The Effects of Rockweed Harvesting

Effect of harvesting on the target species

Effect of harvesting on the associated community

“The ecological impact of marine plant harvesting is related to the intensity of exploitation, the harvesting technique, and the vulnerability of the species or habitat to perturbation (Sharp & Pringle 1990).”

Effects on the target species

- Regrowth
  - Length of time to recovery
  - Biomass, percent cover, or length
  - Changes to plant morphology

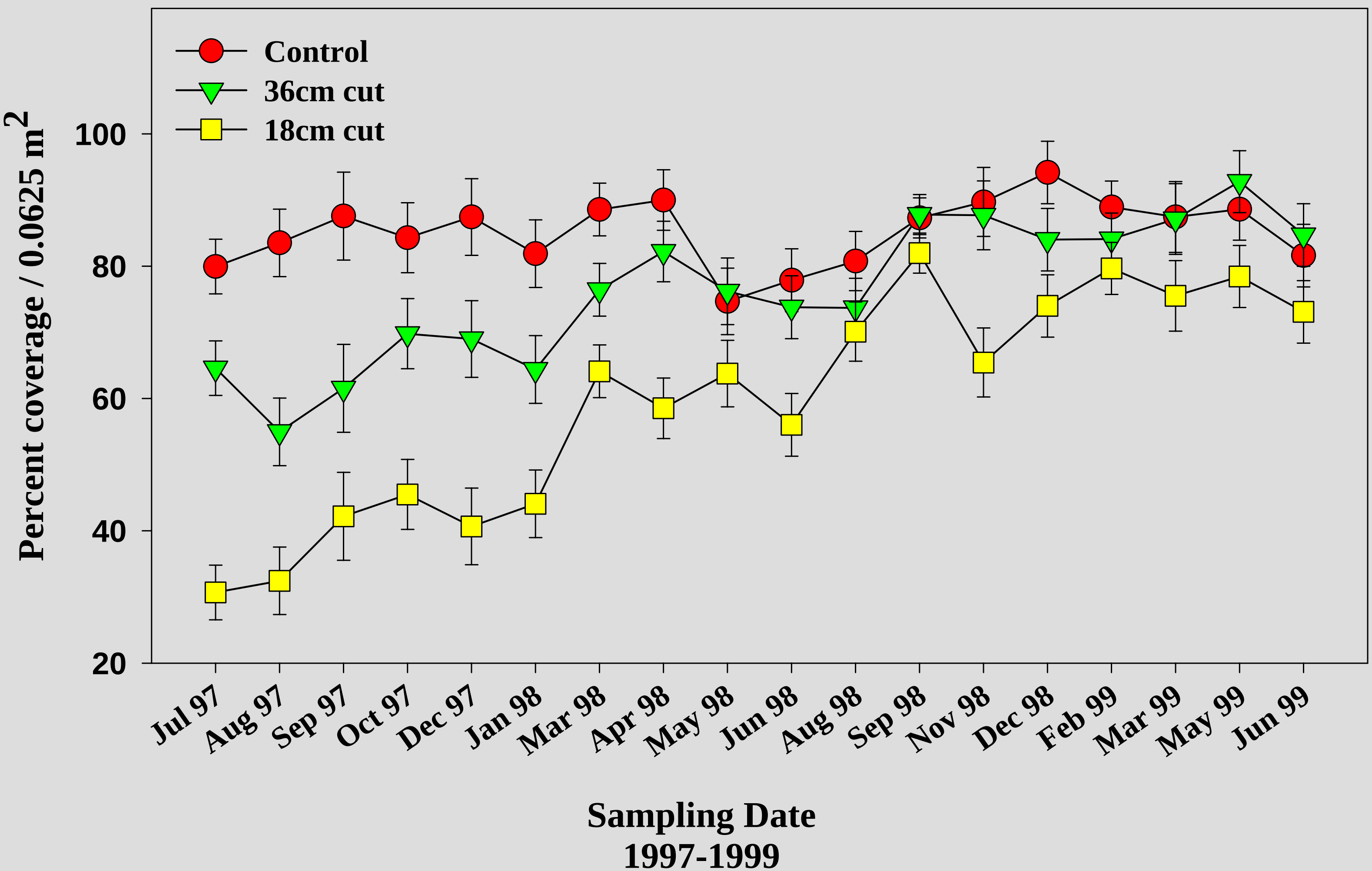
Length of time to recovery

- Recovery to pre-harvest standing crop requires 2.5 to 3 years depending on the productivity and the frond characteristics of the site (Sharp 1987).
- Regrowth was dependent on the age structure of the population, on the extent of the pattern of branching, and on the presence or absence of grazers (Keser et al 1981).
- It takes 3-6 years before the vegetation is re-established and can be cut again after cutting at the holdfast (Baardseth 1970).
- Fronds in harvested stands grew faster than those in uncut stands, however, pre-harvest biomass levels were not reached after two years (Lazo & Chapman 1996).

Length of time to recovery

- *Ascophyllum* cover decreased significantly after harvesting (hand & mechanical) and was nearly recovered after 17 months at one site and 11 months at another site in Ireland (Kelly et al 2001).

- *Ascophyllum* cover decreased significantly after harvesting (18cm and 36cm from the holdfast) but had recovered after 18 months (Fegley 2001)



Temporal changes in the percent coverage of *Ascophyllum nodosum* at various treatment levels. Values represent means +/- S.E. (n = 12/ treatment/ time).

Length of time to recovery

- Two-years following the experimental harvest, the biomass values in the experimental plots were not statistically different from one another despite the fact that the mean biomass in the 18cm cut plots was only 66% of the mean of the control plots (Fegley 2001).

- Two-years following the experimental harvest, control plants were significantly longer than the plants in either of the cut plots (Fegley 2001).

- Shoots between 21-40cm and 41-60cm in the harvested plots increased their biomass by 131% and 249%, respectively over the control plot shoots after the first year of the harvest (Ugarte et al 2006).

Repeated annual harvests

- Repeated annual harvests (scraped, cut 15cm or 25cm from the holdfast) causes a declining biomass yield. Annual harvests should be avoided in Maine (Keser et al 1981).

- Yearly experimental harvesting of *Ascophyllum* stands leaving stumps 15-25 cm high, yields successively lower annual biomass (Sharp 1987).

Changes in morphology

- Long-term harvesting has altered the population structure and population ecology of *A. nodosum* in some areas (Sharp & Pringle 1990).

- Harvesting with a cutter rake will impact patches of rockweed habitat. The largest net change in the harvested patches is in clump biomass not length or number of shoots (Ugarte et al 2006).

- Most unharvested populations of rockweed tend to have a biomodal population structure and harvesting tends to reduce this to unimodal (20-30 cm). The population remained unimodal until the third year post-harvest (Ang et al 1996).

Changes in morphology

- Two-years following the experimental harvest, there was an increase in shoot densities in the harvested plots (Fegley 2001).

- Plants from harvested sites were substantially bushier than those in un-harvested sites in Quahog Bay. No significant difference in length was found between harvested and un-harvested plants (Fegley 2006).

Biomass

- In older populations, most of the plant biomass is located in the upper branching system. In young populations or those at exposed sites, the branches develop closer to the substrate causing shorter plants (Keser et al 1981).

- Fifty percent of the biomass is within the lower half of the plant up to the 90cm length class. In the 130cm length class 50% of the biomass is distributed in the upper 1/3 of the clump (Ugarte et al 2006).

Biomass

- The high variability associated with the biomass sampling makes it difficult to use this information for management purposes (Fegley 2001).
- Did not get consistent results for large-scale harvesting experiments due to different productivity and regenerative powers of the beds themselves and the impossibility of leaving behind the same amount of growing material (Baardseth 1970).

Effects on the community

- Short-term effects
- Long-term effects
  - Understory algal species
  - Epiphytic algal and invertebrate species
  - Understory invertebrates
  - Phytal assemblage
  - Fish
  - Birds

Short-term effects

- Immediately following an experimental harvest there was a decrease in the following species: *Fucus, Hildenbrandia, Phymatolithon, Carcinus, Dynamena, Halichondria and Littorina obtusata.* There was an increase in the abundance of *Nucella* (Fegley 2001).

- Despite the fact that numerous species within the community experienced short-term effects, few effects persisted through time.

- Conclusion: both the target species and the associated community are resilient to single perturbations at a moderate (~36-cm cut) harvesting intensity.

Fucus vesiculosus

Hildenbrandia rubra

Phymatolithon lenormandii

Short-term effects

- Trott and Larsen (2008) conducted a short harvesting study in Cobscook Bay and found that species assemblages were not distinctly different before and after harvesting for both experimental and control sample plots at the level of 65% community similarity.

- There was also no significant impact of harvesting on the abundance of epifauna or on epifaunal species richness on either substrate or rockweed thalli during the two-month duration of the study.

- Trott and Larsen also found that there was no significant impact of harvesting on the abundance of the three species of periwinkle snails.
- Ugarte et al (2010) examined snail by-catch in Cobscook Bay and found that Littorina obtusata was the most abundance by-catch species.

Short-term effects

- Kelly et al (2001) examined the effect of mechanical and hand harvesting on *Ascophyllum* regeneration and biodiversity over an 18 month period in Ireland.

- No significant effects or changes in red algae or *Fucus serratus* could be attributed to harvesting.

- There was an increase in ephemeral algal cover in the mid-shore following the removal of the *Ascophyllum* canopy.

- *Fucus vesiculosus* increased significantly in cover after harvesting at both sites.

- *Littorina obtusata* decreased in the hand-harvested sections of seashore during winter.

Short-term effects

- Boaden & Dring (1980) examined an *Ascophyllum* bed in Northern Ireland 2.5 years after it was severely harvested (95% biomass removal).

- They found that *Mytilus* densities were lower but limpet (*Patella vulgata*) densities were higher.

- The cryptic and emergent fauna, including sponges and barnacles, was impoverished compared to the adjacent, un-harvested area.

- *Carcinus* was unaffected.

- Although this study was comprehensive regarding the types of species sampled, the lack of temporal and spatial replication limits generalization of the results.

Short-term effects

- Black & Miller (1991) found that harvesting (total clearing) led to a reduction in the numbers of *Littorina obtusata*.
- Harvesting led to a 66% reduction in animal abundance, mostly amphipods, nemerteans, and *L. obtusata*.
- There were no significant differences in the number of *Carcinus* and *Spirorbis*.

Fish

- The number and diversity of fish species moving in and out of the *Ascophyllum* bed did not decrease after removal of 95% of the algal standing stock (Black & Miller 1991).
- Fishes were found in low abundance in the intertidal, most were nonexploited species, and the exploited species were of low value.
- Rangeley (1994) was critical of Black & Miller's study stating that their conclusions cannot be substantiated by their data because of sampling biases, errors in experimental design and low statistical power.
- Rangeley further contents that the juveniles of commercially important species were under-represented due to the net mesh size used in the survey.
- Rangeley & Kramer (1995) found that juvenile pollock use rockweed for foraging and as a refuge from predators.

References

Ang, P.O, G.J. Sharp and R.E. Semple. 1996. Comparison of the structure of populations of *Ascophyllum nodosum* at sites with different harvesting histories. Hyrdobiolgia 326/327: 170-184.

Baardseth, E. 1970. Synopsis of biological data on knobbed wrack *Ascophyllum nodosum* (Linnaeus) Le Jolis. FAO Fisheries, Synopsis #38, Rev. 1.

Black, R. and R.J. Miller. 1991. Use of the intertidal zone by fish in Nova Scotia. Environmental Biology of Fishes 31: 109-121.

Boaden, P.J.S. and M.T. Dring. 1980. A quantitative evaluation of the effects of *Ascophyllum nodosum* harvesting on the littoral ecosystem. Helgol. Meeresunters 33: 700-710.

Fegley, J.C. 2001. Ecological implications of rockweed, *Ascophyllum nodosum* (L.) Le Jolis harvesting. Ph.D. dissertation, University of Maine.

Fegley, J.C. 2006. Morphological, population and biomass studies of rockweed (*Ascophyllum nodosum*) in Quahog Bay and Taunton Bay. DMR report.

Kelly, L., L. Collier, M.J. Costello, M. diver, S. McGarvey, S. Kraan, J. Morrissey and M.D. Guiry. 2001. Impact assessment of hand and mechanical harvesting of *Ascophyllum nodosum* on regeneration and biodiversity. Marine Fisheries Services Division, Marine Resource Series No. 19.

Keser, M, R.L. Vadas and B.R. Larson. 1981. Regrowth of *Ascophyllum nodosum* and *Fucus vesiculosus* under various harvesting regimes in Maine, U.S.A. Botanica Marina vol. XXIV: 29-38.

Rangeley, R.W. 1994. The effects of seaweed harvesting on fishes: a critique. Environmental Biology of Fishes 39: 319-323.

Rangeley, R.W. and D. Kramer. 1995. Use of rocky intertidal habitats by juvenile pollock *Pollachius virens*. Mar. Ecol. Prog. Ser. 126: 9-17.

Sharp, G.J. 1987. *Ascophyllum nodosum* and its harvesting in eastern Canada. In: Doty, M.S., Caddy, J.F., Santelices, B. (Eds.), Case Studies of Seven Commercial Seaweed Resources. FAO Fish. Tech. Paper 281, Rome, pp. 3-48.

Sharp, G.J. and J.D. Pringle. 1990. Ecological impact of marine plant harvesting in the northwest Atlantic: a review. Hydrobiologia 204/205: 17-24.

Trott, T.J. and P.F. Larsen. 2008. Evaluation of short-term changes in rockweed (*Ascophyllum nodosum*) and associated eipfaunal communities following cutter rake harvesting in Maine.

Ugarte, R., C. Bartlett and L. Perry. 2010. A preliminary study to monitor periwinkle by-catch and incidence of holdfasts in harvested rockweed, *Ascophyllum nodosum*, from Cobscook Bay, Maine. DMR study.

Ugarte, R.A., G. Sharp and B. Moore. 2006. Changes in the brown seaweed *Ascophyllum nodosum* (L.) Le Jol. plant morphology and biomass produced by cutter rake harvests in southern New Brunswick, Canada.