Fencing the seabed to protect sea scallops *(Placopecten magellanicus)* from predation

R. Boudreau[1], R. Fougère[1], L.-A. Davidson[2] and M. Niles[2]

[1]Sea Perfect Cultivated Products Ltd.
West Arichat, Nova Scotia B0E 3J0

[2] Department of Fisheries and Oceans
Gulf Fisheries Centre, Oceans and Science Branch
P.O. Box 5030, Moncton, New Brunswick E1C 9B6

Canadian Manuscript Report of Fisheries and Aquatic Sciences 2717

Fisheries and Oceans Pêches et Océans

Canada

Canadian Manuscript Report of Fisheries and Aquatic Sciences

Manuscript reports contain scientific and technical information that contributes to existing knowledge but which deals with national or regional problems. Distribution is restricted to institutions or individuals located in particular regions of Canada. However, no restriction is placed on subject matter, and the series reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Technical reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1-900 in this series were issued as Manuscript Reports (Biological Series) of the Biological Board of Canada, and subsequent to 1937 when the name of the Board was changed by Act of Parliament, as Manuscript Reports (Biological Series) of the Fisheries Research Board of Canada. Numbers 901-1425 were issued as Manuscript Reports of the Fisheries Research Board of Canada. Numbers 1426-1550 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Manuscript Reports. The currrent series name was changed with report number 1551.

Manuscript reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

Rapport manuscrit canadien des sciences halieutiques et aquatiques

Les rapports manuscrits contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui traitent de problèmes nationaux ou régionaux. La distribution en est limitée aux organismes et aux personnes de régions particulières du Canada. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du ministère des Pêches et des Océans, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports manuscrits peuvent être cités comme des publications complètes. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports manuscrits sont résumés dans la revue *Résumés des sciences aquatiques et halieutiques*, et ils sont classés dans l'index annuel des publications scientifiques et techniques du Ministère.

Les numéros 1 à 900 de cette série ont été publiés à titre de manuscrits (série biologique) de l'Office de biologie du Canada, et après le changement de la désignation de cet organisme par décret du Parlement, en 1937, ont été classés comme manuscrits (série biologique) de l'Office des recherches sur les pêcheries du Canada. Les numéros 901 à 1425 ont été publiés à titre de rapports manuscrits de l'Office des recherches sur les pêcheries du Canada. Les numéros 1426 à 1550 sont parus à titre de rapports manuscrits du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 1551.

Les rapports techniques sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

This is report MG-01-06-024 for the
Aquaculture Collaborative Research and Development Program (ACRDP)

Cat. No. Fs 97-4/2717E ISSN 0706-6473

Published by:

Department of Fisheries and Oceans Canada
Oceans and Science Branch
Gulf Fisheries Centre
P.O. Box 5030
Moncton, NB
E1C 9B6

Correct citation for this publication:

Boudreau, R., R. Fougère, L.-A. Davidson and M. Niles. 2005. Fencing the seabed to protect sea scallops *(Placopecten magellanicus)* from predation. Can. Manuscr. Rep. Fish. Aquat. Sci. 2717: iv +7 p.

TABLE OF CONTENTS

LIST OF FIGURES

ABSTRACT

Boudreau, R., R. Fougère, L.-A. Davidson and M. Niles. 2004. Fencing the seabed to protect sea scallops *(Placopecten magellanicus)* from predation. Can. Manuscr. Rep. Fish. Aquat. Sci. 2717: iv +7 p.

Sea Perfect Cultivated Products Ltd., a scallop farming company, often has excess scallop juveniles and wants to seed them on the bottom without being subjected to predation. The initial objectives of this project were: to compare the growth rate and survival of scallops cultured in lantern nets (currently used by Sea Perfect) with those cultured on a fenced-in seabed and to monitor and assess the presence of predators on the fenced-in seabed. A fence with an overturned edge was erected on the seabed on the scallop culture site near West Arichat, Nova Scotia. Predators within the enclosure were removed and measured. The scallops were then seeded within the enclosure after they were measured and counted. Scallops were also placed in the traditional lantern nets after they were measured and counted. The scallop density on the bottom (74.7 scallops /m^2) was similar to the density found in the lantern nets (79 scallops /m^2). Bi-weekly surveys and removals of the predators within the enclosure were conducted from May until the end of August 2002. Results indicated that the fence successfully prevented predators from entering the enclosure. However, in 2003, a gap in the overturned edge of the fence was observed. The seeded scallops were no longer present and high densities of predators were observed. As a result, no growth data were obtained. Fencing the seabed can be an effective technique for protecting scallops from predators; however fence maintenance is essential.

RÉSUMÉ

Boudreau, R., R. Fougère, L.-A. Davidson and M. Niles. 2004. Clôturage du fond marin pour protéger les pétoncles (*Placopecten magellanicus*) contre la prédation. Can. Manuscr. Rep. Fish. Aquat. Sci. 2717: iv +7 p.

Sea Perfect Cultivated Products Ltd, une compagnie qui cultive le pétoncle, se retrouve souvent avec un surplus de pétoncles juvéniles, et il aimerait les ensemencés sur le fond marin sans être sujet à la prédation. Les objectifs de ce projet étaient: de comparer le taux de croissance et de survie des pétoncles cultivés dans les paniers lanternes (actuellement utilisés par Sea Perfect) avec ceux cultivés sur le fond marin clôturer et faire le suivi de la présence des prédateurs sur le fond marin clôturé. Une clôture avec un rebord a été installée sur le site de culture de pétoncle près de West Arichat, Nouvelle-Écosse. Les prédateurs sur le fond marin clôturé ont été retirés, comptés et mesurés. Ensuite, les pétoncles ont été ensemencés à l'intérieur de la clôture après avoir été mesurés et comptés. Des pétoncles mesurés et comptés ont aussi été placés dans les paniers lanternes traditionnelles. La densité des pétoncles sur le fond (74.7 pétoncles /m^2) était similaire à la densité retrouvée dans les paniers lanternes (79 pétoncles /m^2). Des suivis pour compter et retirer les prédateurs à l'intérieur de la clôture ont été effectués chaque deux semaines du mois de mai jusqu'à la fin du mois d'août 2002. Les résultats ont indiqués que la clôture était efficace à prévenir l'entrée des prédateurs dans l'enclos. Mais en 2003, des brèches dans le rebord ont été observées. Les pétoncles ensemencés n'étaient plus présents à l'intérieur de l'enclos et des hautes densités de prédateurs ont été observées. Par conséquent, aucune donné de croissance n'a pu être obtenue. Clôturer le fond marin est une technique efficace pour protéger les pétoncles mais l'entretien de la clôture est essentiel.

1.0. INTRODUCTION

The economic feasibility of culturing scallops in suspension is often questioned because of the cost of labour and equipment required. In suspension, the growth and survival of scallops are dependent on the density of scallops (Parsons and Dadswell 1992). If a scallop farmer collects a surplus of scallop spat this does not necessarily mean increased profits. It is often the amount of culture equipment available that limits the number of scallop spat that can be retained.

In the past, excess scallops collected by Sea Perfect Cultivated Products Ltd. were seeded on the seabed of their culture site. Divers monitored for the presence of the seeded scallops, but, unfortunately, the seeded scallops were not found. The seeded scallop spat had either emigrated or succumbed to predation by rock crabs (*Cancer irroratus*) and sea stars (*Asterias* and *Leptasterias* species). One approach to minimizing predation or dispersal of scallop spat seeded on to the bottom is the use of a perimeter fence (David et al. 1980; Strand et al. 1999; Strand et al. 2003).

The initial objectives of this project were to:

1) Monitor growth rate and survival of cultured scallops i) in lantern nets (presently used) and ii) on a fenced-in seabed.
2) Monitor and assess the presence of predators on the fenced-in seabed.

2.0. MATERIALS AND METHODS

The study was conducted on the seabed of Sea Perfect Cultivated Products Ltd. culture site in LeBlanc Harbour, West Arichat, Nova Scotia.

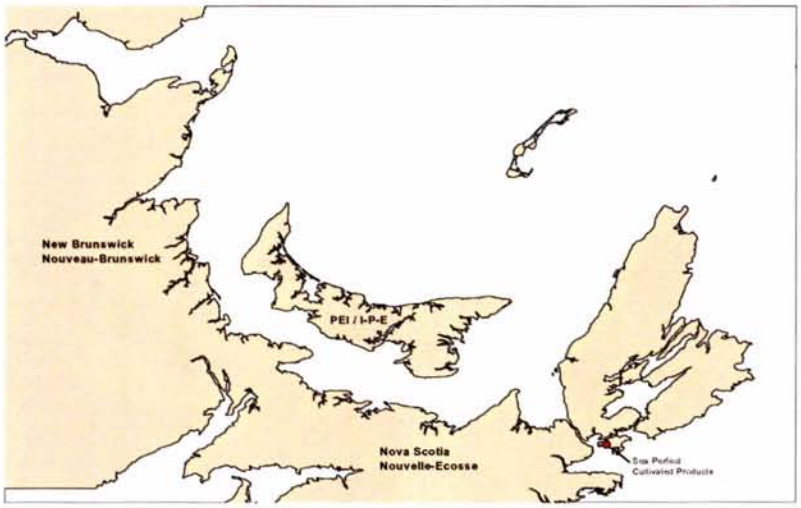


Figure 1. Location of study site in LeBlanc Harbour, West Arichat, Nova Scotia.

The fence design used in this study was similar to the one used by Davis *et al.* (1980) with an over-turned edge to prevent predators from climbing over the barrier and entering the fenced-in area (Figure 2).

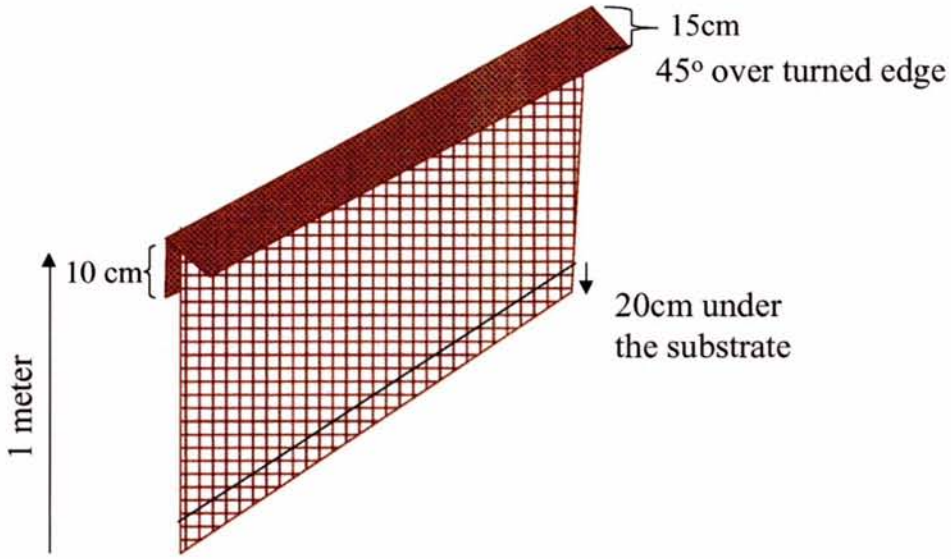


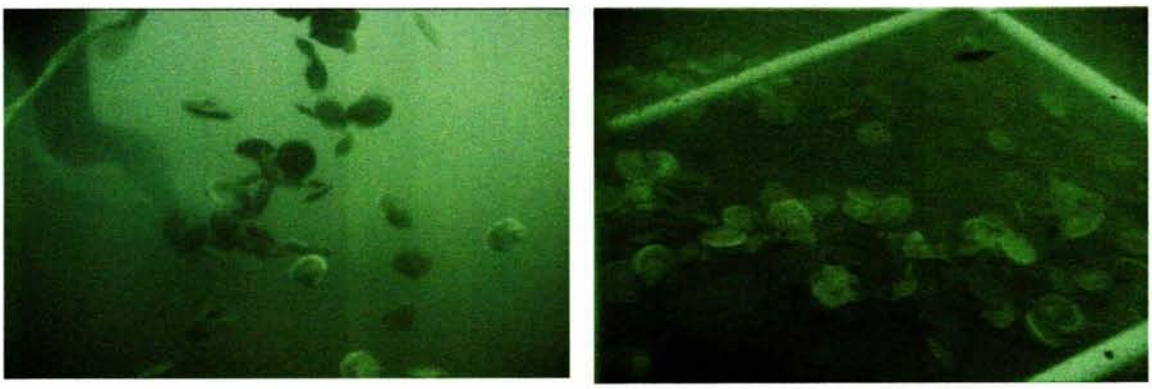
Figure 2. Fence design modelled from Davis et al. (1980).

The fencing was made of 38.1 mm plastic covered wire mesh (same material used in lobster traps) topped with a sheet of galvanised steel (27 gauge) that was overturned at a 45° angle. The section of the galvanised steel that was fastened to the fence measured 10cm and the overturned edge was 15cm. The fence was embedded 20 cm in the substrate and was approximately 1 m above the substrate. It was anchored and stabilised with plastic milk crates that were filled with cement and placed at each corner and at midway points. (Figure 3).

Figure 3. Fence was made with plastic covered wire mesh (a) with an overturned edge of galvanised steel (b) and was anchored with plastic milk crates filled with cement (c).

Most of the fence preparation and installation was conducted in the autumn of 2001; however, final completion occurred from May 5 to 8, 2002. The fenced-in area measured 18.3 m X 18.3 m which gave an enclosed seabed surface area of 334.5 m^2 for seeding.

On May 8, 2002, before seeding the scallops, the predators that were on the seabed within the fenced-in area, were removed. An estimated 25,000 scallops obtained from the 1999 spat collection were then seeded within the fenced-in area from May 13 to 17, 2002 (Figure 4).



a) b)

Figure 4. Scallop seeding (a) and seeded scallops in the enclosed area (b).

Scallops from the same year class were also placed in two lantern nets with ten levels each, one of the traditional culture nets used by Sea Perfect Cultivated Products, at a count of thirteen per level. The surface area of each level of the lantern net was 0.164 m^2 (diameter of 0.457 m).

Divers took video recordings of the seabed and the fence on May 17, 2002 on the last seeding day. Divers then visited the site bi-weekly from May until the end of August 2002 for the removal of the predators. Predators were stored in a freezer until they were counted and measured. Due to cold weather and ice coverage, the site was not surveyed during the winter 2002/2003. On July 9, 2003 divers again visited the survey site to assess the presence of predators and the abundance of scallops.

3.0. RESULTS

The initial shell height of the scallops that were seeded on the fenced-in site and those placed in the lantern nets was 45.7 mm (sd 4.8 mm). The scallops seeded on the seabed within the enclosure were estimated to be distributed at a density of 74.7 scallops /m^2 and the density in the lantern net was 79 scallops /m^2. Unfortunately, it was not possible to monitor the scallops placed in the lantern nets. All the scallops died shortly after the lantern net had been deployed on the culture site. Local culturists felt that the mortality was caused by an uncommon influx of fresh water.

In 2002, results of the predator surveys and removals indicated that the fence was 100% effective at preventing the moonsnail from re-entering the enclosed area. The other predators were able to find their way back in the enclosed area however they were found at lower densities (Figure 5). The survey conducted 10 days after the seeding indicated that the predators were found at densities 2 times lower then their original densities. As the bi-weekly predator surveys and removals continued, the predator level was reduced by a factor of 5 to 7 throughout July and August 2002.

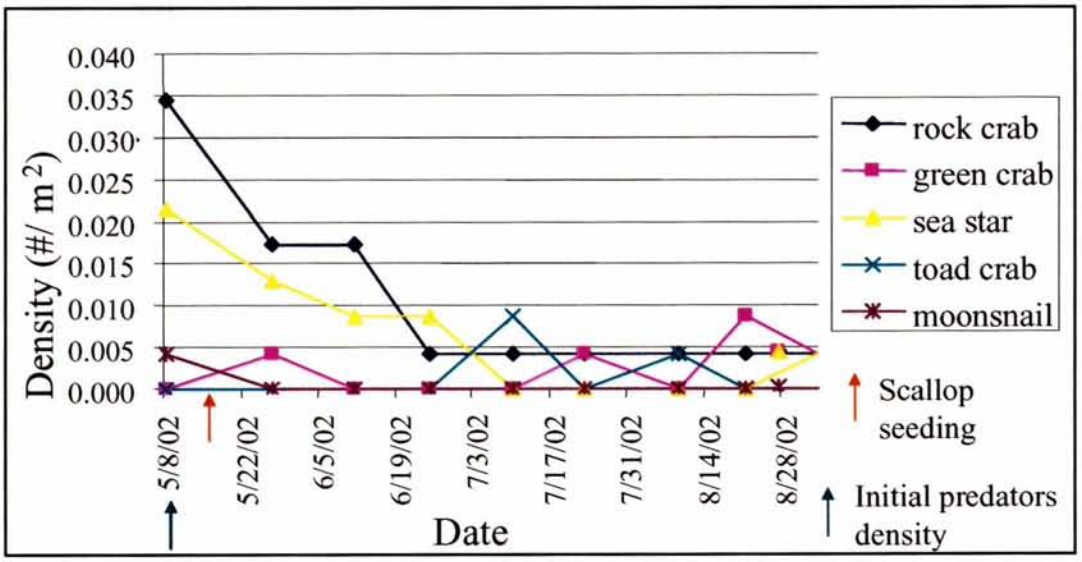


Figure 5. The density (per m^2) of rock crab (*Cancer irroratus*), green crab (*Carcinus maenas*), sea star (*Asterias vulgaris*), toad crab (*Hyas araneus*) and moonsnail (*Euspira heros*) that were recorded and removed from May to end of August, 2002.

Predation of seeded scallops by rock crabs was observed (Figure 6a). Rock crabs were observed to easily travel on the fence (Figure 6b). In 2003, when divers visited the enclosed study site, there were gaps in the overturned edge of the fence (Figure 6c & d). Divers could not locate the seeded scallops and the density of crabs had returned to a high level of 0.020/m^2. Divers also observed many empty scallop shells in one corner of the enclosed study site. They felt that the current was responsible for gathering the empty shells in the same location.

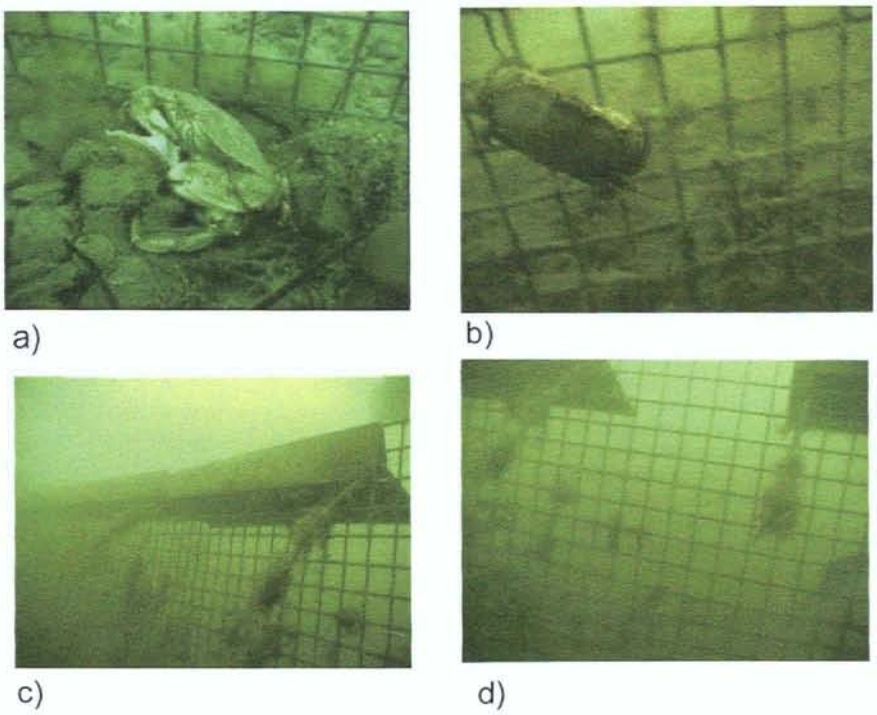


Figure 6. Rock crab feeding on a scallop inside the enclosure (a); Pictures of gaps in the overturned edge of the fence (b & c); Pictures of a crab easily travelling along the fence (d).

4.0. DISCUSSION

In this study, the initial results demonstrated that seabed enclosures can serve to prevent predators from accessing scallops within a fenced-in area. Davies et al. (1980) have successfully used fenced enclosures for the protection of mussel seed (*Mytilus edulis* L.) from predation by green crab (*Carcinus maenas* (L)). Similarly, Strand et al. (1999) demonstrated that it is possible to fence scallops on the seabed to prevent intrusion of the brown crab (*Cancer pagurus*).

The overturned edge seems to be effective at preventing predators from entering the enclosed area because high densities of crabs were observed on the enclosed sea-bed only when a gap in the overturned edge occurred. Unfortunately, during the winter of 2002/2003 certain sections of the overturned edge had separated forming gaps that allowed predators to enter the enclosure. This resulted in a complete loss of seeded scallops and hence did not allow for the collection of growth data.

Seabed enclosures are not a widely used technique, therefore its construction was a learning experience. Strand et al. (1999) also experienced maintenance problems. Their main problems were weak connections between fences and the catch of drifting seaweed, upon which the crabs climbed to pass over the fence. Strand et al. (2003) reported that recent technical improvements of the fences has improved the economic viability of fencing scallops on the seabed in Norway. In Canada, fencing the seabed with technically improved fences, with routine monitoring and maintenance, might also be a viable method of culturing scallops.

5.0. SUMMARY

- A fence with an overturned edge prevents predators such as moonsnail from re-introducing themselves into the enclosed seeding area.
- The density of predators such as crabs (toad, rock and green) and sea stars is reduced by a factor of 5 to 7 on a seabed that is enclosed with a fence with an overturned edge and a bi-weekly predator removal program.
- Crabs can easily climb fences therefore the overturned edge seems to be effective at preventing them from entering the enclosed area because high densities of crabs were observed on the enclosed sea-bed only when a gap in the overturned edge occurred.
- Technically improved fences, with routine monitoring and maintenance, for culturing scallops on the seabed should be investigated.

6.0. ACKNOWLEDGEMENTS

We would like to thank Jean-François Mallet and Bruno Frenette for technical assistance. The study was supported financially by the Fisheries and Oceans Canada Aquaculture Collaborative Research and Development Program (ACRDP) and Sea Perfect Cultivated Product Ltd.

7.0. REFERENCES

Davies, G., P.J. Dare and D.B. Edwards. 1980. Fenced enclosures for the protection of seed mussels (*Mytilus edulis* L.) from predation by shore – crabs (*Carcinus maenas* (L)). Fish. Res.Tech. Rep. MAFF direct Res. Lowestoft, (56) 14 pp.

Parsons, G.J. and Dadswell, M.J. 1992. Effect of stocking density on growth, production, and survival of the giant scallop, *Placopecten magellanicus*, held in intermediate suspension culture in Passamaquoddy Bay, New Brunswick. Aquaculture. 103:291–309.

Strand, O., G.A. Haugum, E. Hansen and A. Monkan. 1999. Fencing scallops on the seabed to prevent intrusion on the brown crab *Cancer pagaurus*. 12th Int. Pectinid Workshop, Bergen (Norway) p. 58.

Strand, O., E.S. Grefsrud and T. Strohneier. 2003. Fenced Farming – A prerequisite for scallop (*Pecten maximus*) seabed culture in Norway? 14th Int. Pectinid Workshop, St. Petersburg, Florida (U.S.A.) p. 27.