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The Impact of *Chondrus* Dragraking on Substrate Stability in Southwestern Nova Scotia

by

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ABSTRACT

Sharp, G.J. and D.L. Roddick. 1980. The impact of Chondrus dragraking on stubstrate stability in southwestern Nova Scotia. Can. MS Rep. Fish. Aquat Sci. 1593: v + 14 p.

Dragrakes and handrakes are the *Chondrus crispus* harvesting tools in southwestern Nova Scotia. Reports of serious substrate damage by the dragrake prompted an extensive survey and experimental program by the Marine Plants Section of Resource Branch, Department of Fisheries and Oceans, in 1979. Dragrakes were found to overturn rocks up to 58 cm x 43 cm maximum dimensions. The total bottom disruption averaged 0.6% to 4.8% of the bottom area, reaching a maximum of 6.8%. Substrate disruption was cumulative - up to eight hours of dragging the same area. The average size of displaced rocks was constant (0.05-0.07 m^2) after the peak of harvesting effort. Dragraking was restricted to 43% of the commercial *Chondrus* beds surveyed and to 11% of the harvest effort. Damage to the resource was sufficient to recommend the development of new harvest methods and phasing out of the dragrake.

Key Words: *Chondrus crispus*, dragrake, substrate, harvest.

RÉSUMÉ

Sharp, G.J. and D.L. Roddick. 1980. The impact of *Chondrus* dragraking on substrate stability in southwestern Nova Scotia. Can. MS Rep. Fish. Aquat. Sci. 1593 : v + 14 p.

Les instruments de récolte de *Chondrus crispus* dans le sud-ouest de la Nouvelle-Écosse sont le râteaux traînant et le râteau à main. A la suite de rapports de dommages sérieux au substrat causés par les râteaux traînants, la Section des plantes marines de la Direction des ressources, ministère des Pêches et des Océans, a entrepris un vaste relevé et un programme expérimental en 1979. On a constaté que les râteaux traînants pouvaient renverser des roches aussi grosses que 58 cm x 43 cm. La perturbation totale du fond représente en moyenne de 0.6 à 4.8% de la superficie du fond, atteignant 6.8%. La perturbation du substrat est cumulative - jusqu'à huite heures de dragage dans la même région. La grosseur moyenne des roches déplacées est uniforme (0.05-0.07 m^2) une fois dépassé le sommet de l'effort de récolt. Nous avons limité le dragage au râteau traînant à 43% des lits commerciaux de Chondrus étudiées et à 11% de l'effort de récolte. Les dommages causés à la ressource sont suffisamment étendus pour recommander la mise au point de nouvelles méthodes de récolte et l'élimination graduelle du râteau traînant.

INTRODUCTION

Chondrus crispus Stackhouse off southwestern Nova Scotia (S.W.N.S.) occurs on granite drumlin (rock and boulders) from 3.5 m above chart datum to 11 m below (Pringle, 1979). The principal means of *Chondrus* harvest in this region is the handrake (MacFarlane, 1956). However, this method is restricted to the low tide and water depth above 3 m. Significant areas of deep-water *Chondrus* beds (< 3 m) exist in S.W.N.S. (Haggerty and Hellenbrand, 1976).

Dragraking is a means of extending the daily harvesting period beyond the low tide and reaching deep-water beds. In the Gulf of St. Lawrence, dragraking from 9 m to 11 m vessels is the principal means of harvesting *Chondrus* on flat sandstone ledges. The ecological impact of this technique for the Gulf was described by Pringle (op. cit.).

Chondrus dragrakes in S.W.N.S. are small (0.9 m x 0.65 m, 15 kg) and are operated from 3.9 m to 4.5 m outboard-powered skiffs (Figure 1). The rake is towed parallel to the shoreline at 0.5 to 1.5 knots. The duration of a tow varies greatly with site, sea state, and standing crop. The rake is pulled in and boarded by hand; *Chondrus* fronds are removed from the tines and large extraneous algae are discarded. Frequently, the dragrake is used to supplement the normal handraking period, although the former is the sole means of harvest for some individuals. Present licensing policy restricts dragraking in southwestern Nova Scotia to those that used this method prior to 1977. This was at the request of harvesters who indicated that dragraking caused significant disruption of the substrate in *Chondrus* beds and that this could be a threat to future yields. A study was thus initiated in May of 1979 to assess the impact of dragraking in *Chondrus* beds.

METHODS

Three approaches were taken to examine the use and impact of dragraking in Lobster Bay (Figure 2). First, test dragraking was carried out in defined areas prior to season opening of June 7 and in a closed area during the season. Second, selected commercial dragraking sites were surveyed for bottom disruption (Figure 3). Thirdly, dragraking effort was assessed for the harvest season in Lobster Bay.

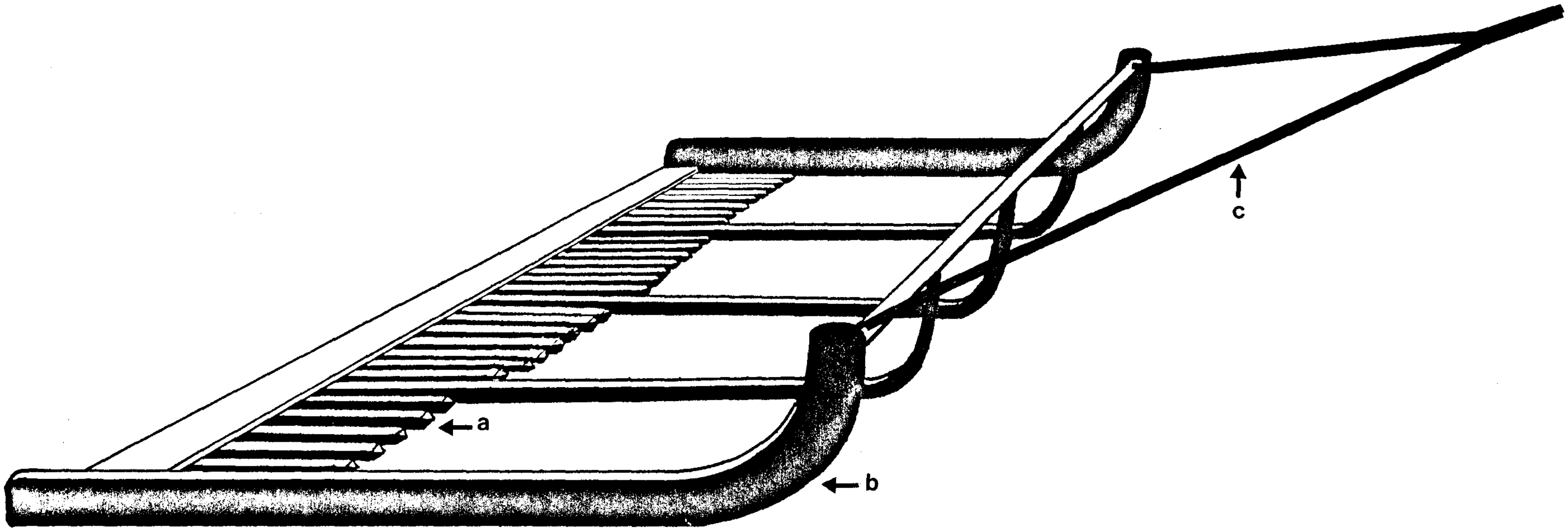

Figure 1. Dragrake design as used in southwestern Nova Scotia: a) tines
b) runners
c) towing bridle

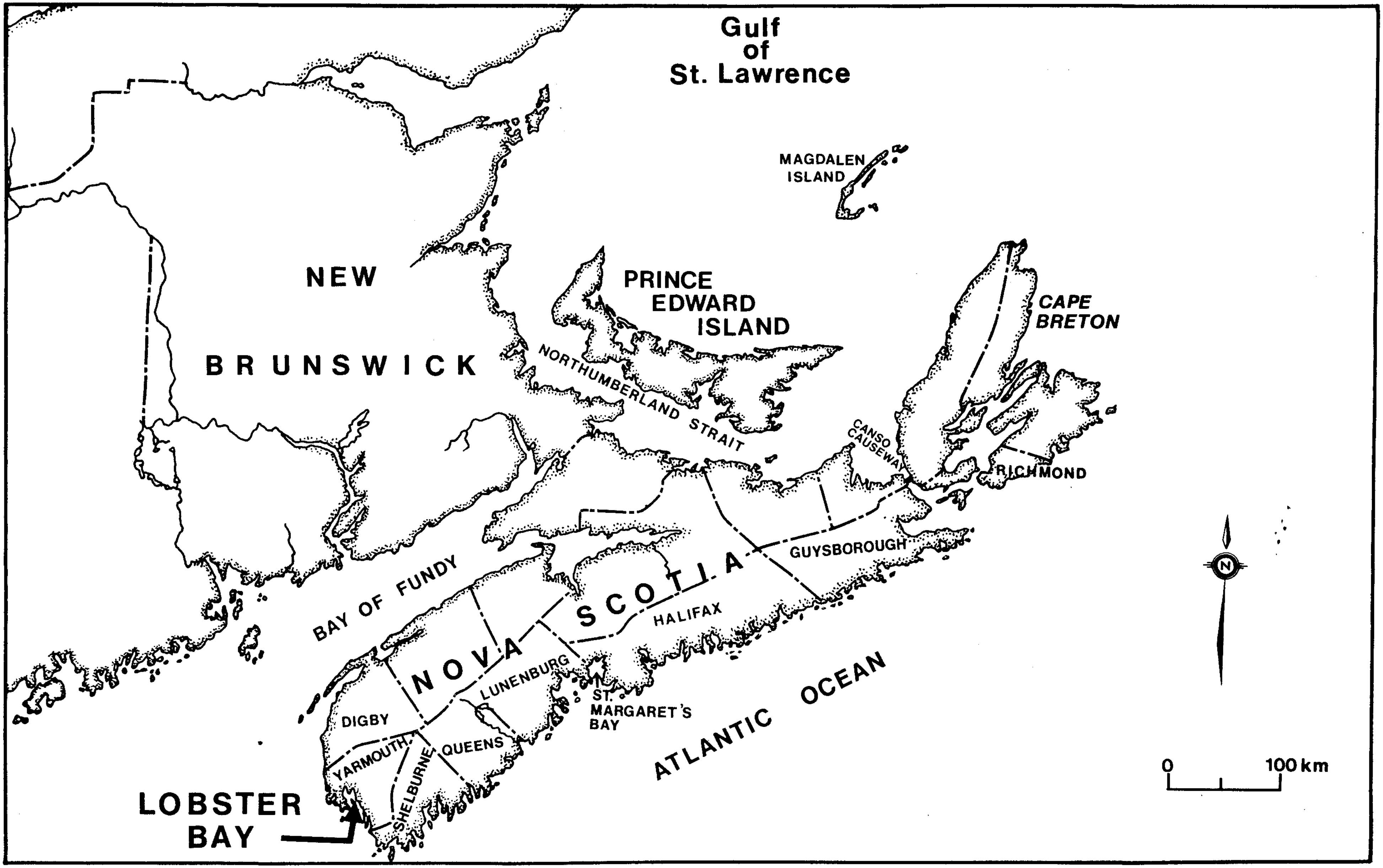

Figure 2. Location of Lobster Bay on the southwest coast of Nova Scotia.

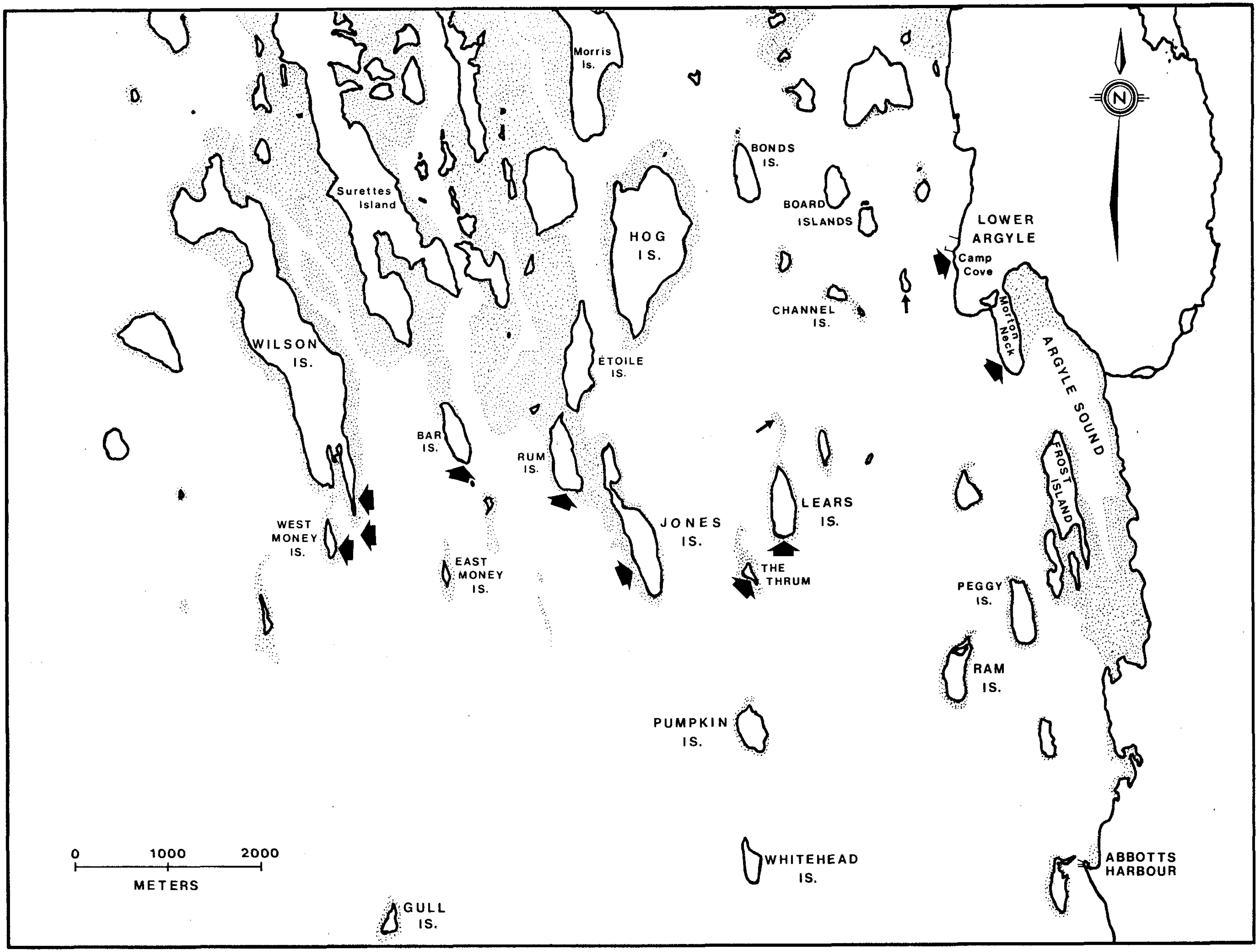

Figure 3. Study sites - Lobster Bay, southwestern Nova Scotia.

Dragraking sites
Handraking sites

TEST DRAGRAKING

At Morton's Neck and the west side of Jones Island, plots (Figure 3) 25 m x 7 m and 41 m x 8.5 m respectively were marked with temporary buoys. These plots were harvested by towing a 15 kg dragrake, 0.9 m x 0.65 m with 1.7 cm tine spacing, from a 4.6 m wooden skiff. After two hours of dragraking at Morton's Neck and three hours of dragraking at Jones Island (equivalent to 0.01 hr/m^2; hours dragged divided by total plot area), the total wet weight of Chondrus and Laminaria removed was recorded. Divers surveyed each plot prior to and following raking, recording the number and maximum dimensions of displaced rocks. The surface area of each rock was calculated by assuming a rectangle formed by the maximum rock dimensions. The sum of rock areas was divided by the area of each transect to arrive at a value for the percentage of bottom area overturned. This calculation assumed the bottom consisted entirely of rocks and boulders. A displaced rock was defined as one having a bare surface showing, with Chondrus or other macrophyte growth flattened underneath it. Additional indicators of a recently displaced rock were anoxic (black) silt cover and/or presence of sessile cryptic invertebrate species.

At Lears Island, an area closed to commercial harvesting, a 10 m x 25 m plot was dragraked for five, 2-hour test periods. Following each harvest the bottom was surveyed for displaced rocks. In conjunction with these dragrake trials, a diver made qualitative observations of dragrake performance while being towed parallel to the dragrake.

COMMERCIAL DRAGRAKING SITE SURVEY

Prior to the season opening, sites identified by local knowledge (Mr. Carl Spinney, pers. comm.*) as dragraking sites were surveyed for bottom disturbance (Figure 3). All rocks encountered along four parallel compass transects through the Chondrus zone that were recently overturned or had pioneer growth were counted.

During the season at nine sites (Figure 3) where dragraking was observed, 40 m sections of shoreline were marked with flagging tape. Beginning at one end of the section, four transects 10 m apart were run parallel to each other and perpendicular to the shoreline. A metered lead line was laid along a compass bearing from the lower limit of Ascophyllum to the lower limit of the Chondrus zone. The maximum dimensions of all rocks within 0.5 m (Wilson Island, 1 m) either side of this transect line classified as recently

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*Mr. Carl Spinney, commercial fisherman, Lower Argyle, N.S.

disturbed were measured to within 5 cm. Rocks with pioneer algal growth (*Scytosiphon*, *Chorda* sp., young *Fucus* or *Laminaria* spp.) were measured and noted in a separate category.

The average size of undisturbed rocks on the east side of Wilson Island and the west side of Jones Island was assessed by measuring three rocks every 2 m on two survey transects per site.

Camp Island (South) and Lears Island Ledge (North) were identified as solely handrake harvesting sites (Figure 3). For a comparison to dragraking sites, the number, position, and size of displaced rocks were surveyed within three, 5 m wide sections of shoreline extending to the low-water mark during a zero tide.

EFFORT

In conjunction with an overall assessment of harvest effort within Lobster Bay, the number of dragrakers active on each bed was noted on a standardized observation route and tide period. Methods are described in detail by Sharp and Roddick (in press).

RESULTS

TEST DRAGRAKING

Dragraking effort level of 0.01 hr/m^2 at two sites resulted in a great difference in the amount of bottom disruption (Table 1). The rocks at the Morton's Neck site were on average much smaller than those at Jones Island West, and more than twice as many were overturned. In relation to *Chondrus* yield, the disruption on the Morton's Neck site was much greater than that at Jones Island West: 1.6 kg versus 22.1 kg per disturbed rock.

Successive dragraking tests on Lears Island showed substrate disturbance was cumulative for eight hours of dragging (Table 2). The average surface area of a displaced rock was 0.05 m^2. The plot began at the upper edge of pure *Chondrus*; however, as evidenced by a 3:1 *Laminaria* spp. to *Chondrus* ratio, there was a significant kelp overstory on the deeper portion of the plot.

Table 1. The amount of dragraking bottom disturbance after equivalent raking pressure at two sites in Lobster Bay as measured by overturned rocks.

Location	Wave exposure	Towing hours/m^2	*Chondrus* harvest (wet kg)	Overturned rocks	Average surface area of overturned rocks (m^2)	% of total bottom area overturned
Jones Is. W.	semi-exposed	0.01	330.75	15	0.14 ± 0.28	0.3
Morton's Neck	semi-sheltered	0.01	54.75	34	0.06 ± 0.06	1.5

Table 2. Bottom perturbation - Lears Island test site after 2, 4, 6, 8, and 10 hours dragraking, August 1-7, 1979, as measured by numbers and surface area of overturned rocks.

	Cumulative total hours dragging	Number of tows	*Chondrus*† (kg)	*Laminaria* (kg)	Cumulative total rocks displaced	Total surface area of rocks displaced (m^2)	Cumulative* % of total bottom area
	2	32	49	178	21	1.7	0.60
	4	28	47	128	43	2.2	0.80
	6	27	33	125	52	2.9	1.20
	8	39	38	79	58	3.1	1.25
	10	37	26	65	59	3.0	1.20
Totals:	10	126	178	575	59	3.0	1.20

†*Chondrus* and others
*Assumes total area is rock or boulder covered.

DIVER OBSERVATIONS

It was observed that smaller rocks (< 0.05 m^2) were moved when Chondrus fronds were bound in the rake tines and did not break before the rock was dislodged. Larger rocks (> 0.05 m^2) were overturned when the rake tines caught under an edge or a cleft in the rock and the full towing force was applied at this point.

COMMERCIAL SITE SURVEY

Surveys conducted prior to the harvest season found an average of 0.16 rocks with pioneer growth per meter of transect surveyed. Rocks with a bare surface averaged 0.08 per meter of transect. Surveys of known dragraking sites found rocks recently overturned from the upper limit of Chondrus down to the lower edge of the Chondrus zone (Table 3).

Sites resurveyed twice during the season had a higher average bottom disturbance in the second survey (Table 3). Camp Cove, surveyed only two days after the season opening, June 7, had levels of substrate disruption in the same range as sites surveyed one month later. Midchannel, between Wilson Island and West Money Island, was a special case since it was subject to dragraking by a Cape Islander boat with two dragrakes and a mechanical hauler.

The highest average bottom disturbance was recorded at Morton's Neck, with a maximum of 6.8% turnover on one transect. The average number of rakers was lower for this site (0.9 $\pm$ 2.4) than Wilson Island (1.4 $\pm$ 1.6). However, transect and shoreline length of these sites suggest raking pressure was applied over a smaller area at Morton's Neck, and mean rock size was smaller.

There was no significant difference between the average area of overturned rocks at sites surveyed near the end of the raking season (Table 3). The largest rock measured was 58 cm x 43 cm at Wilson Island. The maximum percentage of bottom covered with pioneer growth was 0.5% on a Wilson Island transect on July 16, 1979.

The size distribution of displaced rocks was compared with undisturbed rocks in the same area. The average surface area of a displaced rock was 0.06 $\pm$ 0.04 m^2 on the west side of Wilson Island, significantly different from the average surface area of a non-displaced rock 0.12 $\pm$ 0.13 m^2.

Table 3. Dragrake substrate disruption as indicated by overturned rocks in Lobster Bay commercial dragraking sites (1979).

Site	Date	Mean surface area of overturned rocks (m^2)	Maximum dimensions (cm)	% of bottom overturned	Mean distance (m) to first overturn / Mean transect length
Camp Cove	June 9	0.30 ± 0.02 r 0.01 - 0.10	40 x 25	1.4 ± 0.5 r 0.8 - 1.9	5/15
Morton's Neck	June 20	0.04 ± 0.02 r 0.01 - 0.14	37 x 37	1.6 ± 1.1 r 0.6 - 3.2	0/10
Jones Is. W.	July 9	0.06 ± 0.03 r 0.01 - 0.15	53 x 30	2.9 ± 1.0 r 1.2 - 3.8	5/35
Wilson Is.	July 16	0.05 ± 0.02 r 0.01 - 0.10	30 x 35	0.6 ± 0.3 r 0.2 - 0.9	6/80
Bar Is.	July 17	0.05 ± 0.04 r 0.01 - 0.23	38 x 60	1.5 ± 0.5 r 0.8 - 2.0	6/55
Rum Is.	July 17	0.05 ± 0.03 r 0.02 - 0.12	40 x 27	1.6 ± 0.5 r 1.2 - 2.4	10/40
Thrum Is.	July 20	0.06 ± 0.04 r 0.01 - 0.21	48 x 45	1.2 ± 0.4 r 0.7 - 1.5	13/71
West Money Is.	July 26	0.05 ± 0.03 r 0.01 - 0.13	45 x 30	1.7 ± 0.3 r 1.3 - 2.1	14/62
Morton's Neck	Aug. 6	0.06 ± 0.03 r 0.01 - 0.18	49 x 36	4.8 ± 2.0 r 2.8 - 6.8	2/12
Wilson Is.	Aug. 27	0.06 ± 0.04 r 0.01 - 0.25	58 x 43	2.7 ± 1.7 r 1.2 - 4.6	3/50
Midchannel West Money Is. and Wilson Is.	Aug. 29	0.07 ± 0.05 r 0.01 - 0.17	54 x 32	3.4 ± 0.8 r 2.8 - 4.5	†

†No gradient to the intertidal.

The size frequency distributions of rock size of undisturbed rocks and of overturned rocks (Figure 4) further emphasizes that small rocks, < 0.06 m^2, are more frequently displaced. A calculation of the potential for bottom disruption can be derived from this frequency distribution. That is, if we assume all rocks on the bottom less than 0.06 m^2 in an area can be overturned, the total area thus disrupted would be approximately 12%. Actual field measurements only once reached 50% of this value (Table 3).

HANDRAKE SITES

The survey of solely handraked sites, Camp Island and Lears Island Ledge surveyed August 9 and 10, found a range of 0.2% to 0.9% of the bottom area overturned. The mean rock size was 0.06 m^2 and maximum dimensions were 40 x 30 cm.

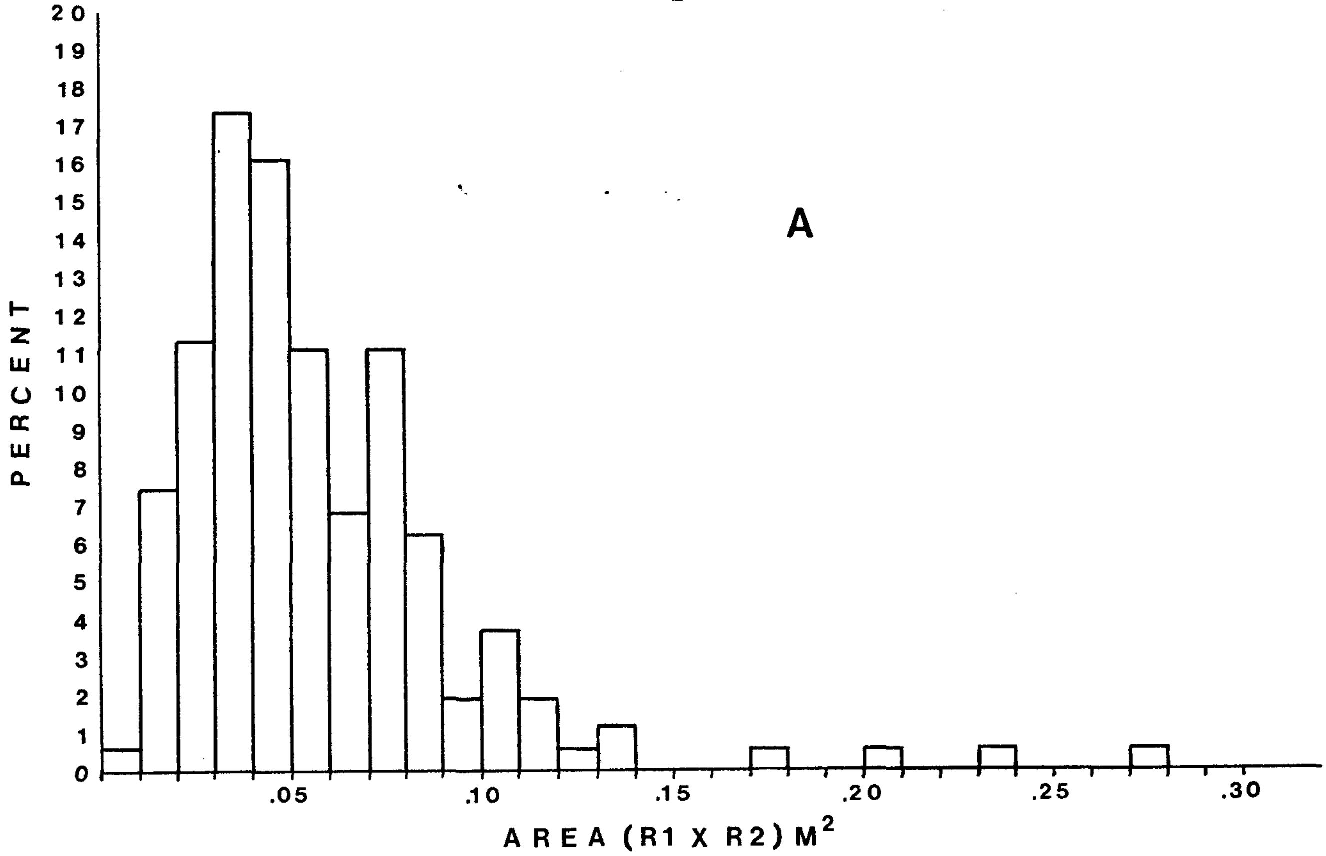
SURVEY OF DRAGRAKING EFFORT

A standardized observation route in the harvest area was completed 27 times in June, July, and August. A total of 1,450 active harvesters were observed, and 11% were dragrakers. Dragraking was observed on 16 of 37 beds (43%). Four beds received the majority (68.2%) of this dragraking effort; Wilson Island (East), 19.3%; West Money Island (East), 24.8%; Jones Island (West), 14.5%; and Thrum Island 19.6%.

DISCUSSION

The results of this survey indicate that *Chondrus* dragraking does cause measurable substrate disruption for the area of S.W.N.S. studied. Areas of predominantly small rock or areas where rocks are not embedded in the surrounding substrate (a condition more common in sheltered zones) are more sensitive to dragrake damage.

The estimates of bottom disruption are based upon conservative assumptions. For instance, in calculating total area disrupted it was assumed that the bottom was 100% *Chondrus* covered over the length of the transects. Therefore, if *Chondrus* cover was less than 100%, the impact of overturned rocks is greater on the standing crop. Another factor not included in the impact estimate is the smothering of *Chondrus* if the overturned rocks cover adjacent plants, thus creating a double impact.



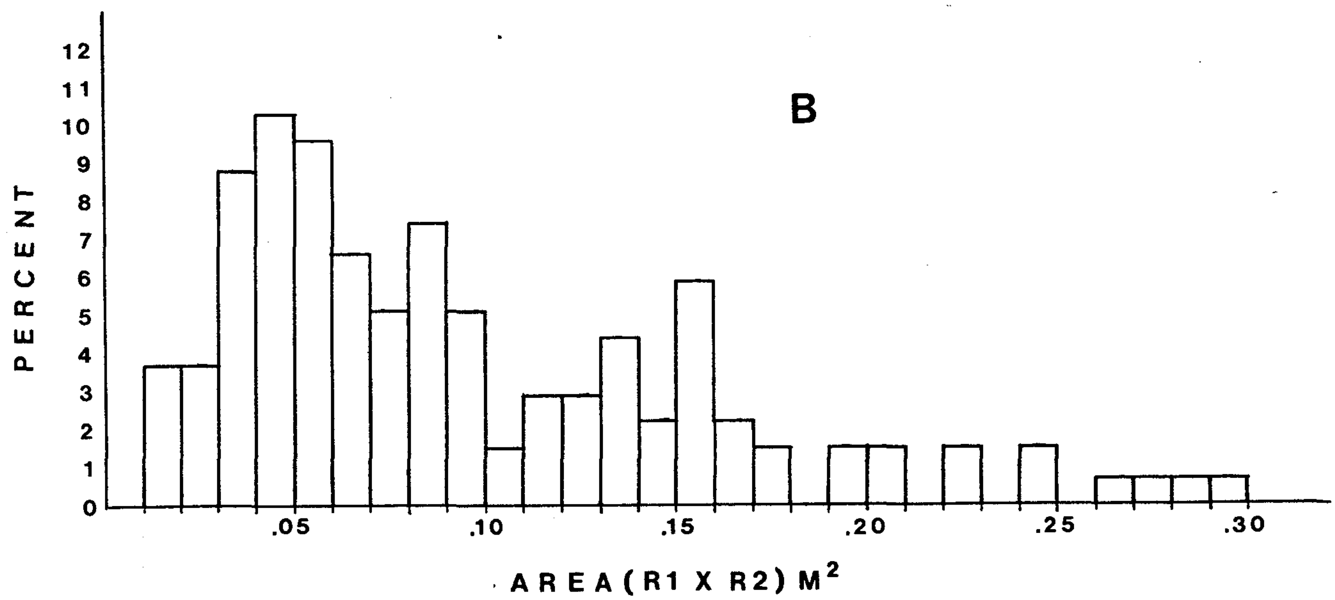


Figure 4. Size distribution of rocks at the Wilson Island dragrake study site following three months of raking pressure.

A - rocks overturned after dragraking
B - rocks undisturbed by dragraking

Whether dragraking damage is cumulative is important. The Lears Island study indicated that after eight hours of dragging, a plateau of damage was reached. The rake encountered the same rocks or rocks too large or well embedded to turn over. Other evidence against cumulative damage was: 1) the mean size of rocks disrupted; 2) areas where dragraking was heavy through the harvest season and had not reached 50% of the theoretical maximum of bottom disruption; 3) Some rocks recently turned over had young (< 2 years) Chondrus plants growing on the former bottom surface, indicating some rocks are turned over repeatedly.

Evidence that some cumulative damage does occur are the rocks with pioneering algal growth which were found in all surveyed areas. Pioneer species rapidly colonized bare surfaces provided by dragraking. Therefore, those rocks bearing this growth must be added to the new bare surfaces when considering total dragrake effects.

Dragraking effort is both small and isolated in relationship to handraking. Theoretically, due to licensing policy no more licenses exist than the number of active dragrake harvesters previous to 1977. However, either more of these licenses may be active or unlicensed harvesting is common since there appears to be an increase in effort (D. Jones, pers. comm.*). As the value of Chondrus increases, there may be a trend to greater dragrake useage. The estimates of dragraking effort are conservative since observations were made during slack low tide, at which time some of the dragrakers were handraking. The areas handraked and dragraked within these beds did overlap in most cases.

There are three management options in the reduction of dragraking impact. The first option, banning the dragrake, is not justified since this study showed this method is restricted in geographical extent and degree of damage. The second option, restricting dragraking to areas of very stable substrate or areas below handragking depth, is not enforceable with the presently available manpower. The final option is to redesign the dragrake or replace it with a low-impact harvest tool. In the interim period, no increase in dragraking effort should be permitted.

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