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The Ecological Impact of Marine Plant Harvesting in the Canadian Maritimes, Implications for Coastal Zone Management

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ABSTRACT: The harvest of algae in Eastern Canada has been active for over 50 years. Benthic ecology studies by the 1950's had established the value of the algal thallus and algal populations as habitats for many species of animals. However, for the first 35 years of marine plant harvests the primary concern of resource scientists was the sustainability of the resource. The incidental removal (bycatch) of non-targeted species was recognized by fisheries managers in the *Chondrus crispus* Stackhouse (Irish Moss) harvest but bycatch limits were not a part of the management plans. The implications of removing algal biomass and the potential of changing the structure of the algal habitat were only recently realized and integrated in resource management plans. A managed *Ascophyllum nodosum* L. Le Jolis harvest removes 17 % of the harvestable standing crop and less than 7.5% of the total biomass. In terms of the total productivity of attached macrophytes in the Bay of Fundy ecosystem this is less than 1 % removals. In general the degree of complexity of an algal thallus is directly related to invertebrate abundance on a per unit biomass basis *Ascophyllum nodosum* harvests can change the relative spatial distribution of the biomass and the complexity of the plant structure. However harvesting is not homogeneous and hence, it increased the patchiness in the habitat. At an exploitation rate of 17% it was not possible to detect changes in the structure of *A. nodosum* beds at a landscape scale. Precautionary management measures incorporated in the management plan for this harvest has made it a model in coastal zone management.

KEYWORDS: *Ascophyllum nodosum, Chondrus crispus,* harvesting, ecosystem management, ecological impact, precautionary approach.

INTRODUCTION

The commercial marine plant industry started in Nova Scotia prior to 1940 with harvests of *Laminaria* Lamour spp. in South-western Nova Scotia for alginate production. This resource was harvested with hand cutting tools and dragrakes operated from small vessels in shallow waters (<5m) (Figure 1)[1]. Landings peaked in 1944 at 3000 wet t and declined until operations ceased in 1949. *Chondrus crispus* Stackhouse (Irish moss) harvests had also begun in Prince Edward Island by 1940 but official landings were not recorded until 1943.[2] In the Gulf of St. Lawrence a dragrake pulled behind lobster vessels quickly superseded the hand rake but substrate prevented this transition in Atlantic Nova Scotia (Figure 2)[2].

The *Chondrus* industry has evolved in 4 periods; the first period involved the initial recruitment of harvesters, development of harvesting techniques and placement of purchasing infrastructure until 1964. The second period was the rapidly increasing demand and effort in the late 60's demand to a peak of 48,000 wet t in 1970 (Figure 2)[2].

Falling demand, dropping effort and foreign competition lead to a third period of declining landings less than 15,000 t in the 1970's and 80's to a final fourth period of low sustained landings with increasing demand in the late 1990's (landings < 10,000 wet t) to the present day[3].

Ascophyllum nodosum Le Joli (rockweed) industrial harvests for alginate production in Nova Scotia production began in 1959[3]. Landings were between 4,000 and 8,000 wet t with a mixture of hand and mechanical methods until 1986 (Figure 2). Norwegian harvesting technology was introduced increasing catch per unit effort and landings to a peak of 30,000 wet t (Figure 2)[3]. The return to hand harvesting techniques after 1992 caused a temporary decline after 1992 to 20,000 wet t. However exploitation of new areas and increasing effort in traditional resource bases increased landings to 45,000 t in 2002.

The primary information needed to develop these industries was the location, abundance and composition of marine plant beds. Both industry and government initiated extensive surveys of large parts of the coasts in the Maritimes[2]. Highest priority questions for the industry were related to the yield that could be obtained annually from each resource base.

The earliest marine plant regulations were instituted by the Nova Scotia provincial government primarily to control and facilitate development and secondly to provide resource conservation. Conservation measures were based on observations of gear impact on re-growth (gear limitations) and seasonality of reproduction (limits to harvesting season)[2]. Other limits to harvest were related to the logistics, drying season, resource accessibility and availability of a harvesting force[2].

In 1976 Canada declared a 200 mile fisheries management zone and the federal government initiated the management of all fisheries. Initial regulations were based on existing data bases and were similar to provincial regulations. Scientists focused on the exploited species to provide the most pertinent biological data to managers. Since the marine plants industry was already active in most areas the initial studies described the characteristics and impact of existing methods and evaluation of conservation measures[2]. These studies included the effects of harvesting on mortality, recruitment and growth of the targeted species[2]. Similarly detailed demographic studies were usually single species oriented with incidental information on the wider marine plant and animal community.

Marine plants were recognized as a part of the benthic habitat with multiple trophic level interactions in Canadian fisheries science in the 1980's. However, inclusion of habitat impacts or protection of marine plant habitat and the concept of ecosystem protection is only a recent addition to marine plants management as a result of wider jurisdictional powers for Fisheries and Oceans Canada under the Oceans Act of 1997[4,5].

This paper examines information gathered in eastern Canada on the impacts of marine plant harvesting both on direct changes of the habitat and potential indirect impacts in the ecosystem. Finally, we discuss the Canadian approach to the management of potential risks to the ecosystem.

Plant Population Impacts

Habitat Architecture

Marine plant harvesting impacts on algal populations can range from virtually complete removal of the habitat to more subtle alterations of the habitat structure. Total removal of the habitat is not economically useful or feasible with existing harvesting technology.

The normal practice of marine plant harvesting in the Maritimes is a partial removal of the algal canopy at exploitation rates of less than 50% of the biomass[6]. These changes in the structure of a marine plant habitat cannot be reflected in a simple measure of mean cutting length of affected shoots. The harvester does not clear cut the stand of marine plants and does not cut all fronds in his path, but the habitat is changed in architecture. The degree of this change can only be assessed by examining several aspects of the harvest on the population structure of the target species. Harvesting can affect the structure of these marine plant habitats by changing branching structure, canopy height, distribution of biomass and overall density of plants and fronds.

The floating canopy of *A. nodosum* changes structure with the tide level from fully extended clumps at high tide to recumbent ones at low tide[7]. The niches available at high tide include the basal structure of the plant between primary shoots and between clumps of shoots. The middle region of the plant has the most complex structure containing lateral and dichotomous primary branches with or without epiphytes[7].

Whole frond mortality is not predominately the case when harvesting species that are long lived with well attached holdfast structures. Both *C. crispus* and *A. nodosum* have encrusting holdfasts that expand horizontally on the substrate[1,8]. Holdfasts are the primary source of annual frond recruitment to the population. Some incidental holdfast removal does occur during most harvesting operations. *Ascophyllum nodosum* harvesters using a cutter rake average 4 to 15 % by weight of fronds with holdfast material attached dependant on location and gear type[8]. *Chondrus* harvests average 5 to 35 % by number of plants with holdfast attached depending on the gear type and local geology[2]. Mechanical harvesters designed for *Ascophyllum* have a higher rate of whole frond removal (20 to 36%) reducing plant density from 92.6 to 73.6 clumps m[9].

Harvesting equipment to be economical must be designed to remove the largest fronds of a marine plant population. The *Chondrus* hand rake will selectively remove the larger fronds in the population, 11% of total frond density while harvesting 39.7% of the biomass[1]. Continual selection of the largest fronds in a population can in the long-term change the reproductive structure of a population. Sustained size selective dragraking of *Chondrus* has impacted the reproductive capacity of *Chondrus* in the Gulf of St. Lawrence. Due to higher sorus densities per frond non-dragraked populations had a higher reproductive capacity than dragraked populations[10].

Mechanical *Ascophyllum* harvesters are also size selective but the degree of change in the canopy will relate to the intensity of the harvest that is under more control with mechanical than hand harvest methods. The Norwegian suction cutter's exploitation rate was 40 to 60% and cut the tagged shoots predominately in the size classes over 50 cm, with an average cutting

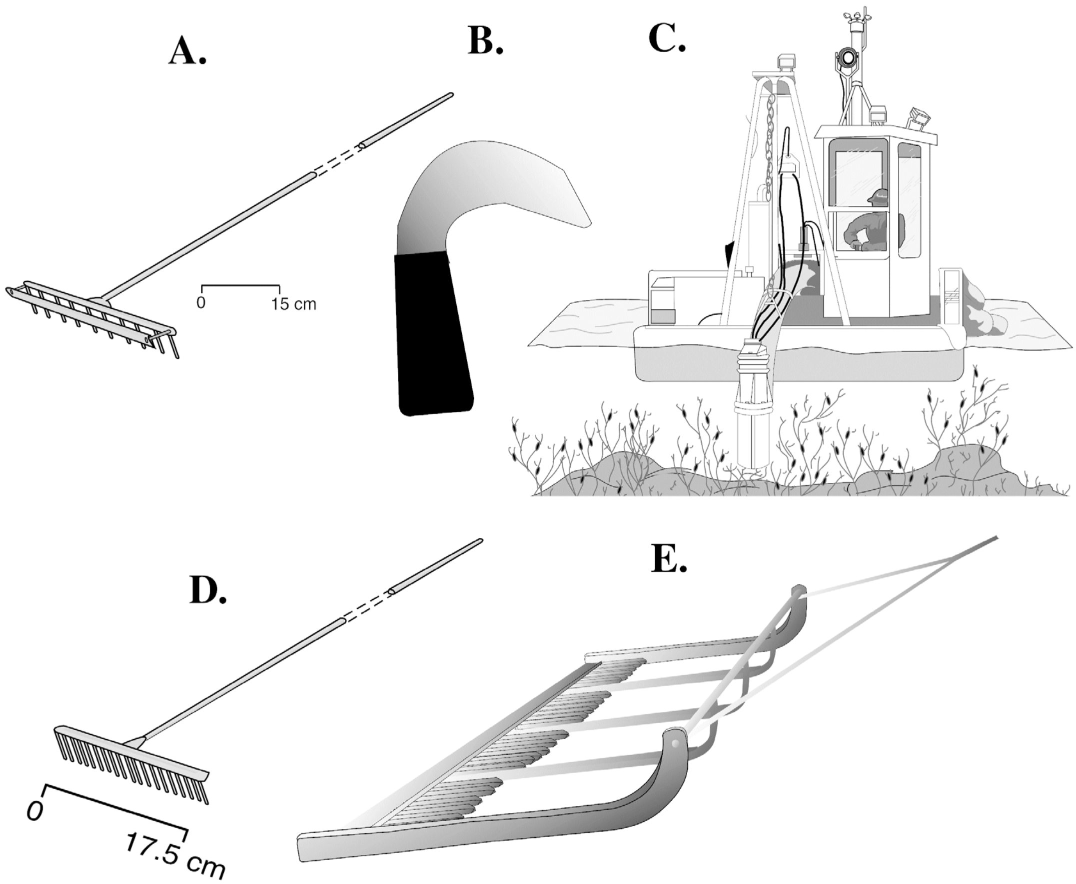

Fig 1. Types of hand and mechanical harvesting equipment used in the marine plant industry of eastern Canada. A. *Ascophyllum nodosum* cutter rake, B. *Ascophyllum nodosum* hand sickle, C. Norwegian suction cutter for *Ascophyllum nodosum* D. *Chondrus crispus* hand rake, E. *Chondrus crispus* dragrake.

height of 29.4 ± 14.9[9]. *Ascophyllum nodosum* hand harvesters exploitation rates range form 5 to 22% of the biomass at an average height of 25.6 to 46.8 ± 15.5 cm above the bottom[8].

An *Ascophyllum* clump is an assemblage of shoots from a common holdfast. The distribution of biomass in a clump is a function of the length, number and branching of the shoot assemblage. The harvester has some control over the clumps to be cut, but once this choice is made the design of the cutter rake determines the characteristics of the impact on an *Ascophyllum* clump. The rake normally cuts diagonally from the basal to distal end. The rake is selective for larger clumps and those clumps have most of the biomass at the upper end of the canopy. The portion of shoots cut within a clump is dependant on their length, while 72% of shoots are below 25 cm only 9.8 % of all shoots are selected by the rake and of these 41.6% are over the length of 25 cm[7,8].

The distribution of biomass in the population of harvested versus non- harvested clumps provides a composite description of the change in habitat structure. The weight distribution of clumps is changed dramatically within a length size class while total length changes to a lesser degree due to the diagonal cut of the rake (Figure 3). The mean clump length of the entire population of a bed at a 17% biomass exploitation rate does not change, however clumps over 90 cm are more highly impacted and loose a minimum of 56.5% of their weight (Figure 3)[7].

The economics of harvesting and processing tends to concentrate exploitation in selected portions of the resource rather than evenly throughout its range. *Chondrus crispus* is distributed from the mid intertidal to 10 m in the sub tidal. Due to the limited depths the rake can reach and the need for a minimum CPUE the harvest is concentrated in the + .3 m to – 1 m zone in southwestern Nova Scotia[2]. In Prince Edward Island

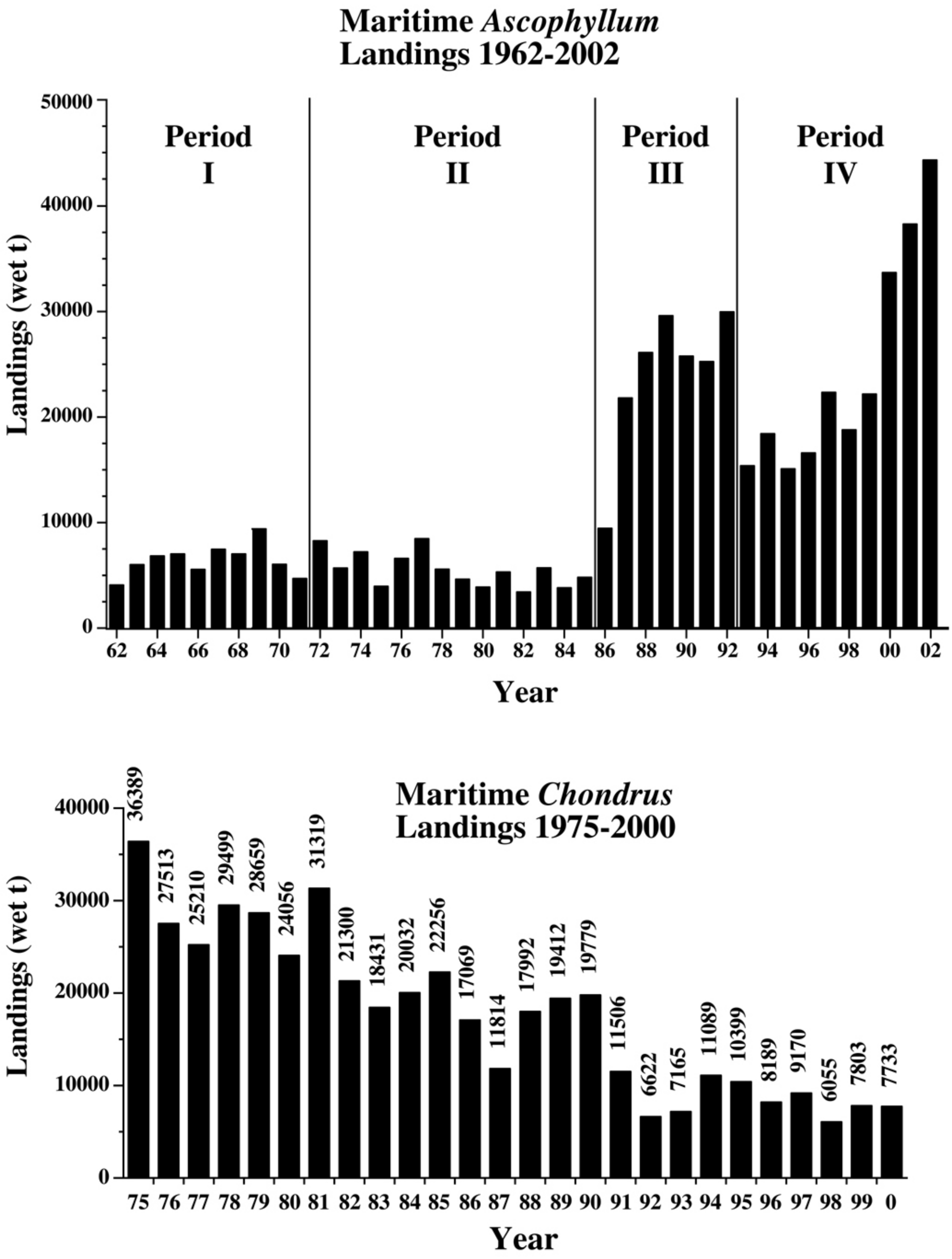

Fig 2. Annual landings from the *Ascophyllum nodosum* and *Chondrus crispus* harvesting industry in Eastern Canada.

harvesting is concentrated on sand stone ledge areas of – 2 m to – 6 m depth[2]. Impacts on the habitat are limited in geographical and vertical extent but are more intense than if they were spread throughout depth the range of the species.

The level of habitat complexity is an important factor affecting carrying capacity for associated species. The larger more branched fronds are lost from the population in a harvest and the impact on carrying capacity may be higher than the simple loss of biomass. A mitigation effect following removal of canopy is the stimulation of the growth of suppressed or shaded understory shoots and initiation of lateral branching[7]. The higher density of rapidly growing young shoots contributes to the recovery of complexity within one year. Kelp species in the Maritimes have a great potential for regrowth from the young sporophyte and gametophyte bank in the light limited substrate[11].

The intensity of harvesting can be measured as the proportion of plants cut within an area and at a set exploitation limit. The incidence of harvest (portion of clumps harvested within a 0.25 m^2 quadrat) at a 17% exploitation rate within an *Ascophyllum* bed 1900 m long and up to 90 m wide ranges from 0 to 0.61 of sample quadrats. The lack of homogeneity of the harvest is due to the rapidly changing tide level in an area with 10m tidal amplitude and prevailing wind and wave conditions prevent the harvester from maintaining the vessel position. The harvester also makes decisions regarding acceptable levels of catch per hour and day and will move if he perceives the target rate is not met (3.5 t per day)[7,8].

The annual harvesting intensity of dragrake harvesters in Prince Edward Island was calculated as a function of the number of harvester days harvesting per season and the area fished per day per harvester day divided by the area of the *C. crispus* bed[2]. Each square meter of the bed was passed over many times during the harvesting season. Some beds were two and one half times more intensely harvested than others; an intensity index (level of effort per area of bed times the total number of boat days) of 16 per hectare versus 38 per hectare[2].

Biomass

The implications of removal of algal biomass from a system can be both local and extensive in the ecosystem. When initial surveys of standing crop are made for a large section of coast line the total biomass of the target species is estimated as a baseline. This baseline tonnage is rarely the total harvestable biomass, due to reasons of accessibility, logistics, and economics. The first discount of total biomass is made for those areas that are not accessible to the harvesting vessel due to wave exposure, distance from landing sites. Other discounts are the acceptable transport distance to the processing facility and the minimum catch per day or week that harvesters will accept depending on unit landed value. Areas that cannot sustain this level of catch are considered un-harvestable. At the beginning of the *A. nodosum* harvest in southern New Brunswick the minimum acceptable biomass was 6 kg m[7]. This figure can change as the economics of the total operation is affected by operational costs and the efficiency of the harvesting technique. After discounting for these factors the annual harvestable standing crop has recently been estimated at 159,683 wet t and 1636 hectares[7]. Management measures that restrict or exclude harvesting such as research/study sites have further reduced the harvestable tonnage by 4105 wet t[5]. The total allowable catch is 50% of the harvestable standing crop over 3 years or 17% per year.

Community

Direct Impacts

The most extreme case of direct impact on the community is denudation of the substrate or disruption of substrate with associated benthos. This impact is possible with intense use of mechanical marine plant harvesting methods. The result of long term intense dragraking harvest activity in the Gulf of St Lawrence was denudation of 1.2 to 2.1% of the bottom in commercial *Chondrus* beds[2].

The mobility of the organism and the portion of its life cycle spent in the habitat relates to its vulnerability to direct impacts. The most common impact is removal associated fauna and flora along with the harvested material and subsequent mortality either in the vessel or in processing as bycatch. Bycatch in the *C. crispus* harvest from the Gulf of St. Lawrence comprised 35 macro invertebrate species and 43 macro algal species[2]. The percentage of the algal bycatch had wide geographical variation ranging from less than 10% to 80% of the catch[1]. The numbers of invertebrates per tow of a mechanical *Chondrus* harvester ranged from 45 to 403 individuals[2].

Observations of bycatch do not always determine the full direct impact of harvest activity as animals can be injured on the bottom without being captured by the harvesting equipment[12]. The *Chondrus* harvesting fleet in western Prince Edward Island captured 4.7 lobsters (*Homarus americanus*) per hour of dragrake harvesting, injuring up to 17.4 %[12]. In proportion to the total number of lobsters caught in traps the injured lobsters represented 1.3 to 2.7% of the total legal lobster catch.

Bycatch sampling is a part of the annual monitoring of *Ascophyllum* harvests in Southern New Brunswick[13]. Macro-invertebrates in 13 indicator taxa were predominantly annelids; gastropods were second in abundance dominated by the snail *Littorina obtusata*.

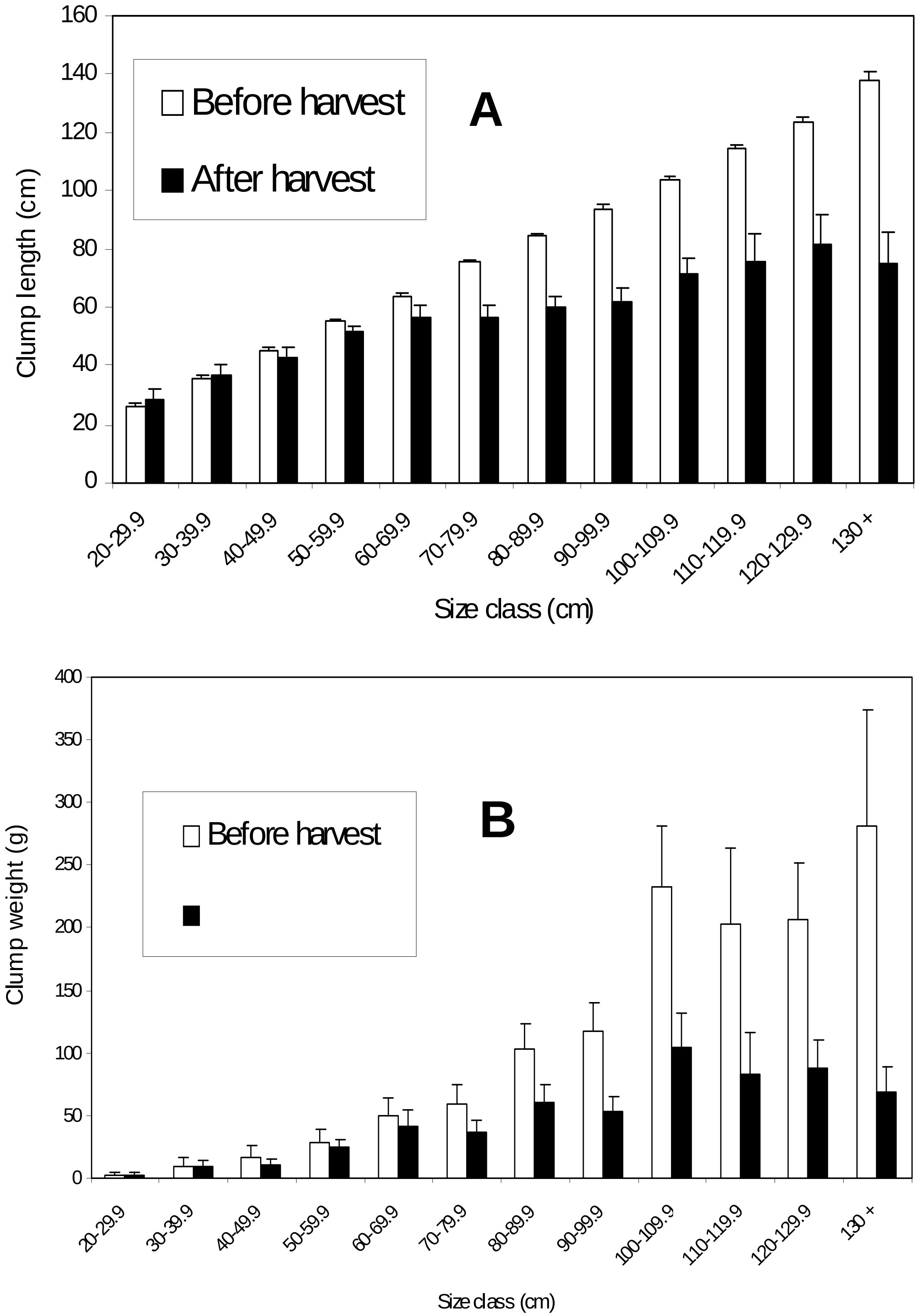

Fig 3. Mean changes in the length (A) and weight (B) of tagged *Ascophyllum nodosum* clumps ±, SE before and after harvest with a hand cutter rake in southern New Brunswick.

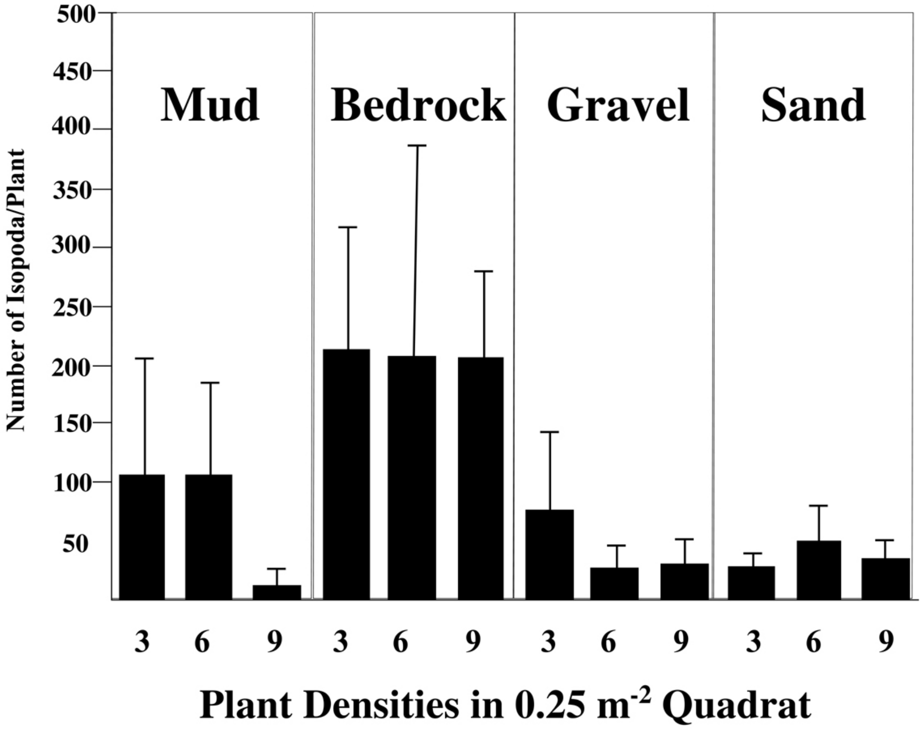

Fig 4. The abundance of isopods recolonizing *Ascophyllum nodosum* clumps previously denuded of all fauna over 4 types of substrates.

The abundance of some micro invertebrates or early stages of invertebrates such as the amphipod *Hyale nilsonni* are strongly associated with the presence of *A. nodosum* epiphytes[14]. Micro invertebrates associated with epiphytes are unlikely to move out of their niche to avoid disturbance or capture. Crustaceans are capable of rapid long distance movements and some species of amphipods move in and out of the substrata into the canopy and are able to respond quickly to disturbance.

Changes in the size of plants in a harvested population of marine plants can affect the density and diversity of canopy invertebrates[15]. Geography, substrate and season can be stronger variables than plant density when perturbed *A. nodosum* canopy is re-colonized (Figure 4)[14]. Recolonization is rapid when the plant is denuded and initial densities of fauna can exceed pre-perturbation levels. However, simple measures of volume, weight or length used in most of these studies may not be sufficient as measures of complexity in this environment.

Indirect Impacts

The most subtle and difficult to define impact of harvesting is the value of this habitat as a shelter from predation and area for foraging. The question is whether change in predation rates or foraging can be related to a change in the canopy that is not catastrophic.

The intertidal zone with and without algal cover is used by 31 fish species at some time in their life history[16]. Estimates of fish use of this shore during immersion of this zone are from 0.6 to 3.9 fish per meter of shoreline in the Bay of Fundy[16]. Complete removal of *Ascophyllum* habitat did not change the use or dietary habits of fish in this zone compared to areas with a full canopy in Nova Scotia[17]. Diet composition of fishes in the rocky intertidal of the Bay of Fundy included a range of 100 invertebrate prey species many of which were closely associated with fucoid species indirectly proving the importance of this habitat for foraging[16].

The *Ascophyllum* habitat also offers shelter from predation during immersion within the floating clumps. The behaviour of schooling juvenile Pollack (*Pollachius virens*) was affected by the relative abundance of *Ascophyllum* canopy, schools would disperse when entering an area of fucoid canopy making them less vulnerable to predation.[16]. This species is vulnerable to up to 16 species of predators including 7 species of piscivorous birds[16]. Changes in algal cover or canopy structure could affect the value of this habitat as a refuge from predation for fishes.

There are at least 8 species of birds that prey on invertebrates associated with the canopy of *Ascophyllum*[18]. Canopy height and density can affect the feeding rates of some bird species[18]. The common eider (*Somateria mollissima*) rears its young in areas with high density cover of *Ascophyllum* and the young feed on gastropods and amphipods associated with the canopy for the first 2 to 3 weeks of life. Changes in canopy height may limit feeding opportunities during the first critical weeks of life when the ducklings cannot dive. Eiders may be more vulnerable to these small changes in habitat since their survivorship is low due to Black-backed gull predation. These more subtle effects could impact other birds using these seaweed beds as foraging areas.

Ecosystem

Harvesting of marine plants is a perturbation of the ecosystem layered within complex trophic and inter-specific relationships. Although there are no ecosystems level studies of harvesting impacts, knowledge of sub components and community interactions can be used to assess the role of marine plants in the coastal ecosystem and the risks of their harvest.

The change in available food or habitat may affect the survival of a key predator and if that predator is not present then the prey becomes abundant. Nova Scotia kelp beds have undergone several cycles of overgrazing by sea urchins creating barren grounds. Recovery of algal populations have only been permitted by massive die-offs of grazers due to disease[19]. It was proposed that kelp cover was needed to enhance or maintain lobster abundance and lobsters were the keystone predators of urchins[19]. However, after under re-examination of the relative abundance of kelps and the commercial landings of lobsters the cause and effect between loss of kelp beds and production of lobsters was disproved[20]. There was an increase in lobster recruitment during the years of low or absent subtidal algal cover. While the exact predator prey relationships may not be clear, kelp beds in Eastern Canada are under stress. Encrusting bryozoans reduce reproductive capacity, invasive *Codium fragile* compete for space, and recurrent overgrazing by sea urchins occurs due to the general loss of fish predators[21]. Commercial harvesting of sea urchins has also become a new factor affecting herbivore marine plant dynamics. A kelp harvest must be carefully managed however there is a need to protect key components of the associated fauna such as exploited fish species[21].

Several *Chondrus* beds in western Prince Edward Island have undergone a dramatic change in dominance of algal species. The major commercial *Chondrus* bed, Pleasant View, has over 15 to 20 years become a *Furcellaria lumbricalis* (Huds.) Lamour. dominant bed[22]. This bed was the most intensively harvested bed in western Prince Edward Island. It was suggested that there was a relationship between long-term drag raking and the change in species dominance as raking was considered detrimental to the survivorship of *F. lumbricalis*[2]. However, the dragrake is selective for the larger fronds and it leaves the majority of fronds allowing rapid recovery of the standing crop[22]. The relationship between this change of species dominance and raking impact is not direct and normal spread of this species regardless of raking impact has occurred over 40 years since its first recognition.

In very near shore systems macrophytes can be an important contributor of primary production. Our direct take of some portion of this production removes it from normal, detrital, particulate and nutrient cycles in the system. However, the total system for these cycles rarely is restricted to the immediate waters of the targeted resource. In southern New Brunswick the contribution to total primary production by macrophytes in the Bay of Fundy is 4 %; the majority of primary production is provided by phytoplankton[23]. *Ascophyllum nodosum* dominates the extensive intertidal and there are few sub tidal macrophytes due to high density populations of sea urchins subtidally. Annual productivity of *Ascophyllum* from this area ranges from 64,000 to 79,550 wet t. The annual harvest is restricted to a quota of 12,000 wet t in 2004 and results in a removal of 7.5% the total standing crop 15.1% to 18.7% of the annual production. The larger Bay of Fundy has a standing crop of 309,670 wet t and 2872 hectares. If *Ascophyllum* is providing 100% of the macrophyte primary production in the Bay of Fundy this harvest is removing less than 1% of the total primary production. *Ascophyllum nodosum* grows on both sides of the Bay of Fundy to the southern New England states and the circulation system encompasses the entire Gulf of Maine, therefore the total primary production pool is much larger.

Total standing crop of *Laminaria longicruris* resources in Maritime Canada are estimated at 858,000 wet tons[11]. The productivity of this species has been calculated from 143- 428 g C m^{-2} yr^{-1}. The ratio of annual production to standing crop for L. *longicruris* populations in south-western Nova Scotia is 2.1:1. Annual harvests to date have reached a maximum of 3000 wet t. Present management restricts harvests to hand methods of gathering with economics that will keep harvests well below 10,000 wet t in the future or 0.6% of annual production of this area.

Discussion

Many knowledge gaps have been recently identified regarding the ecology of the marine plants habitat.[16]. There have been relatively few studies directed at harvesting impact on community ecology. In the face of these gaps the precautionary approach has been proposed[5]. The precautionary approach as defined under the Canadian Oceans Act 1997 is "erring on the side of caution" This definition allows a very wide interpretation that needs some constraints. The concept of ecosystem management is also a part of the Canadian Oceans Act and brings together three interlocking principals "integrated management" using the "precautionary approach" to ensure "sustainable development".

A draft framework for ecosystem-based management in Canada sets principles, operational strategies and performance indicators related to characteristics of the system. The general productivity principle is "ensure that the activity does not cause unacceptable reduction in productivity of each component (primary, community, and population) so that it can play its historical role in the functioning of the ecosystem". At the community productivity level the strategy is to limit removals from any trophic level in respect for the trophic demands of higher levels. The performance indicator for this strategy is trophic level catch biomass. Therefore a level of marine plant catch must be defined in terms of what impact it may have on linked secondary producers such as grazers of all taxa. Habitat principle states "ensure that the activity does not cause unacceptable modification to habitat that is difficult or impossible to reverse in order to safeguard the 'container' (both physical and chemical properties) of the ecosystem" (Canadian Oceans Act 1997). At the ocean bottom and in the marine plants habitat the performance measure is the per cent of the total area impacted and frequency of a disturbance. This target in the marine plant habitat can be more clearly defined since we can directly measure the changes in habitat structure caused by the type of harvesting gear, the level of effort and the exploitation rate.

The biodiversity principle: "ensure that the activity does not cause unacceptable reduction in biodiversity by maintaining enough components (biotypes/ seascapes, species and populations) to preserve the structure and natural resilience of the ecosystem." At the species level this would mean limiting incidental mortality by having bycatch targets, and bycatch mortality limits. A similar series of targets have been outlined for conservation of Arctic biodiversity[24]. In Norway a coordinated industry/ government precautionary approach to kelp harvesting in the north has lead to some kelp beds being protected for their value as feeding grounds for birds[24].

An examination of the marine plant management in eastern Canada with an ecosystem conservation framework reveals inconsistencies of policy between different marine plant harvests. The *Chondrus* harvest in Nova Scotia is an open license or un-limited effort fishery[2]. Bycatch levels are monitored in several marine plant harvests but there are no limits by amount or species. The *Ascophyllum* harvest in southern New Brunswick has many restrictions related to potential risks to the ecosystem or its components and a long-term monitoring program[4,5]. These measures range from prevention of disturbance in duck brooding areas to interference with herring movements near fish traps. Exploitation rates and quota limits are set well below the levels required of sustainability of the targeted species in the precautionary approach.[5]

These limits were instituted in a "new" fishery when the basic aspects of the precautionary approach were being considered under the Oceans Act. Other marine plant harvests including *Chondrus* in South Western Nova Scotia have been established for 40 to 55 years and the process of placing limitations on what have been considered "sustainable" fisheries are not generally supported by the community or the industry.

Harvesting of marine plants in the near shore ecosystem is an impact added to the natural processes that restructure the habitat. Mortality of whole plants or fragments is a continuous process caused by disease, storms, ice scour, grazing and normal senescence. These natural events, whether annual, seasonal or episodic can result in much greater changes in this habitat than caused by human harvest.

In contrast to natural events, harvesting of marine plants is limited in degree, extent, and duration by resource management and commercial constraints. The question remains whether the cumulative effects of successive harvests will restructure the habitat and the ecosystem. The precautionary approach and associated targets are measures to deal with this question. The statistical power required to conduct a before after control experiments that can determine the very subtle changes in the ecosystem at a scale that is meaningful is generally impractical[16]. However, carefully examining parts of the complex relationships in algal stands can help us provide targets or limits to marine plant harvests well below detected effects at the local level. Presently our controls limit: type, duration, degree and extent of change in the habitat. *Ascophyllum nodos*um harvests of southern New Brunswick have demonstrated that these controls can be applied in area based management to a reasonably high level of resolution in the coastal zone[5]. There have been many challenges that Fisheries and Oceans Canada is not managing fisheries effectively and some regarding marine plants. Closer examination of past and present marine plant management in Canada contradicts these assertions[2,10,12,4,5] .

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