1	18.3	.64
2100	24.2	19.5	17.8	.64
2200	24.1	18.4	18.8	.59
2300	24.0	19.5	16.8	.53

Tide Time	Height (m)
0515	1.7
1225	0.5
1920	1.5
0010	1.0

Table 10. Amount of radiation measured in microEinsteins per m^2 per second, at various depths at selected sites. All values are the average of three measurements.

Site	Water Depth (m)	$mE/m^2/sec$ Incident	Sub-surface	Bottom	incident / bottom
West River	1.0	750	505	250	0.33
Panmure Island	0.8	940	630	80	0.09
Graham Pond	0.8	1050	770	400	0.38
	0.5	1050	760	500	0.48
(silt agitated)	0.5	1050	760	50	0.05
Oyster Hole Bridge	2.0	300	200	80	0.27
Basin Head					
a) by T1	1.0	1250	850	250	0.20
b) by T2	0.4	1600	1050	790	0.49
	1.0	1600	1100	650	0.41
c) by T3	0.6; over	1575	1150	625	0.40
	Chondrus plants				
	0.6; over bare substrate (hole)	1600	1100	675	0.42
d) by T4	1.5	1400	950	225	0.16

Table 11. Numbers per m^2 of benthic organisms collected along 5 transects (T1-T5) at Basin Head Harbour, P.E.I., on 21 May 1980.

Species	T1	T2	T3	T4	T5
Nematoda	44		200		22
Euplana gracilis					
Nemertina	89		156		
Eteone longa	22				
Nereis diversicolor	622	978	1044	689	2422
Polydora ligni	622	889	133	444	756
Polydora sp.		22			89
Streblospio benedicti	733	2400	89	333	244
Pygospio elegans	111	67			67
Scolecolepides viridis	89		22		
Scoloplos fragilis	89	244	111	178	111
Oligochaeta	5000	2578	2089	1400	5556
Hydrobia minuta	3800	911	1200	3178	3600
Littorina saxitilis	667	422	2289	667	2856
Littorina littorea	44	44	600	267	311
Nassarius obsoletus	22			22	22
Gemma gemma	22			44	644
Mytilus edulis	289	133	1178	444	533
Mya arenaria		44		44	
Macoma balthica		44		22	
Copepoda					22
Jaera marina		44	222		1044
Corophium spp.	22	289	1356	378	733
Gammarus oceanicus		22	67		
Gammarus lawrencianus			67	44	22
Gammarus sp.	89		2378	422	933
Crangon septemspinosa					22
Mysis stenolepis	22				
Chironomid larvae			44	22	
Apeltes quadricus				22	

Figure 1. Map of Prince Edward Island, showing location of Basin Harbour and other transplant sites.

(1) South Lake
(2) Basin Head
(3) Bay Fortune
(4) Eglington Bay
(5) Howe Bay
(6) Spry Cove
(7) Panmure Island
(8) Graham Pond
(9) Oyster Hole Bridge
(10) Midgell
(11) Savage Harbour
(12) Winter Bay
(13) Covehead
(14) Hillsborough
(15) Keppoch
(16) West River

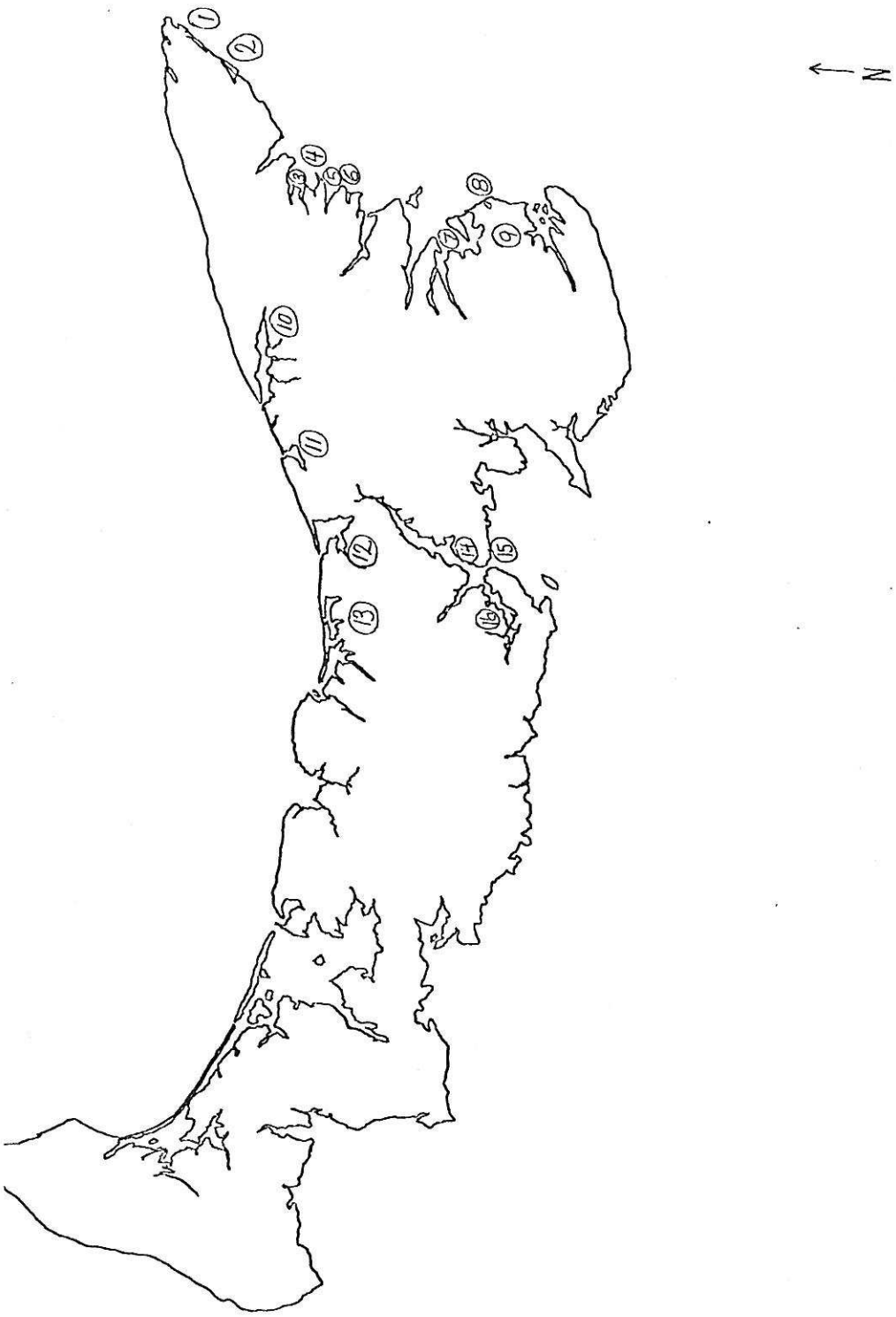
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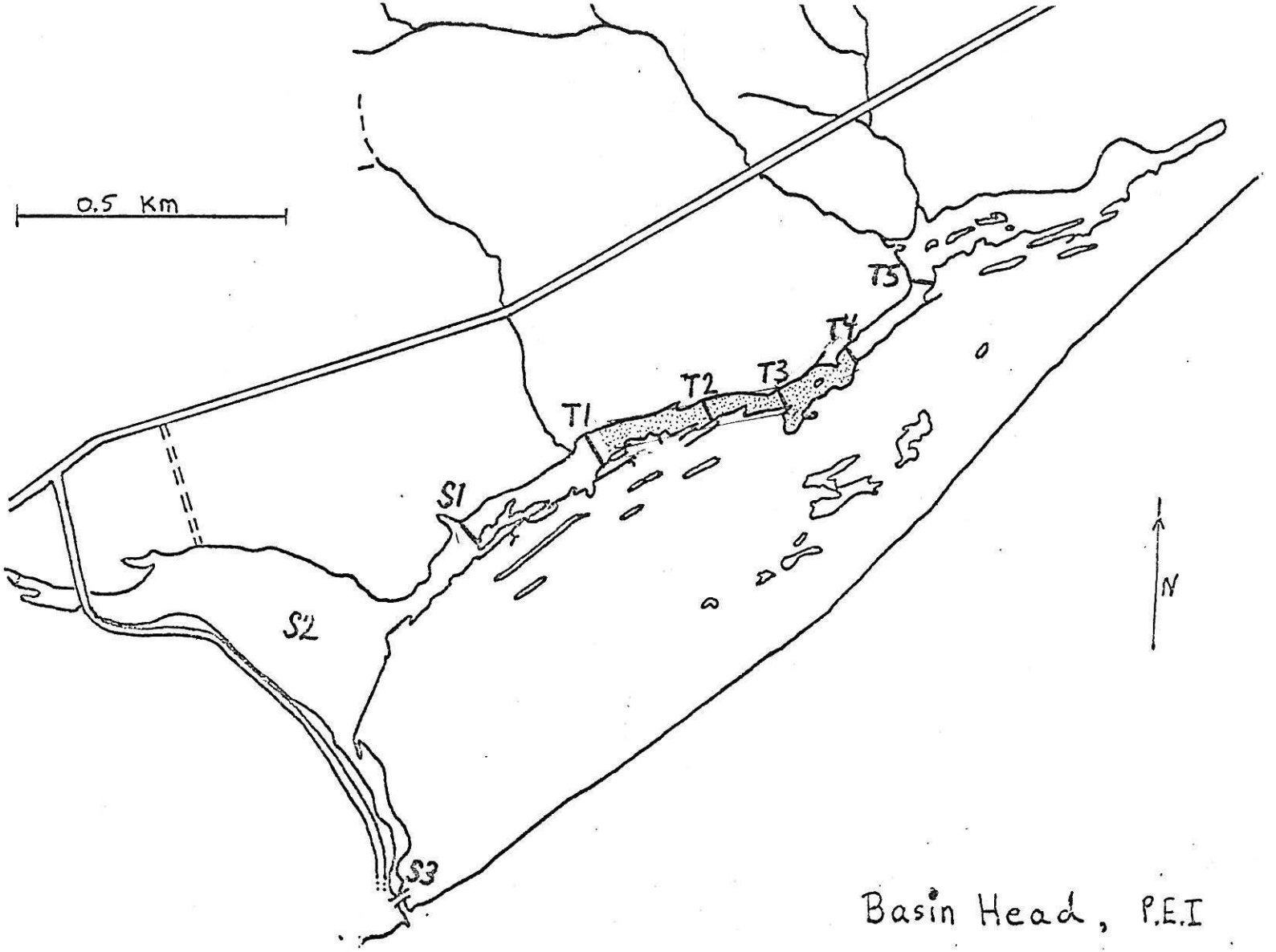
Figure 2. Map of Basin Head Harbour, P.E.I., showing transects 1 through 5 (T1 to T5) and sampling stops S1, S2 and S3. The shaded area between T1 and T4 indicates the extent of the Chondrus bed.



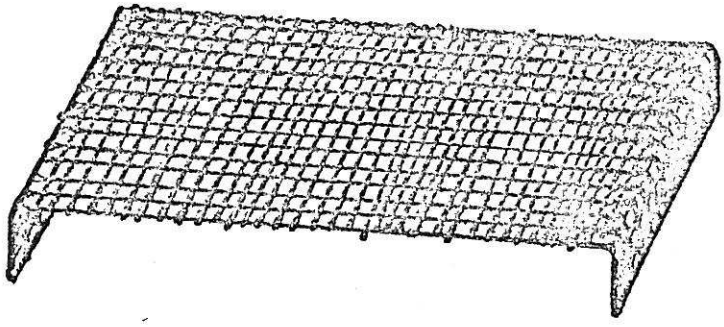
Basin Head, P.E.I

Figure 3. Screen used in transplanting studies

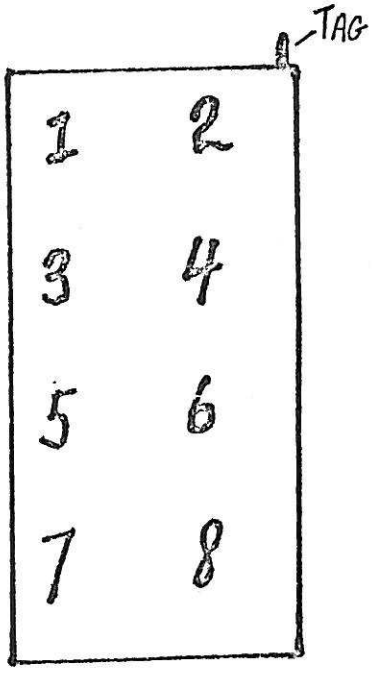
(a) diagram of screen

(b) surface of screen showing tag and reference positions

a)



b)



pendix I. Statistical tests used in calculation Chondrus biomass at Basin Head Harbour, 1980.

1) area of barrachois covered with Chondrus bed (Table 8).

$p \pm 1.96 \frac{pq}{n}$ 95% confidence interval where p is the percent of non-ashore coördinates resulting in a hit and q is the percent of non-ashore rdinates resulting in a miss, and n is the total number of -ashore coördinates.

2) Sample size $n > \frac{1.96\ S^2}{\overline{x}\ (.05)}$ 95% confidence interval

$n > \frac{1.645\ S^2}{\overline{x}\ (0.1)}$ 90% confidence interval

where n is minimum number of hits, S is sample standard ation and $\overline{x}$ is mean weight of Chondrus in a hit.

3) 90% confidence interval for biomass mean weight per sample

$$\overline{x} \pm \frac{1.645\ S}{n}$$

where $\overline{x}$ is mean weight of Chondrus per sample, S is sample standard deviation and n is number of hits

Analysis of the means of the two samples

$$z = \frac{\overline{X}_A - \overline{X}_B}{\frac{S_A^2}{n_A} + \frac{S_B^2}{n_B}}$$

Analysis of the variances of the two means, at the 95% limits of confidence

$$F_{.05(V_1 V_2)} \quad \frac{S_x^2}{S_y^2}$$

where V_1, V_2 are degrees of freedom (sample size n-1)

Appendix II. Description of transplanting sites, screen locations and growth rates of various types of Chondrus. This is intended as a complement for Tables 10 and 11.

ovehead Screens 1, 2, 3, 4, 5, 6, 25, 26 and 31.

One Covehead site was located in the channel connecting Brackley Bay and Covehead Bay, while the other site was situated just off the Stanhope Beach Lodge in Covehead Bay. The latter site was about 100 m from the beach, in patchy eel grass and shells with a soft sand-mud substrate. The channel was shallow to the north adjacent a salt marsh, and much deeper to the south, bordered by a bluff. A very swift current flowed through the deep channel on both rising and ebbing tides. The substrate was soft in the shallow areas, slightly firmer in deeper ones, with abundant eel grass and mussels and with some greenish Chondrus plants showing broadened thalli and attached to mussel shells.

Initially, 3 screens were placed in shallow water (0.5 m) amongst eel grass, mussels and Chondrus, 2 in the channel area (3,4) and one by the Stanhope Beach Lodge (1). After 30 days, BH plants on these screens were bleached and hosted an abundance of mussels, yet showed good growth. Growth was good after a further 24 days, and these plants did not fragment and rot as did specimens at other locations. Red T4 Chondrus fared poorly in the channel, but well by the lodge, while the reverse was true for the green T4. Offshore moss grew well in the first period, but poorly in the second.

Three screens (2, 5, 6) were placed in different clearings in the eel grass bed in about 2 m of water in the southern part of the channel. Growth of all plants on Screens 5 and 6 paralleled that of the shallow ones for both periods, while growth of BH plants on screen 2 varied from a large 9.5% per day to a decrease in weight the first period, and with little growth in the second. Filamentous green and brown algae were epiphytic on some plants from these deep regions.

Two screens (25, 26) of only BH Chondrus were located at Covehead several weeks later. "Foliose" plants fared better in deep water (25) while spriggy and ordinary types grew more rapidly in the shalow area (26). Growth was typically slow in the second period.

One screen of T4 Chondrus (31) was placed in deep water at Covehead. Both red and green varieties grew better in the first period, with green growing slightly faster.

Lake Screen 10

This site was located at the mouth of South Lake. The substrate was bare, and the current swift on both rising and ebbing tides. The screen was placed about 3 m from shore in 0.5 m of water.

After 27 days, the plants were covered with mussel spat and filamentous brown and green algae. Growth was relatively rapid (a few small mussels may have been inadvertently left on, increasing weights slightly). The plants were bleached green at the tips.

After a further 21 days, one plant grew nearly 9% per day (it had been reset to 18 g, and smaller plants seem to increase weight more readily) but the rest remained nearly unchanged, or became rotten and lost weight, and all were bleached green.

;ell Screen 11

This site was located at the mouth of the Midgell river, in St. Peters Bay. The substrate was covered with sparse eel grass, and there was a moderate current. The water was quite fresh at low tide, about 0.5 m deep.

After 27 days, the plants were covered with mussel spat and some silt, but no algal epiphytes. Growth was variable, but all plants gained weight.

After 21 more days, the screen and plants were very silty, and only one plant gained weight. The rest of the plants were rotting and falling to pieces.

age Harbour Screen 12

This site was located at the bridge on Rt. 350 between Canovoy and French Village. The screen was

placed north of the bridge near a mussel raft in 1.0 m of water, the salinity of which was about 17°/₀₀ at low tide. Patches of eel grass were present.

After 27 days, no mussel spat or epiphytes were found. The plants were very green, but growth was very good.

After a further 21 days, 3 plants gained weight, while the rest had lost weight either by losing pieces or by rotting.

ter Bay Screen 13

This site was located west of the bridge over the Winter River in Corran Ban on Rt. 6. The substrate was completly covered with mussels, and a swift current flowed under the bridge. The water became quite fresh at low tide. No natural vegetation was present.

After 27 days, many mussels and mussel spat had become attached to the plants and screen, and one plant had rotted away. Other plants were fragmenting but all increased in weight. Only 7 plants were reset.

After 21 more days, 3 plants decreased in weight, 3 remained nearly the same and one grew 3% per day. The plants were again covered with mussels.

ove Screen 14

This site was located at the mouth of Spry Cove, in a channel about 0.5 m deep. The substrate was coarse sand, with muddy patches with eel grass. The screen was located in sand by an eel grass patch in a swift current.

After 28 days, the screen was covered with coarse sand and all but 2 plants had been broken off. The screen was not reset.

gton Bay Screen 15

This site was located in a shallow embayment behind a short sand spit. The current was moderate, and the substrate was covered with patchy eel grass. The screen was located in a clear patch near an eel grass bed in about 0.5 m of water.

After 28 days the plants were covered with a layer of silt, and growth was variable.

After 19 more days, growth was still good with tips quite green. This exhibited one of the best growth rates for the 2nd time.

Fortune Screen 16

This site was located east of the large pier complex at Bay Fortune in about 1.0 m of water adjacent to open sea. The substrate was mud and sand, with patches of eel grass. The screen was placed in a clearing out about 30 m, in a small bay.

After 28 days, growth was consistently high but plants were bleached very green. Also, lots of amphipods and scale worms were present on the plants.

After a further 19 days, virtually no growth occurred and plants were still very green.

e Bay Screen 17

This site was located just off Rt. 310 at the mouth of Howe Bay, opposite a sand bar. The screen was placed in about 0.5 m of water in loose sand with swift current. No vegetation or mussels were noted.

After 28 days, the screen was silted over and only 2 pieces of plant remained. The current evidently created abrasion with the loose sand. No weights were taken and the screen was not reset.

in Head Harbour Screens 18, 19, 20, 7, 8 and 9

This site is located at Kingsboro on Rt. 16. The screens were set in the arm of the barrachois which extends east from the main harbour. The substrate was muddy, and a moderately swift current existed on both tidal ebb and flow.

Screens 7, 8 and 9 were composed of T4 Chondrus which had been stored for a week in an unaerated tank, and the screens were positioned in the section of the barrachois in which biomass sampling occurred. After 29

days, only one screen showed growth, and after a further 21 days no growth on a screen was observed. The T4 Chondrus is more brittle than BH stock, and more prone to fragmenting, causing weight loss. The tank storage may also have adversely affected the plants.

Screens 18, 19 and 20 were control screens of BH Chondrus and were positioned at sampling transects T1, T3 and T5. After 26 days, the plants were still red but did not grow as well as those at other sites. A further 21 days still revealed no bleaching, but the screen outside the lower limit of the Chondrus bed showed no growth, while good growth was shown by the Chondrus control within the bed. The screen outside the upper limit was lost.

Screens 18 and 19 were reset at T3 to determine growth over winter.

Pond Screen 21

This site was located in Graham Pond just to the east of the bridge on Rt. 17. The screen was placed in about 0.7 m of water of low salinity in moderate current. The substrate was muddy with many eel grass patches, and mussels were present.

After 28 days the plants were still fairly red and mussels had become attached. Growth was fairly good.

After 16 more days, only 1 plant lost weight, 2 were unchanged and the rest increased in biomass. The specimens were still unbleached, similar to BH screens.

nmure Island Screen 23

This site was located to the west of a rock breakwater off the wharf on Panmure Island. The screen was placed in firm substrate beside a patch of eel grass in about 1.0 m of water.

After 28 days, these plants were bleached green, but showed good growth. Few mussels became attached.

After a further 16 days, virtually no growth was exhibited, and the plants were still green.

yser Hole Bridge Screens 22, 24 and 30.

This site was located on Rt. 17 between Point Pleasant and Murray Harbour North, about 400 m west of the junction with 17A. A deep hole (4 m) was found on both sides of the bridge with an abundance of old oyster shells. A few Chondrus plants showing broadened thalli and attached to empty shells were found in these holes. A very swift current flowed under the bridge. Screens were initially pushed into the rocky substrate, but were subsequently anchored to a stake with string. Screen 22 was initially placed south of the bridge in shallow water, but was moved to the other side in the deep hole on the next visit.

After 28 days, the plants on screen 24 were not very bleached, and showed good growth. Mussels had become attached. Screen 22 was not found on this visit; evidently strong currents and eddies uprooted the screen. Screen 30, the T4 screen, showed particularly good growth in green T4 after 14 days.

After 16 more days, the T4 showed much less growth, perhaps due to fragmentation. Screen 24 was not found, and screen 22 was found and weighed after 44 days. Growth was variable, with one plant losing weight, and another growing 4.7% per day.

poch Screen 27

This site was located at the mouth of Charlottetown Harbour off the point at Keppoch, in a more marine than estuarine environment. The screen was set in firm substrate amongst eel grass.

After 28 days, the plants were slightly epiphytized and the tips green. Good growth was shown by all plants, but because of the lateness in summer (19 Aug.) the screen was not reset.

lsborough Screen 28

This site was locted to the north of the Hillsborough bridge on the Bunbury side of the river. The substrate was mud and sand, with a good growth of eel grass; little current flowed at this site.

After 28 days, the plants were silted over and slightly bleached. Fair growth was exhibited, with one plant losing weight as at Keppoch. The screen was not reset.

River Screen 29

This site was located west of the West River Causeway about 150 m south of the bridge. The screen was located in 1.0 m of water just where the bottom slopes off abruptly, and there was little current here.

After 24 days, the plants were heavily epiphytized with bryozoans and filamentous algae, yet still showed very good growth. The screen was left at this site.