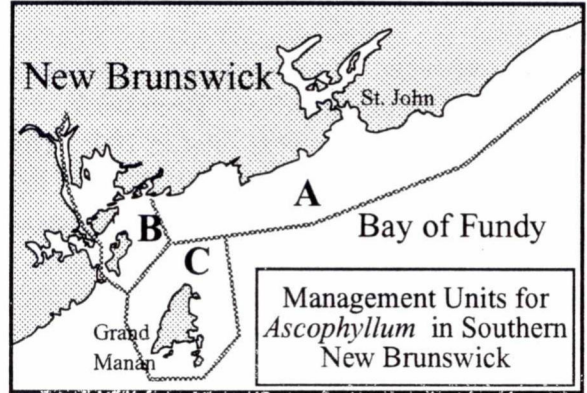




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The Impact of the Rockweed Harvest on the Habitat of Southwest New Brunswick

Background

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.

Summary

- The current fishery is being exploited within the guidelines of the Southwest New Brunswick Rockweed Fishery Management Plan.
- The total harvestable biomass of rockweed is about 77,000t, and the 1998 harvest of 5,781t was not detrimental to the sustainability of the resource.
- The 1998 average exploitation rate was about 10%, which was below the 17% target, and is a relatively low percentage of annual production.
- Changes to rockweed habitat structure that may be caused by the harvest appear to be minimal.
- There was insufficient knowledge to fully evaluate potential habitat or ecosystem level impacts of the harvest. Of all the species potentially impacted, only the local eider duck populations are known to be threatened. These threats arise by other environmental changes.
- There was no evidence to discontinue the harvest in 1999 but to be precautionary it should remain as a pilot-scale harvest.

1998 - 9 1999

The Issue

The rockweed (*Ascophyllum nodosum*) fishery in Southwest New Brunswick was established as a three year pilot in 1995. This was extended until the end of 1998. The last time that the resource status was reviewed by RAP was in April 1998, at which time it was agreed that renewal of the licence would be conditional on a review of the impacts of rockweed harvesting on the habitat.

A RAP meeting was conducted during 28–29 April, 1999 to address the following questions:

- What are the scale and intensity of the current harvest?
- What is the current status of the rockweed resource in Southwest New Brunswick?
- Is there new knowledge on impacts of rockweed harvest on waterfowl, fish, invertebrates, and habitat?
- Is there any evidence that would rule against the rockweed harvest?
- Is the harvest rate of 17% appropriate or should it be changed?

This report presents the conclusions of this meeting.

Scale and Extent of the Current Harvest

Over the past 40 years, the Maritime fishery for rockweed (*Ascophyllum nodosum*) has expanded from a small mechanised fishery centralised in southwest Nova Scotia to an extensive artisanal harvest on both sides of the Bay of Fundy and along the eastern shore

of Nova Scotia (Sharp and Semple, 1997). With this expansion, management of the harvest has become increasingly controlled and intensive with application of quota, gear and area restrictions and consideration of habitat issues.

The fishery in Southwest New Brunswick began in 1995 under a licencing agreement with Acadia Seaplants and within the guidelines of a three-year pilot harvest (1995-97) that was linked to a monitoring, assessment and research program. In 1998, the pilot harvest was extended by one year. The future of this harvest and its management are to be decided prior to initiation of the 1999 fishery.

Harvesting generally occurs during the months of June to September, following the period of rockweed reproduction (May – June). During 1995 – 1998, landings have not reached the annual 10,000 t quota.

Landings, t

Year	Area A	Area B	Area C	Total Annual Harvest
1995	199	703	0	902
1996	198	2669	134	3001
1997	255	3685	702	4642
1998	415	4578	788	5781

Over the past four years, 48 of the 64 sectors have been harvested. It should be noted that as part of the Southwest New Brunswick Rockweed Fishery Management Plan (RMP), there are an additional eight sectors closed to harvesting. In 1998, 37 sectors were harvested, with most of this occurring in Area B, and divided evenly between sectors 6 and 7.

Besides an overall quota, the RMP stipulates minimization of holdfast content and a plant cutting height within specified limits (12.7cm minimum and 25cm average). Holdfast content varies according to year and location but overall in 1998, harvested clumps with holdfasts were 8.3% by weight (kg) of the harvest. This represents a fishing mortality of .01 clumps m⁻². These removals are dominated by large older plants. As well, cut shoot lengths were generally within RMP guidelines during 1996 - 98, with the mean being above 25cm in 21 of 24 sectors. However, the cut minimum of 12.7 cm was not met in 13 of the 24 sectors. This minimum cutting height is not within the capabilities of the existing harvesting gear.

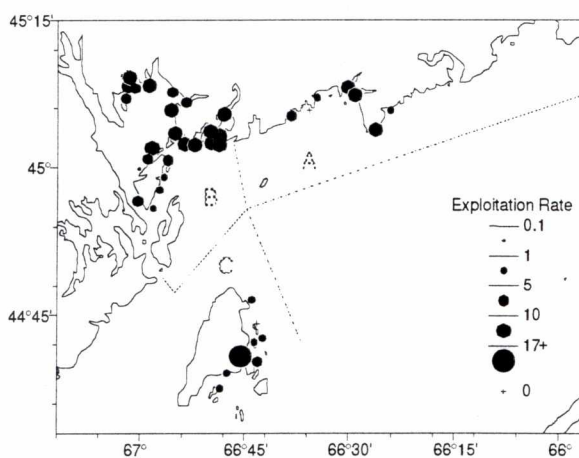
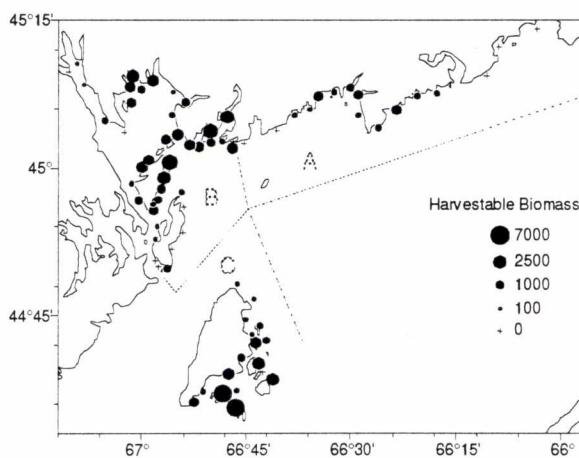
Resource Status

Rockweed comprises more than 90% of the fucoid biomass in the intertidal zone of the Atlantic coast. Information collected during summer 1994, September 1995, February 1996 and February 1997 was used to provide estimates of plant biomass (Sharp and Semple, 1997). Every year, about 64,000 – 79,500 t of new biomass are produced, which is equal to about 50% of the ‘standing’ biomass. The annual quota of 10,000 t takes 13 - 16 percent of this production. Losses due to natural causes (storms, etc.) are thought to be similar to the annual production and thus the standing biomass appears not to change greatly over time. Therefore, the 1994 survey results are considered representative of the resource in 1998.

The total harvestable biomass in Southwest New Brunswick is about 77,000 t, of which about 60,000 t is in sectors harvested during 1998. The average exploitation rate in these harvested sectors was about 10 %, and, with

the exception of sector 9-2 on Grand Manan, harvesting in all sectors was below the 17% threshold. In the case of sector 9-2 on Grand Manan, the exploitation rate was about 20 % which is not considered a concern.

Area	Harvestable Biomass, t	1998 Exploitation Rate, %
A	5,340	7.8
B	40,678	11.3
C	13,907	5.7
Total	59,925	9.7



There are clear differences in average annual growth among locations, an overall increase in shoot size with age is observed. Average

growth varies between 10 – 17cm yearly once the maximum canopy size has been reached. In an unharvested rockweed bed, small (<10cm) shoots within a clump are dominant. However, due to the relationship between length and weight, longer shoots make up most of the weight of the clump. Also, as the clump grows, the distribution of biomass changes, with the biomass in longer clumps being closer to the growing tips than in shorter clumps. Therefore, clumps longer than 50cm contribute over 80% of the total biomass of an unharvested resource. These relationships are affected by wave action, with the biomass in exposed sites concentrated closer to the bottom than sheltered sites, presumably due the loss of vesicles by wave action.

Harvesting over a wide range of exploitation rates only modestly shifts the average length of clumps to shorter plants. This is due to the selection properties of harvesting, with the percent selection of clumps increasing with length (50% at about 60cm).

Potential impacts of rockweed harvest

A) Habitat structure

Habitat structure of rockweed is the complexity contributed to the benthic architecture by the plant's size, branching, density and biomass.

The impacts of harvest on the structure of the rockweed habitat are of short duration (less than one year), due to the rapid growth rate and replacement of cut branches (Ang et al. 1993). The current level of harvest removes 13% to 16% of the annual production and thus the biomass harvested in

a rockweed bed is replaced within the harvesting season.

Harvesting occurred in 39 of the 64 management sectors in Southwest New Brunswick in 1998 with rockweed removals being 6% of the total biomass. Sectors were harvested in a patchy manner due to factors like gear limitations, tide, resource availability, wave exposure and catch per unit effort.

Rockweed is harvested within beds in patches that vary from 1 m² to as large as 300 m². The harvest within these patches is not homogeneous. From 3% to 100% of the clumps are impacted by the cutter rake. Rockweed clumps impacted by the cutter rake are reduced in length by 21% to 39%, depending on the exploitation rate. Clumps cut by the gear have about 10% of their shoots cut. A higher proportion of the biomass of individual clumps is in the top part of the clump as the length increases. The average height of the canopy is not changed significantly in patches when less than 44% of the clumps in a patch is impacted by the cutter rake. Within patches, the low tide or primary substratum cover (not thickness) will not be reduced at cutting heights above 30 cm.

Several knowledge gaps of rockweed habitat structure remain. An understanding of change in biomass made by the harvest in individual clumps is required. A measure of complexity within a clump and the stand is also required as is an extensive survey of patches in the harvest (several beds or an entire sector).

B) Eider and other waterfowl

A range of waterfowl are found in association with rockweed in Southern New Brunswick, including purple sandpiper, kingfisher, common tern, Bonaparte's gull, common loon, double-crested cormorant, osprey and common eider. There is no information on potential rockweed harvesting impacts on these species. However, common eider are felt to be of particular importance as rockweed provides an important habitat for the rearing of young, and it is a species at risk due to predation by black-back gull.

Eider ducklings appear to depend on rockweed habitat for food at a stage when their ability to dive is poorly developed. Large-scale reduction in canopy height could reduce foraging time for young ducklings because of their inability to reach the submerged rockweed (Hamilton 1997). Eiders feed on an array of invertebrates in the rockweed beds and it was thought that partial removal of the rockweed, particularly the canopy, would make these invertebrates more vulnerable to predation and thus in the longer term impact the eider population. However, removal of rockweed in unharvested areas and feeding by eiders did not have a noticeable impact on the abundance or diversity of invertebrates. If the rockweed harvest does not reduce canopy height, the impact on eider is considered to be minimal. Further, given the large foraging range of creches (eider flocks), rockweed harvesting effects may be small and localized, and unlikely to have a wide-ranging impact. Notwithstanding this, due of the vulnerable status of eider, **it would be prudent to avoid harvest in areas where ducklings feed from early June to mid-July where rockweed**

harvesting creates significant boat traffic. Currently, harvesting in these areas commences in the beginning of July.

The knowledge of the rockweed-eider interaction is limited. It is unknown if the availability of eider duckling prey (littorinids) differs between harvested and unharvested rockweed beds. It is unknown if changes in availability of rockweed and /or changes in prey densities affect the growth and survival of ducklings. The appropriate spatial scale for studying the distribution of eider during the vulnerable duckling period is also uncertain and there are areas of high eider densities that should be avoided during critical periods of eider development. The high abundance of black-back gull is resulting in high mortality of eider ducklings, and it is not known how harvesting practices interact with this source of mortality.

C) Fish

Based on studies (Rangeley 1994a,b 1998, Rangeley & Kramer 1995a,b & 1998). conducted in Passamaquoddy Bay during 1989-91, about 30 species of fish are found in association with rockweed in Southwest New Brunswick. Of these, 21 were common and 19 were present as juveniles, but none is considered to be geographically-restricted or at a vulnerable level of abundance.

Over 100 invertebrate species were consumed by fishes associated with the rockweed; most prey were crustaceans associated with algae. Nine species of piscivorous (fish-eating) fish were found foraging in the intertidal zone, mostly at night, while seven species of piscivorous birds were found feeding at all tidal stages throughout the day. Rockweed was shown to be a predator refuge for some fish such as

juvenile pollock. The latter showed a preference for the dense cover of rockweed. Finally, fish behaviour and habitat use has been shown to be dependent on fish density and rockweed area.

A new baseline study in progress is examining how fish utilize rockweed beds that differ in biomass. This study is not designed to evaluate the impact of the harvest, so its results must be interpreted with caution. In this study, about 12 species of fish were found associated with rockweed, of which 85% of the individuals were pollock. Abundance was greatest at night and fish movements were along shore. A comparison between areas with and without rockweed is required.

There is insufficient information to evaluate the impact of rockweed harvest on the intertidal abundance and behaviour of nearshore fish. Further, current methods of assessing fish populations have a low probability of detecting significant changes in abundance, should they occur. Much higher sampling rates and lengthy studies (~5-15 years) may be necessary to detect the impacts of rockweed on the fish community (Rangeley, 1998).

D) Invertebrates

A wide range of invertebrate species is found in association with rockweed in Southwest New Brunswick but none is geographically-restricted or threatened. Studies on small experimental plots, harvested at 50% exploitation has shown that the reduction in biomass did not affect the abundance or diversity of invertebrate species (Hamilton, 1997).

Canopy invertebrates were identified as prey species for fish and birds, including eider ducklings. For those species most closely associated with rockweed canopy, such as the smooth periwinkle *Littorina obtusata*, there is a direct relationship between abundance and biomass (Sharp et al. 1997). Other species including *Littorina littorea* and most amphipods are of low and highly variable abundance in the canopy. Harvesting removes biomass, but also changes the shape and length of individual clumps. Shape and length of rockweed clumps can be more important to some recolonizing species than biomass. Isopod abundance increased with length of the clump. In contrast, gastropods were more abundant in short dense clumps.

There are very great differences in abundance of some species related to season. Settlement or juvenile stages of invertebrate species contribute greatly to this seasonal change and their high mortality increases abundance variability. Regardless of a high degree of variation in abundance, species' assemblages were similar over a wide geographic range of rockweed habitat. The overall abundance and composition of the canopy invertebrate population has been found to be similar in Southwestern Nova Scotia and southern New Brunswick during the summer months.

Regarding the direct impacts of harvesting, the by-catch is primarily composed of littorinids and bivalve spat. The abundance of invertebrates in the by-catch is highly variable, being dependent on season and site.

While there is some information on the use of the rockweed by the invertebrate community, overall there was insufficient knowledge to judge if there was an impact of rockweed harvest on any of these species.

An understanding of the population dynamics of dominant canopy invertebrates in harvested and unharvested patches and clumps is required. As well, seasonal changes of canopy invertebrate abundance and diversity between sites needs study, as does the replacement rate for invertebrates most impacted by the fishery.

Renewal of Southwest New Brunswick Rockweed Fishery Management Plan in 1999

a) Is there any evidence that would rule against the rockweed harvest?

There is no evidence that the current level of harvest will cause a negative impact on the resource in the short term. Nevertheless, it would be prudent to consider varying the target harvest rate according to habitat conditions and exposure. More work on this issue is required.

Holdfast removal in the current harvest is not considered to be a concern due to the low incidence of holdfasts in the harvest. Nevertheless, the incidence of holdfasts in the harvest is most likely linked to type of substrate and thus some areas may require protection when information on the relationship between holdfast removal and substrate becomes available.

Although there was incomplete information on the by-catch of invertebrates and no information on the potential impacts, the evidence is insufficient to rule against the harvest of rockweed.

Regarding the impact of the rockweed harvest on the ecosystem, specifically use as a habitat by waterfowl, fish, other aquatic

flora, there is insufficient information to describe the role of rockweed in the ecosystem and thus it is not possible to determine harvest impacts. The changes in habitat structure under the present management strategy are patchy and limited in extent.

There has been some increase in knowledge since 1992 but most of this work has improved our understanding of the rockweed and its habitat structure and not its role in the ecosystem. The type of information that has been acquired includes:

- the spatial relationship of organisms within rockweed habitat;
- utilization of rockweed as habitat (degree of dependence of commercial and non-commercial fish on rockweed for habitat);
- local contribution of rockweed to primary production;
- trophic links (i.e. the role of rockweed in the coastal zone food web –how does change in light and temperature impact on dependent species);
- temporal variation (which species depend on rockweed and the seasonal variations of this use); and
- the importance of detached rockweed as habitat and the relative importance of these habitats in the ecology of the coastal zone.

Despite the progress over the past decade, there remains many gaps in our knowledge and there are many questions regarding the importance of rockweed in the food chain and to dependent species.

The harvest of rockweed can proceed on a pilot basis until these knowledge gaps are

satisfactorily filled. Nevertheless, a research program that focuses on specific issues that pertain to rockweed and the associated ecosystem must be part of this harvest plan.

b) Is the harvest rate of 17% appropriate or should it be changed?

While the 17% rate of harvestable biomass might be appropriate for the resource in Southwest New Brunswick, it may not be appropriate for specific areas. These areas might include beds that, because of the substrate, would be vulnerable to holdfast removal during harvest, for example beds known to be used by young eider ducklings, and beds adjacent to designated protected areas. These areas need to be mapped and might be harvested at a different exploitation rate, following a schedule which takes into consideration use by various species, or might be excluded from the management plan entirely, in the case of designated protected areas.

Conclusions

The rockweed harvest at the current level of exploitation is not detrimental to the resource. The current harvest is a relatively low percentage of the annual production and any change to rockweed habitat structure is likely to be minor. There is insufficient knowledge to fully evaluate potential impacts of the harvest on other components of the ecosystem. Of the species potentially impacted, only the local eider duck populations are known to be threatened. These threats are through other environmental changes.

There was no evidence to discontinue the harvest in 1999 but to be precautionary it should remain as a pilot-scale harvest. In

addition, a working group should be formed to direct the research questions that have been raised in this report. Approval for any long-term harvest plan would be contingent upon our ability to evaluate the role of rockweed in the ecosystem.

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References

- Ang, P.O., G. J. Sharp and R. E. Semple, 1993. Changes in population structure of *Ascophyllum nodosum* (L.) Le Jolis due to mechanical harvesting. *Hydrobiologica* 260/261: 321-326.
- Hamilton, D. J. 1997. Community consequences of habitat use and predation by common eiders in the intertidal zone of Passamaquoddy Bay. PhD, U of Guelph, 211p.
- Rangeley, R.W. 1998. Variability in the use of rockweed habitats by fishes: implications for detecting environmental impacts. p28-29. In M.D.B. Burt & P.G. Wells (eds.) Coastal monitoring and the Bay of Fundy. Proceedings of the Maritime Atlantic Ecozone Science

- Workshop in St. Andrews, NB. Nov. 11-15, 1997.
- Rangeley, R.W. 1994a. Habitat Selection in Juvenile Pollock, *Pollachius virens*: Behavioural Responses to Changing Habitat Availability. Ph.D., McGill University (Montreal). 179 p.
- Rangeley, R.W. 1994b. The effects of seaweed harvesting on fishes: a critique. *Environmental Biology of Fishes* 39: 319-323.
- Rangeley, R.W. & D.L. Kramer. 1998. Density-dependent antipredator tactics and habitat selection in juvenile pollock. *Ecology* 79(3): 943-952.
- Rangeley, R.W. & D.L. Kramer. 1995a. Use of rocky intertidal habitats by juvenile pollock *Pollachius virens*. *Marine Ecology Progress Series* 126: 9-17.
- Rangeley, R.W. & D.L. Kramer. 1995b. Tidal effects on habitat selection and aggregation by juvenile pollock *Pollachius virens* in the rocky intertidal zone. *Marine Ecology Progress Series* 126: 19-29.
- Sharp, G., R. Semple and I. Barkhouse 1997. Macro Invertebrates Associated with *Ascophyllum nodosum* (L.) Le Jolis Canopy in the Gulf of Maine and the Impact of Harvesting on the Canopy. In M.D.B. Burt & P.G. Wells (eds.) *Coastal monitoring and the Bay of Fundy. Proceedings of the Maritime Atlantic Ecozone Science Workshop in St. Andrews, NB. Nov. 11-15, 1997.*
- Sharp, G. and R. Semple. 1997. Rockweed *Ascophyllum nodosum*. DFO Can. Stock Assess. Sec. Res. Doc. 97/31, 12p.

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