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Catch comparison of lobster traps equipped with two types of escape mechanisms

M. Lanteigne, D. J. Jones[1] and P. Mallet

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

[1]Miminegash Field Station
Department of Fisheries and Oceans
Miminegash, Prince Edward Island
C0B 1S0

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

[1]Miminegash Field Station
Department of Fisheries and Oceans
Miminegash, Prince Edward Island
C0B 1S0

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Abstract

Lanteigne, M., D. J. Jones and P. Mallet. 1995. Catch comparison of lobster traps equipped with two types of escape mechanisms. Can. Tech. Rep. Fish. Aquat. Sci. 2073: 14p.

A comparison study was conducted on American lobster (*Homarus americanus*) catches in traps equipped with two different types of escape mechanisms. The study was conducted in a commercial fishing setting with the participation of a fisher from Lobster Fishing Area 24, in the northern region of Prince Edward Island.

The results collected during 15 fishing days were used to estimate catch differences (in weight) between traps equipped with circular escape mechanisms (44.45mm in diameter) and traps equipped with rectangular escape mechanisms (38.1mm in height, 127mm in width). Traps with circular escape mechanisms caught 37.3% more sub-legal lobsters (carapace length < 63.5mm) than traps with rectangular escape mechanisms. In the same order, the catch difference for lobsters in the canner size category (carapace length ≥63.5mm and < 81mm) was 6.2%. No difference was observed for catches in the market size category (carapace length ≥ 81mm).

Key words: Lobster, American Lobster, *Homarus americanus*, trap, escape mechanism, selectivity.

Résumé

Lanteigne, M., D. J. Jones and P. Mallet. 1995. Catch comparison of lobster traps equipped with two types of escape mechanisms. Can. Tech. Rep. Fish. Aquat. Sci. 2073: 14p.

Une étude comparative des captures de homard (*Homarus americanus*) a été effectuée en utilisant des casiers équipés de deux types de mécanismes d'échappement. L'étude a été effectuée dans un contexte de pêche commerciale, avec la participation d'un pêcheur de la zone de pêche du homard 24, dans le secteur nord de l'Île-du-Prince-Édouard.

Les résultats obtenus lors de 15 jours de pêche ont permis d'estimer les différences entre les captures (en poids) de casiers équipés de mécanismes d'échappement circulaires (diamètre de 44.45mm) et de casiers équipés de mécanismes d'échappement rectangulaires (hauteur de 38.1mm, largeur de 127mm). Les casiers équipés de mécanismes d'échappement circulaires ont capturé 37.3% plus de homards sous-légaux (longueur de carapace < 63.5mm) que les casiers équipés de mécanismes d'échappement rectangulaires. Dans le même ordre, la différence dans les captures de homard de la catégorie "de conserve" (longueur de carapace ≥63.5mm et < 81mm) a été de 6.2%. Aucune différence n'a été observé dans la capture de homard de la catégorie "de table" (longueur de carapace ≥81mm).

Mots clés: Homard, homard d'Amérique, *Homarus americanus*,. casiers, mécanisme d'échappement, sélectivité.

Introduction

The potential benefits of using escape mechanisms on lobster (*Homarus americanus*) traps as a mean of reducing catches of under size animals have been studied and discussed since the early 1940's (Wilder, 1943, 1949; Templeman, 1958; and Nulk, 1978). A recent study by Maynard *et al.* (1987) in the Gulf of St. Lawrence has shown differences in selectivity between circular and rectangular escape openings. Based on the results of that study, a regulation was adopted in 1987 for the southern Gulf of St. Lawrence stating that all lobster traps be fitted with a mechanism allowing the escapement of sub-legal lobsters entering the trap. The overall objective of the regulation was to minimize the handling therefore, the indirect fishing mortality of sub-legal size lobsters. Depending on the management unit or Lobster Fishing Area (LFA, Figure 1), the regulations allowed the use of different types of mechanisms and construction materials as long as they fall into the regulated opening shapes and dimensions presented in Table 1.

Table 1. Regulations on minimum carapace size and escape mechanism (shapes and dimensions) in each Lobster Fishing Area of the southern Gulf of St. Lawrence.

Lobster Fishing Area	Minimum carapace size at capture (mm)	Diameter of openings, circular mechanism* (mm)	Height and width of openings, rectangular mechanism (mm)
23, 25	66.7 mm	44.45 mm	height 38.1 mm
24	63.5 mm		width 127 mm
26A	65.1 mm		
26B, 27	70.0 mm	50.8 mm	height 38.1 mm
			width 127 mm

All types of escape mechanisms need to be positioned at 76mm or less from the floor of the trap.
* a minimum of two circular openings per trap are required

The circular and rectangular escape mechanisms in use in LFA 23, 24, 25, 26A and 26B have very different selectivity (Maynard *et al.* 1987). The circular escape mechanisms (CEM) retain smaller lobsters when compared to the rectangular escape mechanisms (REM). The reason for the presence of two types of escape mechanisms in the regulations is mainly to accommodate the different legal minimum carapace sizes in effect in the different LFAs (Table I).

With the increasing concems on resource conservation and the recent catch decline in some areas, the fishing industry is promoting the establishment of management tools to maximize resource production and protection. Fishers have indicated for years that the escape mechanism can be an efficient management tool and can be easily endorsed by all fishers. However, these fishers also indicated that the present regulation is too permissive and should be revised. However, before changing the present regulation, fishers want to know the impact on their catches of modifying the escape mechanism regulation, especially those concerning the CEM.

This document presents the results of a joint study between the Prince Edward Island Fishermen Association (P.E.I.F.A.) and the Department of Fisheries and Oceans (DFO). The catch and the overall selectivity of two (2) types of escape mechanisms were compared following a scientific protocol adapted so the study could be conducted in a commercial lobster fishing setting. The comparison study was designed to quantify any potential catch differences when using the two types of escape mechanisms permitted by law in LFA 24.

Material and Methods

Data collection

The catches from lobster traps fitted with the two types of escape mechanisms were compared while conducting regular commercial lobster fishing during the spring lobster fishing season in LFA 24. The study was conducted with a commercial fisher near Morell, Prince Edward Island (Figure 1). A total of 80 traps of the same type and dimensions were selected from the full set of 300 traps use by the fisher. The traps were made of wire mesh attached on a wood frame. Their dimensions were 107 cm in length, 91 cm in width and, 36 cm in height. The trap type selected for the comparison study is in use by approximately 16% of the fishers in LFA 24 (M. Lanteigne, unpublished data).

Half (40) of the traps selected for the comparison study were equipped with circular escape mechanisms (CEM) and the other half with rectangular escape mechanisms (REM) as stipulated in the regulations (Table 1). All the traps were individually labelled and the fisher was requested to keep them adjacent and to alternate the position of traps with CEM and REM on each string. A string consisted of eight traps attached on a single longline at 10 m intervals. The fisher was also requested to use the same bait type and quantities in all experimental traps. The traps were set in depths ranging from 4 to 20 meters and fished every 24 hours (one soaking day) with the exception of three (3) fishing days where the soaking time was approximately 48 hours.

An onboard observer conducted the sampling on a daily basis. To minimize disruption of regular fishing activities, only two to six experimental traps were included in any one string. Consequently, experimental traps were distributed among 16 strings. This setup resulted in a wide distribution of the traps over the study area.

The data collected consisted of the following (Appendix I);

- string number, position and depth
- trap number and type of escape mechanism
- trap soak time (number of days since the last time the trap was fished)
- carapace length (CL, mm) of each lobster in the trap
- sex (male, female, egg bearing female)
- missing claws (crusher, pincer)

Analyses

For the analyses, the lobster were divided in three (3) size categories corresponding to the commercial grading adopted in the lobster fishing industry.

- sub-legal size category (< 63.5 mm)
- canner size category (≥63.5 mm and < 81 mm)
- market size category (≥81 mm)

All female lobsters carrying eggs were excluded from the size categories as they are released.

The total number of lobsters and catch per trap (g) was calculated for each size category and trap sampled. The lobster individual weights were calculated by using allometric equations provided by Maynard *et al.*, 1992;

$$WT = b \times CL^{a}$$

where:	WT	=	weight (g) for a given carapace length	
	CL	=	carapace length (mm)	
	a_{male}	=	0.00140744	(constant)
	a_{female}	=	0.0031	(constant)
	b_{male}	=	2.8675	(constant)
	b_{female}	=	2.6838	(constant)

All the carapace length measurements in the experiment were rounded to the lower millimetre, therefore, the size range for the sub-legal and the canner size categories had to be adjusted to accommodate the minimum legal size set to 63.5 mm CL in LFA 24. An approximation was obtained by dividing equally the size frequency and calculated weight for all the lobsters identified as 63 mm and assigning equal portions to the sub-legal and canner size categories.

The prevalence of lobster caught with one or two missing claws for males and females was tested for independence of the type of escape mechanism using a chi-square test (Sokal and Rohlf, 1981). The same test was used to analyze the occurrence in traps of lobsters of each lobster size category, in relation with the type of escape mechanism. Egg bearing females were not included in the analyses but are displayed for information in the tables.

A mixed nested model ANOVA was used to compare the total catch per trap of the two types of escape mechanisms for each size category. The factors used in the statistical analyses were the fishing day, the soak time, the string (nested within the fishing day) and the type of escape mechanism. This model is based on the assumption that the string is a random factor within any given fishing day as the fisher is changing the geographical position of the strings on a daily basis.

The trap position in any given string was not recorded during the sampling therefore, could not be use as a factor in the analysis. The source of variation associated with the trap position on a string and the potential interaction between traps on the same string was assumed constant for all traps and for the two types of escape mechanisms tested.

Results

General

The sea sampling was conducted during 15 fishing days from June 12 to June 30, 1995. A total of 323 traps with CEM and 308 traps with REM were sampled during the comparison study. The general area where the fishing activity took place is presented in Figure 1. Table 2 summarizes the basic statistics, and the prevalence of each sex, including the percentage of egg bearing females. The sex ratio of the catch was 1:1 with percentages of egg bearing females ranging from 1.7% to 2.8%. The size frequency distributions of lobsters captured from each type of escape mechanism are presented in Figure 2 (egg bearing females are not shown).

The mean daily fluctuations of the carapace length, number of lobsters per trap, and catch per trap are presented in Figures 3, 4 and 5 respectively for sub-legal and canner size categories, and for each type of escape mechanism. No apparent difference is observed in the mean carapace size between escape types. However, some differences are observed in the mean number of lobster per trap, and mean catch per trap of the sub-legal size category. Traps fitted with REM have slightly lower number of lobster and catch per trap compared to the CEM. No strong temporal trend was observed other than a slight decrease in mean size, number of lobster per trap and catch per trap for the canner size category as the season progresses, reflecting the normal removal of commercial size classes.

The occurrence of male and female lobsters with one or two missing claws did not show a significant difference (χ^2 =1.313, *df* = 1, $P > 0.05$) between CEM and REM, suggesting that the prevalence of lobsters with missing claws is independent of the type of escape mechanisms (Table 3). Following this initial analysis, the prevalence of missing claws was not retained as a factor inducing variability.

Table 2. Number of lobsters measured, mean carapace length (*SD*=standard deviation) for male, female and egg bearing females lobsters, and for each type of escape mechanism.

Escape mechanism	Number of traps sampled	Sex	Number of lobsters measured	Percentage of each sex	Mean carapace length in mm *(SD)*
Circular	323	Male	655	48.9%	64 *(6.3)*
		Female	661	49.4%	64 *(7.0)*
		Egg bearing	23	1.7%	72 *(4.6)*
Rectangular	308	Male	481	48.5%	66 *(6.0)*
		Female	483	48.7%	65 *(6.8)*
		Egg bearing	28	2.8%	75 *(10.1)*

After an initial ANOVA analyses, the soak time factor was removed as it was not providing a significant source of variation for each size category analyzed ($P > 0.05$). The results without the soak time factor, for each size category are presented in Table 5.

Sub-legal size category

The mean catches per trap for sub-legal size lobsters were 357.3g (*n* = 323, *SD* = 313.35) and 224.1g (*n* = 308, *SD* = 229.93) for traps with CEM and REM respectively (Table 4). The ANOVA on the catch per trap by the two types of escape mechanisms showed a significant difference ($P < 0.0001$, Table 5) suggesting that sub-legal size lobster catches were significantly greater in traps with CEM than in traps with REM. The fishing day (date), the string and the string x escape type interaction did also show significant differences ($P < 0.05$). The significant string x escape type interaction suggests that the catch per trap variability within the strings could not be explained by the fishing day or the type of escape mechanism alone. The mean catch per trap throughout the sampling period is presented in Figure 5 for each type of escape.

Table 3. Contingency table of the occurrence of lobsters with one or two missing claws, by sex and by type of escape mechanism (egg bearing females are not included). Results of the test of independence (chi-square, Sokal and Rohlf, 1981) are shown.

Escape mechanism	Male	Female
Circular	87	104
Rectangular	67	102
	χ^2 =1.313 ^{ns}, *df* = 1	

ns = not significant

The occurrence of sub-legal size lobsters was significantly ($P < 0.05$) lower in traps fitted with rectangular escape mechanisms (Table 6). From all the traps sampled during the comparison experiment, 83.0% of the traps with circular escape mechanisms and 70.1% of the traps with rectangular escape mechanisms did contain lobster of the sub-legal size category.

Canner size category

The mean catch per trap for canner size lobsters were 510.9g (*n*=323, *SD*=411.56) and 479.3g (*n*=308, *SD*=407.33) for traps fitted with CEM and REM respectively (Table 4). The ANOVA (Table 5) did show significant differences ($P > 0.05$) of the catch per trap between escape types, strings ($P < 0.01$) and fishing day ($P < 0.001$). The fishing day factor provided most of the variability followed by the string and finally the type of escape mechanism. There was no significant interaction ($P > 0.05$) between the string and the type of escape. The temporal fluctuation of the mean catch per trap is presented in Figure 5 for both types of escape mechanisms.

Table 4. Mean catch per trap (g) and standard deviation (*SD*) for each size category and type of escape mechanism.

Size category	Mean catch per trap in grams *(SD)*	
	Circular escape	Rectangular escape
Sub-legal size	357.3 *(313.35)*	224.1 *(229.93)*
Canner size	510.9 *(411.56)*	479.3 *(407.33)*
Market size	40.3 *(192.88)*	28.01 *(142.97)*

The percentage of traps sampled containing canner size lobster was 90.1% and 87.7% for traps with circular and rectangular escape mechanisms respectively (Table 6). However, the difference between the number of traps containing canner size lobsters was not significant ($P > 0.05$), suggesting that the occurrence of lobsters in traps was independent of the type of escape mechanisms.

Market size category

The mean catch per trap for market size lobsters were 40.3g (*n*=323, *SD*=192.88) and 28.1g (*n*=308, *SD*=142.97) for traps with circular and rectangular escape mechanisms respectively (Table 4). The ANOVA (Table 5) demonstrated that there was no significant difference in catch per trap for the two types of escape mechanisms, with the string and with the string x escape interaction ($P > 0.05$). The fishing day was the only factor that did show a significant difference ($P < 0.001$).

Lobsters of the market size category were present in only 6.2% and 4.5% of the traps fitted with CEM and REM respectively (Table 6). However, the difference between the number of traps containing lobsters was not significant ($P > 0.05$), suggesting that the occurrence of market size lobsters in traps was independent of the type of escape mechanisms.

Discussion

The study showed that traps with rectangular escape mechanisms (REM) caught fewer sub-legal lobsters than traps with circular escape mechanisms (CEM). The comparison study was able to show significant differences in the lobster catch of traps employing both CEM and REM as permitted in present Atlantic Fisheries Regulations. The REM reduced the catch (in weight) of sub-legal lobsters by 37.3% when compared to the CEM. In addition, traps fitted with REM caught 6.2% fewer canners size (≥63.5 mm and <81 mm) lobsters (by weight) than traps using the CEM. However, there was no significant catch differences in the market size category. These observations are consistent with the results from a selectivity study conducted by Maynard *et al.* (1987) at Salmon Beach (Baie des Chaleurs, northern New Brunswick).

Table 5. Analysis of variance (nested mixed model) for the effect of fishing day (or date), string and escape mechanism type on the catch per trap for the following lobster size categories; A) sub-legal size, B) canner size, C) market size.

A. Sub-legal size category (lobsters < 63.5 mm)

Source of variation	Degree of freedom	Sum of squares	F value	P value
Fishing day	14	1595228.75	1.79	0.0377 *
String (fishing day)	205	17147258.08	1.32	0.0112 *
Escape type	1	1783236.25	28.07	0.0001***
String x Escape type	15	2096005.19	2.20	0.0061**
Error	244	14130974.08		

B. Canner size category (lobsters ≥ 63.5mm and < 81 mm)

Source of variation	Degree of freedom	Sum of squares	F value	P value
Fishing day	14	6798365.19	3.71	0.0001***
String (fishing day)	205	35143182.84	1.31	0.0128 *
Escape type	1	534943.59	4.08	0.0440 *
String x Escape type	15	979719.55	0.50	0.9411 *ns*
Error	380	49769775.37		

C. Market size category (lobsters ≥ 81 mm)

Source of variation	Degree of freedom	Sum of squares	F value	P value
Fishing day	14	1237181.73	3.36	0.0001***
String (fishing day)	205	6067949.81	1.13	0.1613 *ns*
Escape type	1	41610.80	1.58	0.2090 *ns*
String x Escape type	15	621050.45	1.58	0.0776 *ns*
Error	380	9984449.09		

* = $P < 0.05$ ** = $P < 0.01$ *** = $P < 0.001$ *ns* = not significant

Table 6. Contingency tables of the number of traps containing lobsters for each size category and type of escape mechanism. The sample (N) consisted of 323 traps with circular escape mechanisms and 308 traps with rectangular escape mechanisms. Results of the test of independence (chi-square, Sokal and Rohlf, 1981) on the prevalence of traps containing lobsters for each size category, in relation with the type of escape mechanism, are shown.

Escape mechanism	Size category: Sub-legal		Canner size		Market size	
	Number of traps with lobsters	Number of traps without lobsters	Number of traps with lobsters	Number of traps without lobsters	Number of traps with lobsters	Number of traps without lobsters
Circular	268	55	291	32	20	303
Rectangular	216	92	270	38	22	286
	χ^2 =14.549 ***, *df*=1		χ^2 =0.944 ^{ns}, *df*=1		χ^2 =0.229 ^{ns}, *df*=1	

*** = $P < 0.001$, *ns* = not significant

Based on theoretical retention curves calculated by Maynard *et al.* (1987), the rectangular openings allow 97.5% of the sub-legal size lobsters (≤63.5mm) to escape compare with 35.3% for the traps with circular openings. By subtracting these values, it can be estimated that a change from circular to rectangular escape mechanism should theoretically provide an escapement increase of 62.2%[1] (by weight) for the sub-legal size lobsters. This percentage of escapement represents a higher value than the results obtained in the present comparison study (37.3%).

Maynard *et al.* (1987) also estimated escapements (by weight) of canner size lobsters 19.8% and 1.6% for CEM and REM respectively. Therefore, a change from the CEM to REM could theoretically result in the escapement of 18.2% of canner size lobsters by weight. This percentage is approximately three times the value calculated in the present comparison study (6.2%).

Numerous factors can be responsible for the discrepancies between the results presented by Maynard *et al.* (1987) and the present study. The trap specifications (e.g.: size, design), the fishing method (e.g.: number of traps per string, bait type), the fishing ground location and characteristics, the environmental conditions and the lobster population structures are factors that can affect trap selectivity. Although both studies are showing difference in magnitude, both are presenting the same trends and showing a substantial reduction in the capture of sub-legal lobsters by using the REM instead of the CEM. The studies also show that changing from the circular to the rectangular escape mechanisms will result in some reduction in capture of commercial size lobsters (canner size category). However, catch reduction experienced by fishers should only be temporary. As indicated in the Gardner Pindfold report (Anon., 1993), the overall landings will recover after a few years and may increase as the lobsters that are escaping will grow to larger, heavier sizes. In addition, the benefits of reducing the capture of sub-legal lobsters provides a better survival rate for these lobsters and a greater chance to grow to commercial sizes.

[1] % escapement increase = (% escapement rectangular) - (% escapement circular)

Acknowledgments

Special thanks are extended to Roy Drake who conducted the experiment during his regular fishing activities and to Donna Waltman for conducting the daily sampling and data compilation.

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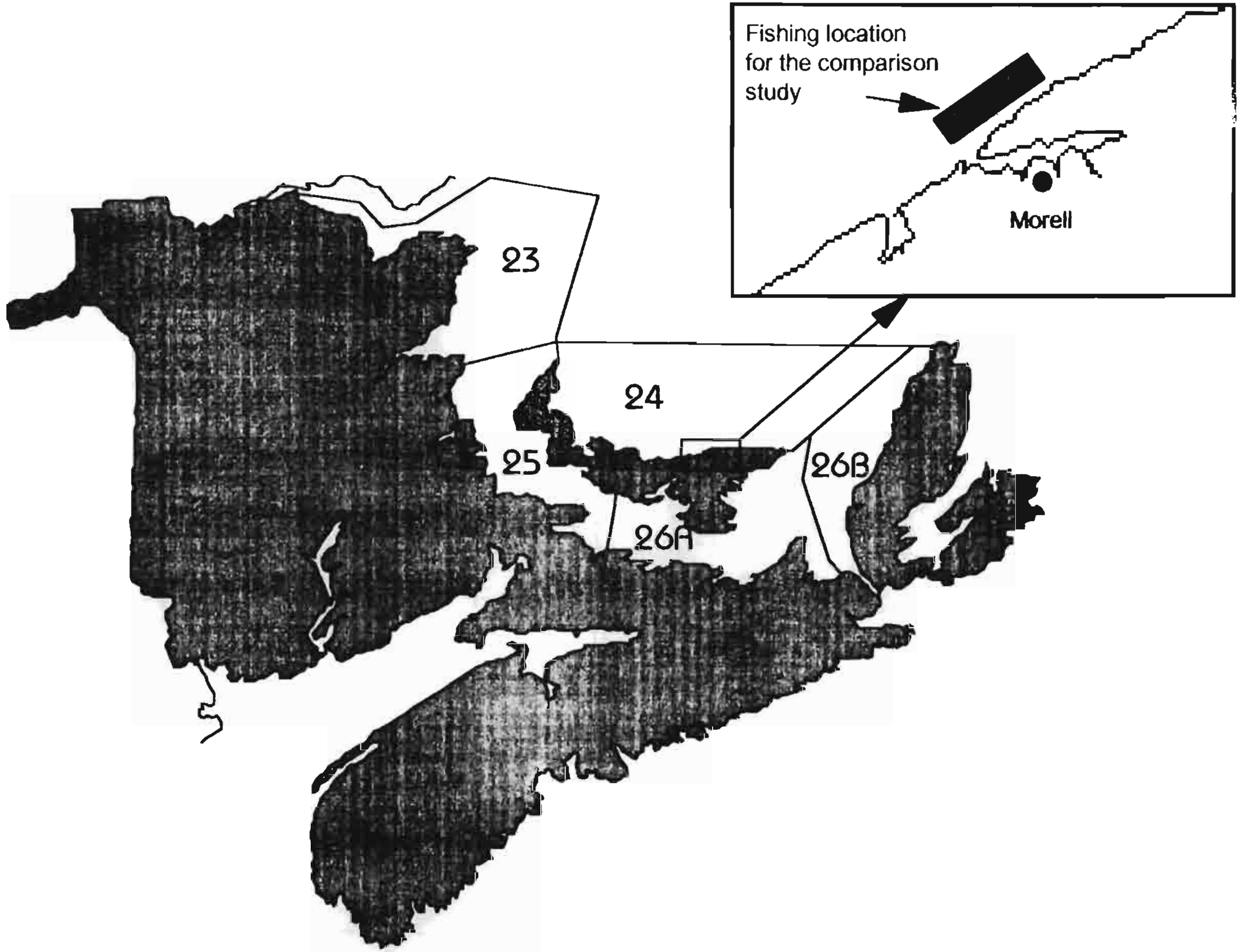

Figure 1. Lobster Fishing Areas (LFA) and fishing location for the lobster escape mechanism comparison study.

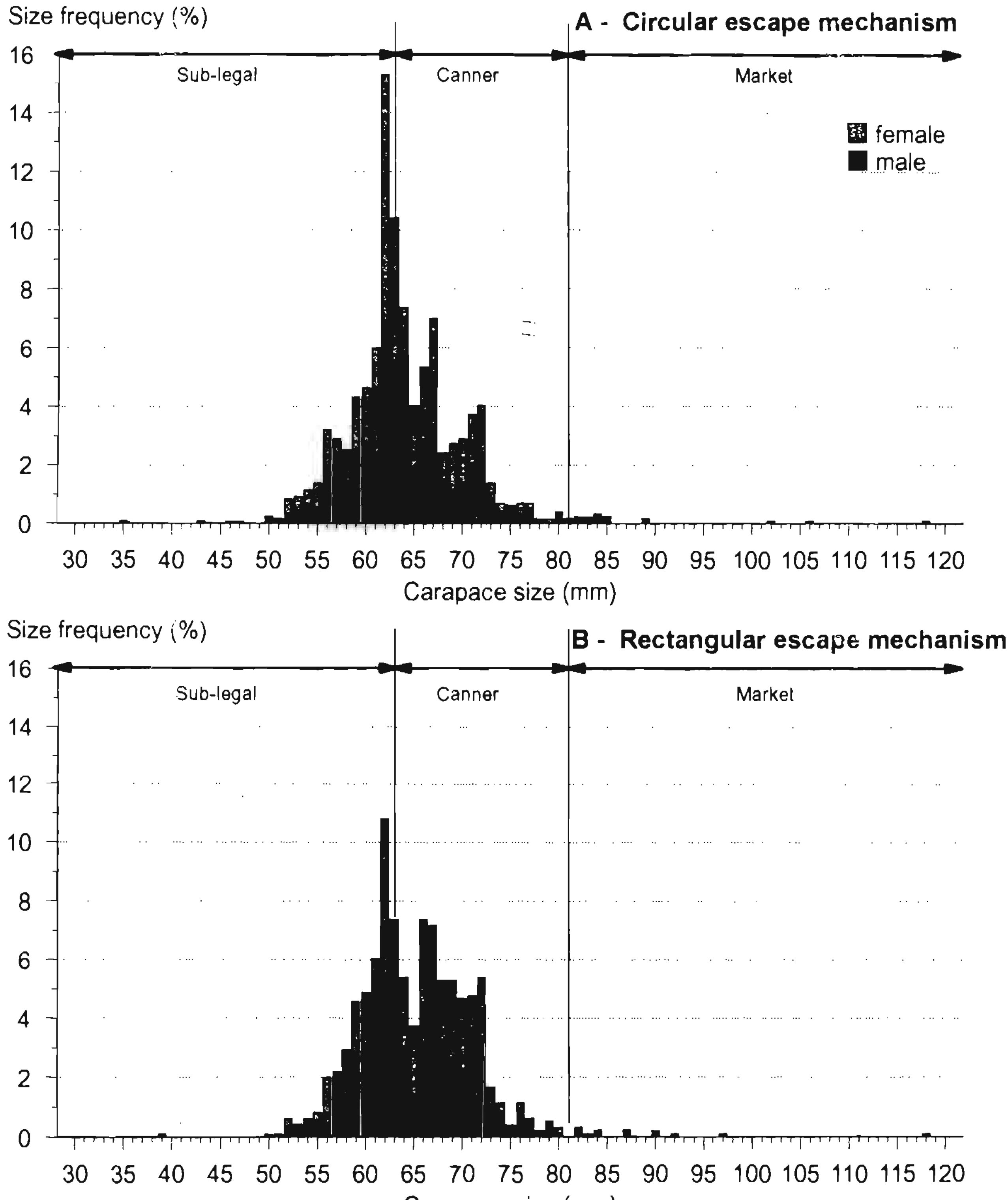

Figure 2. **Relative frequency size distributions of all the lobsters sampled during the experiment in traps equipped with circular escape mechanisms (A), rectangular escape mechanisms (B) and for each sex (egg bearing females are not included).**

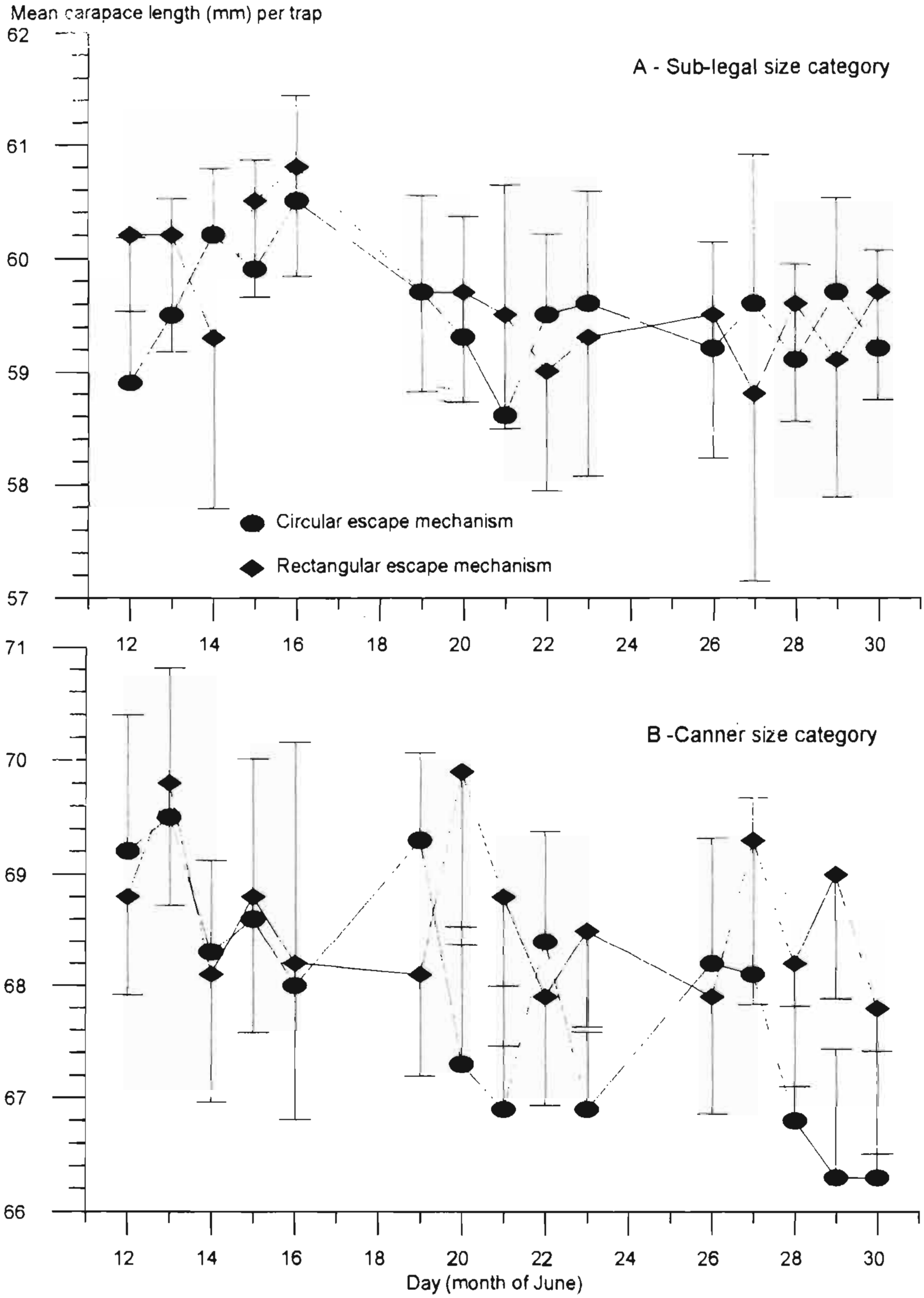

Figure 3. **Daily fluctuations of the mean carapace length (mm) per trap fished, for sub-legal (A) and canner (B) lobster size categories and for each type of escape mechanism. Upper and lower confidence intervals (95%) are indicated for the circular and rectangular escape mechanisms respectively.**

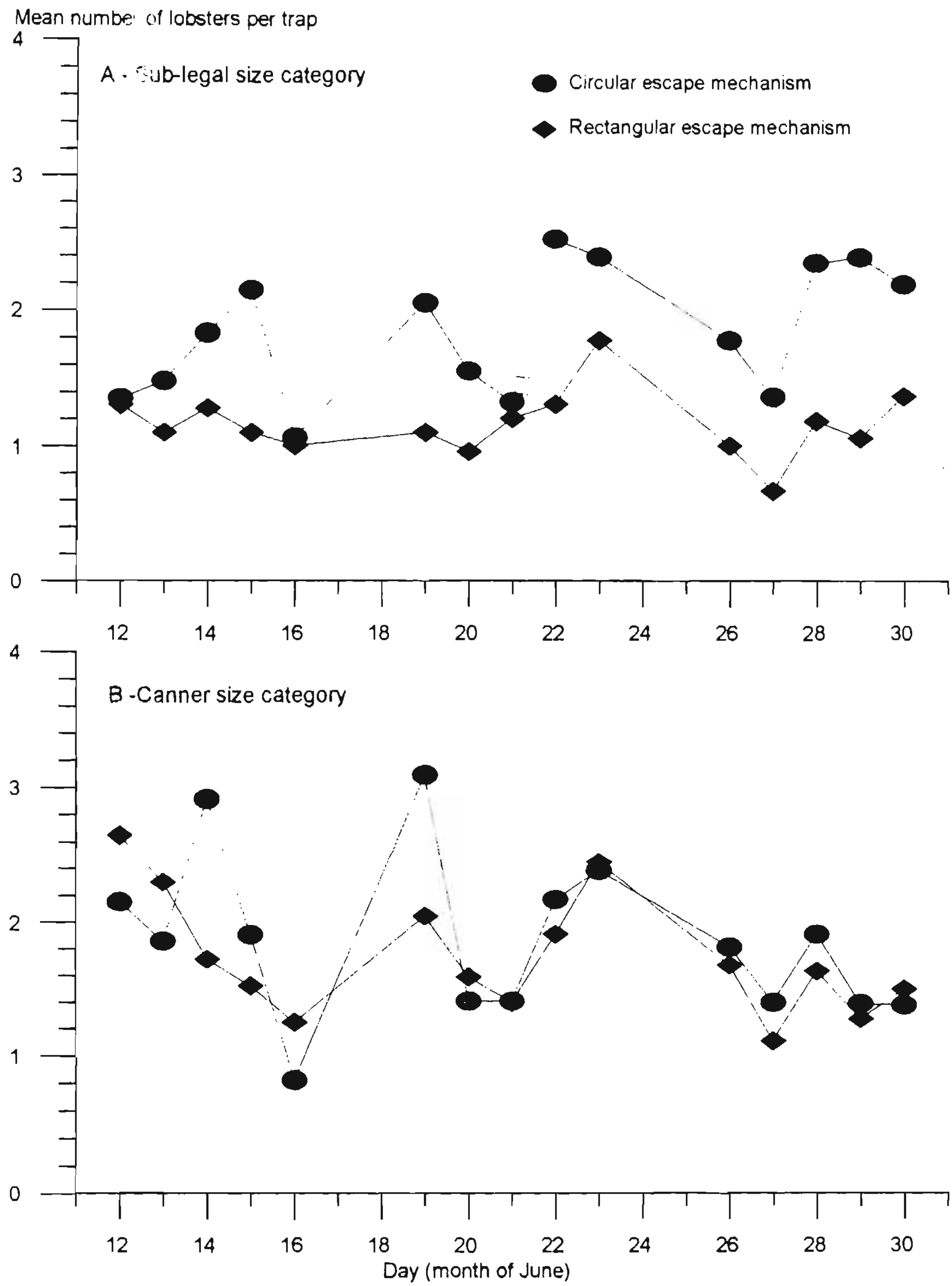

Figure 4. Daily fluctuations of the mean number of lobsters per trap fished, for sub-legal (A) and canner (B) lobster size categories and for each type of escape mechanism.

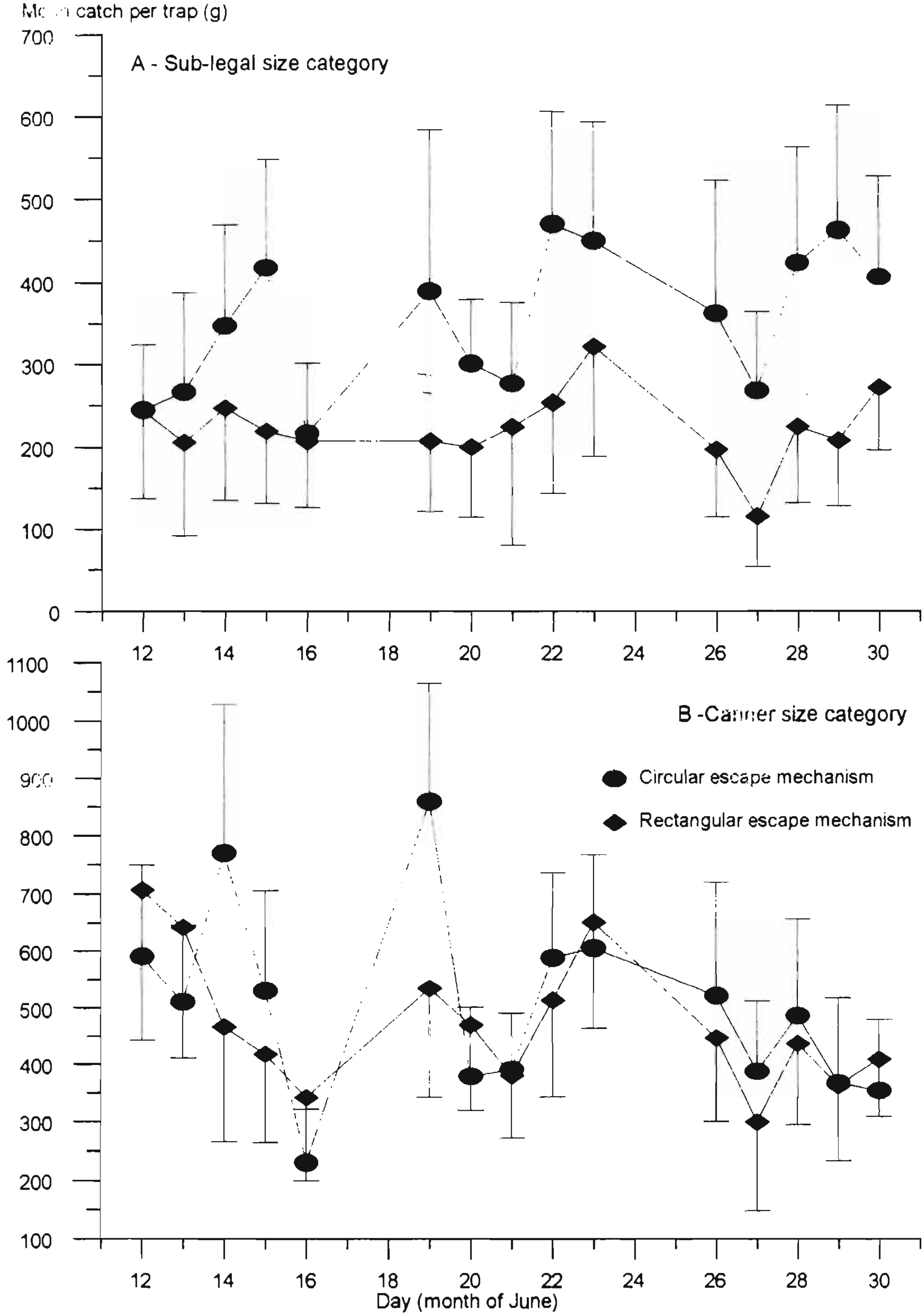

Figure 5. Daily fluctuations of the mean catch (g) per trap fished, for sub-legal (A) and canner (B) lobster size categories and for each type of escape mechanism. Upper and lower confidence intervals (95%) are indicated for the circular and rectangular escape mechanisms respectively.

Appendix I. Sea sampling data collection forms.

PEIFA - DFO JOINT EXPERIMENT ON TRAP ESCAPEMENT - 1995

Sea Sampling form Size Frequency Distribution

Port: ______________ **Date:** __________ **Sampler:** ______________

Number of traps per string: __________ **Soak days:** __________ **Page** ____ **of** ____

String	Trap Number	Type of escape C,R	Sex F,M,B	Carapace length (mm)	Egg stage 1,2,3	Missing claws C, P	Position (lat.long or Loran C)		Depth m, ft, fathoms

Type of escape:	C= circular opening, R= rectangular opening
Sex:	F= female, M= male, B= egg berring female
Egg stage:	1= eggs black, not spotted, 2= eggs tan-colored to dark brown some or all with eyespots visible, 3= eggs tan-colored to dark brown, with some or most eggs hatched or missing
Missing claws:	C= crusher (claw with blunt edges) , P= pincer (claw with sharp edges)
Depth:	m= meters, ft= feet, fathoms (1 fathom = 6 feet)