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TRAP DESIGN FOR A DIRECTED ROCK CRAB FISHERY

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ABSTRACT

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A trap design that catches rock crabs while excluding lobsters needs to be specified in regulations of this new and developing fishery before the industry makes a large investment in unsuitable gear. Several designs of top and side entry traps were tested in three locations. A rectangular entrance in the top of wire lobster traps or conical crab traps was best at excluding lobsters. The circular top entrance caught moderately more crabs and lobsters. The designs tested did not differ in the capture rate of subcommercial sized rock crabs. All designs were of robust construction and would cost <$50 each. The top rectangular entrance is recommended because it is best at excluding lobsters while maintaining good crab catches. Although conical traps had higher crab catches than lobster traps, there use would be of no conservation benefit and need not be specified in regulations. Based on previously published data, a round escape gap of 70 mm diameter is recommended to reduce the catch of subcommercial sized crabs.

RÉSUMÉ

Miller, R.J., and R. Duggan. 1997. Trap design for a directed rock crab fishery. Can. Tech. Rep. Fish. Aquat. Sci. 2154: v + 11 p.

Il convient d'imposer un modèle de casier qui retienne le crabe commun tout en excluant le homard dans la réglementation de cette pêche nouvelle et en développement, avant que l'industrie n'investisse trop d'argent dans des engins inadéquats. Plusieurs modèles de casier à entrée latérale ou supérieure ont été essayés à trois endroits. Il s'est avéré que les casiers métalliques à homard ou les casiers coniques à crabe munis d'une entrée rectangulaire à la partie supérieure étaient ceux qui permettaient le mieux d'exclure le homard des prises. Les casiers à entrée circulaire supérieure capturaient légèrement plus de crabe et de homard. Les modèles de casier mis à l'essai ne présentaient entre eux aucune différence dans les taux de capture de crabe commun de taille inférieure à la taille commerciale. Ils étaient tous de construction robuste et leur coût unitaire pourrait être inférieur à 50 $. On recommande l'entrée supérieure rectangulaire parce que c'est elle qui permet le mieux d'obtenir de bonnes captures de crabe tout en excluant le homard. Bien que les prises de crabe des casiers coniques à crabe étaient supérieures à celles des casiers à homard, il n'y aurait aucun avantage pour la conservation à imposer spécifiquement ce type de casier dans la réglementation. D'après des données déjà publiées, un orifice d'évasion circulaire de 70 mm de diamètre est recommandé pour réduire les prises de crabe de taille inférieure à la taille commerciale.

INTRODUCTION

A trap design which minimizes the bycatch of lobsters (Homarus americanus) while obtaining a good catch of rock crab (Cancer irroratus) is needed for the directed rock crab fishery on the Atlantic coast of Nova Scotia. This fishery first came under regulation in 1995 and is still small and in the experimental stage. A good trap design should be specified in regulation before participants make a large investment in traps.

Lobster bycatch can be a problem in the directed rock crab fishery because the directed fishery takes place entirely outside the lobster season when no lobster fishers are at the wharf to identify poaching. The season also includes the post-molt stage in autumn when lobsters are especially vulnerable to capture by traps (Templeman 1939). If lobsters are excluded from capture in crab traps they will be spared handling by crab fishers and the fishers will be spared the temptation to illegally retain this high value species.

Because traps are a passive gear, and capture success is a result of animal behavior, they can be designed for a small bycatch. There are three opportunities during the capture process for targeting the catch: bait attraction, trap entry, and trap escape.

Dead decapods, or pieces of them, included in the bait reduces the catch of conspecifics (c.f. Miller 1990 for review). During small trials, the authors (unpublished) found that traps baited with frozen mackerel captured twice as many lobster as traps baited with the same amount of frozen mackerel plus a small amount (<10% by weight) of lobster internal organs. However, lobster parts are usually not available to crab fishermen at reasonable cost.

Escape gaps are useful for reducing bycatch of nontarget species as well as undersized individuals of the target species. However, their effectiveness changes with trap soak time and the number of animals captured, and they can easily be closed by a fisher who wants to retain illegal catch. Therefore, the best defense against bycatch is to prevent entry.

The purpose of this study was to identify the size, shape, and location of trap entrances which permit only a small bycatch of lobsters yet a good catch of the target rock crabs. Escape gaps were not included in the experimental traps so as not to confound the interpretation of the catch resulting from different entrances. Furthermore, Krouse (1978) has provided data to calculate escape gap sizes.

METHODS

Three experimental series were included. Series I was conducted from 13-20 August, 1996 at 2-15 m depth in a variety of locations in the upper portion of Jeddore Harbour, Halifax County. Series II was conducted from 16 September to 1 October, 1996 at 12-15 m depth, also in

upper Jeddore Harbour, but entirely in the main harbour channel. Series III was conducted from 8-10 October, 1996 on either side of the center portion of Shad Bay, Halifax County, at 5-8 m depth. Series I and II were intended to capture both rock crabs and lobsters. The location for Series III was chosen for its abundance of lobsters, including a large range of sizes. This location had few crabs. Each series compared five trap types. One trap of each type was set in a line about 20 m apart and in random order. Traps were set over one night in all cases.

Series I traps were baited with about 200 g of frozen mackerel placed in a canister with 1-2 mm wide slits. In Series II traps were baited with the same bait, but in wire mesh boxes to allow more odour to escape. The same boxes were used in Series III, but with frozen herring bait. Within a series all trap types were baited the same.

Dimensions of trap designs are given in Table 1 and photos of traps are seen in Fig. 1. When a rectangular side-entrance was used in a wire lobster trap, the entrance ring was removed from the entrance head and replaced by a piece of galvanized wire mesh (hardware cloth). Top entrances added to lobster traps were placed over the kitchen end and the side entrances were covered over with a piece of wire mesh. The conical traps used in Series II and III were framed with steel rod and covered with polypropylene mesh of 3.8 cm stretch measure. Top entrances used in both lobster and cone traps were made from the bottom 8 cm of a plastic bucket with either the entire bottom (20 cm diameter) or a rectangular hole (5.4 X 20 cm) cut out. An exception was the rectangular top-entrance in Series I, which was constructed of sheet aluminum.

The 13 cm diameter entrance is a common size in commercial parlor lobster traps and would require no alteration. To replace these entrance rings with rectangular entrances requires only minor alteration. The 4.8 cm high and 7.6 cm high entrances used in Series I were the sizes specified in the rock and Jonah crab management plans respectively. In Series II and III the 4.8 cm high entrance was replaced by a 5.4 cm high entrance because a few of the largest rock crabs could not pass through the smaller opening. All rectangular entrances were longer than necessary to allow the largest crabs to pass.

Top entrances were also tried in lobster traps because Stasko (1975) and Gendron and Hebert (1991) found that wooden lobster traps with top entrances caught no lobsters and more crabs than conventional wooden lobster traps with side entrances. Cone-shaped traps used in Series II and III are the trap shape of choice in many crab fisheries world-wide. Top entrance choices were a large round opening because this is the usual shape, and a rectangular slot because that shape would exclude large lobsters.

Catch-per-trap-haul was compared among trap types using 1-way ANOVA; data were not transformed. Treatment means were compared using the lsd test with an alpha of 0.05.

Table 1. Trap designs used in experimental fishing.

Series	Trap type	Trap size (cm)	Entrance location	Entrance size (cm)
I	lobster	91 X 47 X 31 high	side	13 diameter
			side	4.8 X 15
			side	7.6 X 15
			top	20 diameter
			top	4.8 X 25.5
II & III	lobster	91 X 47 X 31	side	13 diameter
			side	5.4 X 15
			top	5.4 X 20
	cone	94 bottom X 43 top X 43 high	top	20 diameter
			top	5.4 X 20

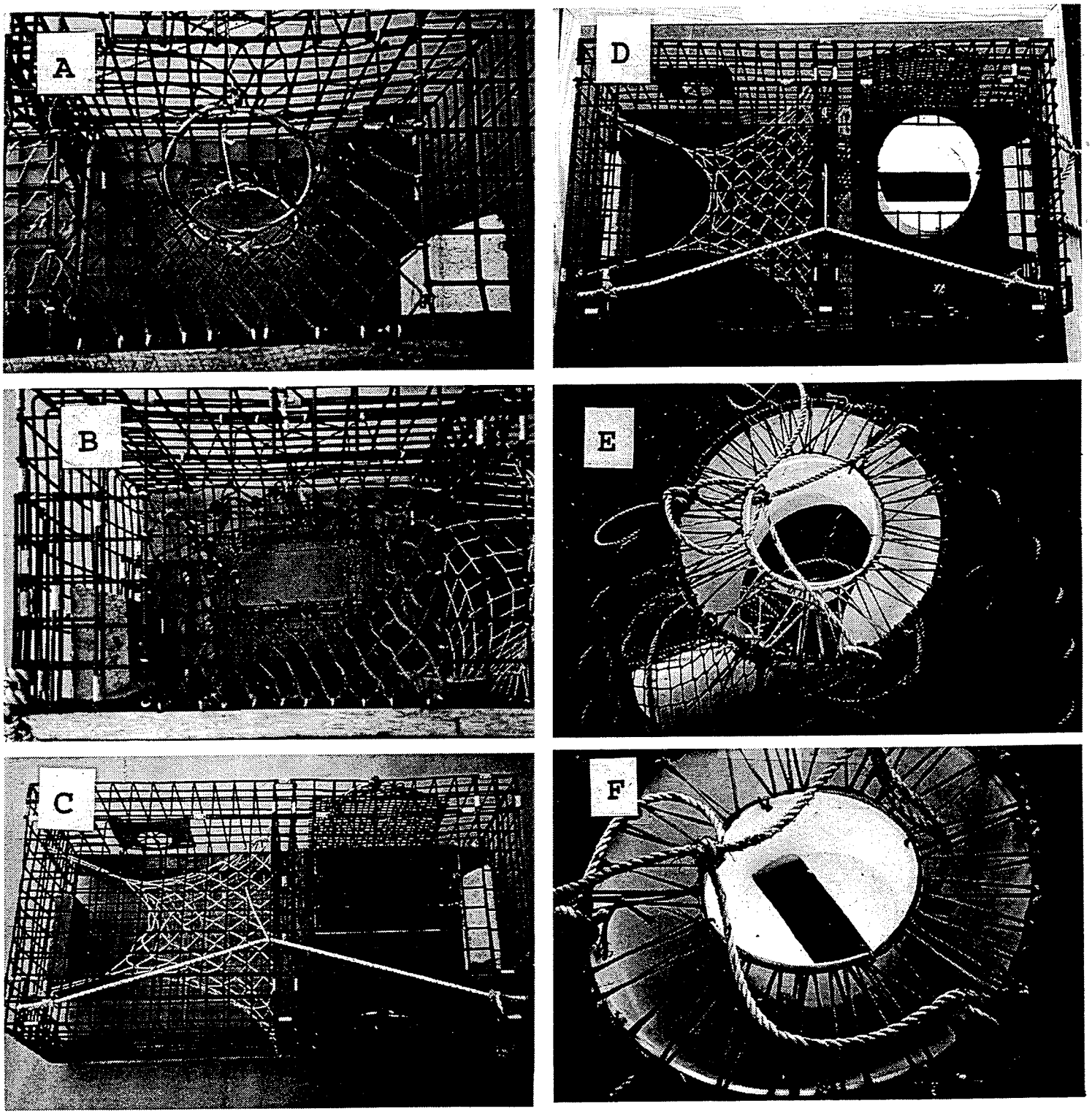

Figure 1. Trap designs: A- standard lobster trap with 13 cm diameter side entrance; B- lobster trap with 7.6 X 25.5 cm side entrance; C- lobster trap with 4.8 X 25.5 cm top entrance; D- lobster trap with 5.4 X 20 cm top entrance; E- cone trap with 20 cm diameter top entrance; F- cone trap with 5.4 X 20 cm top entrance.

RESULTS

Because crab shells are rigid and scarcely compressible a crab could not pass through a rectangular opening of a height (or smallest dimension) of less than the height of the crab's body. The crab could also not pass through an opening whose width is less than its length (rostrum to abdomen). Crabs may choose not to pass through larger openings, but these shell dimensions set the minimum limits.

The following relationships of height (H) and length (L) to width (W) is based on measurements (in mm) of 34 large male crabs.

$$H = 5.2 + 0.33\ W \quad r = 0.92$$
$$L = 7.1 + 0.66\ W \quad r = 0.97$$

In Series I the high variance among replications and the variety of habitats fished in the series made data interpretation problematical. However, lobster catch rates of >1/trap in the standard traps and traps with the 7.6 cm high side entrances were unacceptably large (Table 2). Crab catches were low and variable and not included.

In Series II lobster catches were clearly highest in the standard trap with no significant difference among other types (Table 2). However, it is worth noting that traps with top rectangular entrances had low lobster catches in both Series I and II.

Catch of large crabs (greater than the legal minimum size of 102 mm carapace width) in Series II was markedly lowest in the standard trap. The cone traps with a 20 cm diameter entrance had higher catches than the modified lobster trap with 5.4 X 15 cm top entrance. There were no significant differences among catches of crabs <102 mm CW (Table 2). The high variances for this size group suggests they have a highly contagious distribution.

No case can be made for top or side entrance reducing catch of subcommercial crabs, or for the 5.4 cm rectangular entrance excluding large crabs. Catch ratios of small to large crabs was similar in 5.4 cm top and side entrances in Series II. Comparing the Series II size frequencies of commercial crabs captured in traps with rectangular and round entrances (Fig. 2) suggest no exclusion of large crabs by the 5.4 cm entrances.

The high lobster catches in standard traps are expected to be the cause of low crab catches in these traps. In Series II correlations were r = -0.85 for large crabs and lobsters and -0.56 for small crabs and lobsters.

Series III trapping was conducted in an area chosen for high lobster density including a high portion of small lobsters, whereas series II captured predominately large lobsters (Fig. 3). The ratios of commercial:subcommercial lobster catches in the standard trap was 6.4:1 and 1.3:1 in Series II and III respectively. The crab catch in Series III was <1 per trap and is not considered further.

Table 2. Mean and standard error of catch per trap of rock crabs and lobsters. Means not significantly different are connected by horizontal lines. Trap types: standard- unaltered wire lobster trap with 13 cm diameter entrances; 7.6 side, 4.8 side, and 5.4 side- wire lobster traps with rectangular side entrances of the height indicated and 15 cm long; 4.8 top and 5.4 top- wire lobster traps with top entrances of the width indicated and 15 or 20 cm long; 20 top- wire lobster trap with a top entrance of 20 cm diameter; 20 cone- conical trap with top entrance of 20 cm diameter; 5.4 cone- conical trap with rectangular top entrance 5.4 by 20 cm.

Series (hauls/ trap type)	Species & size	Trap type - mean catch (SE)				
I (12)	All lobsters	7.6 side 1.7 (0.7)	Standard 1.6 (0.4)	20 top 0.8 (0.3)	4.8 side 0.4 (0.5)	4.8 top 0.0 (0)
II (10)	Crabs ³102mm CL	20 cone 25.7 (1.7)	5.4 side 21.7 (2.1)	5.4 cone 20.5 (1.7)	5.4 top 18.4 (1.2)	standard 13.0 (2.5)
	Crabs <102mm CL	5.4 side 19.1 (2.0)	20 cone 17.4 (4.0)	5.4 top 11.7 (5.8)	standard 10.7 (3.3)	5.4 cone 10.3 (3.1)
	All lobsters	Standard 5.2 (0.9)	20 cone 0.5 (0.2)	5.4 top 0.3 (0.2)	5.4 side 0.3 (0.2)	5.4 cone 0.0 (0)
III (6)	Lobsters ³81mm CL	Standard 5.5 (0.4)	20 cone 1.2 (0.3)	5.4 side 0.7 (0.3)	5.4 top 0.5 (0.2)	5.4 cone 0.0 (0)
	Lobsters <81mm CL	5.4 side 4.5 (0.6)	Standard 4.3 (0.3)	5.4 top 1.5 (0.6)	20 cone 1.0 (0.5)	5.4 cone 0.8 (0.4)

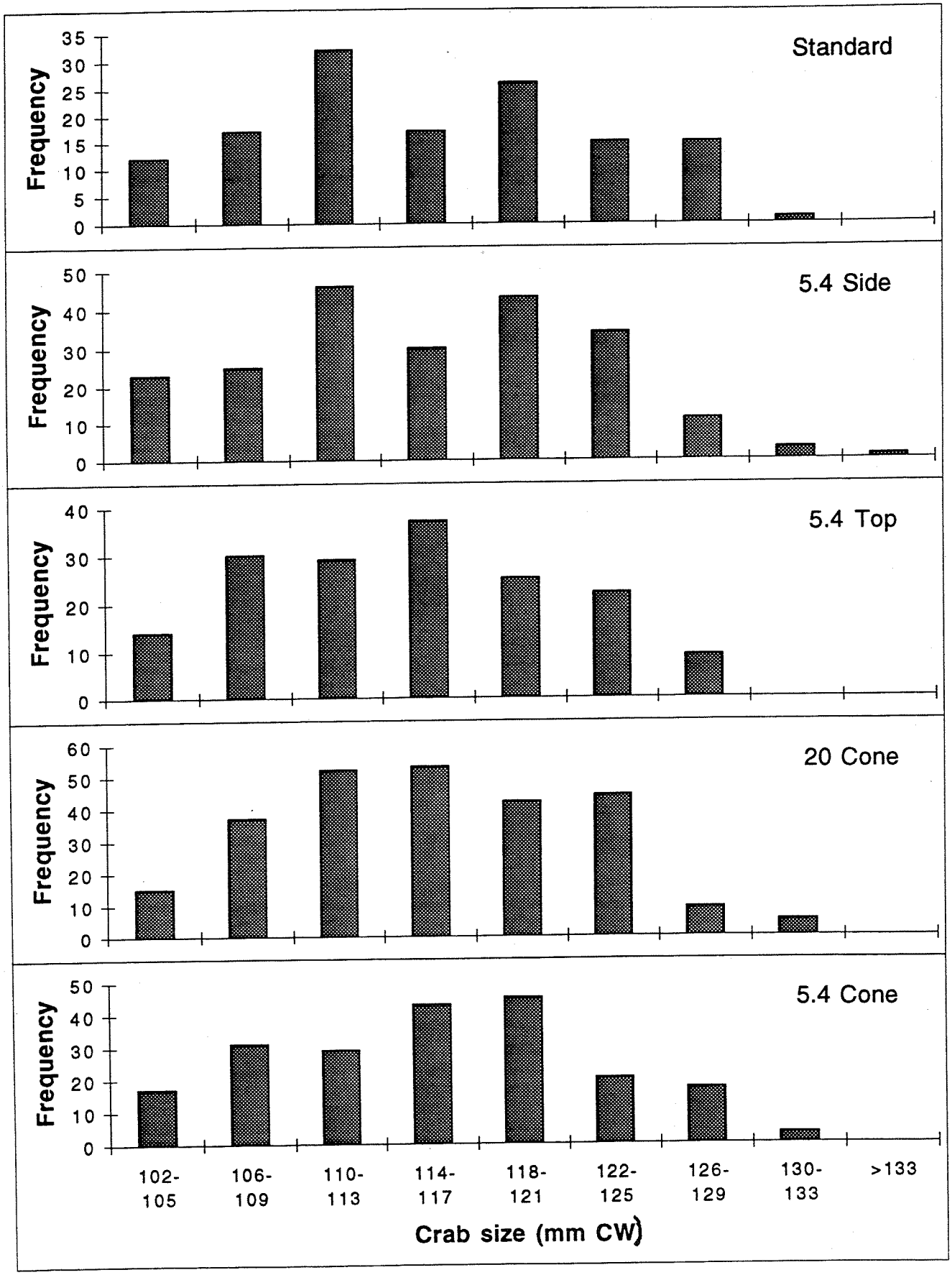

Figure 2. Size frequency of commerical sized rock crabs captured in Series II.

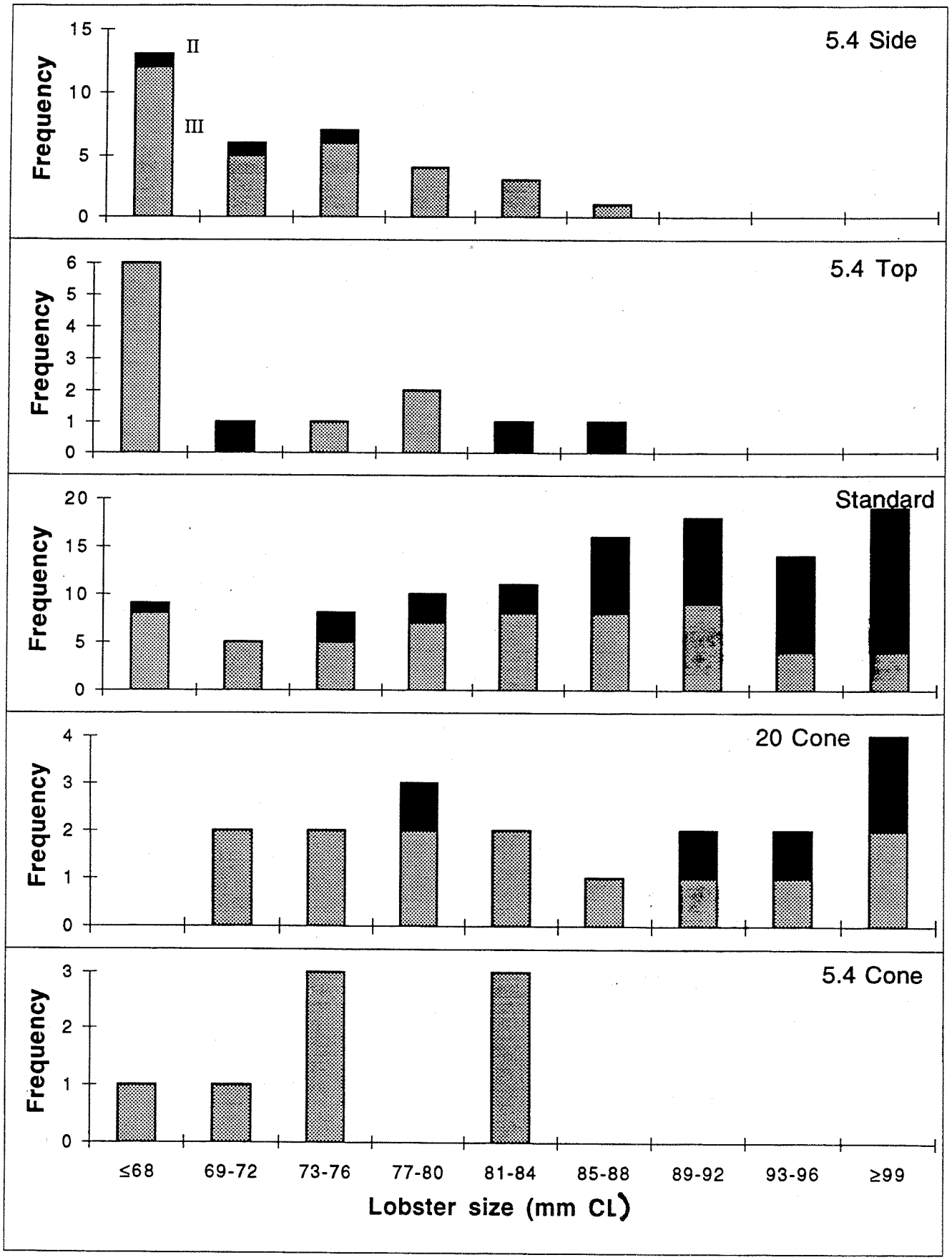

Figure 3. Size frequency of all lobsters captured in Series II and III.

The standard lobster trap caught the most commercial sized lobsters followed by the cone trap with the 20 cm diameter entrance. The lobster trap with 5.4 cm high side entrance caught the most subcommercial sized lobsters. The two trap types with 5.4 cm top entrances caught the fewest lobsters.

All trap designs tested were of robust construction and all could be purchased for <$50.

DISCUSSION

A trap design selected for a directed crab fishery should have the following characteristics: 1) low bycatch of other species, 2) low bycatch of subcommercial sizes of the target species, 3) design criteria easy to enforce (and not easily circumvented), 4) high catches of commercial sizes of the target species, and 5) affordable price and robust construction.

Experimental results reported here have shown that all side entrance traps can yield high lobster catches. Even though lobster catches could be reduced with the addition of escape gaps, selectivity is variable and gaps can easily be closed by a fisher wanting to retain lobsters. Preventing entry is a more certain means of avoiding capture.

The cone trap with the 20 cm diameter top entrance caught marginally more lobsters than the cone or modified lobster trap with rectangular top entrances. Gendron and Hébert (1991) caught high numbers of lobsters (2.3 and 1.8 per trap on rock and sand respectively) in cone traps with a large round entrance and no escape gaps, although this decreased to 0.6 and 0.3 lobsters per trap on rock and sand respectively when traps had four escape gaps.

Our cone traps with a rectangular entrance caught no lobsters in Series II and only subcommercial sizes in Series III. Gendron and Hébert (1991) caught 0.2 and 0.05 lobsters per trap on rock and sand respectively in cone traps with a 57 mm wide top slot and four escape gaps.

Both Stasko (1975) and Gendron and Hébert (1991) caught zero lobsters in wooden lobster traps fitted with rectangular top entrances. Gendron and Hébert's traps had escape openings, Stasko's had none. In our wire lobster traps with rectangular top entrances no lobsters were caught in Series I, only 0.3/trap in Series II, but 2.0 per trap of mostly subcommercial sizes in Series III.

We obtained relatively low crab catches in standard lobster traps, as did Stasko (1975) and Gendron and Hébert (1991). The negative impact of lobsters on rock crab catches has been demonstrated before in field (Richards et al. 1983) and laboratory (Miller and Addison 1995) trapping experiments.

Our next lowest crab catches were obtained in cone and modified lobster traps with rectangular top entrances, although the catch

reduction was not large relative to the cone trap with a round entrance. Gendron and Hebért (1991) found that all modifications of the cone trap out-fished the wooden lobster trap with top rectangular entrance by a factor of three or more. No doubt other variations of top entry traps could be developed that would improve crab catches without increasing the lobster bycatch.

No design used in our study was a clear choice to reduce entry of undersized crabs. Chiasson et al. (1993) found that a plastic skirt on the outside of cone traps reduced the catch of undersized snow crabs by about 25% without reducing the commercial catch. This selectivity occurred because small crabs had insufficient leg span to reach across the skirt.

Krouse (1978) reported a carapace width-length (in mm) regression based on measurement of 103 male rock crabs ranging from 90-122 mm CW.

$$CL = 3.72 + 0.68\ CW$$

From this regression it was calculated that a crab with a carapace width of 102 mm, the current legal minimum size, would be retained by a circular hole of 70 mm diameter. Because Krouse measured carapace width as the distance between the two most posterior notches, and most crab buyers measure width as total width outside the notches, carapace width was entered in the equation as 99 mm rather 102 mm.

In conclusion, the top entry trap is clearly preferred to side entry because of the reduction in lobster bycatch. The slot rather than round entrance on top probably further reduces commercial sized lobster catches in modified lobster plus cone traps. Several variations of traps with rectangular top entry have been reported on (Stasko 1975; Gendron and Hébert 1991; this study), and some of these yielded good crab catches. Additional possibilities remain to be tried. A 70 mm diameter circular escape gap would reduce bycatch of undersized rock crabs.

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