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A Study to Develop a Replacement for the Basket-Dragrake for *Chondrus* Harvesters of the Southern Gulf of St. Lawrence

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A STUDY TO DEVELOP A REPLACEMENT FOR THE BASKET-DRAGRAKE FOR *CHONDRUS* HARVESTERS OF THE SOUTHERN GULF OF ST. LAWRENCE

by

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ABSTRACT

Pringle, J.D., J. Murchison, and D. Jones. 1979. A study to develop a replacement for the basket dragrake for *Chondrus* harvesters of the southern Gulf of St. Lawrence. Fish. Mar. Service Manuscript Report No. 1496.

The basket dragrake was banned as a *Chondrus* harvesting implement due to its adverse ecological impact. A joint industry/provincial-federal committee was created to design a replacement. It was decided the latter should be simple in design and used in conjunction with the dragrake. Two prototypes (Exp. 1 and Exp. 2), both elevated on runners, were constructed. Sea trials were conducted on the Pleasant View bed, near Miminegash, P.E.I. The experimental design included the traditional dragrake and the basket dragrake. The mean hourly production for Exp. 1, Exp. 2, and the basket dragrake was 35.1 kg, 19.4 kg, and 28.1 kg, respectively; the differences were significant ($P < 0.01$ and $P < 0.05$). The mean number of rocks snagged/h by Exp. 1, Exp. 2, and the basket dragrake was 1.6, 1.1, and 153.4, respectively; the mean number of lobsters captured/h was 0.17, 0.33, and 0.50, respectively. There was not a significant ($P < 0.05$) difference in number of immature plants captured/h between the implements, but the harvest of Exp. 1 had significantly ($P < 0.05$) more fronds attached to holdfasts (200.2 ± 88.6) than the harvest of the basket dragrake (125.9 ± 80.0). The reasons for this are discussed.

Three Exp. 1's were tested off Tignish, P.E.I., along with three dragrakes. The mean hourly production in the Exp. 1's was 126.1 kg. The mean number of rocks and lobsters/h/basket was 13.7 and 7.3, respectively; only one lobster was crushed. The percentage immature fronds and fronds attached to holdfasts in the harvests of both Exp. 1's and the dragrakes was not significantly different ($P < 0.05$).

It was concluded that Exp. 1 would be a satisfactory replacement for the basket dragrake, and its future use by harvesters is discussed.

Key words: Ecological impact, *Chondrus crispus*, Miminegash, Tignish, harvesters, basket dragrakes, holdfasts, immature plants, lobsters.

RÉSUMÉ

Pringle, J.D., J. Murchison, and D. Jones. 1979. A study to develop a replacement for the basket dragrake for *Chondrus* harvesters of the southern Gulf of St. Lawrence. Fish. Mar. Service Manuscript Report No. 1496.

L'impact écologique néfaste du râteau traînant à panier utilisé pour la récolte de *Chondrus crispus* ayant amené son interdiction, un comité composé de l'industrie et des gouvernements fédéral et provincial entreprit d'inventer un remplacement. Il fut décidé que ce dernier devrait être de conception simple, et utilisable de pair avec le râteau traînant à panier. On construisit deux prototypes (Exp. 1 et Exp. 2), tous deux élevés sur patins. Les essais en mer eurent lieu sur le banc Pleasant View, près de Miminegash, I.-P.E.I. Le râteau traînant traditionel et le râteau traînant à panier faisaient partie de l'expérience. La production moyenne horaire de l'Exp. 1, l'Exp. 2, et du râteau traînant à panier s'est élevée a 35.1 kg, 19.4 kg, et 28.1 kg, respectivement, ce qui produisit des différences significatives ($P < 0.01$ et $P < 0.05$). Le nombre moyen de cailloux ramassés par heure par l'Exp. 1, l'Exp. 2, et le râteau traînant à panier s'est élevé a 1.6, 1.1, et 153.4, respectivement; le nombre moyen de homards capturés par heure s'est élevé à 0.17, 0.33, et 0.50, respectivement. La récolte horaire de plantes immatures par les différents instruments produisit des différences non significatives ($P < 0.05$) mais la récolte de l'Exp. 1 comportait un nombre significativement plus grand de frondes attachées au disque basal (200.6 ± 88.6) que la récolte du râteau traînant (125.9 ± 88.0). Nous discutons des raisons derrière cette différence.

On fit l'essai de trois Exp. 1 au large de Tignish, I.-P.E., de pair avec trois râteaux traînants. Les Exp. 1 produisirent en moyenne 126.1 kg par heure. La nombre moyen de cailloux par heure par panier s'est élevé a 13.7 et 7.3, respectivement; un seul homard fut écrasé. Les pourcentages de frondes immatures et de frondes attachées au disque basal récoltées par les Exp. 1 et les râteaux traînants n'étaient pas significativement différents ($P < 0.05$).

En conclusion, Exp. 1 pourrait remplacer le râteau traînant à panier de façon satisfaisante et nous en discutons l'usage futur par les pêcheurs.

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INTRODUCTION

Chondrus crispus Stackhouse (Irish moss) is harvested in certain areas of the southern Gulf by dragrakes (Pringle, 1976). The morphologically mature fronds bind between the tines and are either pulled free of the holdfast or the latter is detached from the substrate. Fronds dislodged by the passage of the dragrake often do not bind between the tines and hence float free. Active dragraking in an area creates a sizeable build-up of unattached fronds. Harvesters developed the basket-dragrake (Pringle, 1979) in the early 1970's to increase the efficiency of the dragrake by recovering the unattached fronds. The basket-dragrake consists of a dragrake with metal frame (Pringle, op cit.) extending behind and over the teeth. Plasticized wire mesh is secured to the frame, creating a basket. Initially, the basket-dragrakes were deployed to gather any large quantity of unattached *Chondrus*; however, by 1974, the majority of harvesters employed them full time (Joe Wedge, pers. comm.*).

A study was initiated in 1975 to assess the ecological impact of *Chondrus* harvesting techniques (Pringle, 1979). A result of this study was the banning of the basket-dragrake (Pringle, op cit.) due to its adverse affect on both *Chondrus* and lobster (*Homarus americanus*). It tended to collect sizeable boulders, increasing the weight of the implement and increasing its scouring action on the substrate. Lobsters caught inside were crushed by the rocks.

The first author suggests that an attempt be made to replace the basket-dragrake. To this end, a joint federal/provincial (Prince Edward Island) study was undertaken in 1977. A committee of *Chondrus* harvesters was set up to guide the design of the experimental baskets.

METHODS AND MATERIALS

It was decided by the committee that an implement that would gather unattached *Chondrus* only was required; a harvester that would complement the dragrake, not replace it. The design was to be simple, not requiring pumps or hoses, and be both relatively inexpensive and maintenance free. The harvesters suggested a design based on the horse scoop (Fig. 1), a basket without tines, elevated on runners that is pulled behind horses in the surf to collect storm-tossed *Chondrus*. Two experimental baskets were constructed (Figs. 2 and 3), both elevated on runners. Exp. 1 (Fig. 2) had a low profile, while Exp. 2 (Fig. 3) was higher. (For details of the construction of Exp. 1, see Fig. 1 in the Appendix.)

The initial trials were carried out off Miminegash (Fig. 4) on the Centennial Pride, a boat owned and operated by Leo Gallant, an experienced *Chondrus* harvester. The Hauler method for retrieving the rakes was employed (Pringle, 1979); with this method the boat follows a circular pattern over the *Chondrus* bed, thus spreading the harvesting implements. The bottom harvesting gear (rakes, etc.) is attached by rope, 2.5 cm x 20 m, to the

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**Chondrus* harvester, Miminegash, P.E.I.

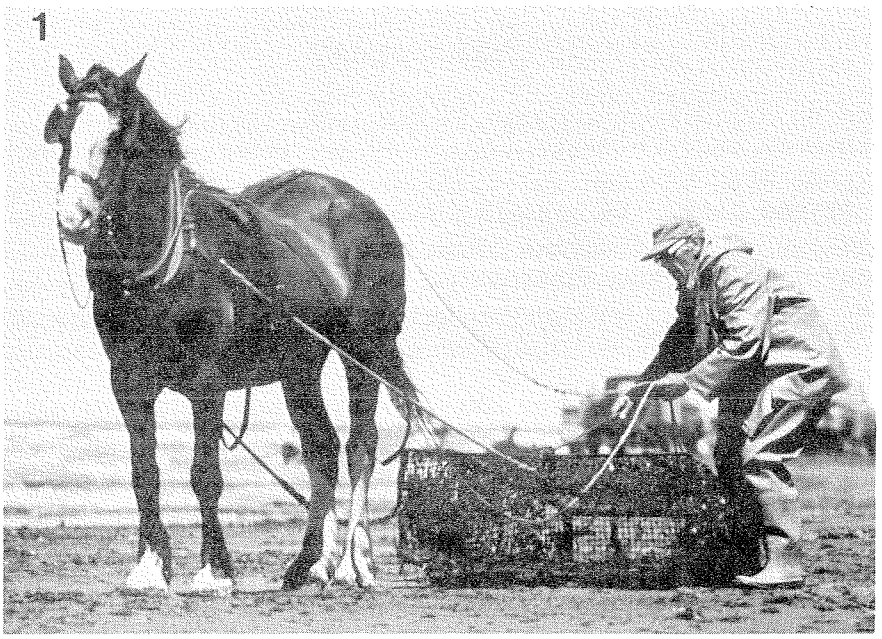

Figure 1. A *Chondrus* harvester preparing to employ a horse scoop near Miminegash, Prince Edward Island. Note the elevation of the basket on runners.

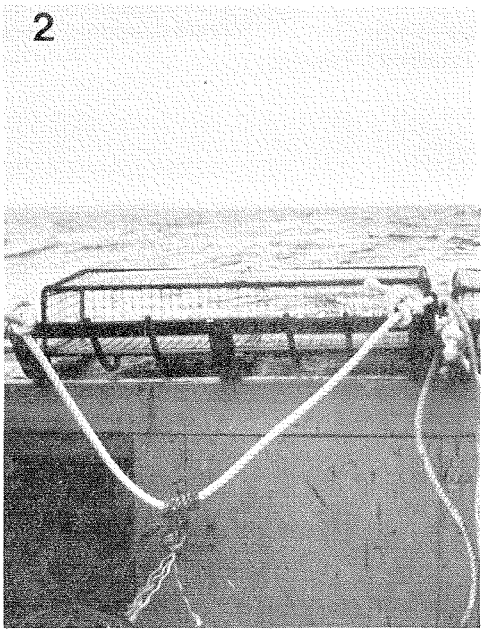

Figure 2. Experimental Basket #1 (Exp. 1).

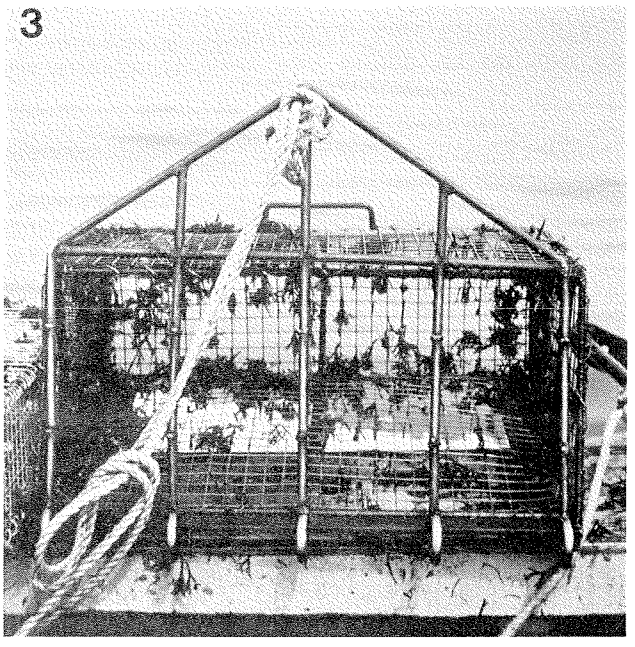

Figure 3. Experimental Basket #2 (Exp. 2).

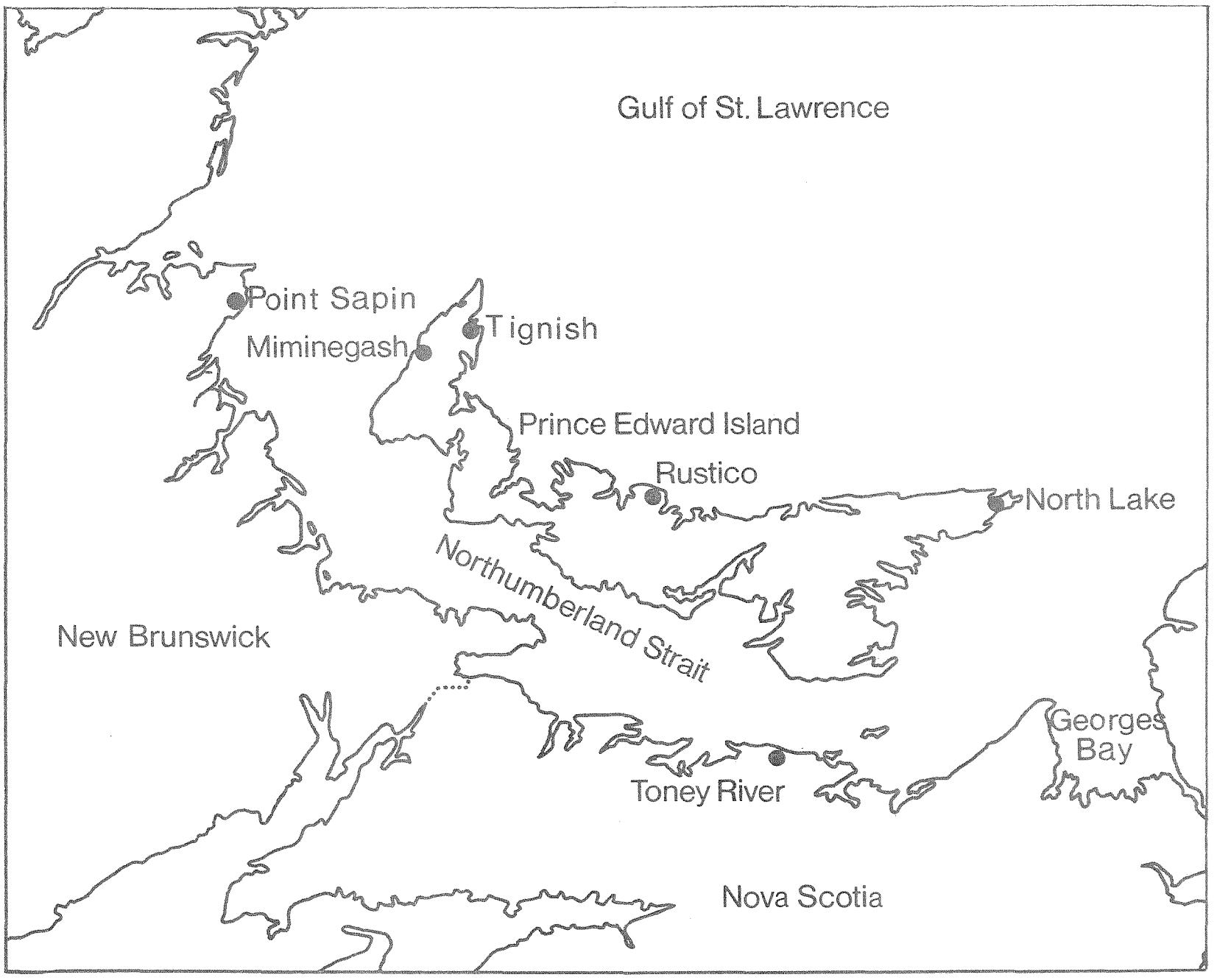

Figure 4. The southern Gulf of St. Lawrence, showing the location of Miminegash and Tignish.

bulwark and follows the boat as shown in Figure 5. Four types of implements were employed; three dragrakes, a basket-dragrake, and one each of Exp. 1 and Exp. 2. Because the position of the implements in relation to one another might affect performance, the location was changed hourly and the production recorded. Table 1 gives the hourly position and Figure 5 shows each position.

Each hourly harvest per implement was placed in polyethylene bags and weighed at days end. These hourly harvests were sampled for population structure haphazardly; the sample size was 300 g/45 kg of harvest. Each frond per sample was categorized morphologically (Classes I to IV) as described by Pringle (1979) and Pringle and Semple (1976). As well, a fifth category, Class V, was used: These are fronds with greater than three dicotomies but with a truncated stipe. Because of the latter, one is unsure whether these plants are Class III or IV.

The hourly production per implement, the number of immature (Classes I and II), and mature fronds per sample and the incidence of holdfasts per sample were grouped and a mean (Alpha 325 Univariate Statistics Pak) calculated. A Munroe Alpha 325 Scientist desk-top computer was employed for all calculations (Munroe Calculator Co., Toronto, Canada). Means were tested for significant differences with the Student's t-test for independent means, which is part of the Alpha 325 Significance Pak, 9272V.

Between August 10-16, three Exp. 1's were tested in various *Chondrus* beds off Tignish, Prince Edward Island (Fig. 4) from a 10.5 m boat skippered by *Chondrus* harvester, Edgar Gaudet. Three dragrakes were employed in front of the baskets. Samples were removed in a similar fashion as outlined above.

RESULTS

Miminegash

The number of tows per hour per implement and the respective production are given in Table 2. The mean production per tow ranged between 4.2 kg (Exp. 2) and 7.9 kg (Exp. 1). The mean production per hour per implement type (Table 3) varied significantly ($P < 0.5$), ranging between 19.4 kg (Exp. 2) and 42.6 kg (three dragrakes). The dragrake production was significantly ($P < 0.01$) greater than that of both Exp. 2 (19.4 kg) and the basket-dragrake (28.1 kg). The mean hourly production for Exp. 1 was significantly ($P < 0.05$ and $P < 0.01$) greater than both the basket-dragrake and Exp. 2.

The mean number of rocks/hour/implement ranged between 1.1 (Exp. 2) and 153.4 (basket-dragrake) with Exp. 1 acquiring only 1.6 (Table 4). The mean number of lobsters captured/hour in the basket-dragrake, the Exp. 2 and Exp. 1 was 0.50, 0.33, and 0.17, respectively (Table 4).

The number of fronds sampled per harvesting implement ranged from 2,882 (Exp. 2) to 5,692 (Exp. 1), a difference by a factor of 2.0. This difference between Exp. 1 and both the dragrakes and basket-dragrake was 1.09. Consequently, to permit statistical analyses to be based on an equal number of fronds, the number of fronds of the above were multiplied by the respective factors (Tables 5 and 6).

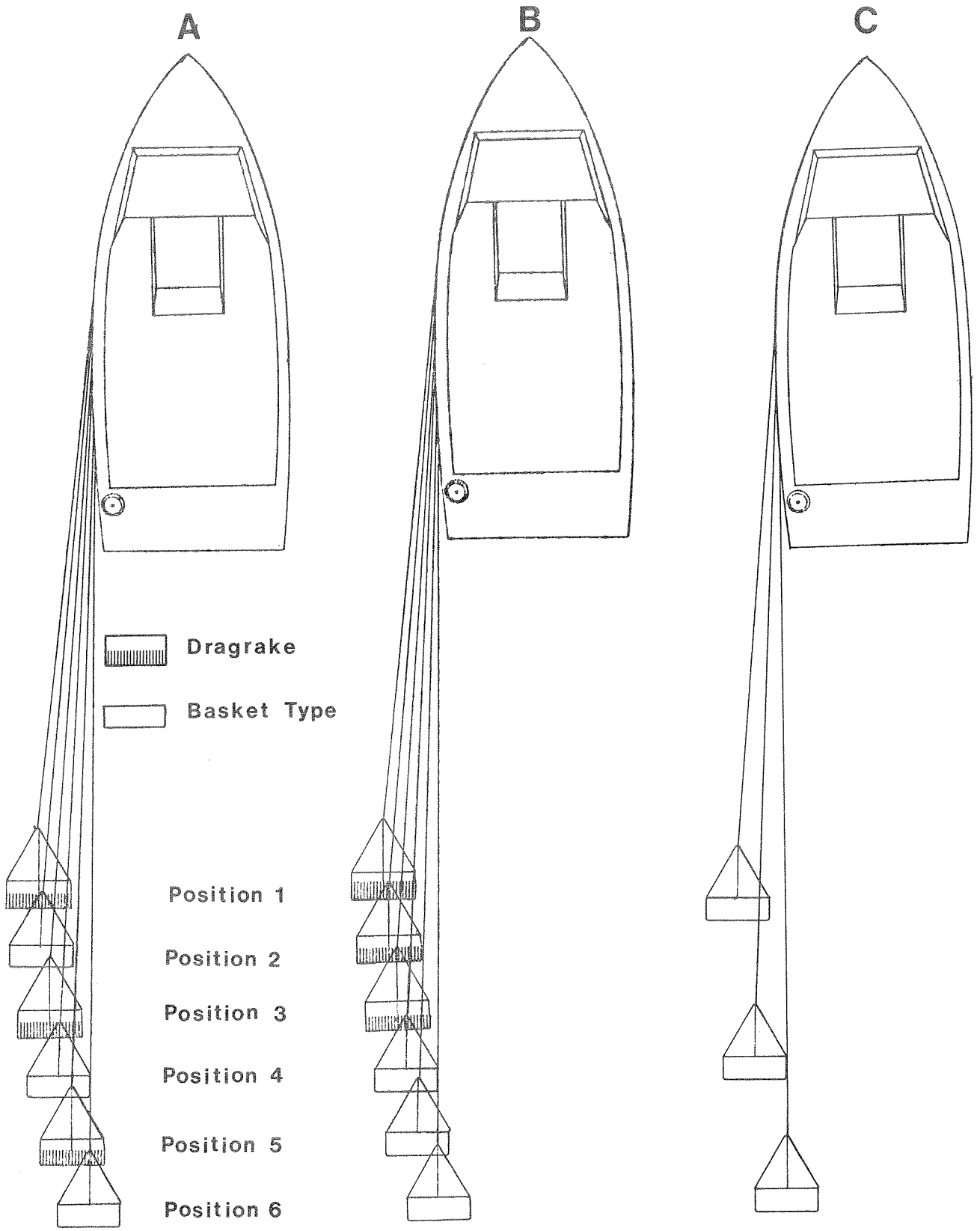

Figure 5. A diagrammatic sketch showing the aerial view of a hauler and the positioning of the harvesting gear as employed in this study.
A. The dragrakes alternating with the baskets and basket dragrake.
B. The three dragrakes preceding the baskets and basket dragrake.
C. The baskets and basket dragrakes only.

A significant difference ($P < 0.05$) was not observed in the number of immature fronds in the harvest of each of the four implements studied (Table 5). The mean number of fronds with holdfasts attached ranged between 200.2 ± 88.6 (Exp. 1) and 125.9 ± 80.0 (basket-dragrake); a significant ($P < 0.05$) difference (Table 6). The differences between the other implements in the incidence of holdfasts was not significant

Tignish

The mean hourly production per day for Exp. 1 (hereafter referred to as a basket) ranged between 73.3 kg and 176.6 kg (Table 7); the extreme variation was due to the differences between the beds harvested. The overall mean hourly production was 126.1 kg for all trials combined. The basket snared rocks at a mean rate of 2.9/tow or 13.7/hour; lobsters were captured at a mean rate of 1.5/tow or 7.3/hour. Of the 190 lobsters captured in toto, 42 had missing claws and one was crushed.

Six thousand, two hundred forty-one *Chondrus* fronds were categorized morphologically and observed for holdfasts; 3,070 from the dragrake harvest and 3,171 from the basket harvest (Table 8). The percentage immature fronds (Classes I and II) in the dragraked and basket harvests were 50.4 and 48.3, respectively (Table 3); not a significant ($P < 0.05$) difference. There was, however, significantly ($P < 0.05$) more Class V fronds in the basket harvest (Table 9). The percentage fronds attached to holdfasts in the harvest of the baskets and dragrakes was 48.2 and 51.1, respectively; not a significant difference (Table 9). The percentage immature fronds attached to holdfasts in the harvests of the baskets and dragrakes was 83.0 and 84.1, respectively.

DISCUSSION

Of the two prototypes tested, it appears Exp. 1 was superior to Exp. 2. The production was greater by a factor of 1.8, the rock snaring was only slightly greater (1.6/hour vs. 1.1/hour), lobsters captured was less (0.17/hour vs. 0.33/hour) and there was no significant difference in either the number of immature fronds or fronds bearing holdfasts (Tables 5 and 6). It is suggested that the difference in production between Exp. 1 and Exp. 2 was due to the increased height of the latter. There is sufficient room to permit the creation of an eddy once the end of the basket becomes plugged with fronds. The eddy removes fronds from the basket.

The objective of the study was to develop a harvester that would at least equal the productivity of the basket-dragrake but with a reduced ecological impact. This has been accomplished. The productivity was significantly greater (Table 3), the number of rocks snared/hour was less by a factor of 96, and the number of lobsters captured/hour was less by a factor of 3. The most important aspect of these data are the reduced number of rocks; thus, the lobsters that are captured in Exp. 1 are much less likely to be injured than in the basket-dragrake.

There was no significant ($P < 0.05$) difference in the percentage of immature fronds between the harvests of Exp. 1 and the basket-dragrake, but there were significantly ($P < 0.05$) more plants attached to holdfasts in the former. This was unexpected. The basket-dragrake is equipped with tines (Pringle, 1979) and is towed in direct contact with the ocean bottom. Exp. 1 is elevated off the ocean bottom on three runners (Fig. 2). Consequently, the only fronds harvested are those severed but not retained by the dragrake preceding it or the unattached fronds that are winnowed by the dragrake. There is little doubt the runners of Exp. 1 sever attached fronds, but they would not be captured directly as the runners do not precede the basket. The significantly higher number of fronds attached to holdfasts in the Exp. 1 harvest must be due to a significantly higher number of them in the unattached population.

The bulk of the unattached *Chondrus* in dragraked beds during the harvesting season is due to the passage of dragrakes and basket-dragrakes. Fronds bearing holdfasts are retained by dragrakes given that there is a frond sufficiently long enough to bind between the tines and that binding takes place. Due to the passage of these implements, holdfasts are scoured off the substrate (particularly when the basket-dragrakes were employed) at a greater rate than those pulled off due to mature fronds binding between dragrake tines. (The greater majority likely bear immature fronds as 86.2% of the immature plants did [Table 1, Appendix].) These scoured holdfasts become part of the unattached population and it appears, are recovered by Exp. 1 more efficiently than the basket-dragrake. In an unpublished study, the size of holdfasts removed by each implement was determined (Pringle, unpublished data). Those recovered in the harvest of Exp. 1 were significantly ($P < 0.05$) smaller than those removed by dragrakes.

It is obvious from the production figures (Table 3) that the use of Exp. 1 (hereafter referred to as basket) would be beneficial to the harvester. Four baskets and four rakes could be employed simultaneously; the placement would depend on the nature of the resource. Were there a lot of unattached *Chondrus*, it would be worthwhile emptying the baskets when the rakes are cleaned (every three to four minutes). The most efficient method of arranging the rakes and baskets could then be employed; a rake alternating with a basket (the technique yielded 53.6 kg/hour). Given the conditions of the study, late June, the harvester could then expect 1715.2 kg/8-hour day. If there is proportionally more attached than unattached *Chondrus*, the four rakes could be placed in front of the four baskets (this technique yielded 46.6 kg/hour). Again, under the conditions of these trials this would yield 1491.2 kg/8-hour day. It should be noted that these trials were carried out when harvesting was at a lull due to low resource.

The basket does not recover unattached *Chondrus* independently; a device such as a dragrake must precede it to produce a winnowing effect; obviously the distance between the dragrake and the basket is important - too close and the basket rides the rake, too great and the *Chondrus* settles before collection can take place.

The basket functioned well over the boulder-strewn bottom off Tignish. It should be noted that the trials were carried out three weeks after the peak harvest. As well, trials were carried out when often the unattached concentration was low. Nevertheless, the mean overall hourly productivity was 126.1 kg (Table 7) for the three baskets. This would equal 168.1 kg/hour for four units, or 1344.8 kg/8-hour day. On August 16, the mean hourly production for 6.2 hours was 176.6 kg for three units; were four used, one could expect 235.5 kg, or 1884.0 kg/8-hour day. Mr. Gaudet, the skipper, was extremely interested and would like to see the basket adopted in his district (Marine Plant Harvesting District 2). More lobsters were captured in this district as the trials were held later than in District 1 (it appears lobsters move onto the *Chondrus* beds in late July [Pringle, unpublished data]). However, of the 190 captured, only one was crushed; 22% had claws missing; but a good percentage of this damage was likely due to other causes (Scarratt, 1973). The majority of mossers are lobstermen as well; thus, the bulk of the captured lobsters will be returned to the ocean.

All basket-type implements are banned to *Chondrus* harvesters in all marine plant harvesting districts; consequently, to permit the use of the basket, changes in the Atlantic Coast Marine Plant Regulations would have to be made. The only reservation the authors have is that the runner basket requires a preceding implement to create the winnowing effect. To make the operation efficient, this would have to be a dragrake. Unfortunately, the dragrake removes holdfasts (Pringle, 1979). When dragrakes only are employed, the harvester will move to new grounds once mature plants are depleted. However, if there is a large quantity of unattached plants over an already extensively harvested bed, then the harvester could find it profitable to continue harvesting when using the basket, despite few mature plants being removed in the tines. The extent to which this might happen is unknown and should be determined.

On the other hand, there is the possibility the use of the basket could reduce adverse ecological impact. The daily effort of the majority of harvesters is a function of the amount they require to make a living wage. They may have to pull six dragrakes for eight hours to achieve this. If the basket were employed they may either only harvest six hours to attain this or pull three dragrakes and three baskets. Either way, it would be beneficial as the ecological impact of the basket is less than the dragrake.

The other alternative is to make the basket self winnowing. This would permit it to be employed without the dragrake in areas where there were large concentrations of unattached *Chondrus* but where the attached *Chondrus* is immature. Studies should be carried out to develop a self-winnowing basket.

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TABLE 1. The positioning of implements (D.R. = Dragrake, Exp. 1 = Experimental Basket #1, Exp. 2 = Experimental Basket #2, and Bask. D.R. = Basket Dragrake) behind the boats; hauler method employed.

Hour of study	Position of implements					
	1	2	3	4	5	6
1	D.R.	D.R.	D.R.	Exp. 1	Exp. 2	Bask. D.R.
2	D.R.	Exp. 1	D.R.	Exp. 2	D.R.	Bask. D.R.
3	Exp. 1	Exp. 2	Bask. D.R.			
4	D.R.	D.R.	D.R.	Exp. 1	Exp. 2	Bask. D.R.
5	D.R.	Bask. D.R.	D.R.	Exp. 1	D.R.	Exp. 2
6	Bask. D.R.	Exp. 1	Exp. 2			
7	D.R.	D.R.	D.R.	Bask. D.R.	Exp. 2	Exp. 1
8	D.R.	Exp. 1	D.R.	Bask. D.R.	D.R.	Bask. D.R.
9	Exp. 2	Bask. D.R.	Exp. 1			
10	D.R.	D.R.	D.R.	Exp. 1	Exp. 2	Bask. D.R.
11	D.R.	Exp. 1	D.R.	Exp. 2	D.R.	Bask. D.R.
12	Exp. 1	Exp. 2	Bask. D.R.			
13	D.R.	D.R.	D.R.	Bask. D.R.	Exp. 2	Exp. 1
14	D.R.	Bask. D.R.	D.R.	Exp. 1	D.R.	Exp. 2
15	Bask. D.R.	Exp. 1	Exp. 2			
16	D.R.	D.R.	D.R.	Exp. 1	Exp. 2	Bask. D.R.
17	D.R.	Exp. 2	D.R.	Bask. D.R.	D.R.	Exp. 1
18	Exp. 2	Bask. D.R.	Exp. 1			

TABLE 2. The hourly production for each of four types of harvesting implements tested off Miminegash.

Hour of study	Dragrakes		Basket dragrake		Exp. 1		Exp. 2	
	No. of tows	Prod. (kg)	No. of tows	Prod. (kg)	No. of tows	Prod. (kg)	No. of tows	Prod. (kg)
1	9	61.2	3	30.2	3	32.2	2	17.2
2	4	38.3	4	27.9	4	34.5	4	6.8
3	-	-	5	31.8	5	-	5	10.4
4	8	59.2	3	18.1	3	44.2	3	24.3
5	4	36.3	4	36.1	4	37.7	4	41.3
6	-	-	5	10.4	5	65.8	5	40.8
7	10	49.7	4	34.7	3	31.2	3	8.9
8	5	44.2	5	37.0	5	39.7	5	9.8
9	-	-	5	39.9	5	36.5	5	-
10	9	48.8	3	18.8	3	28.1	3	11.8
11	4	49.0	4	25.4	4	44.5	4	34.2
12	-	-	5	40.6	5	-	5	13.4
13	7	44.5	4	42.0	4	29.5	4	28.8
14	3	19.7	3	19.7	3	26.8	3	5.7
15	-	-	4	23.4	4	36.3	4	19.7
16	5	32.7	3	18.4	3	17.9	3	18.4
17	4	27.9	4	31.5	4	24.0	4	-
18	-	-	4	20.4	4	33.1	4	-
Total	72	511.5	72	506.3	71	562.0	70	291.5
Mean prod./tow		7.1		7.0		7.9		4.2

TABLE 3. Student's t-values between the hourly production of each harvesting technique tested off Miminegash.

	Hourly production (kg)	Student t-values		
		Dragrake	Basket dragrake	Exp. 1
Dragrake	42.6 ± 12.3[a]			
Basket Dragrake	28.1 ± 9.3	3.69 (v = 28)**		
Exp. 1	35.1 ± 10.8	1.72 (v = 26)	2.04 (v = 32)*	
Exp. 2	19.4 ± 12.0	4.95 (v = 25)**	2.36 (v = 31)	3.85 (v = 29)**

*Significant at the 0.05 level
**Significant at the 0.01 level
[a]One standard deviation

TABLE 4. The number of rocks and lobsters per basket type per hour of harvest.

Date of observations	Hour No.	No. of rocks and lobster/implement					
		Basket dragrake		Exp. 1		Exp. 2	
		Rocks	Lobster	Rocks	Lobster	Rocks	Lobster
28 June	1	143	2	2	0	1	1
	2	199	0	5	0	0	0
	3	255	1	0	0	0	0
	4	205	1	0	0	0	0
	5	143	0	2	0	0	0
	6	162	1	2	0	0	0
29 June	7	109	0	3	0	0	0
	8	147	0	3	0	3	0
	9	127	1	1	1	2	1
	10	98	0	2	0	0	0
	11	194	1	1	0	1	0
	12	245	0	1	0	1	0
30 June	13	155	0	1	0	0	1
	14	120	0	0	0	4	0
	15	78	0	2	0	6	2
	16	200	0	1	0	2	0
	17	81	0	0	2	0	0
	18	101	2	2	0	0	1
Totals		2,762	9	28	3	20	6
Mean no. per hour		153.4	0.50	1.6	0.17	1.1	0.33

TABLE 5. Student's t-values for the number of immature fronds in each harvest from Miminegash.

Method of harvesting	Mean no. of immature fronds	Adjusted mean no. of immature fronds	Student t-value		
			Dragrake	Basket dragrake	Exp. 1
Dragrakes	156.2 ± 81.2[c]	171.1[a] ± 88.8			
Basket dragrakes	124.4 ± 75.9	139.4[a] ± 81.6	0.99 (v = 27)		
Exp. 1	204.7 ± 96.1	204.7 ± 96.1	0.91 (v = 23)	2.01 (v = 28)	
Exp. 2	84.2 ± 66.7	168.4[b] ± 133.5	0.06 (v = 24)	0.75 (v = 29)	0.81 (v = 25)

Adjustment factor: a = 1.09
b = 2.0

[c]One standard deviation.

TABLE 6. Student's t-values for the number of fronds attached to holdfasts in each harvest from Miminegash.

Method of harvesting	Mean no. of fronds bearing holdfasts	Adjusted mean no. of holdfasts	Student's t-values		
			Dragrake	Basket dragrake	Exp. 1
Dragrake	171.5 ± 101.8[c]	186.9 ± 111.0[a]			
Basket dragrake	115.5 ± 73.4	125.9 ± 80.0[a]	1.73 (v = 27)		
Exp. 1	200.2 ± 88.6	200.2 ± 88.6	0.33 (v = 23)	2.41 (v = 28)*	
Exp. 2	73.9 ± 60.6	147.7 ± 121.2[b]	0.86 (v = 24)	0.60 (v = 29)	1.28 (v = 25)

Adjustment factors: a = 1.09
b = 2.00

*Significant at the 0.05 level.

[c]One standard deviation

TABLE 7. Data gathered during the assessment of the Experimental Basket #1 in Chondrus beds off Tignish.

Date	Hours harvesting	Daily production (kg)	Hourly production (kg)	No. of tows	Rocks		Lobsters			
					Total no.	No./tow	Total no.	No./tow	No. with claws missing	No. crushed
10 Aug.	4.0	337.5	84.4	13	46	3.5	13	1.0	3	0
11 Aug.	4.5	608.7	135.3	21	66	3.1	21	1.0	5	1
12 Aug.	6.0	440.0	73.3	34	30	0.9	31	0.9	0	0
15 Aug.	5.5	821.9	149.4	27	91	3.4	63	2.3	17	0
16 Aug.	6.2	1 095.0	176.6	28	125	4.5	62	2.2	17	0
Total	26.2	3 303.1	619.0	123	358		190.0	1.5	42	1
Mean			126.1			2.9				

TABLE 8. Summary of harvesting data gathered from both dragrakes and Exp. 1 from Chondrus beds off Tignish.

Harvesting method		Number of fronds in each category					Total no. of fronds	Number of fronds attached to holdfasts				Total no. with holdfasts
		1	2	3	4	5		1	2	3	4	
Basket	Total no. fronds	922.00	610.00	713.00	154.00	772.00	3,171.0	907.0	362.00	250.00	10.00	1,529.00
	Mean no. fronds	131.70 ± 72.00[a]	87.10 ± 47.86	101.90 ± 33.36	22.00 ± 6.90	110.30 ± 33.65	453.0	129.60 ± 71.78	51.70 ± 32.68	35.70 ± 30.79	1.40 ± 1.40	218.40
	Percentage	29.10	19.20	22.50	4.90	24.30		59.30	23.70	16.40	0.70	48.20
Dragrake	Total no. fronds	931.00	616.00	920.00	171.00	432.00	3,070.0	922.00	379.00	237.00	12.00	1,568.00
	Mean no. fronds	133.00 ± 20.00	88.00 ± 19.71	131.40 ± 23.08	24.40 ± 8.87	61.70 ± 32.59	483.6	131.70 ± 20.00	56.70 ± 12.91	33.90 ± 13.48	1.70 ± 1.80	224.00
	Percentage	30.30	20.10	30.00	5.60	14.10		58.80	25.30	15.10	0.80	51.10

[a]One standard deviation

TABLE 9. Student t-values between samples collected from Dragrakes and Exp. 1 from Chondrus beds off Tignish.

	Number of fronds in each category					Number of fronds attached to holdfasts				Total number holdfasts
	1	2	3	4	5	1	2	3	4	
t-values (v = 12)	0.05	0.04	1.93	0.57	2.75*	0.08	0.38	0.15	0.33	0.12

*Significant at the 0.05 level.

APPENDIX

TABLE 1. The number of fronds in each morphological class, both attached and unattached to holdfasts, for the three dragrakes.

Hour of study	The number of fronds/ morphological class					The number of plants attached to holdfasts/class			
	1	2	3	4	5	1	2	3	4
1	71	58	213	84	122	70	37	33	2
2	69	71	133	21	82	67	34	21	0
3	-	-	-	-	-	-	-	-	-
4	229	146	263	61	114	229	115	96	10
5	47	27	100	46	92	45	21	14	0
6	-	-	-	-	-	-	-	-	-
7	78	53	186	73	90	75	24	36	3
8	107	51	149	59	96	106	35	38	1
9	-	-	-	-	-	-	-	-	-
10	126	64	170	62	56	123	46	46	9
11	49	45	147	34	72	49	24	23	0
12	-	-	-	-	-	-	-	-	-
13	118	116	141	52	97	117	83	38	14
14	69	17	69	13	40	68	7	14	0
15	-	-	-	-	-	-	-	-	-
16	81	57	116	38	53	81	36	26	8
17	85	50	77	34	67	85	39	10	0
18	-	-	-	-	-	-	-	-	-
Total	1,129	755	1,764	577	981	1,115	501	395	47
						86.2%		13.3%	

TABLE 2. The number of fronds in each morphological class, both attached and unattached to holdfasts, for the basket dragrake.

Hour of study	Number of fronds/ morphological class					Number of fronds attached to holdfasts/morphological class			
	1	2	3	4	5	1	2	3	4
1	-	-	-	-	-	-	-	-	-
2	23	26	65	21	88	18	13	5	0
3	59	51	95	12	39	59	21	12	0
4	32	30	51	9	48	32	15	3	0
5	36	99	112	20	160	32	38	5	0
6	1	9	24	1	30	1	3	0	0
7	131	167	177	29	109	128	106	33	1
8	107	56	110	43	74	104	40	36	0
9	121	96	123	32	86	121	68	52	0
10	70	58	66	9	69	70	39	17	0
11	61	29	45	22	58	59	24	12	0
12	37	21	84	44	75	36	13	6	5
13	86	92	133	41	48	66	26	19	0
14	100	86	72	8	83	100	56	18	0
15	37	22	54	11	32	36	16	10	0
16	52	19	50	8	54	51	14	5	0
17	118	85	124	28	131	111	49	9	0
18	104	53	55	18	72	103	44	12	1
Total	1,175	999	1,440	356	1,256	1,127	585	254	7

TABLE 3. The number of fronds in each morphological class, both attached and unattached to holdfasts, for Exp. 1.

Hour of study	Number of fronds/ morphological class					Number of fronds/morphological class attached to holdfasts			
	1	2	3	4	5	1	2	3	4
1	70	42	91	24	50	70	31	16	1
2	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-
5	38	37	112	33	83	35	22	19	1
6	193	212	240	41	152	183	100	58	4
7	139	78	135	22	63	133	39	22	0
8	132	85	143	51	93	130	62	19	3
9	174	61	142	43	64	174	42	33	4
10	52	21	71	26	54	49	11	8	1
11	165	117	139	32	65	161	79	31	0
12	-	-	-	-	-	-	-	-	-
13	126	89	137	21	70	122	50	24	1
14	105	72	97	23	64	102	49	39	0
15	94	62	101	29	52	91	53	26	2
16	-	-	-	-	-	-	-	-	-
17	100	66	119	17	72	95	33	23	1
18	224	107	144	26	90	221	87	42	1
Total	1,612	1,049	1,671	388	972	1,566	658	360	19

TABLE 4. The number of plants in each morphological class, both attached and unattached to holdfasts, for the experimental basket #2.

Hour of study	Number of fronds/ morphological class					Number of fronds/morphological class attached to holdfasts			
	1	2	3	4	5	1	2	3	4
1	28	36	73	12	29	27	12	13	0
2	6	15	24	3	7	0	6	3	0
3	12	12	31	3	22	12	7	1	0
4	60	57	74	24	49	59	5	9	3
5	60	46	115	42	93	57	20	16	1
6	76	110	149	36	104	76	41	6	1
7	11	15	24	7	17	11	9	1	0
8	12	5	24	7	20	12	4	7	3
9	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-
11	39	47	92	42	54	37	36	13	2
12	8	11	21	9	54	8	4	2	0
13	131	95	107	28	71	126	65	30	8
14	57	60	23	6	10	57	52	6	0
15	76	57	64	8	30	76	44	15	0
16	18	19	66	8	21	18	11	11	1
17	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-
Total	594	585	887	235	581	576	316	133	19

TABLE 5. The number of fronds and the number attached to holdfasts in each morphological category from the harvest of dragrakes off Tignish.

Date	Sample Number	Weight of Chondrus (g)	Number of fronds in each category					Total no. of fronds	Number of fronds attached to holdfasts				Total no. with holdfasts
			1	2	3	4	5		1	2	3	4	
11 Aug.	1		152	77	152	15	63	459	149	41	31	0	221
	2	286.0	157	55	144	34	43	433	157	44	49	1	251
	3	123.0	142	81	114	28	52	417	142	54	30	2	228
17 Aug.	1		139	115	140	20	39	453	137	69	29	0	235
	2		114	102	147	28	44	435	113	76	14	5	208
	3	424.5	103	100	136	34	133	506	102	62	54	1	219
	4	207.7	124	86	87	12	58	367	122	51	30	3	206
			931	616	920	171	432	3,070	922	397	237	12	1,568
			133	88	131.4	24.4	61.7	438.6	131.7	56.7	33.9	1.7	224

TABLE 6. The number of fronds, and the number attached to holdfasts, in each morphological category from the harvest of the Exp. 1 off Tignish.

Date	Sample number	Weight of *Chondrus* (g)	Number of fronds in each category					Total no. of fronds	Number of fronds attached to holdfasts				Total no. with holdfasts
			1	2	3	4	5		1	2	3	4	
11 Aug.	1	242.7	98	47	87	30	120	382	98	21	6	1	126
	2	330.0	231	168	164	22	178	763	229	91	100	2	422
	3	326.6	106	40	84	32	84	346	106	29	33	4	172
17 Aug.	1	295.1	38	66	75	16	86	281	38	35	24	0	97
	2	382.0	139	132	120	16	120	527	132	92	19	0	243
	3	328.0	227	98	114	15	98	552	223	74	45	1	343
	4	316.0	83	59	69	23	86	320	81	20	23	2	126
Totals		2,220.4	922	610	713	154	722	3,171	907	362	250	10	1,529
Mean		317.2	131.7	87.1	101.9	22.0	110.3	453	129.6	51.7	35.7	1.4	218.4

TABLE 7. The number, and adjusted number, of fronds with holdfasts in each sample: harvesting area - Miminegash.

Sample Number	Dragrakes		Basket Dragrakes		Exp. 1	Exp. 2	
	No. of holdfasts	Adjusted no. of holdfasts (1.09)	No. of holdfasts	Adjusted no of holdfasts (1.09)		Holdfasts	Adjusted no. of holdfasts (2.0)
1	142	154.8	-	-	118	52	104
2	122	133.0	36	39.2	-	9	18
3	-	-	92	100.3	-	20	40
4	450	490.5	50	54.5	-	76	152
5	80	87.2	65	70.9	77	94	188
6	-	-	4	4.4	345	124	248
7	138	150.4	268	292.1	194	21	42
8	180	196.2	180	196.2	214	24	48
9	-	-	241	262.7	253	-	-
10	224	244.2	126	137.3	69	-	-
11	96	104.6	95	103.6	271	188	176
12	-	-	60	65.4	-	14	28
13	252	274.7	111	121.0	197	221	442
14	89	97.0	174	189.7	190	115	230
15	-	-	62	67.6	172	135	270
16	151	164.6	70	76.3	-	41	82
17	134	146.1	169	184.2	152	-	-
18	-		160	174.4	351	-	-
Mean	171.5 ± 101.8[a]	186.9 ± 111.0	115.5 ± 73.4	125.9 ± 80.0	200.2 ± 88.6	73.9 ± 60.6	147.7 ± 121.2

[a]One standard deviation

TABLE 8. The number, and adjusted number, of immature fronds for each harvesting technique tested off Miminegash.

Sample number	Dragrakes		Basket Dragrakes		Exp. 1	Exp. 2	
	Number of immature fronds	Adjusted no. of immature fronds (1.09)	Number of immature fronds	Adjusted no. of immature fronds (1.09)		Number of immature fronds	Adjusted no. of immature fronds (2.0)
1	129	140.6	-	-	112	64	128
2	140	152.6	49	53.3	-	21	42
3	-	-	110	119.9	-	24	48
4	375	408.7	62	67.6	-	117	234
5	74	80.6	75	147.1	75	106	212
6	-	-	10	10.9	405	186	372
7	131	142.8	298	324.8	217	26	52
8	158	172.2	163	177.6	217	17	34
9	-	-	217	236.5	235	-	-
10	180	207.1	128	139.5	73	-	-
11	94	102.5	90	98.1	282	86	172
12	-	-	58	63.2	-	19	38
13	234	255.0	178	194.0	215	226	452
14	86	93.7	186	202.7	177	117	234
15	-	-	59	64.3	156	133	266
16	138	150.4	71	77.4	-	37	74
17	135	147.2	203	221.3	166	-	-
18	-	-	157	171.5	331	-	-
Mean	156.2 ± 81.2[a]	171.1 ± 88.8	124.4 ± 75.9	139.4 ± 81.6	204.7 ± 96.1	84.2 ± 66.7	168.4 ± 133.5

[a]One standard deviation.

TABLE 9. Percentage fronds in each morphological category and percentage of each attached to holdfasts (Miminegash).

Method employed	Total no. of fronds	Percentage fronds in each category					% fronds attached to holdfasts	Percentage fronds in each category attached to holdfasts			
		1	2	3	4	5		1	2	3	4
Dragrakes	5,206	21.7	14.5	33.9	11.1	18.9	39.5	98.8	66.4	22.4	8.2
Basket dragrakes	5,226	22.5	19.1	27.6	6.8	24.0	37.8	95.9	58.6	17.6	2.0
Exp. 1	5,692	28.3	18.4	29.4	6.8	17.1	45.7	97.2	62.7	21.5	4.9
Exp. 2	2,882	20.6	20.3	30.8	8.2	20.2	36.2	97.0	54.0	15.0	8.1

EXPERIMENTAL BASKET NUMBER I

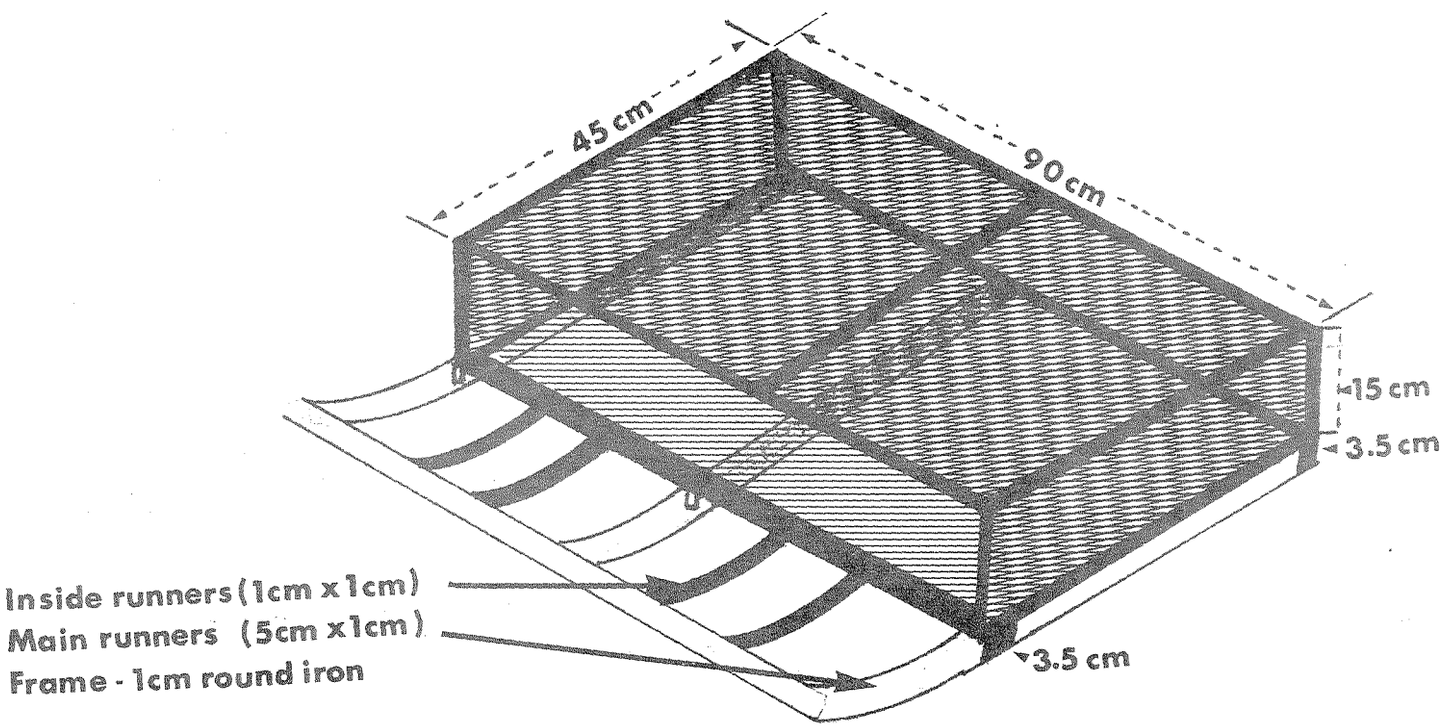

Figure 1. A diagrammatic sketch of the Experimental Basket #1 (Exp. 1), showing its dimensions.