PERFORMANCE OF THE NEW ENGLAND HYDRAULIC DREDGE FOR THE HARVEST OF STIMPSON'S SURF CLAMS (*Mactromeris polynyma*)

Jean Lambert and Patrice Goudreau

Invertebrate and Experimental Biology Division
Department of Fisheries and Oceans Canada
Maurice Lamontagne Institute
850 route de la Mer, P.O. Box 1000
Mont-Joli (Québec)
G5H 3Z4

1996

Canadian Industry Report of
Fisheries and Aquatic Sciences 235

Pêches et Océans
Fisheries and Oceans

Canada

Canadian Industry Report of Fisheries and Aquatic Sciences

Industry reports contain the results of research and development useful to industry for either immediate or future application. They are directed primarily toward individuals in the primary and secondary sectors of the fishing and marine industries. 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.

Industry 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 1-91 in this series were issued as Project Reports of the Industrial Development Branch, Technical Reports of the Industrial Development Branch, and Technical Reports of the Fisherman's Service Branch. Numbers 92-110 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Industry Reports. The current series name was changed with report number 111.

Industry 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 canadien à l'industrie sur les sciences halieutiques et aquatiques

Les rapports à l'industrie contiennent les résultats des activités de recherche et de développement qui peuvent être utiles à l'industrie pour des applications immédiates ou futures. Ils sont surtout destinés aux membres des secteurs primaire et secondaire de l'industrie des pêches et de la mer. 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 à l'industrie peuvent être cités comme des publications complètes. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports à l'industrie 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 91 de cette série ont été publiés à titre de rapports sur les travaux de la Direction du développement industriel, de rapports techniques de la Direction du développement industriel, et de rapports techniques de la Direction des services aux pêcheurs. Les numéros 92 à 110 sont parus à titre de rapports à l'industrie 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 111.

Les rapports à l'industrie 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.

Canadian Industry Report of Fisheries
and Aquatic Sciences 235

1996

PERFORMANCE OF THE NEW ENGLAND HYDRAULIC DREDGE FOR THE HARVEST OF STIMPSON'S SURF CLAMS *(Mactromeris polynyma)*

J. Lambert and P. Goudreau

Invertebrate and Experimental Biology Division
Department of Fisheries and Oceans Canada
Maurice Lamontagne Institute
850, route de la Mer
P.O. Box 1000
Mont-Joli (Québec)
G5H 3Z4

Cat. no. Fs-97-14/235 E ISSN 0706-3694

Correct citation for this publication:

Lambert. J. and P. Goudreau. 1996. Performance of the New England hydraulic dredge for the harvest of Stimpson's surf clams (*Mactromeris polynyma*). Can. Ind. Rep. Fish. Aquat. Sci. 235: vii + 28 p.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Lambert, J. and P. Goudreau. 1996. Performance of the New England hydraulic dredge for the harvest of Stimpson's surf clams (*Mactromeris polynyma*). Can. Ind. Fish. Aquat. Sci. 235: vii + 28 p.

The New England hydraulic dredge has been used recently in the commercial harvest of Stimpson's surf clams (*Mactromeris polynyma*) in the Gulf of St. Lawrence. We undertook a study to determine the harvesting efficiency of this fishing gear and its immediate impact on the mollusc populations. The study was carried out in two parts: the first part, in 1993, took place aboard a commercial clamming boat. The second, in 1994, was conducted aboard a research vessel of the Department of Fisheries and Oceans. The sampling of each station was conducted with a hydraulic dredge and the assistance of a professional dive team. For both parts of the study, Stimpson's surf clams that were large enough to be retained in the dredge's bucket were harvested with an efficiency of over 90%. Of the clams remaining on the bottom, almost two-thirds were damaged by the dredge. A small percentage of other molluscs species that were not harvested were also damaged. More than 20% of the clams harvested by the dredge showed signs of damage. Clams smaller than 66 mm in length were rare on the study sites, thus it was not possible to assess gear selectivity or the effect of dredging on small individuals. However, by using a 19 mm plastic mesh (Vexar™) lining in the dredge, a more representative range of Stimpson's surf clams present in the area was obtained.

RÉSUMÉ

Lambert, J. et P. Goudreau. 1996. Performance of the New England hydraulic dredge for the harvest of Stimpson's surf clams (*Mactromeris polynyma*). Can. Ind. Fish. Aquat. Sci. 235: vii + 28 p.

La drague hydraulique de type Nouvelle-Angleterre est utilisée depuis peu dans le golfe du Saint-Laurent pour la récolte de la mactre de Stimpson (*Mactromeris polynyma*). Une étude a été entreprise afin de déterminer l'efficacité de récolte de ce type d'engin et l'impact immédiat de son passage sur les mollusques présents. Cette expérience a été réalisée en deux volets, le premier a été effectué en 1993 à partir d'un palourdier commercial et le second en 1994 sur un navire de recherche du ministère des Pêches et des Océans. L'échantillonnage de chaque trait a été réalisé par la drague hydraulique et l'assistance d'une équipe de plongeurs professionnels. L'ensemble des résultats a demontré que ce type d'engin de pêche pouvait récolter des mactres de Stimpson de taille assez grande pour demeurer dans le panier de la drague avec un taux d'efficacité supérieur à 90%. Près des deux tiers des mactres de Stimpson laissées sur le fond ont été endommagées lors du passage de la drague. Par contre, un faible pourcentage des autres espèces de mollusques non récoltées ont été endommagées. Parmi les mactres récoltées par la drague, plus de 20% présentaient un bris quelconque. La rareté de mactres de taille inférieure à 66 millimètres sur les sites de l'expérience n'a pas permis d'évaluer la sélectivité de l'engin de pêche ainsi que l'effet de ce type de pêche sur les petits individus. Cependant, l'utilisation d'une drague doublée avec un treillis de plastique (Vexar™) d'une maille de 19 millimètres, a permis d'obtenir une meilleure représentativité de la plage de tailles des mactres présentes dans le milieu.

INTRODUCTION

Hydraulic dredges with jets of water directed at the base of the blade originate from a technology introduced in the middle of the 1940's (Yancey and Welch 1968). This method is the best way to capture endobenthic molluscs and causes less damage to the shells than "dry" methods, which do not have the advantage of water pressure to loosen the bottom sediments (Medcof and Caddy 1971, Murawski and Serchuk 1989). The capture efficiency of a hydraulic dredge may vary depending on the species that it is designed to capture and the ability of the fisherman to successfully maneuver the gear. Both Medcof and Caddy (1971) and Meyer et al. (1981) showed that the capture efficiency of a hydraulic dredge may exceed 90% if it is properly maneuvered. Meyer et al. (1981) observed that an ineffectively used hydraulic dredge leaves behind many Atlantic surf clams (*Spisula solidissima*) on the surface of the sediment after its passage and damages the shells, leaving them more susceptible to predation. On the other hand, to explain the lack of reduction in CPUE (Catch Per Unit Effort) at sites where the total number of tows was sufficient to cover more than 100% of the bottom sediment surface, Roddick and Kenchington (1990) hypothesized that hydraulic dredges were not as efficient as previously believed for the collection of Stimpson's surf clam *(Mactromeris polynyma)*.

The New England hydraulic dredge has been used over the past few years in Québec mainly for the capture of Stimpson's surf clams. There is little available information regarding the performance of this dredge for the capture of this mollusc, which, according to Caddy et al. (1974), buries itself a little deeper in the sediments than does the Atlantic surf clam. To analyze the effects of a hydraulic dredging fishery on population dynamics and to provide more accurate population estimates for scientific research, a better understanding of the performance of this type of dredge in the collection of Stimpson's surf clams is essential.

The goal of the present study was to evaluate the efficiency of the New England hydraulic dredge for the capture of Stimpson's surf clams. The study also aimed at estimating the percentage of clams damaged during collection by the dredge as well as those displaced during each tow but not captured. The damage to other resident mollusc species was also examined. Finally, various observations that may improve our understanding of the dredge's performance are presented.

METHODS

The study was carried out in two parts. The first was undertaken in 1993 aboard a commercial fishing vessel and the second in 1994 aboard a DFO (Department of Fisheries and Oceans) research vessel. A New England hydraulic dredge (Figure 1) was used on both vessels.

PART 1:

The first part of the study, on the *Brigitte Susan,* took place from 6 to 10 July 1993. The vessel measures 12.57 m (41 ft, 3 in) and has a 125 horsepower diesel engine. The dredge used had a total length of 2.13 m (7 ft), a basket height of 43.2 cm (17 in), and a total width of 1.52 m (5 ft), of which 1.22 m (4 ft) was the width of the blade. At the time of this experiment, the blade height was 15.2 cm (6 in). The space between the rods of the basket measured about 2.5 cm (1 in). Twelve water jets were directed at the base of the blade. The hydraulic pump, with a capacity of 4091 liters per minute (900 imperial gallons per minute), was connected to an 80 horsepower diesel motor. The diameter was 12.7 cm (5 in) at the pump entry and 10.2 cm (4 in) at the exit. A 10.2 cm diameter hose joined the pump to the entry of the dredge's jets. A constant pressure of 4.2 kg per cm^2 (60 lbs per in^2) was maintained at the pump exit for each tow.

For this first phase of the study, 16 sample stations were selected based on known beds of Stimpson's surf clam near Sept-Îles in the Gulf of St. Lawrence (Table 1). One tow was conducted at each station. However, data and observations were only collected for 13 stations, two of which were sampled with the dredge lined with 19 mm (0.75 in) mesh plastic VEXAR ™ netting. One station served solely to collect information on video, and stations 2 and 16 could not be sampled because excessive levels of suspended sediment prevented the dive team from working.

PART 2:

The second part of the study was conducted between 25 and 27 May 1994 on the DFO vessel *NSC Calanus II*. The overall length of this vessel is 19.9 m (65 ft, 3 in), with a maximum width of 6.9 m (22 ft, 8 in). The vessel has a draught of 2.8 m (9 ft, 2 in) and a 550 horsepower diesel motor. The dredge used in 1994 had a total length of 2.22 m (7 ft, 3.5 in), a basket height of 42 cm (16.5 in), and a width of 1.67 m (5 ft, 6 in), of which 1.36 m (4 ft, 5.5 in) was the width of the blade (Annex 1). The metal rods of the basket were about 2.5 cm (1 in) apart. The height of the blade could be adjusted and varied between 17.8 and 22.9 cm (7 and 9 in). The pressure used varied between 3.2 and 4.2 kg per cm^2 (45 and 60 lbs per in^2). Fourteen water jets were directed about 15 cm (5.9 in) in front of the blade. The hydraulic pump and the hose were identical to those used in the 1993 study.

For this second phase of the study, nine sample stations were designated in an area near Baie-Comeau and Manicouagan, on Québec's upper north shore (Table 2). The stations were chosen based on information obtained during an exploratory fishery conducted in 1993 (J. Lambert, unpublished data). As in 1993, one tow was conducted at each station, but data was collected for only 7 of the 9 attempted tows. At one station there was zero visibility due to suspended sediments, which prevented the dive team from seeing the trace left by the dredge in the bottom sediments. Another station was not sampled so the divers could film the passage of the dredge.

The sampling methodology was the same for both years of the study. For each tow, the weight and number of captured Stimpson's surf clams were noted, while only the total number was noted for other molluscs species. The clams were measured to the nearest millimeter and the duration of each tow was noted in seconds. About 20 minutes after completion of the tow, two divers descended to the bottom to collect molluscs greater than 2 cm in length that were left in the traces of the dredge or thrown outside the traces. The divers were careful to remove surface sediments to obtain individuals in the process of re-burrowing. They also measured the distance covered by the dredge, noting water column depth at the beginning and end of the tow, and visually assessed the type of bottom sediment. The condition of the molluscs collected by the divers was evaluated, and the Stimpson's surf clams were weighed, counted, and the intact clams were measured. Abundances of the other mollusc species collected by the divers were also recorded. The average speed of each tow was estimated based on the distance covered by the dredge and the time taken for each tow. The efficiency of the hydraulic dredge for capturing the different species of molluscs was calculated according to the following equation:

$$\text{Efficiency} = \frac{\text{Quantity collected with the dredge}}{\text{Quantity collected with the dredge} + \text{quantity collected by the divers}} \times 100$$

The efficiency is expressed as percent of individuals captured and in percent of weight captured. However, it should be noted that the efficiency estimation by weight might be biased because the weights of broken individuals were estimated based on the average weights of intact individuals.

RESULTS AND DISCUSSION

MACROBENTHOS AT THE SAMPLE STATIONS

The samples collected by both the divers and the dredge revealed that the sample sites situated in the regions of Sept-Îles and Baie-Comeau were populated mainly by Stimpson's surf clams, but also by other species. The most abundant were whelk (*Buccinum sp.*), Arctic wedge clam (*Mesodesma arctatum*), Greenland cockle (*Serripes groenlandicus*), truncated (soft-shell) clam (*Mya truncata*), and northern propeller clam (*Cyrtodaria siliqua*) (Tables 3 and 4). At certain stations, the divers observed large numbers of sand dollars, brittle stars, and occasionally a few green sea urchins. At one of the stations situated near Baie-Comeau, the divers noted a high density of juvenile snow crabs (*Chionoecetes opilio*). These observations were generally confirmed following examination of the contents of the dredge. Other invertebrates were occasionally observed in low numbers either by the divers or collected in the dredge. The divers observed a large number of whelk attracted to the molluscs whose shells were broken by the passage of the dredge. Other predators observed by the divers, the common crab (*Cancer irroratus*), snow crab, spider crab (*Hyas araneus*), several species of sea stars, and the northern moon snail (*Euspira heros*), were less abundant. While the damaged molluscs succumbed rapidly to predation, the majority of other endobenthic molluscs had already begun to re-bury themselves upon arrival of the divers. However a minimal number of molluscs may have escaped the attention of the divers.

OBSERVATIONS DIRECTLY RELATED TO THE DREDGING

The divers observed that the hydraulic dredge used on the *Brigitte Susan* left traces about 12 cm in depth, while the dredge on the *NSC Calanus II,* with the blade height adjusted to 18 cm, left traces of about 15 cm in depth. On a few occasions, the depth of the traces left by the two runners of the dredge were unequal and could be up to 30 cm deep on one side. In 1994, the divers observed that the dredge was advancing irregularly across the bottom, making short stops, slight accelerations, and even small bounces. The average speed of dredging was 11 m per min (0.35 knots) on the *Brigitte Susan* and 16 m per min (0.52 knots) on the *NSC Calanus II.*

EFFICIENCY

For both parts of the study, it was found that the New England dredge was very efficient for capturing Stimpson's surf clams. The average efficiency of the unlined dredge was 91% for the first part of the study and 93% for the second part.

In seven of the ten tows conducted by the *Brigitte Susan* with the unlined dredge, the dredge efficiency was greater than 90% and attained nearly 100% at certain stations (Figure 2a). Only the tow at station 5 resulted in an efficiency less than 80%. At this station, the divers noted a strong current flowing perpendicular to the dredge's pass. The tows made with the lined dredge resulted in efficiencies of 95% at station 13 and 86% at station 15. It is important to note that the sampling of station 14 was not completed because the divers noted many molluscs left on each side of the lined dredge's traces. There are several possible explanations for this apparent anomaly in dredge performance: the dredge may have been moving sideways or a hard bottom under a sandy layer could have caused the jets of water to rebound and displace the clams outside the path of the dredge. It is also possible that an accumulation of rocks and organisms inside of the lined dredge could have hindered the crosswise penetration of water and subsequently impeded the collection of the clams. This last hypothesis seems the most likely considering observations by the divers for this station and area.

All of the tows conducted on the *NSC Calanus II* resulted in a collection efficiency equal to or greater than 90% for Stimpson's surf clams (Figure 2b). A maximum efficiency of 97% was obtained at station 7. It was observed that these stations, characterized by relatively flat sandy sediments, were favorable for the proper maneuverability of the dredge.

Relationships between dredge efficiency and factors such as dredge speed, water depth, blade height, or pressure used could not be determined; a greater sampling effort would have been required to draw any such conclusions. According to fishermen, the speed and direction of currents at a given site also influence the maneuverability and hence the performance of this type of dredge.

It is interesting to note that hydraulic dredges also efficiently capture other species of molluscs (Figure 3). Certain species, such as the Arctic wedge clam, seem to be more difficult to collect because of their small size. For other species, such as the Atlantic razor clam, capture is usually difficult because of their elongated shell and because of the depth at which they typically bury themselves. These two species could possibly be collected with a higher efficiency following modification of certain parameters of the dredge, such as blade height and the distance between the metal rods of the dredge basket.

SHELL DAMAGE

Among the Stimpson's surf clams not collected by the dredge and subsequently collected by the divers, 67 and 63% were broken in the first and second parts of the study respectively (Tables 5 and 6). It is important to emphasize that these high percentages of damaged individuals represent a small proportion (less than 10%) of this species present on the site prior to the passage of the dredge. Damages ranged from breakage of one shell to nearly complete crushing of the entire shell, which sometimes hampered identification of the species. It was also not possible to verify if there was a relationship between the size of the clams and the relative damage caused since it was usually impossible to measure the broken clams.

While less abundant, other mollusc species collected by the divers usually had a lower proportion of broken shells (Tables 5 and 6), although more than 50% of the razor clams were damaged. Less than 25% of northern propeller clams and truncated soft-shelled clams had damaged shells while all of the Arctic wedge clams collected by the divers were undamaged.

Stimpson's surf clams collected in the dredge were also found to be damaged. An average of 23% of the clams collected during the 12 tows on the *Brigitte Susan* were broken between the moment of capture and final deposition on the bridge of the boat (Table 7). For the seven tows conducted with the *NSC Calanus II*, 21% of the clams retained in the dredge were found to be broken at the time of their examination on the bridge (Table 8). The highest rates of damage to the clams retained in the dredge in 1994 were at stations 1 and 3, where the lowest water pressure (3.2 kg/cm^2 or 45 lbs/in^2) was used. These two tows were also conducted at the highest operational speeds, 19 and 25 m/min., and with a blade height of 17.8 cm. The lowest percentage of damaged clams was found at station 8, where a water pressure of 4.2 kg/cm^2 (60 lbs/in^2), a speed of 16.6 m/min., and a blade height of 22.9 cm were used. The numbers of broken shells obtained in this study are on the same order of magnitude as those found for other studies. For example, in a study in the Bering Sea, Kauwling and Bakus (1979) noted that 16% of the Stimpson's surf clams were damaged during collection. Roddick and Kenchington (1990) indicated that 27.6% of Stimpson's surf clams were damaged following scientific collections made near Nova Scotia. These numbers are of importance considering that the majority of damaged Stimpson's surf clams collected as part of the commercial fishery in Québec are thrown back and thus not counted in official catch landings.

Even though the small number of tows limits definitive conclusions, our results suggest a possible link between the proportion of damaged Stimpson's surf clams collected by the dredge and water pressure, blade height, and even tow speed. Kauwling and Bakus (1979) mentioned that these factors could be responsible for damage created by this type of dredge, and added that the shells could also break between the metals rods of the dredge's basket, which was also observed by Roddick and Kenchington (1990). On several occasions during 1993, the presence of large cobbles collected in the dredge with the clams may have caused much of the shell damage. In addition, it is also important to point out that several shells were broken when the dredge contents were dumped onto the deck during both 1993 and 1994.

SIZE STRUCTURE

We get a good idea of the size structure of Stimpson's surf clams with the data from the two study sites. In 1993, the size of Stimpson's surf clams captured with the dredge without the additional plastic mesh lining varied between 31 and 127 mm and averaged 96 mm (Figure 4a); a single individual measured less than 52 mm. Two modes were evident, one at 78 mm and the other at 99 mm. The size distribution of clams not broken and collected both inside and outside of the dredge's traces by the divers ranged from 54 to 117 mm (Figures 4b and c). The proportion of individuals less than 90 mm was much higher among the clams not collected by the dredge. The absence of clams less than 85 mm in length among those not captured by the dredge with the additional mesh (Figure 5b) suggests that the lining increases the dredge's efficiency in capturing smaller individuals.

The size of clams captured in the dredge during the second part of the study varied between 64 and 115 mm, with both a mean and a peak at 94 mm (Figure 6a). The size of clams not collected by the dredge ranged from 50 to 110 with an average of 91 mm (Figures 6b and c). A comparison of the size frequencies of clams captured by the dredge and collected by divers to evaluate gear selectivity could not be made due to the scarcity of small individuals and the small number of sample stations. The distance between the metal rods of the dredge's basket, 25 mm in this study, is the principal means of controlling the size of clams collected, so the dredge selectively collected clams with a width larger than 25 mm. Width corresponds to length based on the following equation: Length = 2.39 X Width + 6.5, a relationship based on clams measuring approximately 66 mm in length collected near Sept-Îles. An examination of the data reveals that clams of this size or smaller were rare in our samples. As a result, the effect of specimen size in the calculation of dredge capture efficiency can be dismissed without significantly affecting the results. It should be noted that the majority of clams collected by the divers could not be measured because of shell damage.

THE EFFECTS OF DREDGING ON THE ENVIRONMENT

Based on diver observations, dredge passage causes a large amount of sediment to be suspended in the water column. Although most sediments were principally composed of sand and rapidly resettled, a finer sediment cloud often remained more than 30 minutes after the tow. This sediment cloud was more rapidly dispersed when the current was strong. A study by Kauwling and Bakus (1979) showed that the use of a hydraulic dredge on a bed of Stimpson's surf clams in the Bering Sea only had a minimal effect on the grain size composition of the bottom sediments despite the observed resuspension of fine sediments. The authors noted that fine sediments were only a small component of the bottom sediments, which consisted primarily of medium to coarse sand. According to these same authors, the disturbance of bottom sediments by the dredge left traces that persisted from several days to several years. Diver observations in the present study revealed that the sediments remaining in the traces were much less compacted than in adjacent areas.

The high efficiency of the dredge for the capture of Stimpson's surf clam and the minimal damage caused to other molluscs, which are less abundant in beds of this clam, suggest that the use of the New England hydraulic dredge has a minor short term impact on resident molluscs. A few studies mention that the use of the hydraulic dredges on beds of endobenthic molluscs would have little long term negative effects on the benthos (Kauwling and Bakus 1979, MacKenzie 1982). Only those organisms with limited mobility or limited ability to re-burrow would be affected by the sediment displacement. These organisms would not be numerous in beds of Stimpson's surf clams since sediments associated with these clams are often already unstable. A long-term study would be necessary to verify the effect of this type of dredge on the physical environment and the ecosystem in general.

CONCLUSIONS

The two New England dredges used in this study are very efficient for capturing Stimpson's surf clams. The degree of efficiency, which averaged more than 90%, is similar to the efficiencies mentioned in the literature for the collection of other endobenthic species with hydraulic gear (Medcof and Caddy 1971, Meyer et al. 1981). The majority of Stimpson's surf clams not collected during dredging were damaged, but represent only a small percentage of capturable clams (Figure 7). Direct and indirect mortality due to this type of fishing totaled nearly 100% for several stations sampled in the current study. It is important to note that these values apply only to those individuals present at the sample sites, which, for the most part, were of a sufficient size to be retained in the dredge's basket.

A considerable proportion of the Stimpson's surf clams collected by the hydraulic dredges were damaged between the moment of capture and final deposit on the bridge of the boat. This portion of the collected biomass becomes unusable and is lost to the fishery without being evaluated. Fishermen should make a concerted effort to minimize these losses.

We could not determine gear selectivity because of the low abundance of juveniles. Nevertheless, the size classes captured with the lined dredge suggests that this modification would be helpful for obtaining a more realistic estimate of the number and size of individuals present. A more extensive sampling program would be necessary to accurately evaluate the selectivity and performance of a dredge with this modification.

Although bottom disturbance at the time of dredging appears to be substantial, there is currently no evidence to conclude that the effects on either a short or long term basis would be harmful for other resident benthic organisms. A small proportion of other mollusc species present at the sample stations and not captured by the dredge were damaged. A more detailed environmental impact study would be necessary to define the effects of a dredging fishery on the ecosystem.

ACKNOWLEDGMENTS

We would like to thank captains Henri Paul Mercier of the *Brigitte Susan* and Jean-Paul Boudreau of the *NSC Calanus* as well as other members of the crew for their collaboration during this study. We would particularly like to thank François Hazel, Chief of Scientific Diving at Maurice Lamontagne Institute, Mont-Joli, who contributed considerably to the elaboration of the sampling methodology and realization of this project. We also thank the divers of the diving firm "La Scubathèque": Louis Bourdages, Yves Gagnon, Gilles Fournier, Martin Demers, and Phillipe Bernier for their diving expertise and excellent work during this study. We appreciate the help of Daniel Lepage, biologist, in organizing the biological data, particularly for the identification of the collected organisms. Finally, we thank Michel Giguère and Marcel Boudreau for revising the document, Deborah Steel for the English translation, and Diane Bélanger for the page-setting.

REFERENCES

Caddy, J.F., R.A. Chandler and D.G. Wilder. 1974. Biology and commercial potential of several underexploited molluscs and crustacean on the Atlantic coast of Canada. Federal-Provincial Committee on Utilization of Atlantic Resources. Montréal, Feb. 1974, 111 pp.

Kauwling, T.J. and G.J. Bakus. 1979. Effects of hydraulic clam harvesting in the Bering Sea. Tetra Tech Report TC3324. Prepared for: North Pacific Fishery Management Council; 183 pp.

MacKenzie, C.L. Jr. 1982. Compatibility of invertebrate populations and commercial fishing for ocean quahogs. N. American J. Fish. Management 2: 270-275.

Medcof, J.C. and J.F. Caddy. 1971. Underwater observations on performance of clam dredges of three types. ICES C.M. 1971/B:10.

Meyer, T.L., R.A. Cooper and K.J. Pecci. 1981. The performance and environmental effects of a hydraulic clam dredge. Mar. Fish. Review 43(9): 14-22.

Murawski, S.A. and F.M. Serchuk. 1989. Mechanized shellfish harvesting and its management: The offshore clam fishery of the eastern United States, p. 479-506. *In*: J.F. Caddy (ed.) Marine Invertebrate Fisheries: Their assessment and management. John Wiley and Sons Inc. N.Y.

Roddick, D.L. and E. Kenchington. 1990. A review of the Banquereau Bank fishery for *Mactromeris polynyma* for the 1986 to 1989 period. CSCPCA Res. Doc. 90/14: 27 pp.

Yancey, R.M. and W.R. Welch. 1968. The Atlantic coast surf clam with a partial bibliography. US Fish. Wild. Ser. Circ. 288: 1-13.

Table 1. Site and tow characteristics of samplings made by the *Brigitte Susan* in 1993.

Station	Site	Sediment type	Depth (m)	Tow distance (m)	Tow duration (min.)	Speed (m/min.)	Water Pressure (kg/cm^2)	Blade height (cm)	Notes
1	Grosse Boule	mud and fine sand	24.1	25.6	3.33	7.7	4.2	15.2	Normal
2	Grosse Boule	-	-	-	-	-	4.2	15.2	Zero visibility
3	Grosse Boule	mud and fine sand	24.4	22.3	4.07	5.5	4.2	15.2	Normal
4	Grosse Boule	mud and fine sand	21.3	41.1	3.15	13.1	4.2	15.2	Normal
5	Baie Moisie	mud and sand	25.3	44.5	3.00	14.8	4.2	15.2	Normal
6	Baie Moisie	sand	21.3	38.1	3.07	12.4	4.2	15.2	Normal
7	Baie Moisie	sand	22.6	34.4	3.25	10.6	4.2	15.2	Normal
8	Baie Moisie	sand	21.9	35.1	3.13	11.2	4.2	15.2	Normal
9	Baie Ste-Marguerite	-	-	-	-	-	4.2	15.2	Video taken
10	Baie Ste-Marguerite	mud and sand	13.4	51.8	4.00	13.0	4.2	15.2	Normal
11	Baie Ste-Marguerite	mud and sand	21.3	25.9	3.03	8.6	4.2	15.2	Normal
12	Baie Ste-Marguerite	mud and sand	23.8	22.9	3.07	7.4	4.2	15.2	Normal
13	Baie Moisie	sand	25.6	57.9	3.13	18.5	4.2	15.2	Dredge with mesh liner
14	Baie Moisie	-	-	-	-	-	4.2	15.2	Lined dredge problem
15	Cayes de l'est	sand	25.0	14.0	1.35	10.4	4.2	15.2	Dredge with mesh liner
16	Baie de la Boule	-	-	-	-	-	4.2	15.2	Zero visibility

Table 2. Site and tow characteristics of samplings made by the *NSC Calanus II* in 1994.

Station	Site	Sediment type	Depth (m)	Tow distance (m)	Tow duration (min.)	Speed (m/min.)	Water pressure (kg/cm^2)	Blade height (cm)	Notes
1	Baie-Comeau	Sand	13.7	58	3.00	19.3	3.2	17.8	Normal
2	Baie-Comeau	Sand	17.1	50	3.00	16.7	4.2	17.8	Normal
3	Baie-Comeau	Sand	16.8	75	3.00	25.0	3.2	17.8	Normal
4	Baie-Comeau	Sand	15.8	26	3.00	8.6	4.2	17.8	Normal
5	Manicouagan	Sand	9.8	-	3.00	-	4.2	17.8	Video
6	Manicouagan	Sand	-	-	3.00	-	4.2	17.8	Zero visibility
7	Manicouagan	Sand	14.0	26	3.00	8.6	4.2	22.9	Normal
8	Baie-Comeau	Sand	15.5	50	3.00	16.6	4.2	22.9	Normal
9	Baie-Comeau	Sand	16.2	50	3.00	16.6	4.2	22.9	Normal

Table 3. Abundances of the principal mollusc species captured by the dredge or collected by the divers in 1993.

Species	Captured	
	Number	Percentage of total
Stimpson's surf clam (*Mactromeris polynyma*)	3785	75.2
Greenland cockle (*Serripes groenlandicus*)	353	7.0
Northern propeller clam (*Cyrtodaria siliqua*)	336	6.7
Truncated (soft-shell) clam (*Mya truncata*)	179	3.6
Whelk (*Buccinum* sp.)	128	2.5
Arctic wedge clam (*Mesodesma arctatum*)	97	1.9
Pelican's foot (*Aporrhais occidentalis*)	54	1.1
Island cockle (*Clinocardium ciliatum*)	47	0.9
Arctic rough mya (*Panomia arctica*)	26	0.5
Razor clam (*Ensis directus*)	18	0.4
Atlantic razor clam (*Siliqua costata*)	4	0.1
Astarte (*Astarte* sp.)	3	0.1
Northern moon snail (*Euspira heros*)	2	0.0

Table 4. Abundances of the principal mollusc species captured by the dredge or collected by the divers in 1994.

Species	Captured	
	Number	Percentage of total
Stimpson's surf clam (*Mactromeris polynyma*)	2192	90.0
Northern propeller clam (*Cyrtodaria siliqua*)	127	5.2
Whelk (*Buccinum* sp.)	74	3.0
Arctic wedge clam (*Mesodesma arctatum*)	12	0.5
Truncated (soft-shell) clam (*Mya truncata*)	11	0.45
Greenland cockle (*Serripes groenlandicus*)	11	0.45
Blue mussel (*Mytilus edulis*)	6	0.25

Table 5. Number of broken and intact individuals collected by divers in 1993.

Species	Inside the traces		Outside the traces		Total	
	Intact	Broken	Intact	Broken	Intact	Broken
Stimpson's surf clam (*Mactromeris polynyma*)	48	130	65	104	113	234
Greenland cockle (*Serripes groenlandicus*)	15	5	10	4	25	9
Northern propeller clam (*Cyrtodaria siliqua*)	48	10	22	6	70	16
Truncated (soft-shell) clam (*Mya truncata*)	123	16	23	9	146	25
Arctic wedge clam (*Mesodesma arctatum*)	27	0	11	0	38	0
Island cockle (*Clinocardium ciliatum*)	8	0	0	0	8	0
Razor clam (*Ensis directus*)	15	18	3	3	18	21

Table 6. Number of broken and intact individuals collected by divers in 1994.

Species	Inside the traces		Outside the traces		Total	
	Intact	Broken	Intact	Broken	Intact	Broken
Stimpson's surf clam (*Mactromeris polynyma*)	38	80	21	20	59	100
Greenland cockle (*Serripes groenlandicus*)	7	0	1	0	8	0
Northern propeller clam (*Cyrtodaria siliqua*)	4	9	14	1	18	10
Truncated (soft-shell) clam (*Mya truncata*)	19	7	12	0	31	7
Whelk (*Buccinum* sp.)	25	0	8	0	33	0
Arctic wedge clam (*Mesodesma arctatum*)	157	0	55	0	212	0
Razor clam (*Ensis directus*)	6	2	2	2	8	4
Atlantic razor clam (*Siliqua costata*)	27	0	2	0	29	0
Blue mussel (*Mytilus edulis*)	8	0	42	0	50	0

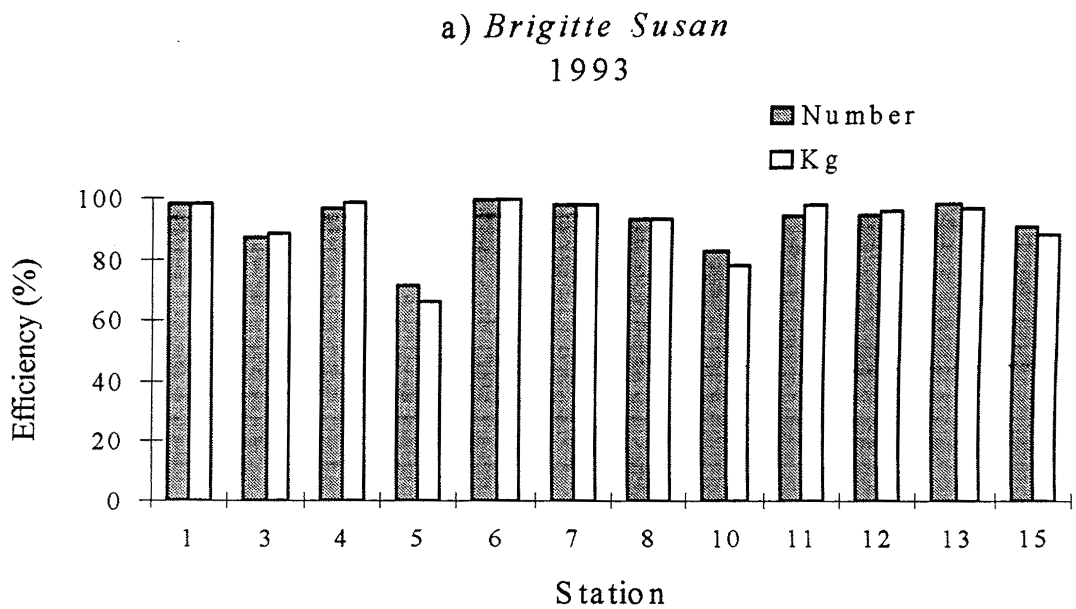
Table 7. Proportion of Stimpson's surf clams captured by the dredge that were broken in 1993.

Station	Total (n)	Broken (%)
1	374	32
3	54	57
4	461	29
5	466	30
6	397	20
7	578	15
8	458	24
10	60	50
11	128	22
12	80	16
13	712	13
15	17	59
	Total 3785	Average 23

Table 8. Proportion of Stimpson's surf clams captured by the dredge that were broken in 1994.

Station	Total (n)	Broken (%)
1	478	29
2	651	18
3	431	32
4	200	11
7	73	12
8	99	2
9	310	14
	Total 2242	Average 21

Figure 1. New England type hydraulic dredge.



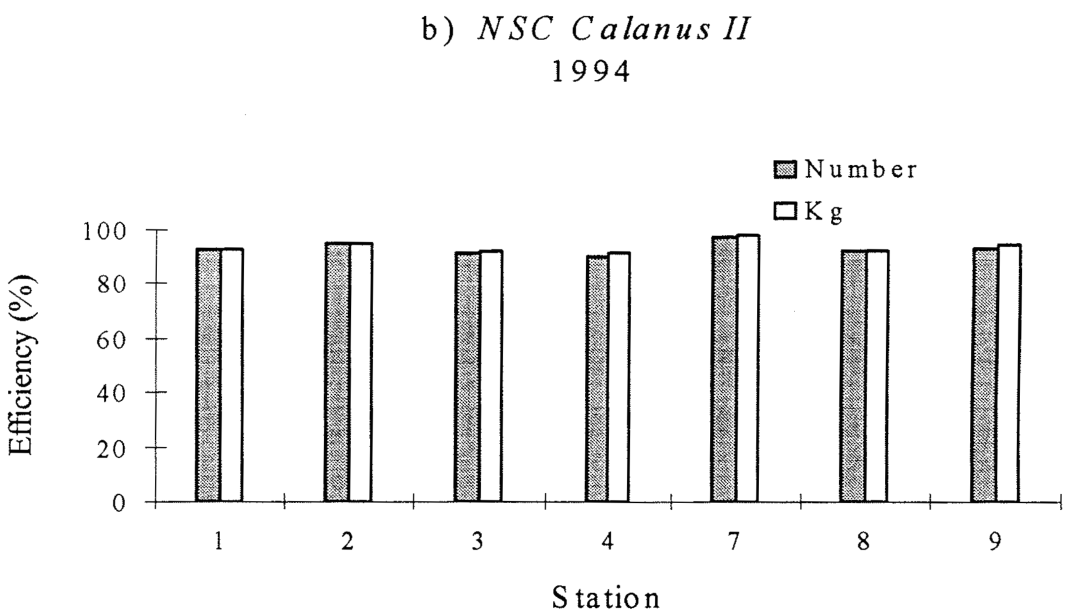


Figure 2. Efficiency of the hydraulic dredge (a) in 1993 on the *Brigitte Susan* and (b) in 1994 on the *NSC Calanus II*.

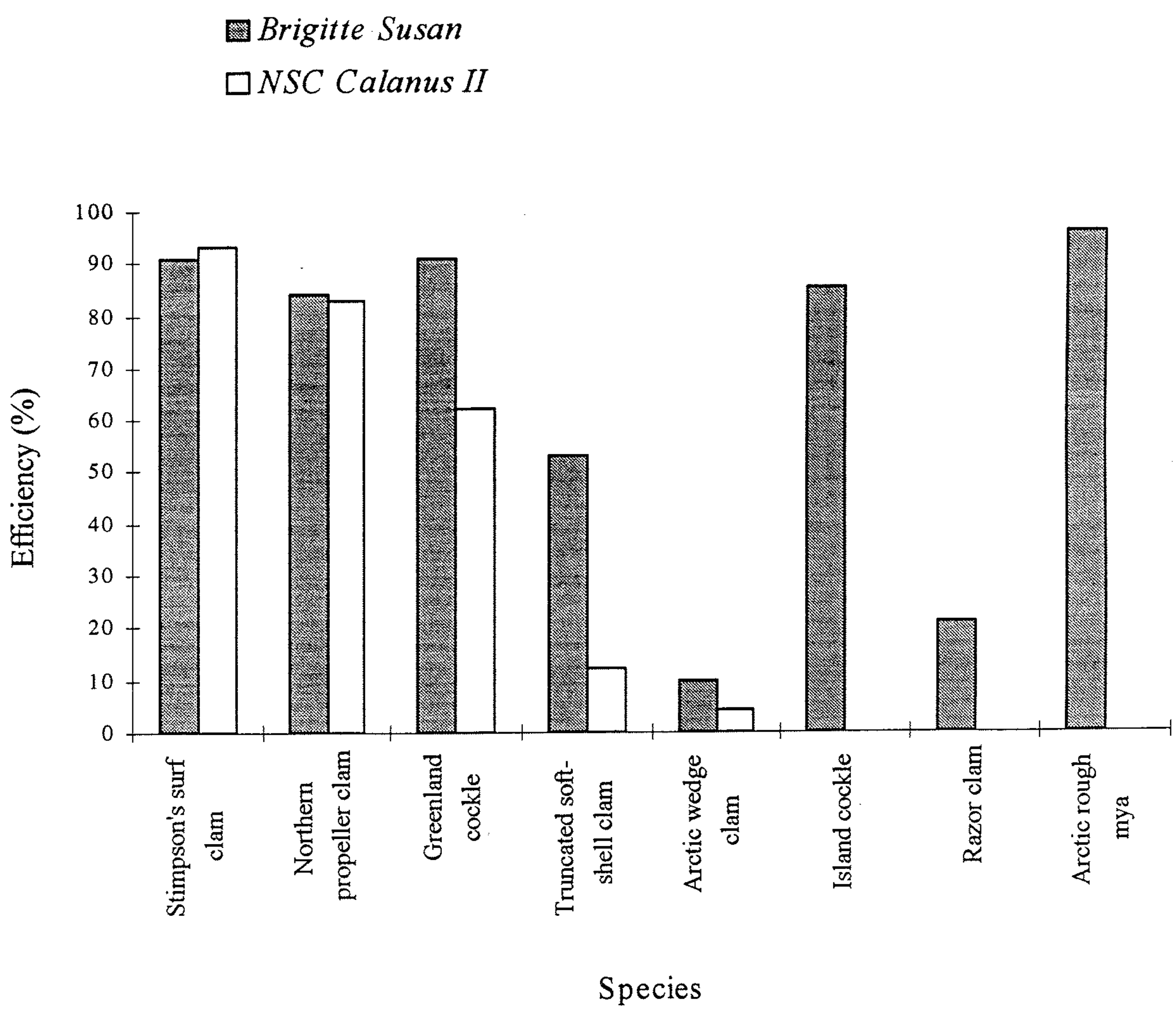


Figure 3. Average efficiency of the hydraulic dredge for the collection of other species of bivalve molluscs during the sampling periods in 1993 on the *Brigitte Susan* and in 1994 on the *NSC Calanus II*.

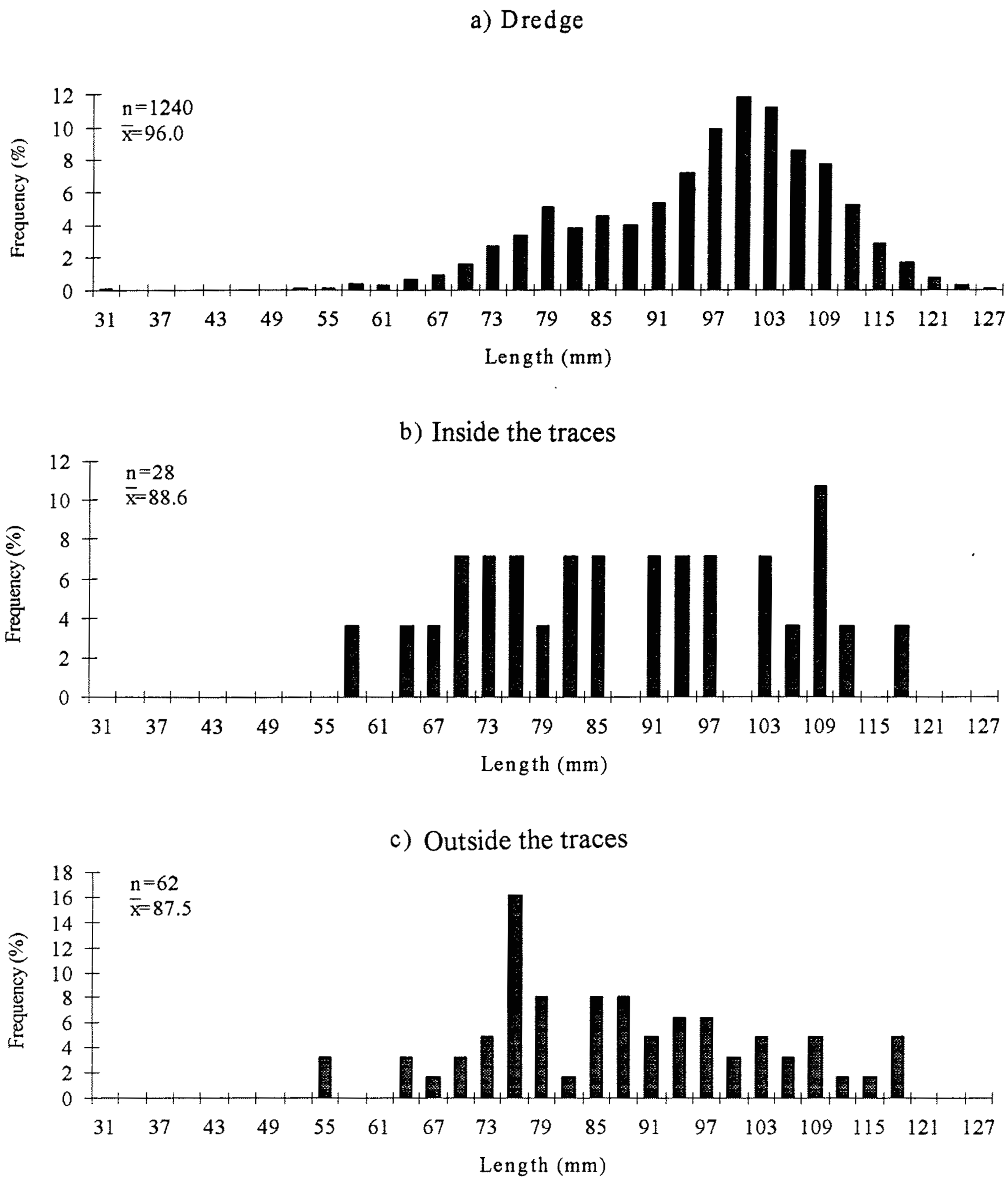


Figure 4. Size structure, by 3 mm classes, of Stimpson's surf clams in 1993 (a) captured by the dredge, (b) not captured and collected by divers inside the traces and (c) not captured and collected by divers outside the traces.

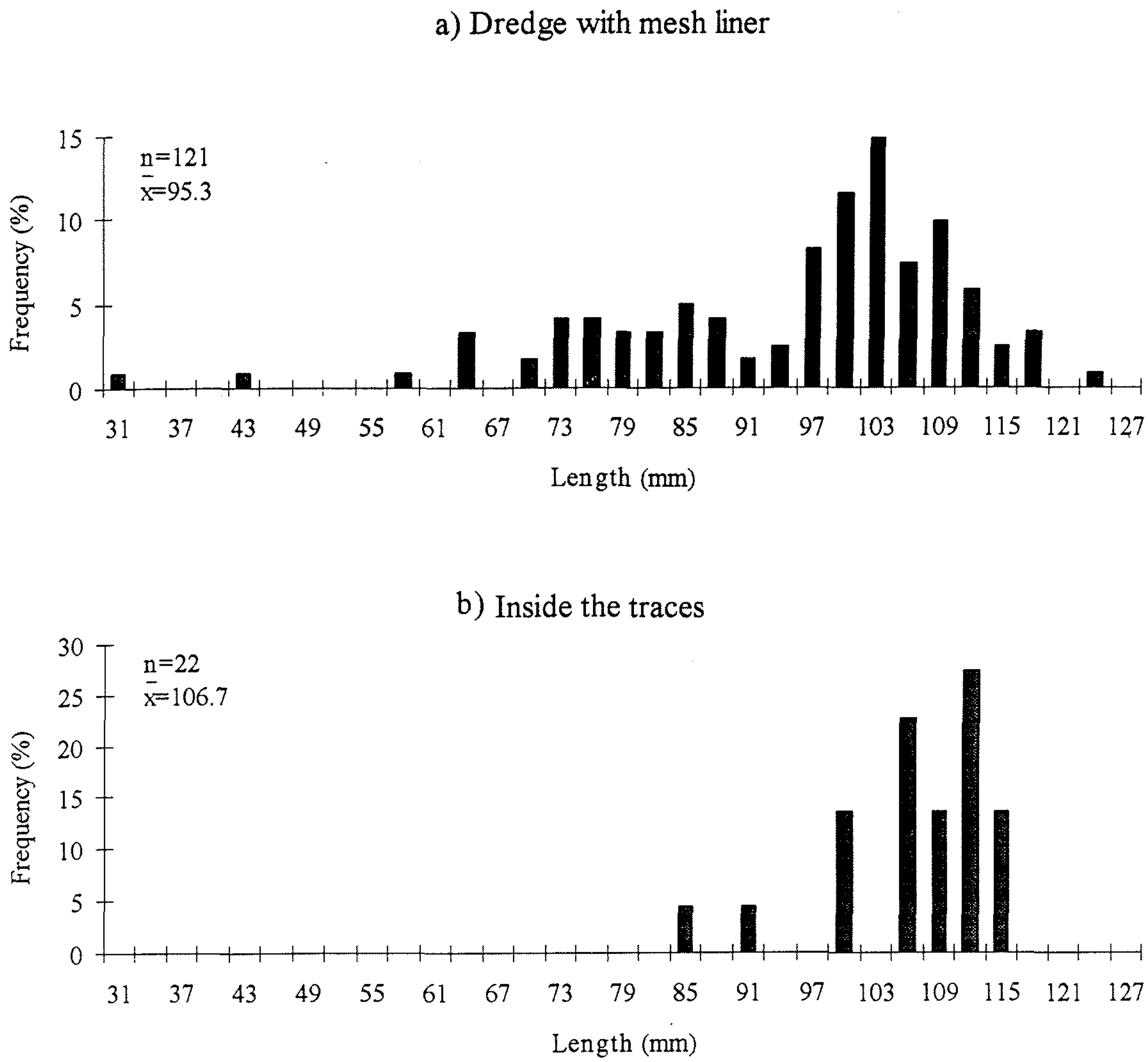


Figure 5. Size structure, by 3 mm classes, of Stimpson's surf clams in 1993 (a) captured by the dredge with the mesh liner (mesh size 19 mm), and (b) not captured and collected inside the traces by divers.

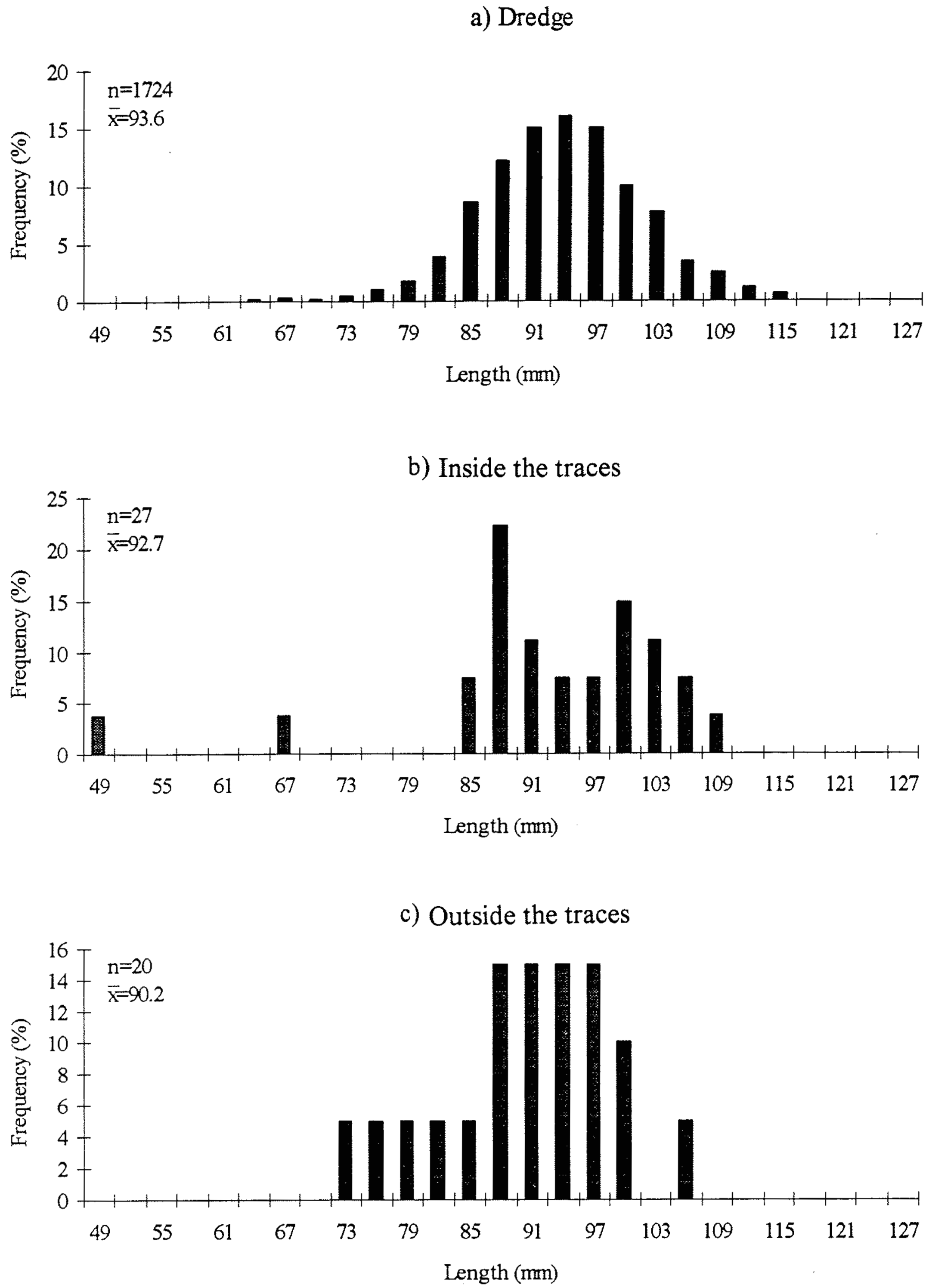


Figure 6. Size structure, by 3 mm classes, of Stimpson's surf clams in 1994 (a) captured by the dredge, (b) not captured and collected inside the traces by divers, and (c) not captured and collected by divers outside the traces.

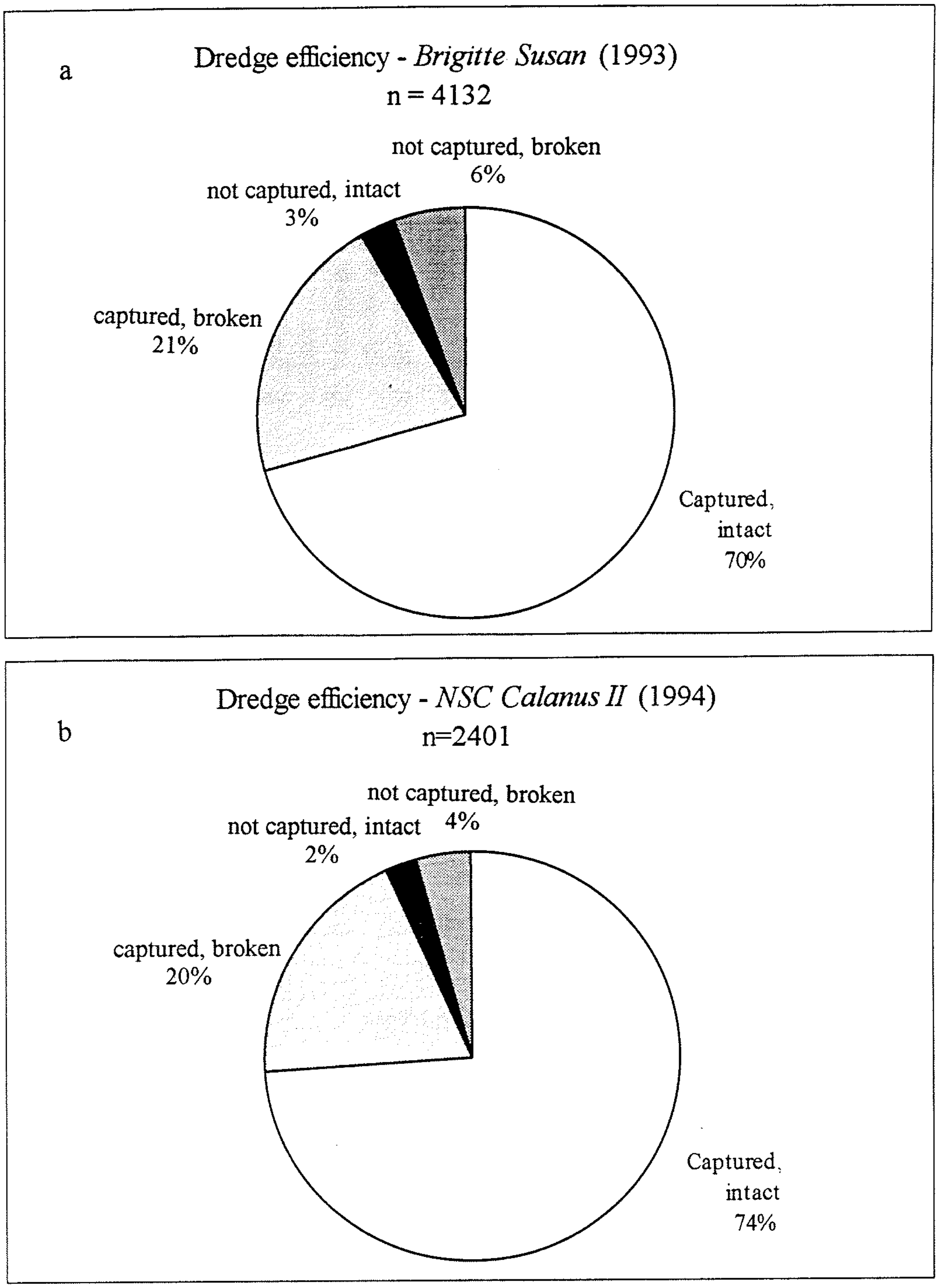
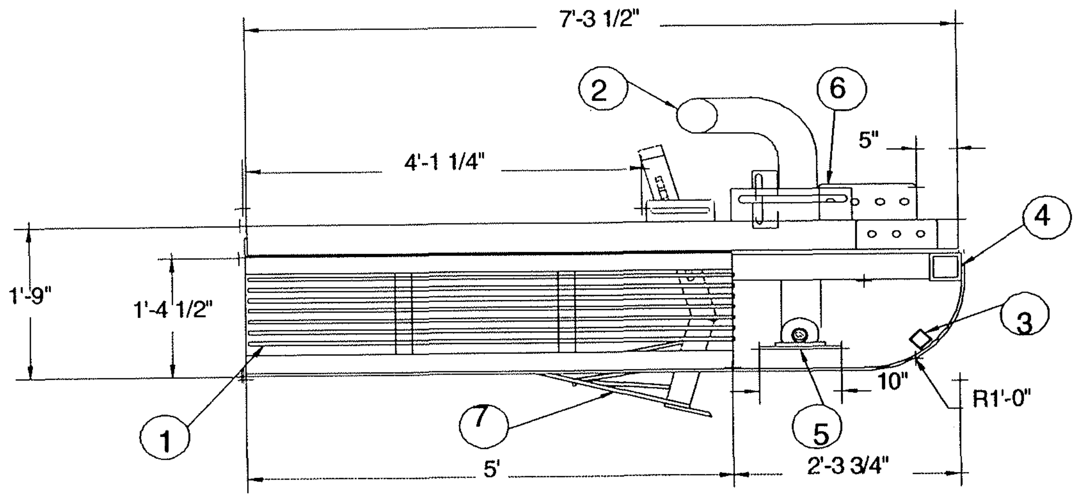


Figure 7. Percentages of Stimpson's surf clams, intact or broken, that were captured by the dredge or collected by divers in (a) 1993 or (b) 1994.

Source: M. René Fillion
ex-Mont-Joli Machinerie Ltée
1619 Aubin, Mont-joli,
Québec

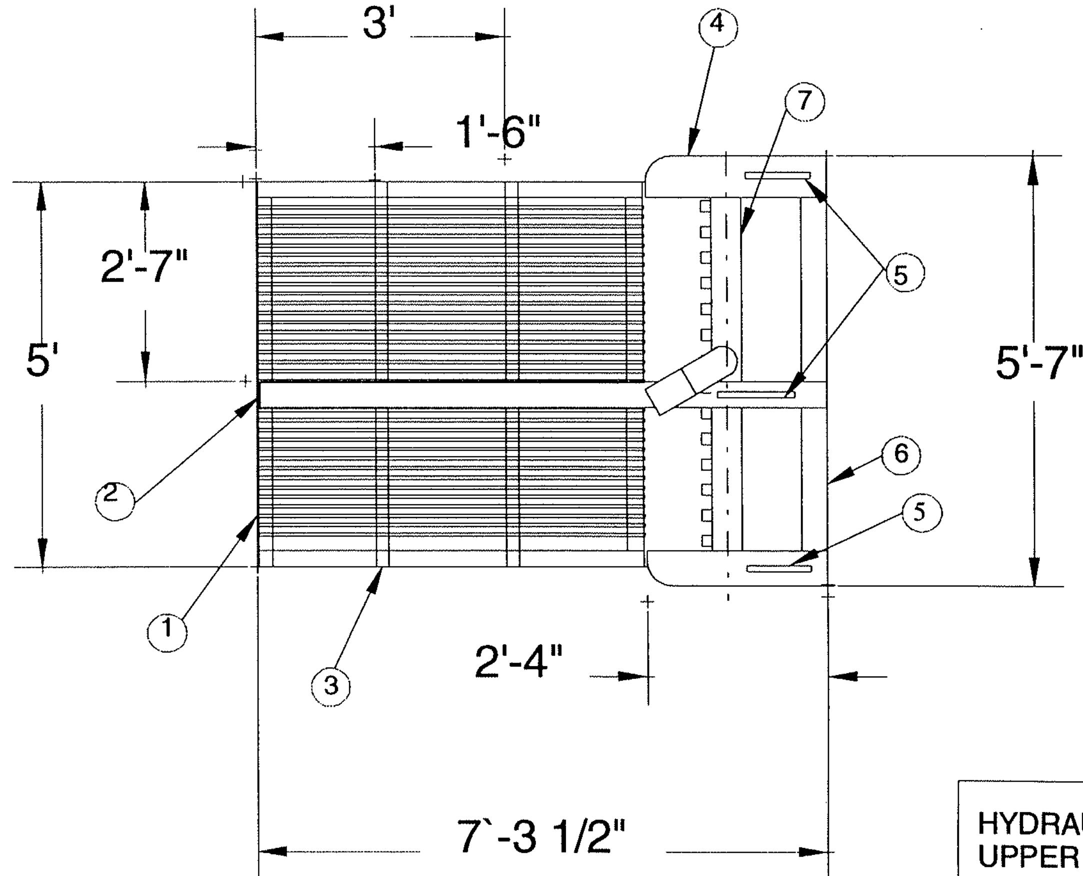


PIECE	QTY	DESCRIPTION	PIECE	QTY	DESCRIPTION	PIECE	QTY	DESCRIPTION
1		1/2" DIA 1 1/2 C/C	4	1	HSS 4 X 4 X 3/8			
2	1	TUBING 4" SCHEDULE 40	5		SEE DETAILS			
			6		SEE DETAILS			
3	1	HSS 2 X 2 X 1/4	7		SEE DRAWING ADJUSTABLE BLADE			

HYDRAULIC DREDGE
SIDE VIEW

PROJET: NO.PROJET
FAIT: R.F. REF:
DATE: 09/94
SCALE: NONE
DESSIN

Annex 1. Hydraulic dredge plan

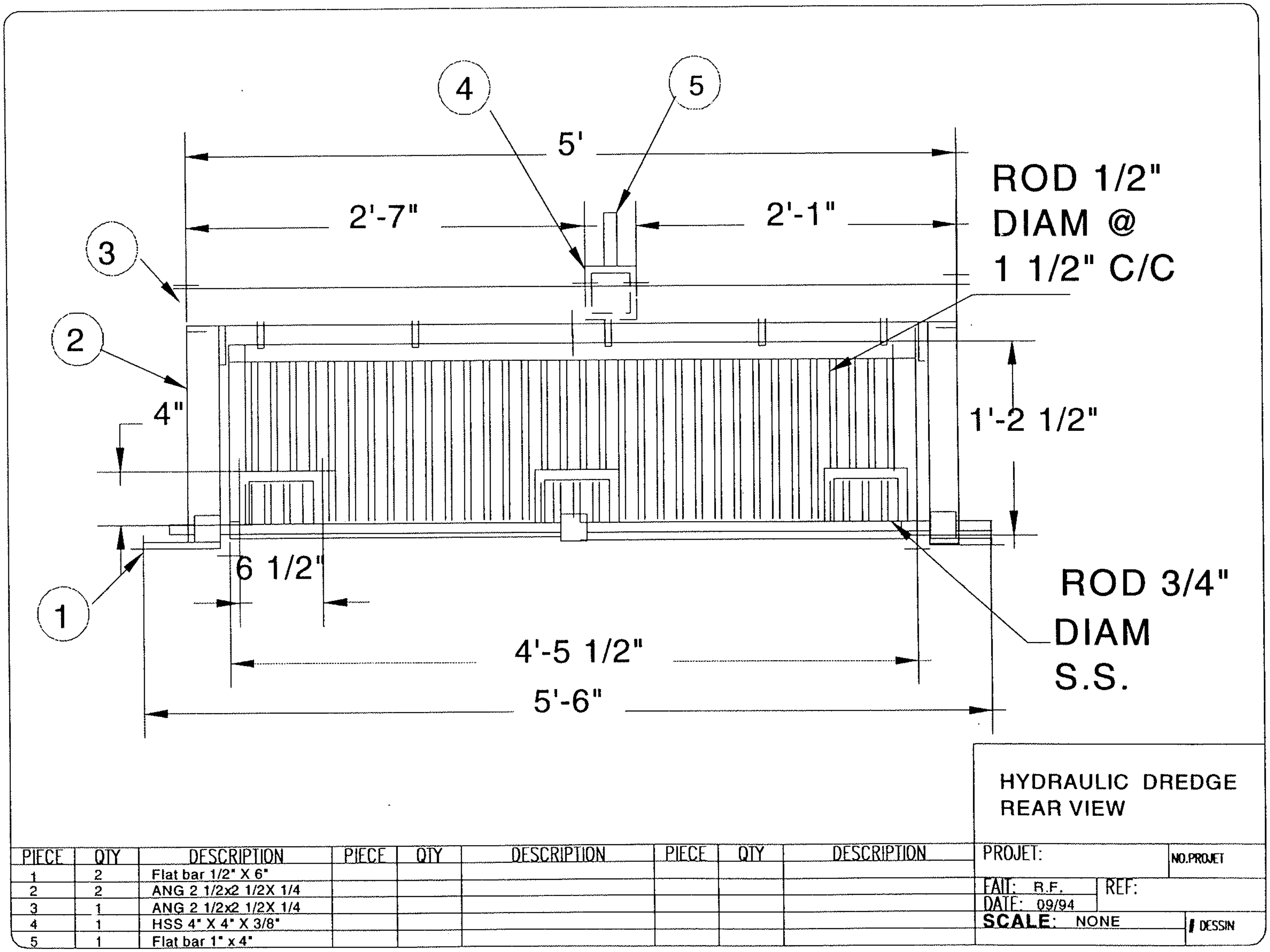


HYDRAULIC DREDGE
UPPER VIEW

PIECE	QTY	DESCRIPTION	PIECE	QTY	DESCRIPTION	PIECE	QTY	DESCRIPTION
1		1/2" DIAM 1 1/2 C/C	5		TOW CABLE ANCHOR			
2		HSS 4 X 4 X 3/8						
3		ANG 2 1/2X2 1/2X1/4	6		HSS 4" X 4" X 3/8			
4		FLAT BAR 3/4" X 6"	7		SEE WATER JETS DRAWING			

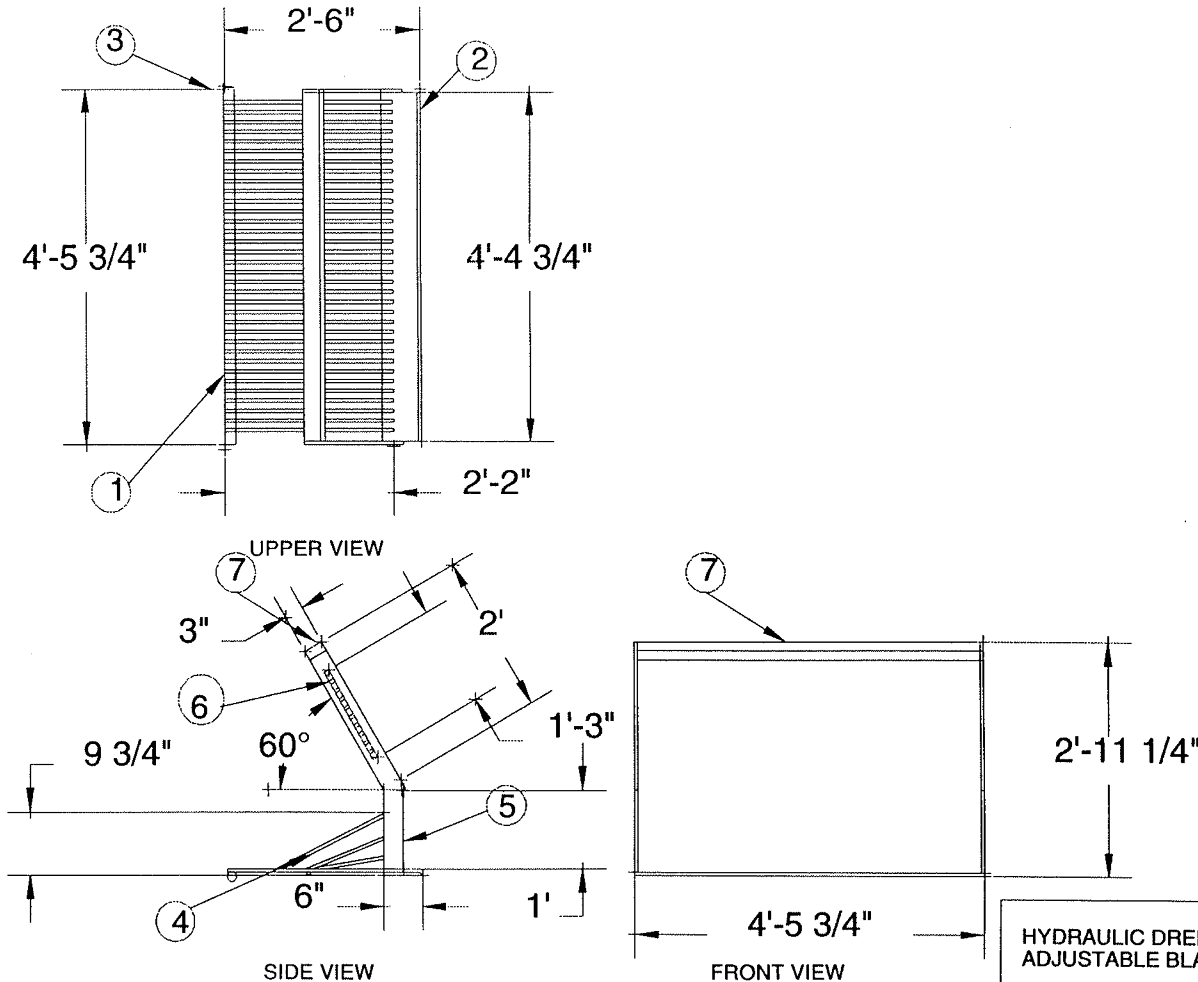
PROJET: NO.PROJET
FAIT: R.T. REF:
DATE: 09/94
SCALE: NONE
DESSIN

Annex 1. (continued)



PIECE	QTY	DESCRIPTION	PIECE	QTY	DESCRIPTION	PIECE	QTY	DESCRIPTION
1	2	Flat bar 1/2" X 6"						
2	2	ANG 2 1/2x2 1/2X 1/4						
3	1	ANG 2 1/2x2 1/2X 1/4						
4	1	HSS 4" X 4" X 3/8"						
5	1	Flat bar 1" x 4"						

Annex 1. (continued)

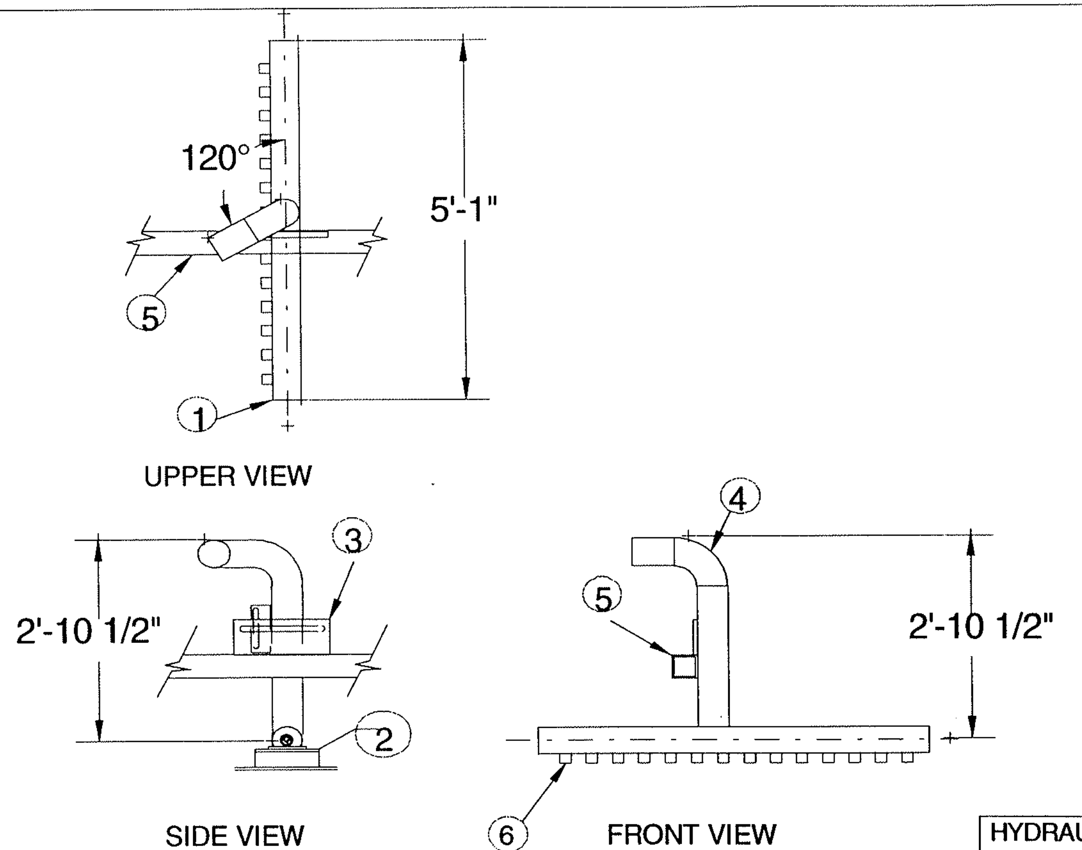


PIECE	QTY	DESCRIPTION	PIECE	QTY	DESCRIPTION	PIECE	QTY	DESCRIPTION
1		PIPE 1/2" DIAM	4		PIPE 1/2" SCHD 40			
		1 1/2 " C/C	5		FLAT BAR 1/2" X 3"			
2		BLADE 1/2" X 6"	6		HOLE 3/4" 1 1/2" C/C			
		ABRASION	7		HSS 1" X 3" X 3/16"			
		RESISTANT (T-1)						

HYDRAULIC DREDGE
ADJUSTABLE BLADE DETAILS

PROJET: NO.PROJET
FAIT: R.F. REF:
DATE: 09/94
SCALE: NONE # DESSIN

Annex 1. (continued)

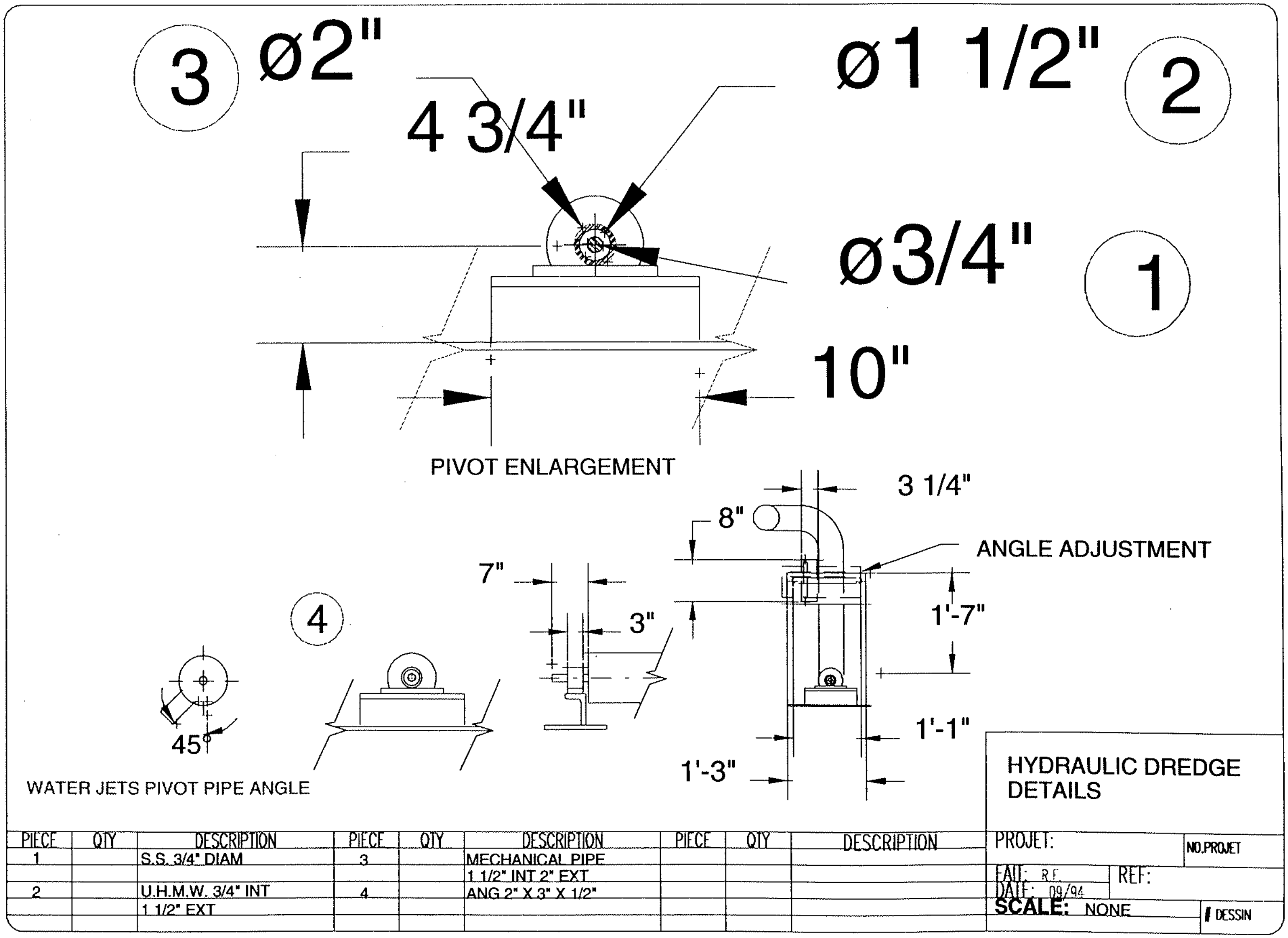


HYDRAULIC DREDGE
WATER JETS DETAILS

PIECE	QTY	DESCRIPTION	PIECE	QTY	DESCRIPTION	PIECE	QTY	DESCRIPTION
1		PIPE 4" DIA SCHD 40	6		PIPE 1/2" DIA			
2		SEE DETAILS			3" LONG 4" C/C			
3		SEE DETAILS			FLAT END			
4		BEND 90° SCHD 40						
5		HSS 4" X 4" X3/8"						

PROJET:	NO.PROJET
FAIT:	REF:
DATE:	
SCALE: NONE	DESSIN

Annex 1. (continued)



Annex 1. (continued)