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Rockweed
(*Ascophyllum nodosum*)

by

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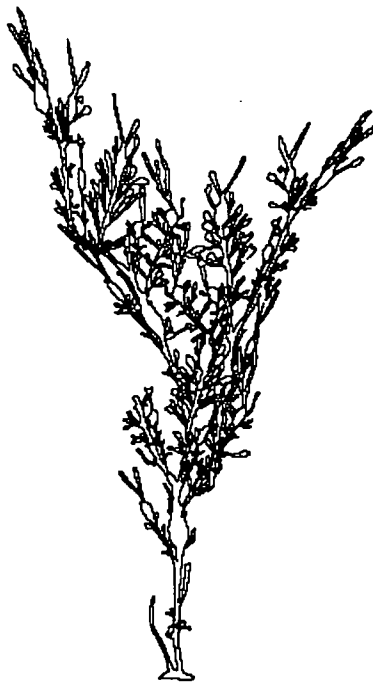
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Abstract

Ascophyllum nodosum Le Jolis (Rockweed) has been exploited by artisan and mechanical methods for 38 years in the Maritimes. The most intensive harvests and management began in 1986. The history of harvesting and resource status characterizes six distinct areas. Newly developed harvests of southern New Brunswick are characterized by very low exploitation rates less than 5% in contrast to exploitation rates above 20% in Lobster Bay, Nova Scotia. Yields per hectare of bed have peaked at 47.7 t in 1989 in Lobster Bay. Catch per unit effort is very dependent on experience ranging from 33.0 SD 9.0 t per week to 3.4 SD 1.9 t per week. Landings in 1997 are expected to increase both due to changing effort patterns and more intensive management.

Resumé

L'ascophylle noueuse (*Ascophyllum nodosum* Le Jolis) est exploitée au moyen de méthodes artisanales et mécaniques depuis 38 ans dans les Maritimes. C'est en 1986 que la récolte et la gestion ont pris toute leur intensité. L'histoire de la récolte et de l'état de la ressource met en évidence six zones distinctes. Les récoltes qui se sont récemment développées dans le sud du Nouveau-Brunswick se caractérisent par de très faibles taux d'exploitation, moins de 5 %, par rapport à ceux de la baie Lobster, en Nouvelle-Écosse, qui sont supérieurs à 20 %. Les rendements par hectare de peuplement ont culminé à 47,7 t en 1989 dans la baie Lobster. Les prises par unité d'effort dépendent largement de l'expérience, s'échelonnant entre 33,0 ET 9,0 t à 3,4 ET 1,9 t par semaine. On s'attend à ce que les débarquements de 1997 augmentent en raison de changements dans l'application de l'effort et d'une gestion plus intensive.

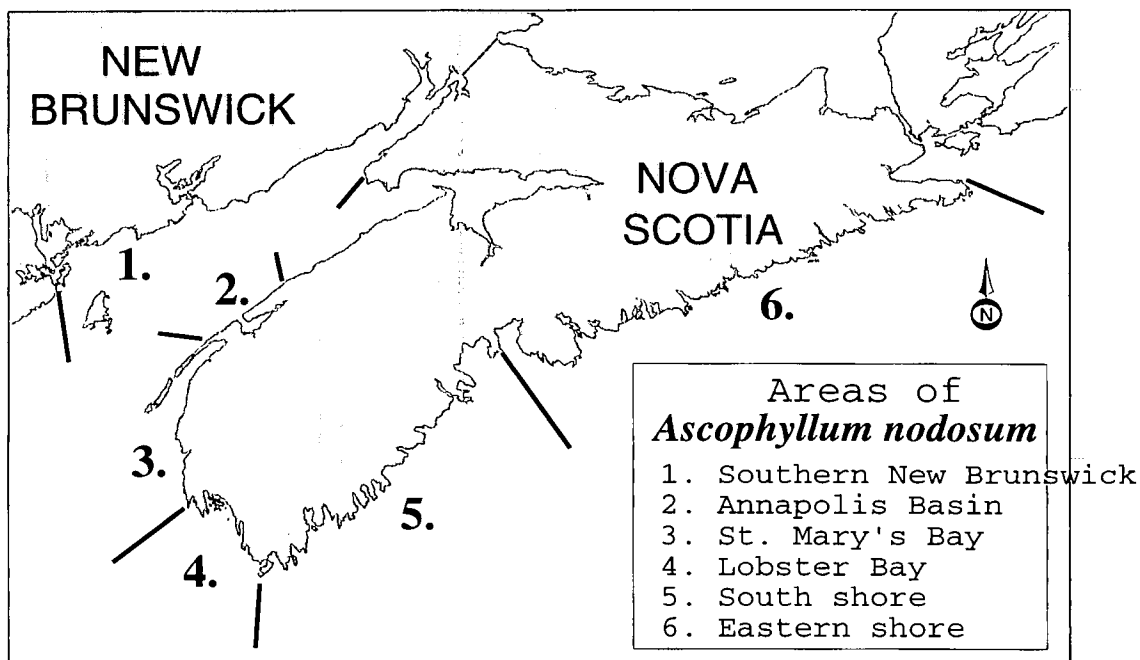


Introduction

Rockweed is the dominant brown seaweed in the intertidal zone along the Atlantic coastline of the Maritimes. Its range extends from the Arctic Circle to New Jersey. Rockweed occurs in a wide range of wave exposures but is replaced or mixed with related species (*Fucus* spp.) in the most exposed areas or parts of the coast frequently affected by moving ice. This seaweed is attached to rocks or bedrock by a holdfast. It has complex branching structures with V branching and side branches. As the tide rises, the plant floats by means of gas bladders (vesicles) on the shoots. In the spring, specialized bladders (receptacles) form on the sides of shoots. These are reproductive structures containing either egg or sperm producing tissues. Reproductive products are released in the late spring to early summer and the receptacles fall off after release. Newly settled germlings are extremely vulnerable to grazers and wave action as a result, recruitment of new plants is episodic. However, the majority of new shoots arise from basal holdfast tissues.

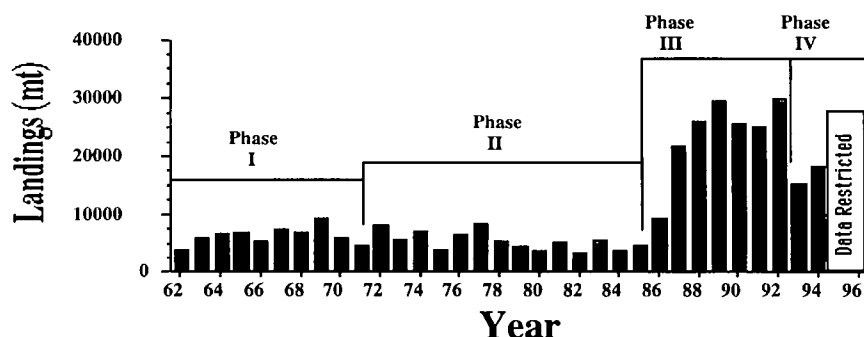
Growth occurs at the distal ends of branches. Length increases on each main branch from 10 to 20 cm per year.

Rockweed forms a very stable cover in the intertidal zone but storms, ice action and pollution can reduce abundance or restrict its distribution. Any foreshore development that changes the type of bottom such as boulder removal or siltation will reduce abundance and distribution.

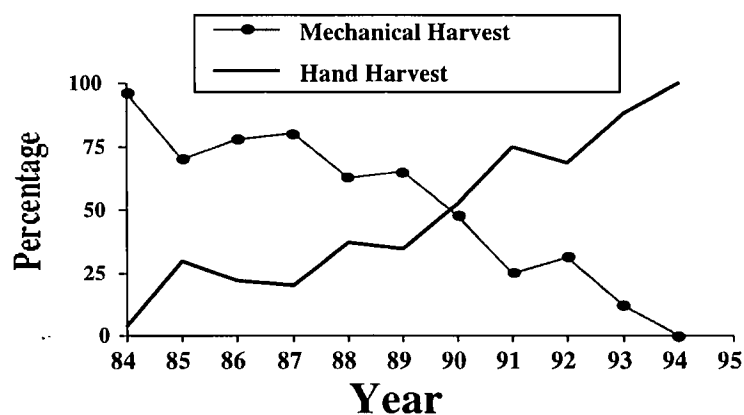


The Fishery

Rockweed was traditionally used for agricultural purposes along the Maritime coastal areas. Commercial exploitation began in the late 1950's to use rockweed for a seaweed extract (sodium alginate) and "kelp" meal. Exclusive licenses were issued by the Nova Scotia government to two companies to harvest in the area with the highest standing crop: southwestern Nova Scotia (Areas 3 and 4). Federal conservation regulations were promulgated in 1975.



The industry has had four distinctive phases with the greatest changes occurring in the last 10 years. During the first phase from 1959 to 1972, independent harvesters gathered rockweed from the shore with hand cutting tools such as knives and sickles. A toothed rake with a long wooden pole was used from boats. This eventually developed into a cutter rake with sharpened blades. Harvesting was active in Areas 2, 3 and 4 during this period. The introduction of mechanical harvesters over several years in the early 1970's began the second phase. Aquamarine harvesters extended the harvesting season and provided continuity of raw material supply. The average annual harvest did not change with this new technology. Hand cutting of rockweed was still active but accounted for less than 20% of annual landings. The third phase was characterized by the replacement of the Aquamarine machines by a highly efficient technology, the Norwegian suction cutter in 1984. The suction cutter harvested 33.6 t daily verses 3.5 t daily per hand-harvester. An efficient materials handling system using bags and barges, delivered the increased harvests. The new technology plus a new buyer/processor for "kelp meal" resulted in a dramatic increase of landings to over 30,000 t. Vigorous purchasing initiatives spread the harvest from traditional areas of southwestern Nova Scotia to most of the provinces' coastline, extending to Areas 5 and 6. During the period from 1985 to 1989, there was severe competitive harvesting in some parts of the resource, the "Open Areas" that were not under direct company management. The cutter rake is the preferred hand-harvest equipment that is used from boats from Yarmouth to Canso. In shoreline accessible areas like Annapolis Basin and St. Marys Bay, the preferred tool is still the sickle.



The fourth phase was marked by a reversion to hand-harvesting methods and a reduction, then cessation in purchasing by one of the major processors. The absorption of one buyer/processor left only two companies active in 1996. A new harvesting area was opened in southern New Brunswick in 1995 with a pilot scale harvest strategy under a joint industry, federal, provincial management agreement.

Resource Status

Annapolis Basin:

Harvesting in Annapolis Basin began in the early 1960's and the area remained open to all buyers and harvesters until 1992. Competition between harvesters led to severe overharvesting on the northern shore and parts of the southern shore between 1988 and 1991. Severe harvesting occurs when plants are cut below 13.5 cm and the exploitation rate exceeds 90%. Rockweed landings during this period were over 2400 t. Corrective action included temporary division of the Basin between two harvesting companies, followed by partial closures in 1993, 1994 and full closure in 1995.

The Basin was reassessed during this period with remote sensing and transect surveys of biomass. Remote sensing in 1993 found 30% of the bed area in the early stages of biomass recovery. The fully recovered standing stock in the Basin is estimated at between 7,500 and 10,000 t. A comprehensive survey in 1994 estimated the standing stock at 4100 t. In 1995, four beds in the southern sector were surveyed in detail. Biomass and plant length were fully recovered and a conditional quota of 500 t was permitted for these beds for 1996. The quota has not been reached to date. New harvesting strategies were enforced to allow a higher mean cutting height (20 cm) and a lower exploitation rate 50 to 60% versus 80 to 90% in previous years.

Outlook

The Annapolis Basin rockweed resource is still in a state of recovery from the overharvesting of the late 1980's and early 1990's. The resource must be placed under a long term management strategy to prevent poor harvesting practices and competitive harvesting or the resource will not recover. The Basin should sustain an annual harvest in the 1,000 to 1,200 t range.

St. Mary's Bay:

The history of harvesting in St. Mary's Bay is similar to Annapolis Basin. Although Digby Neck is licensed to one company, the mainland shore has been an open harvest area from Cape St Mary's eastward. The head of the Bay has the largest beds directly accessible to "walk on" harvesting. Overharvesting was observed in beds north of Weymouth in 1993. As restrictions were placed on Annapolis Basin, effort was displaced to St. Mary's Bay. Qualitative surveys of 6 beds in 1996 determined the beds were recovering but the plants had not reached harvestable lengths. No landings were reported in 1996 although it was open to harvest.

Outlook

The data base for assessment of St. Mary's Bay is very limited regarding bed area and biomass. In order to place the Bay under a sustainable harvesting strategy, a full of assessment of the Bay must be completed. Without a strategy, the Bay will be pulse harvested with declining overall abundance.

Lobster Bay:

Lobster Bay is defined as the shore, island and shoals between Yarmouth and the southern tip of Cape Sable Island. This area has the longest history of rockweed harvesting in the Maritimes and remains the core area for rockweed harvesting. A total of 1100 ha. of rockweed beds grow on drumlin shorelines from extreme wave-sheltered areas along the Tusket River

estuary to the wave-exposed Mud and Seal Islands. Harvesting technology has evolved from hand-harvesting techniques to mechanical and back again over the past 37 years.

Assessment is based on detailed landing data by 203 sub-sectors of the resource. The resource base in each sector was surveyed with remote sensing and estimated in 1988. There have been ground biomass surveys of portions of this resource since but no recent comprehensive survey is publicly available. Sub-sectors have been clumped in five units to improve the reliability of data, since some sectors include the borders between licenses and others have been transferred between companies.

The resource can be divided into two sections: ones that have been harvested primarily by hand techniques consistently for the past 37 years and those areas with a recent transition to hand-harvesting.

Landings

Landings from Lobster Bay have represented 67.8 to 88.0% of the total rockweed landings in the Maritimes in the past 8 years.

Landings have decreased dramatically in the last 4 years in contrast to the previous 5 year boom in the Lobster Bay harvests. Over two-thirds of these landings originated from the Comeau Hill to Pubnico point area.

Exploitation rates

The exploitation rate is the amount of seaweed harvested from the estimated original standing crop. Optimal exploitation rates for large harvest areas is 17% annually. This is maximum percentage of the biomass that may be harvested annually to allow sustainable harvesting. A higher rate of harvest would not allow the biomass to recover eventually decreasing the amount available for harvest. Areas would have to be left fallow for recovery. The exploitation rates in the late 1980's and early 1990's routinely exceeded this target level in both the hand harvest and mechanically harvested sectors in Lobster Bay.

Exploitation rates (%) of the standing crop from the Lobster Bay area.

Year	Ym-Ch	Tusk	CH-PP	PH	WH
1989	28	40	18	27	15
1990	22	13	12	13	15
1991	16	11	22	14	9
1992	23	23	22	13	12
1993	14	6	10	15	5
1994	21	5	18	12	4
1995	22	4	11	13	5

Code: Ym=Yarmouth, CH=Comeau Hill, Tusk=Tusket Islands, PP=Pubnico Point, PH=Pubnico Harbour, WH=Woods Harbour

Mechanical harvesters exceeded exploitation rates of 60% while hand-harvesting rarely exceeded 30%. The mechanical harvesters cropped an area and left it fallow for a couple of years before reharvesting. Hand-harvested areas have exceeded the optimal exploitation rate (17%) in all but 2 of the last 7 years in the Yarmouth to Comeau's Hill and Pubnico Harbour areas. Since 1993, exploitation rates dropped to one-half or less of the rates in previous 5 years in the Tusket Islands and Woods Harbour areas.

Yields per hectare

Mechanically harvested sectors had significantly higher yield, 35 t ha⁻¹ prior to 1993. Following the transition to hand harvest methods yield dropped to less than 20 t ha⁻¹. Selected harvest sectors in areas with a sustained 5 year hand-harvest was over 20 t ha⁻¹ in 3 of five years. Although there is some annual variation in landings in hand-harvest areas; 95% of sectors have harvesting activity every year. Mechanically harvested sectors were cycled more regularly. In 1991, 51% of mechanically harvested sectors were inactive.

Metric tons per hectare (t/ha) harvested from the Lobster Bay area.

Year	Ym-Ch	Tusk	CH-PP	PH	WH	Mean
1989	34.1	47.7	21.9	32.6	18.6	31.0
1990	26.9	15.5	14.6	15.3	11.9	16.8
1991	19.6	12.9	26.8	17.3	11.4	17.6
1992	27.4	27.5	26.2	15.1	14.3	22.1
1993	17.1	6.6	12.0	17.5	6.4	11.9
1994	25.3	6.1	21.9	14.5	4.4	14.4
1995	26.9	4.3	13.5	15.1	5.9	13.1
Mean	25.3	17.2	19.6	18.2	10.4	

Code: Ym=Yarmouth, CH=Comeau Hill, Tusk= Tusket Islands, PP=Pubnico Point, PH=Pubnico Harbour, WH=Woods Harbour

Catch per unit effort

Weekly individual landings of hand harvesters in Lobster Bay averaged 18.0 SD 9.0 t per harvester per week. The highliner in this area averaged 33.0 SD 9.3 t per week. There was a significantly lower CPUE in the Tusket to Cheboque area 15.6 SD 9.6 t per week compared to Rocco Pt. to Tusket 18.0 SD 7.9 t and Pubnico Harbour 24.0 SD 8.7 t per week.

Holdfast removal

Recent changes by the industry in cutter rake design and maintenance have decreased the rate of holdfast removal. Over the past 3 years the rate has dropped from 21% by weight to 14.1% (survey by Nova Scotia Department of Fisheries & Aquaculture) and 10.6% (survey by Acadian Seaplants Limited). In some landing sites, the holdfast content was 5% or less.

Outlook:

Some parts of the resource in Lobster Bay have been under heavy harvesting pressure in the last 3 years. The sector landing data prove that there is no rotation of harvests in some sectors but rather a steady or increasing pressure. Re-introduction of hand-harvesting techniques has lowered average exploitation rates for the mechanically harvested area but some individual sectors within these units have exceeded the target

exploitation rates. If the exploitation rate is not lowered to or below 17% for these sectors or the harvest is placed on a rotational harvest schedule, there will be a slow but steady decline in harvests. Landings overall for the Bay will not decline in 1997 since many sectors have only been lightly harvested and effort can be redirected.

South Shore Nova Scotia

Barrington Bay, immediately east of Cape Sable Island has been harvested periodically over the past 37 years. Harvesting to the east of Baccaro Pt. have only commenced in the last 6 years. The shoreline from Shelburne to the Queens County line is licensed to one company with the exception of three bays that remain open harvest areas. Machine harvesters were first used in Shelburne Bay in 1990 removing 4492 t at exploitation rates up to 80%. This was a pulse harvest since in the following years landings did not exceed 1100 t. "Gentlemen's Agreements" have divided the coast from the Queens County line to Halifax between two companies. Landings from this area have been less than 400 t annually. Surveys of rockweed distribution and biomass were completed in Shelburne County in 1989 and Lunenburg County in 1991, St. Margarets Bay in 1992. Biomass was 8.7 kg m⁻² in Shelburne Co. and declined to 5.0 kg m⁻² in the Lunenburg Co. area. The average zone width was 10 to 12 m.

Outlook

Although the majority of this harvesting area is under license or "Gentlemen's Agreement", only pockets of the resource are regularly utilized. There is no annual management plan formulated. If the area was fully exploited an annual sustained harvest of 2000 t is possible.

Eastern Shore

East of Halifax the rockweed resource tends to be in sheltered bays. The plants are shorter than in southwestern Nova Scotia and the width of the zone is only a few meters wide. Harvesting began in 1992 and landing sites were established in 5 bays by 1995. Landings have not exceeded 1000 t.

Outlook:

There are no comprehensive surveys of bed area or biomass for the Eastern Shore. The most viable harvest areas are now being utilized. It is unlikely landings will exceed 1000 t. The potential for overharvesting does exist since no exclusive license or "Gentlemen's Agreement" is in effect for the Eastern Shore.

Southern New Brunswick

Data bases existing prior to 1992 indicated a rockweed resource exceeding 140,000 tons in southern New Brunswick. Following a review of the available assessment data and a consideration of habitat issues, CAFSAC 92 recommended a controlled harvest not exceeding 10,000 annually be permitted in New Brunswick for three years to 1998.

Exclusive purchasing rights to the resource were allocated under a joint federal, provincial, company agreement within three year pilot scale harvesting plan. Maximum exploitation rates were set at 50% over 3 years. The agreement specified: hand cutter rake, areas of special limitations, and closures. Prior to each harvesting season a three year and annual harvest plan was required by sector. Reporting was based on 86 sub-sectors of the resource and was monitored by a third party. Additional commitments were made to resource assessment and impact monitoring by the company.

Harvesting of rockweed began in July of 1995 on the mainland shore of Charlotte County and was active on Grand Manan as well in 1996.

Landings did not reach the quota or the company harvest plan for 1995 or 1996. Logistical problems, equipment and training issues were major reasons for short falls. Establishing landing sites separate from existing wharves and developing materials handling procedures restricted the rate of landings. Harvesters were becoming familiar with a new industry; learning how to harvest and handle material. The high tidal amplitude tended to restrict harvesting to rising tides. There was a degree of turnover in personnel as individuals evaluated their work options. A wide variety of vessels were used in the first year but very few had the required capacity for 3 to 5 tons of rockweed. In 1996, a standard vessel was introduced with adequate power and carrying capacity. Drying conditions were very poor in the key harvesting month of July in southern New Brunswick.

Harvestable Standing crop:

Initial bed area measurements for mainland Charlotte county with the exception of Passamaquoddy Bay were based on satellite images. In 1995 a new series of 1:12,500 aerial photos taken during low tide were acquired for this area. All photos were digitized and analysis begun with NIH image analysis software. These enabled the measurement of area with a higher resolution than satellite resulting in a ground-truth error of 2%. Acadian Seaplants initiated a ground survey in each of the harvesting sectors. A comparison of pre-1995 data was made in 3 sectors 6-5, 7-5, 7-9. In sectors 6-5 and 7-5 the harvestable crop was 47% and 72 % higher than allocated in the 3 year pilot scale harvest. In contrast sector 7-9 was found to contain a large cover of Fucus and the harvestable crop of rockweed was one third of the pilot scale harvest projection.

The annual harvestable crop from Beaver Harbour to Alma (Area A) was not economically obtainable. Initial estimates of rockweed for the coastline from Point LePreau toward St. John only included those beds without a steep foreshore and those with some degree of wave shelter. However, bedrock ledges in this area are of high relief and create the equivalent of miniature cliffs. The cutter rake as designed for New Brunswick will remove only a few centimeters of plants 50 cm long in this environment. Samples from Area A, typically have the majority of their biomass below 70 cm. The company established crews in some harbours on this shoreline in 1995. As they test harvested this shoreline, acceptable CPUE came only from those portions of beds that had protective ledges or foreshore. To reach these pockets boats had to move through wave exposed waters making weather critical.

Exploitation rates:

The exploitation rates were limited in the pilot harvesting plan to a maximum of 50% spread over 3 years (17% annually). Harvesting was active in 20 of the eighty-six potential harvesting sectors in 1995 and 29 were active in 1996. The mean tonnage per hectare removed per sector was 2.1 SD 1.1 t ha⁻¹ maximum 4.29 t in 1996 and .92 SD .82 t ha⁻¹ maximum 3.31 t in 1995. Based on a fully recovered standing stock of 85 to 130 t ha⁻¹ annual maximum exploitation rates were 5% to 3% in 1996 and 4% to 2.5% in 1995.

Catch per unit effort:

The average landings per individual in all harvest areas was 8.6 SD 6.0 t. The highliner averaged 19.5 SD 6.3 t per week. Maximum landings per individual were 33.2 t in one week. Minimum weekly landings were 3.4 SD 1.9 t per person.

Holdfast retention

In 1996, over 300 samples were taken from the harvest for holdfast analysis. The annual mean was 4.4 sd 6.9 % by weight.

Incidence of Harvest

In harvested quadrats from 4 sites, the proportion of rockweed clumps (cut to total clumps) sampled was 23%. The mean length of cut clumps at 17% exploitation rate was 67.1 SD 25.0 cm N = 251.

Outlook

Landings in New Brunswick are expected to increase in 1997 toward the maximum allowable harvest for southern New Brunswick. Harvestable amounts within many harvesting sectors will need adjustment based on the higher resolution of bed areas and biomass. Unless the pilot scale harvest plan is adjusted between Areas A B and C, the landings are expected to be short of the 10,000 t quota in 1997 by at least 1,500 t to 2,000 t.

The low level of holdfast removals, low incidence of harvest and exploitation rate indicate that the productivity of the resource and integrity of habitat structure is being maintained as targeted in the management plan.

Issues of sustainability and habitat impact will be reviewed in 1997, prior to any further harvest or allocation.

Acknowledgements

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For more information

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Additional Reading

Sharp, G. 1986. *Ascophyllum nodosum* and its harvesting in Eastern Canada. In: Case studies of seven commercial seaweed resources. (eds) Pringle, J. and A. Mathieson. FAO Technical Paper 281, p. 3-46.

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