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Methods employed by the Canadian offshore fleet as a means to limit the size of catches in the 2J3KL cod fishery

by

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Abstract

In recent years, the relationship between exploitable biomass and commercial catch per unit effort for the 2J3KL cod stock has deteriorated, thus causing some problems in that aspect of the assessment. This inconsistency in the catch rate series appears to be at least in part attributable to a change in the catchability coefficient. In the early 1980s, extremely large catches led to changes in the way the 2J3KL cod were fished. These new methods appear to have affected catchability.

This paper describes the fishing technologies which were used to limit catch. Based on technological information extracted from the Newfoundland Observer program narrative trip reports plus detailed catch and effort data from the same source, it would appear that changes in gear configuration and fishing strategies since 1981 have resulted in a gradual decrease in catch per tow, independent of stock abundance. Shortening of the average tow length from 2.04 (± 0.04) hours in 1980 to 1.47 (± 0.01) hours in 1987 failed to adequately limit size of catch since the gear tended to become filled very early in its deployment. Also, discarding and dumping of fish effectively reduced amount of fish that were to be processed and landed but regulations introduced in 1987 curtailed this activity. Starting in 1983, cut away sections in the codend, referred to as windows, were designed to restrict size of catch to an upper limit by releasing fish beyond a certain point in the codend. However, frequency of use and position of windows was not consistent among vessels, areas fished, or over the duration of the fishing trip making a direct estimate of their affect on the catch rate difficult. On average, placement of the window was designed to limit individual catches to 12 t. However, frequencies of catch rates indicated much larger catches even when windows were in use because of improper placement or clogging. Average mesh size also increased from 128 mm in 1980 to greater than 135 mm after 1982, presumably affecting catchability.

Résumé

Au cours des dernières années, la relation entre la biomasse exploitable et les prises par unité d'effort commerciales dans le stock de morue des divisions 2J3KL s'est dégradée, entraînant ainsi des problémes dans cet aspect de l'évaluation. Cette discordance dans l'évolution des taux de prises semble être partiellement attribuable à un changement du coefficient de capturabilité. Au début des années 1980, les prises très élevées ont amené une réforme des méthodes de pêche de la morue dans les divisions 2J3KL. Or, les nouvelles méthodes semblent avoir affecté la capturabilité.

Le présent document décrit les techniques de pêche utilisées pour limiter les prises. Il ressort des renseignement techniques provenant des rapports de mission des observateurs de Terre-Neuve, ainsi que des données détaillées sur les prises et l'effort provenant des mêmes sources, que les modifications apportées aux engins et aux stratégies de pêche depuis 1981 ont abouti à une diminution graduelle des prises par trait, indépendamment de l'abondance des stocks. L'abaissement de la durée moyenne du trait, de 2,04 (± 0,04) heures en 1980 à 1,47 (± 0,01) heure en 1987, n'est pas parvenue à réduire adéquatement les prises, les engins ayant eu tendance à se remplir rapidement dès leur mouillage. Par ailleurs, le tri et le rejet du poisson ont eu pour effet de réduire la quantité de poisson à débarquer et à transformer, mais l'adoption d'une nouvelle réglementation en 1987 a coupé court à cette pratique. En 1983, on a commencé à ménager des ouvertures, appelées fenêtres, dans le cul-de-chalut. Cette méthode visait à réduire les prises en permettant aux poissons se trouvant au-dessus d'une certaine hauteur dans le cul-de-chalut de s'échapper. Toutefois, la fréquence d'utilisation et la position des fenêtres variant d'un bateau à un autre, d'un secteur de pêche à un autre, ou d'un voyage de pêche à un autre, il a été impossible d'estimer les effets de cette méthode sur le taux de prise. En général, les fenêtres devaient être placées de mainière à limiter les prises par trait à 12 tonnes. La fréquence des taux de prise dénote cependant des prises très supérieures à ce chiffre même dans le cas où l'on utilisait des fenêtres, en raison de la position incorrecte de celles-ci ou de leur obstruction. On présume que l'augmentation de la taille moyenne des mailles, qui est passée de 128 mm en 1980 à plus de 135 mm après 1982, a également affecté la possibilité de capture.

Introduction

The relationship between commercial catch per unit effort and exploitable biomass is a useful element in the assessment of fish stocks, if catchability is stable. However, for the 2J3KL cod stock (Fig. 1 for NAFO Div..), during the period 1978-87, the relationship between catch rate and biomass deteriorated thus causing some problems in that aspect of the assessment. This inconsistency in the catch rate series may be attributable, at least in part, to changes in the manner in which the fishery was prosecuted. Pinhorn (1988) found catchability coefficients to be positively correlated with indices of technological changes for fleets fishing groundfish including the 2J3KL cod stock off Canada's east coast. For this reason, an examination of fishing technology - specifically, gear configuration and fishing strategies - particularly with respect to changes that may have occurred during 1980-88 - might provide clues as to why the catch rates and biomass series were not correlated.

During the early 1980s, in NAFO Div. 2J and 3K winter fishery, size of catches increased dramatically to a point where ability of the Canadian fleet to retain and process cod in some of the catches was adversely affected. Concurrently, the Canadian vessels were converting to containerized storage facilities as a step toward improved product quality. As a side effect, this changeover to containers reduced processing and storage capacity which, in turn, made smaller catches more desirable. In addition, the introduction of enterprise allocation further contributed to the problem by altering fishing strategies. Together, these changes likely affected fishing patterns and catch rates during the 1980s.

In spite of the introduction of new strategies to reduce catch size, the problem of under capacity remained. In areas of highest concentrations of fish, even reduced tow times did not prevent catches from being too large to handle. In some instances, nets were reported to be too full to bring onboard. Also, processing schedules were affected to the point where some fish were not processed and iced on a timely basis. Although increased dumping and discarding helped to reduce the amounts processed per set (Kulka 1986), the strategy was not completely successful. Fishing companies were obliged to find other ways to overcome the problem of oversized catches. One method, in addition to decreased towing time, was to modify the gear so as to reduce the size of the largest catches. The purpose of this paper is to describe and quantify gear modifications and other technology used by the fishing companies to limit the size of catches. Effect on size of catches is also examined.

Methods

Sections of Observer Program narrative trip reports pertaining to fishing technology (report format and techniques estimating catches are described in Kulka and Firth, 1987) suggested that changes were made in otter trawl gear and fishing strategies as early as 1982. Gear configuration data were extracted and, where possible, quantified for the northern cod fishery, 1980-87. Windows (cut away sections in the codend), changes in the mesh size and type, and introduction of SCANMAR (electronic devices designed to detect weight of catch while the net is still deployed) were identified as techniques adopted by companies to minimize large catches. Also, unrelated to gear, but nonetheless a method used to reduce processing volume, was discarding or dumping of the catch.

Data pertaining to windows for 1980-84 were available only on a trip basis, rather than set by set. For 1985-86, presence or absence was recorded by NAFO Division within trips. From the trip report narratives, the following information was available: period and area of use, optimum catch rate (the desired amount of fish that could be taken as it related to placement of the window in the codend), window distance from the cod rope, window opening (m^2), and number of windows. From these data, ranges and approximate means were estimated. For 1987 only, detailed information was available pertaining to use of windows for most trips. For this year, where possible, sets were classified as to the presence or absence of windows; and frequencies of catch rates were compared for each unit area (Fig. 1) and month. Yearly estimates of percent of sets exceeding 12 t per tow were weighted by NAFO Div. and quarter.

Mesh type classification, not available set by set, was categorized for each trip. Percent occurrence of diamond or square was calculated. Codend mesh size, on the other hand, was recorded on a set-by-set basis. Mean size and variance were calculated for each year and NAFO Division. Specifically, in reference to mesh size, it should be noted that measurements made by observers were used as a monitoring technique only; hence, they were not official with respect to Canadian Fisheries Regulations. In addition, mean tow lengths and percent discarding from set-by-set data were calculated and trends examined over the period of study.

Results and Discussion

Starting about 1981 and reaching a peak in 1983-84 in NAFO Div. 2J, and 1984-85 in Div. 3K (Table 1), observed catches in the winter fishery often exceeded the capacity of the vessel in terms of handling and processing. Sets exceeding 25 t (55,000 lbs) of cod were not uncommon in certain areas. To compensate, tow length was reduced from 2.05 hours (± 0.04, 2 x standard error) in 1980 to 1.47 hours (± 0.01) in 1987 (Fig. 2) with some yearly fluctuations (vertical bars are 2 x standard error). Based on a preliminary sample, it is estimated that 1988 levels are approximately the same as 1987. However, shortening tow length was usually inadequate for limiting catch size since the gear tended to become filled very early in its deployment.

Another ad hoc method often employed by the Canadian fleet to limit the catch was to discard small fish or dump portions of the catch regardless of fish size. Although, in part, discarding may be related to the unmarketability of small fish, dumping was likely solely a result of the unmanageably large catches. Kulka and Stevenson (1986) indicated that a significant portion of marketable fish were discarded in 1985 and 1986. Figure 3 confirms that, for the Newfoundland offshore fleet, observed discarding (including dumping) rose steadily from less than ½ of 1% in 1980 to 11% by weight in 1986. Regulations introduced in 1987 requiring the inclusion of discarded fish against the quota effectively reduced discarding to the historic levels. It is also notable, that, as discarding was reduced in the latter period, so was the length of tow.

Increased discarding and reducing tow length apparently did not solve the problem of very large catches and related handling difficulties. Thus, gear modifications were also employed. Cut away sections in the codend, referred to as windows, were designed to restrict size of catch to an upper limit as dictated by position of the window. In 1983 (Table 2), fishing companies started to employ this modification on an experimental basis. The object was to limit maximum size of catch without affecting the smaller catches. The frequency of window usage increased from non usage in 1982 to an average of 78% of the total observed tows in 1988. However, the use of windows was not consistent among vessels, areas fished, or over the duration of the trip. Openings were easily made or closed depending on size of catches at the time. Therefore, size of catch from previous tows dictated whether a window would be used for any given set.

They were used mainly, but not exclusively, in NAFO Div. 2J and 3K where catch rates were greatest. Each captain appeared to have a distinct preference for frequency of use and positioning of the window(s). Observer narrative reports indicated that, upon haulback, at times, some of the catch escaped through the window even for small catches. To avoid this problem, windows were often sewn shut when catches were small. Because presence or absence of a window was not recorded on a set-by-set basis, a description of the exact pattern of usage was not possible. However, the configuration of these modifications was quantifiable (Table 2). Number of windows ranged between 1 and 3 arranged linearly down the length of the codend (Fig. 4). Generally, the shape was rectangular; occasionally, triangular. When a second or third window was used, its purpose was to release fish if the first window became clogged. Observer narrative reports indicated that blocked or closed windows were not an uncommon occurrence. Particularly, when redfish were taken as a bycatch, the fish would become entangled in the mesh, effectively reducing the opening. The position of the window was set to prevent catches over a certain size. In consultation with individual captains, it was found their desired "optimum catch rate," at least for the period 1986-88, was on average 12 t (26,000 lbs). However, preference varied widely with a range of 5 to 20 t depending on the individual captain. On average, the distance of the first (or only) window from the codend rope was reduced from 12 m in 1985 (the first year configuration data were collected) to 9 m (5-19 m range) in 1988. Presumably, the reduction relates to a learning or tuning procedure used by captains to match maximum size of catch with their target. Also related to learning, window openings were increased from an average .25 m^2 (0.1-0.3 m^2 range), in 1985, to 0.5 m^2 (0.1-1.8 m^2 range), in 1988, for more effective release of fish. Once again, this was likely a result of captains trying to minimize clogging without affecting the gears stability or its ability to catch fish. Deployment of the various modifications in the earlier years amounted to an experimental procedure with the aim of eliminating large catches. Overall, adjustment of tow length, shifting area fished, increase or decrease catch, and placement of a window(s) in the codend were the strategies used by captains to try to achieve a constant catch rate of about 12 t per hour.

Figure 5 compares frequencies of catch rates (per tow) for observed Newfoundland-based vessels (OT5)in 1987, with respect to presence or absence of windows, by month and unit area. Only those trips in 1987 that were classified on a set-by-set basis were used and month/unit areas with fewer than 10 sets were eliminated. The top two figures, yearly summaries for all classified sets, regardless of month or unit area, indicate a pattern contrary to what one might expect. That is, catch sizes are shifted to slightly higher categories where windows were used. For the most part, this pattern also appears in the 15 month/unit area comparison (the data are summarized by month and unit area in order to minimize time period and effort location as it affects size of catch). This pattern relates to the ease of closing or opening the windows depending on catch trends. Captains often immediately sewed windows closed when catches dropped due to loss of fish during haulback and probably because they suspected that the window might, in some way, be contributing to the lowering of the catch. Catches, for the most part, were well below the "optimum catch rate" of 12 t when codends were lacking windows simply because the window was sewn closed when catches dropped. Therefore, when windows were absent, the vessel was fishing in areas of low concentrations and most sets were small. This was routinely done in spite of the fact that the net could not release small catches of fish when the windows was properly positioned - except during haulback. On the other hand, when windows were opened, catches sometimes exceeded 12 t even for the same month/area combinations as when closed. In part, the reason for this is the range of position of window from cod rope. Captains sometimes placed the windows further up the codend effectively increasing net retention capacity well beyond the target 12 t, or windows became clogged and retained greater amounts of fish. Therefore, even when the windows were present they were not always fully effective. However, when used, they restricted catches in the upper range in varying degrees thereby reducing the catch rate. Estimating magnitude of the effect is impossible because of the window closures during periods when catch rates were low. Reports of tows that were retrieved full to the window was common. Figure 5 confirms this with a general drop at or near 12 t in frequency catch per tow.

Figure 6 shows the frequency of catch per tow by year, NAFO Div., and quarter. Figure 7 summarizes the trend in catch per tow exceeding 12 t since 1980, regardless of the presence or absences of windows. In 1980, catches exceeding 12 t were rare (2.2%) in all 3 NAFO Divisions. Windows had not yet been introduced. However, in 1981, 1982, and 1983, in NAFO Div. 2J and 3K, percent of catches exceeding 12 t increased from 10.2% to 13%. In response to increasingly large catches, windows were introduced in 1983. Following a slight reduction to 11.8% of catches exceeding 12 t in 1984, the percent of catches greater than 12 t peaked at 18% in 1985. This occurred in spite of the increasing use of windows - 10% of sets in 1983, 20% in 1984, and 45% in 1985. In 3K, 21% of the observed quarter 1 sets in 1985 exceeded 12 t - some as high as 30 t. During 1986 and 1987, catches over 12 t dropped back to 7% and 10.6% respectively, while windows usage increased to 52% and 63%. However, that portion of the reduction that can be directly attributed to the use of windows is uncertain. It is certain that large catches continued to be a problem in 1987 - mainly, in NAFO Div. 2J and 3K - in spite of the increasing window usage. Preliminary catch data for 1988 indicate a similar pattern. Because there did not seem to be a trend in reduction of large sets between 1984 and 1987, in spite of increasing window usage and a reduced average length of set (see Fig. 2), it is likely that concentrations of fish similar to those in 1983-84 continued to be present throughout 1985-87 while catchability in the latter years was reduced as a result of technological changes.

Also during the period of study, average size and type of mesh changed. Although size related to a change in regulations rather than the large catch problem, changing mesh size would nonetheless affect catchability of the gear. In 1982, minimum mesh size allowable under Canadian fishery regulations was increased to 130 mm for all net materials. Prior to this, 120 mm could be used for polyamides (nylon). Figure 8 shows that for the northern cod fishery, average size of mesh used in 1980 for the observed fishery was 128 mm. This average increased to 135 mm in 1982, concurrent with the regulation change. The average fluctuated slightly during the 1983-86 period then and rose to 137 mm in 1987, possibly as a result of the requirement in that year to report and apply all discarded fish against the quota. Preliminary 1988 figures indicate a similar average size of mesh. Although difficult to quantify, the increased mesh size undoubtedly contributed to a change in catchability in the early 1980s. The mix of diamond and square mesh also changed over the period of study. Records of mesh type were recorded only after 1985. Prior to this, it is likely that the dominant mesh type was diamond. For trips where mesh type was recorded, the indication was mix of diamond to square in each of 1986, 1987, and 1988. The effect of mesh type on catchability is unclear, but it is thought that square mesh release small fish more effectively. Comments made by captains as recorded in observer narrative reports suggested that square mesh was more effective at releasing small fish.

From 1986 to 1988, SCANMAR, an electronic device used to detect weight of fish in the net while the gear is still deployed, was introduced by the large fishing companies. Although its use was limited when used (see Table 2), it would likely have the effect of reducing tow length, particularly where fish were abundant. Figure 2 confirms reduced tow length in 1986-88.

Conclusion

Pinhorn (1988) noted that change in catchability was positively correlated with technological changes that occurred in the groundfish fisheries during the 1970s - specifically, with respect to vessel size and power - and upgrades in navigation and fish detection equipment. These changes were aimed at increasing catch sizes. Conversely, in the 1980s, alterations in gear configurations were undertaken as a response to increasing and unmanageably-large catches, reduced handling capacity of the vessels, and changes in the regulations with respect to retention and recording of small fish. It is felt that these changes also affected catchability but in a negative manner. Namely, the use of windows, increase in mesh size, change in mesh type, and introduction of SCANMAR were all aimed at reducing size of individual catches below a certain level. Presumably, these technological changes decreased catchability over the period of their use. However, interactions among techniques used to reduce catch size and non-consistent patterns of usage made it impossible to directly estimate the effect on catchability. An increasing presence of windows likely had the effect of depressing the catch rates with respect to actual fish abundance. However, even where the presence or absence of windows was recorded for each set, their affect could not be quantified because of the preference of captains to sew the openings shut whenever catches decreased. Based on observed patterns, the drop in commercial catch rate for 1986 and 1987 is likely, in part, a result of the changes in gear technology. This is consistent with the apparent leveling out or drop in proportion of catch exceeding 12 t in the latter years. Factors such as changes in fishing effort location or actual stock abundance (as it affects density of commercial concentrations) that would also affect catch rates cannot be distinguished from the effect of the technological changes that occurred during the 1980s. The fact that industry was forced, on an increasing basis during the 1980s to use methods which reduced catch size is evidence of increasing density in the commercial concentrations.

References

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Kulka, D. W., and J. R. Firth. 1987. Observer Program Training Manual - Newfoundland Region. Can. Tech. Rep. Fish. Aquat. Sci. No. 1355 (Revised): iv - 197 p.

Pinhorn, A. T. 1988. Catchability in some of the major Groundfish fisheries off the east coast of Canada. J. Northw. Atl. Fish. Sci. Vol. 8: 13-23.

TABLE 1 OBSERVED CATCH AND EFFORT BY YEAR AND NAFO DIVISION FOR 2J3KL COD, 1980-1987

YEAR	NAFO DIVISION	# OF OBSERVED SETS	CATCH PER HOUR (t)	CATCH PER SET (t)	AVERAGE TOW LENGTH	STD ERROR TOW LENGTH	TOTAL CATCH (t)	LARGEST CATCH (t)
80	2J	112	2.3	4.9	2.08	0.057	545.0	48.0
	3K	566	1.3	2.9	2.12	0.028	1,615.3	17.8
	3L	277	1.3	2.5	1.90	0.026	703.0	19.4
81	2J	388	4.8	7.6	1.59	0.045	2,940.2	35.5
	3K	289	3.7	6.0	1.60	0.035	1,725.4	40.5
	3L	369	1.1	2.3	2.03	0.030	839.0	17.7
82	2J	635	3.6	6.4	1.76	0.024	4,061.8	50.0
	3K	159	1.6	3.2	1.98	0.051	503.8	25.1
	3L	351	0.9	1.9	2.11	0.024	660.2	12.7
83	2J	449	7.6	11.3	1.49	0.036	5,066.5	61.6
	3K	544	2.6	5.0	1.95	0.025	2,719.1	41.0
	3L	748	1.1	2.3	2.08	0.020	1,739.0	24.5
84	2J	8	8.1	13.2	1.62	0.096	105.8	28.0
	3K	264	3.5	6.0	1.72	0.035	1,578.4	68.0
	3L	443	1.9	3.9	2.09	0.031	1,731.3	27.1
85	2J	17	0.6	1.0	1.67	0.113	16.9	2.3
	3K	325	5.2	7.8	1.49	0.032	2,521.1	26.5
	3L	164	1.5	2.9	1.86	0.055	469.4	18.2
86	2J	25	3.1	4.9	1.58	0.133	122.8	15.5
	3K	1,071	3.6	6.0	1.65	0.017	6,426.2	83.8
	3L	727	1.7	3.4	1.97	0.028	2,486.9	24.0
87	2J	3,824	3.6	5.4	1.49	0.007	20,827.9	30.4
	3K	2,722	5.1	6.7	1.32	0.009	18,328.8	40.5
	3L	713	1.4	3.0	2.07	0.022	2,128.2	24.0
		======					========	
		15,190					79,861.8	

Table 2. Summary of gear alterations undertaken by captains of the Newfoundland offshore fleet since 1980.

Year	% Activity Obs.	% Usage of Windows		Optimum Catch Rate (t)		Window Dist. from Codend (m)		Window Opening Size (m²)		SCANMAR % Usage		MESH TYPE Ratio of Diamond to Square	
		Nat. Sea	FPI	Average	Range	Average	Range	Average	Range	Nat. Sea	FPI	Nat. Sea	FPI
1980	15	0	0	-	-	-	-	-	-	-	-	-	-
1981	12	0	0	-	-	-	-	-	-	-	-	-	-
1982	8	0	0	-	-	-	-	-	-	-	-	-	-
1983	12	5-20	5-20	-	-	-	-	-	-	-	-	-	-
1984	13	15-25	15-25	-	-	-	-	-	-	-	-	-	-
1985	12	35-50	40-55	-	-	12	12	0.25	0.1-0.3	-	-	-	-
1986	30	55	50	12	4-20	10	8-12	0.3	0.3-0.4	-	12	-	.50
1987	95	53	67	12	4-20	10	8-14	0.3	0.1-0.5	-	7	.65	.61
1988	95	74	78	12	5-20	9	5-19	0.5	0.1-1.8	4	12	-	.45

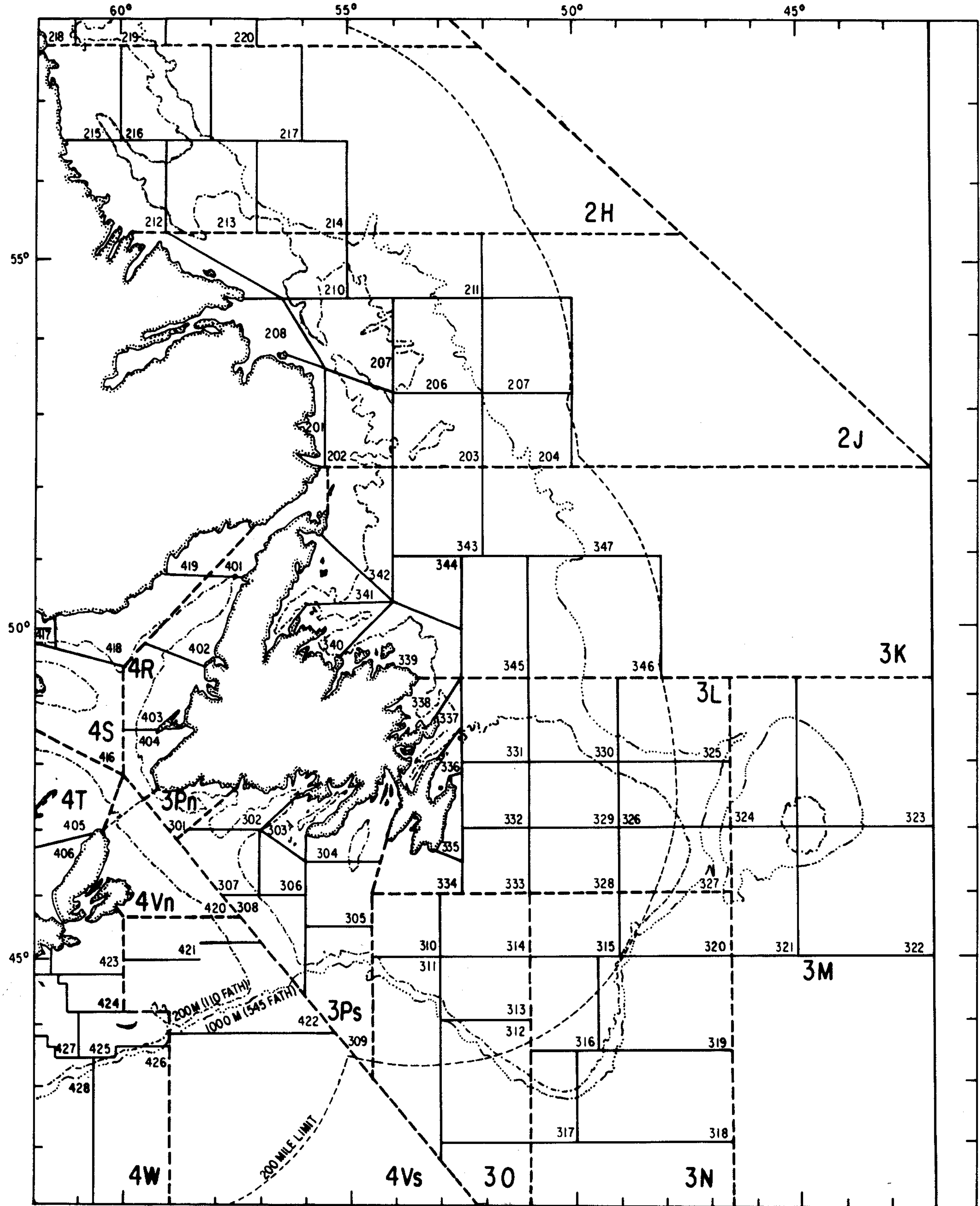


Fig. 1. Map of NAFO divisions showing numerically coded unit areas.

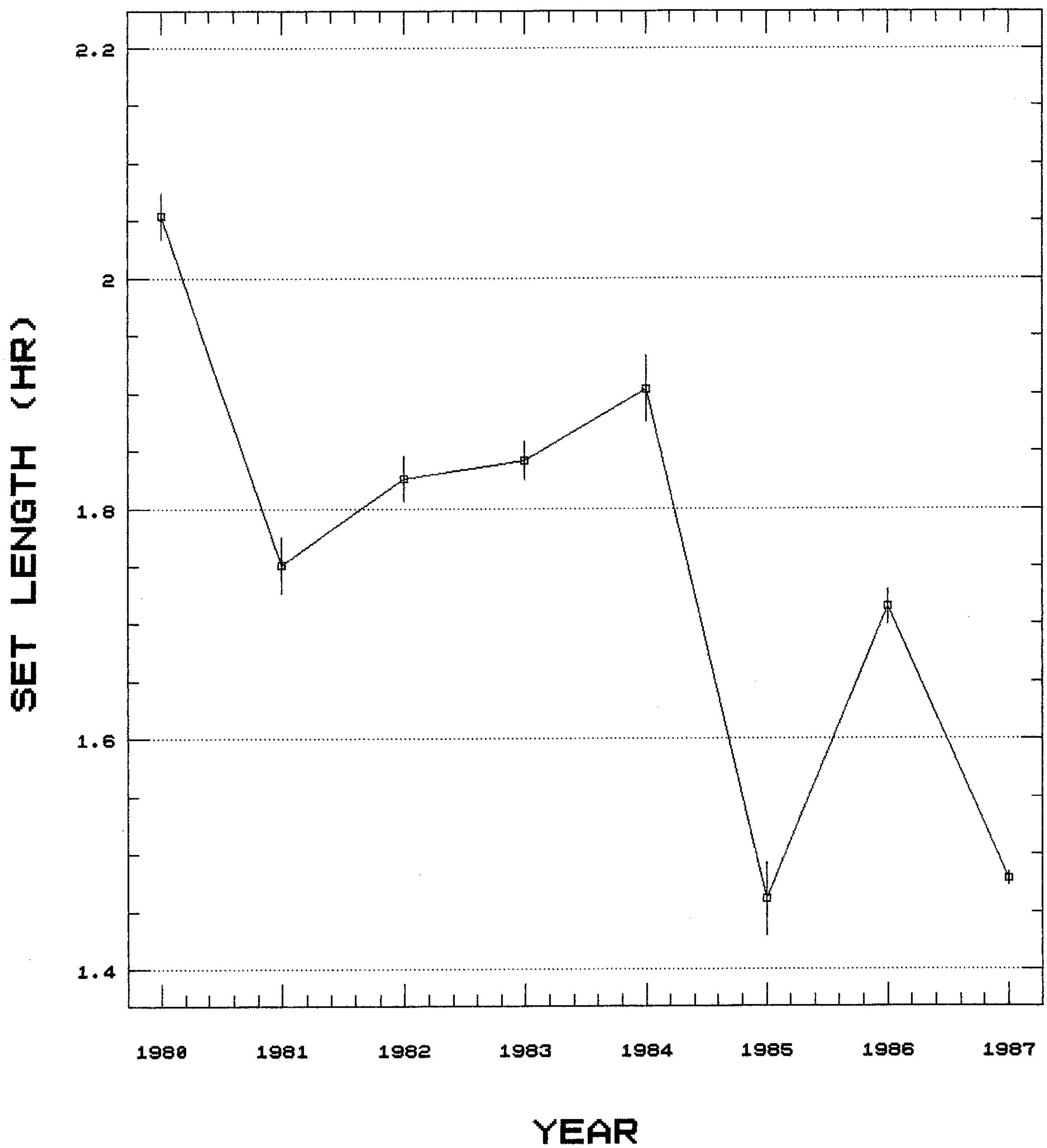


Fig. 2. Average length of observed fishing sets in the domestic 2J3KL fishery, 1980-87. Vertical bars are two standard errors.

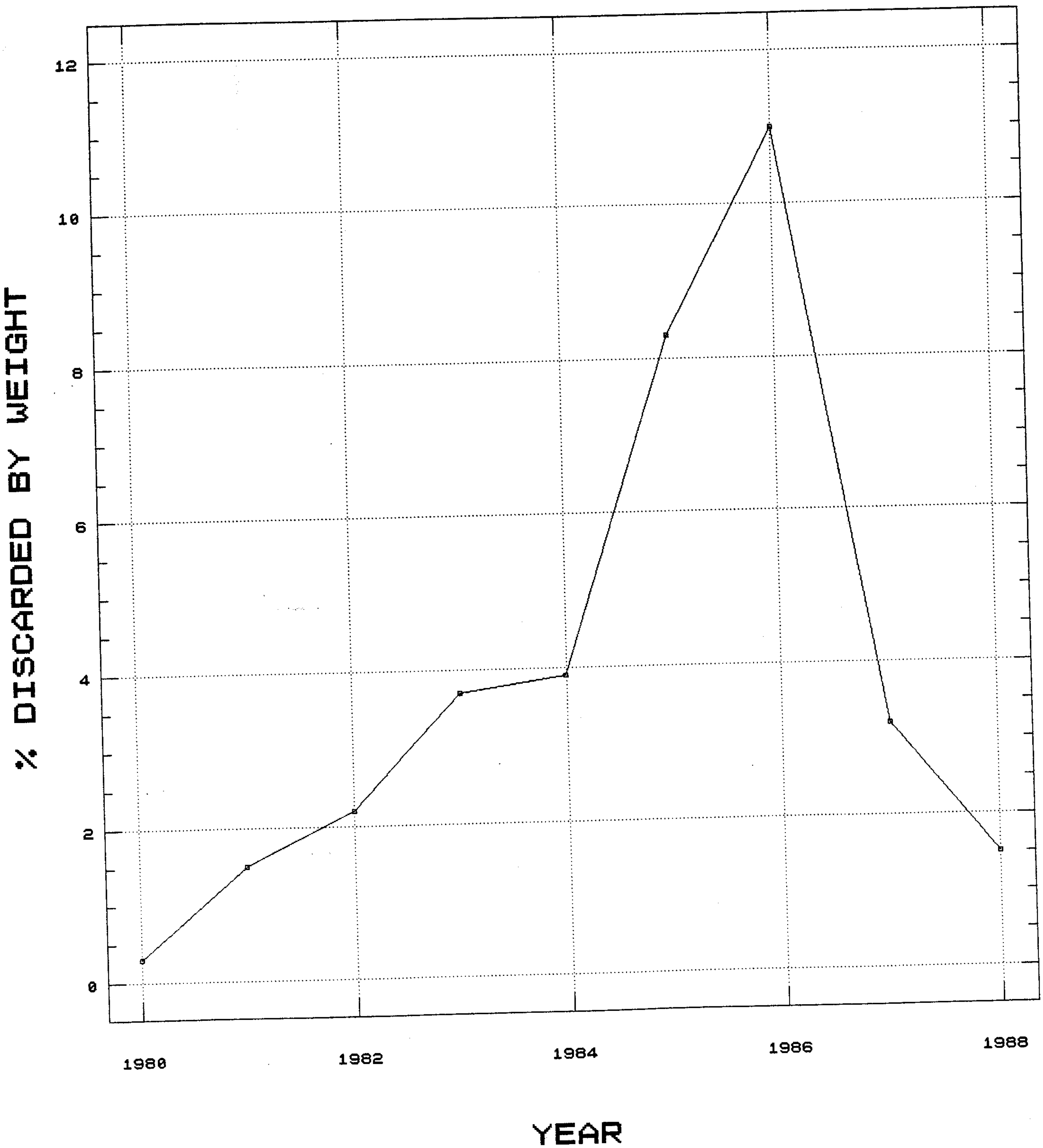


Fig. 3. Percent of cod discarded by weight in the domestic 2J3KL fishery, 1980-88.

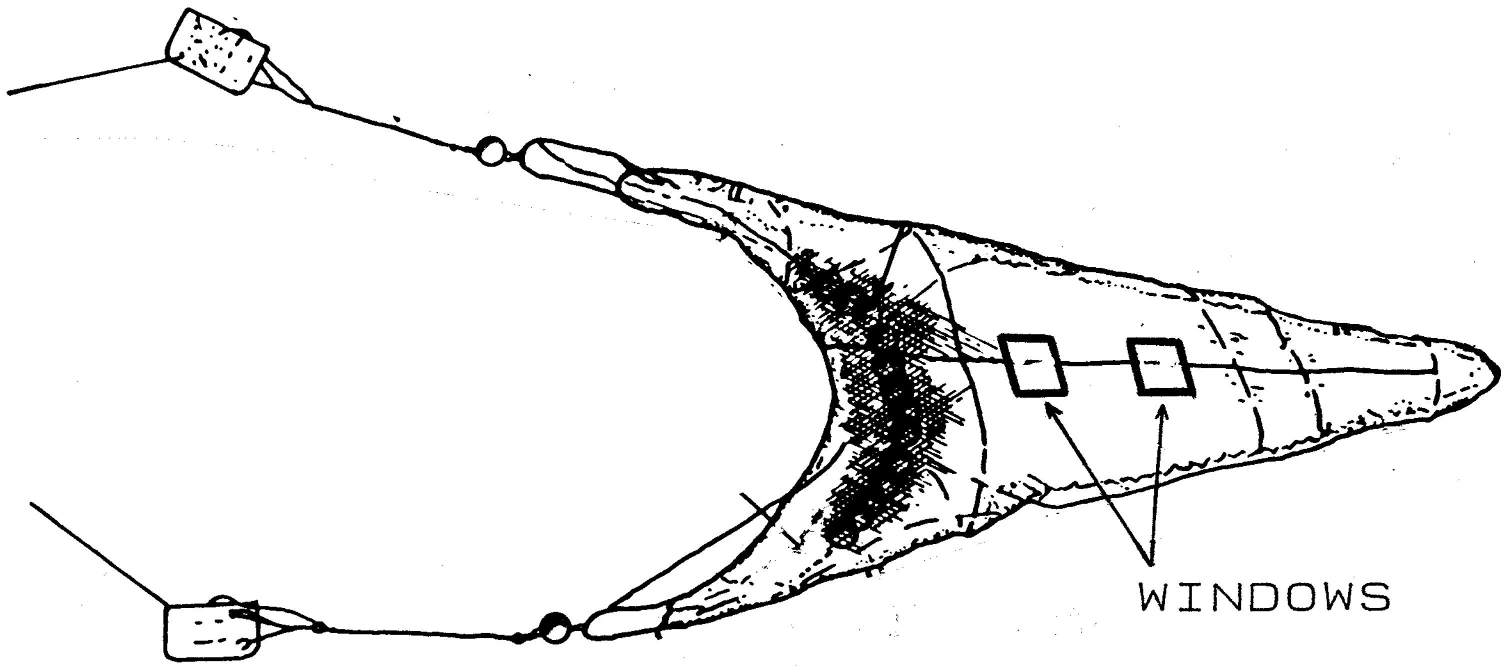


Fig. 4. Diagram of typical otter trawl gear showing the approximate position of windows.

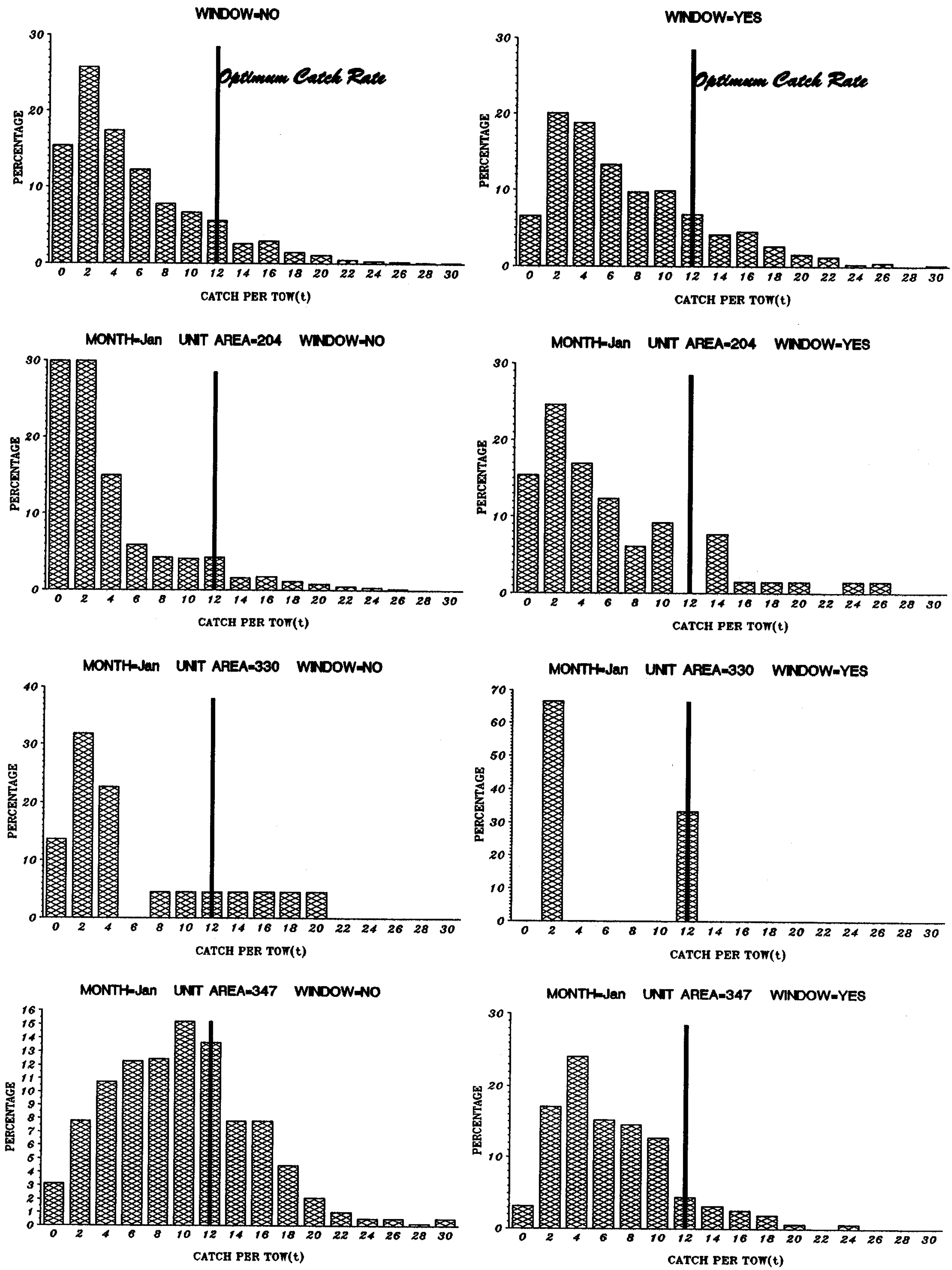
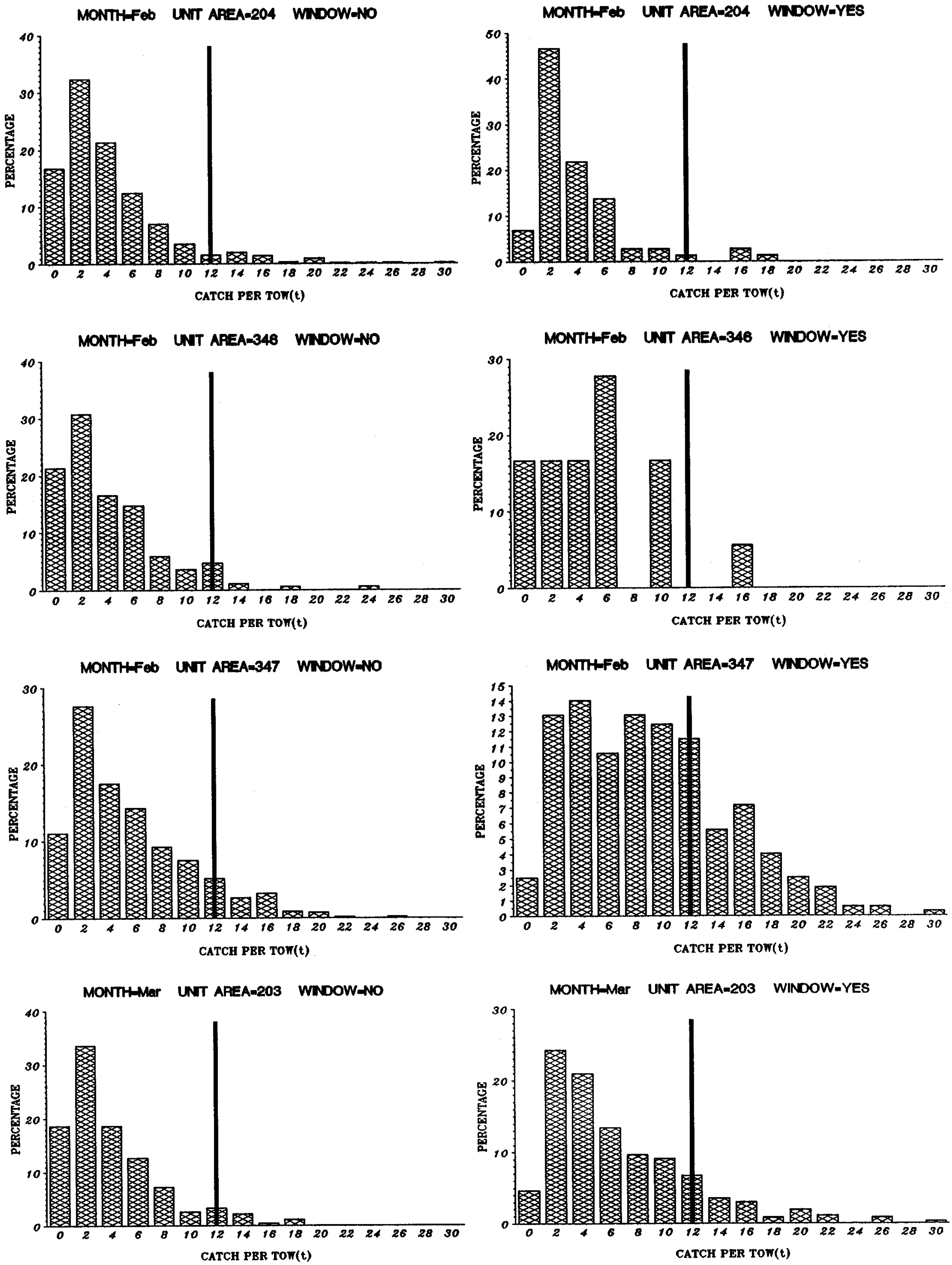


Fig. 5. Comparison of catch frequencies from the 1987 fishery by month and unit area where sets were classified with respect to presence or absence of windows. "Optimum catch rate" refers to the size of catch captains did not want to exceed.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MONTH=Feb UNIT AREA=347 WINDOW=YES
MONTH=Mar UNIT AREA=203 WINDOW=NO
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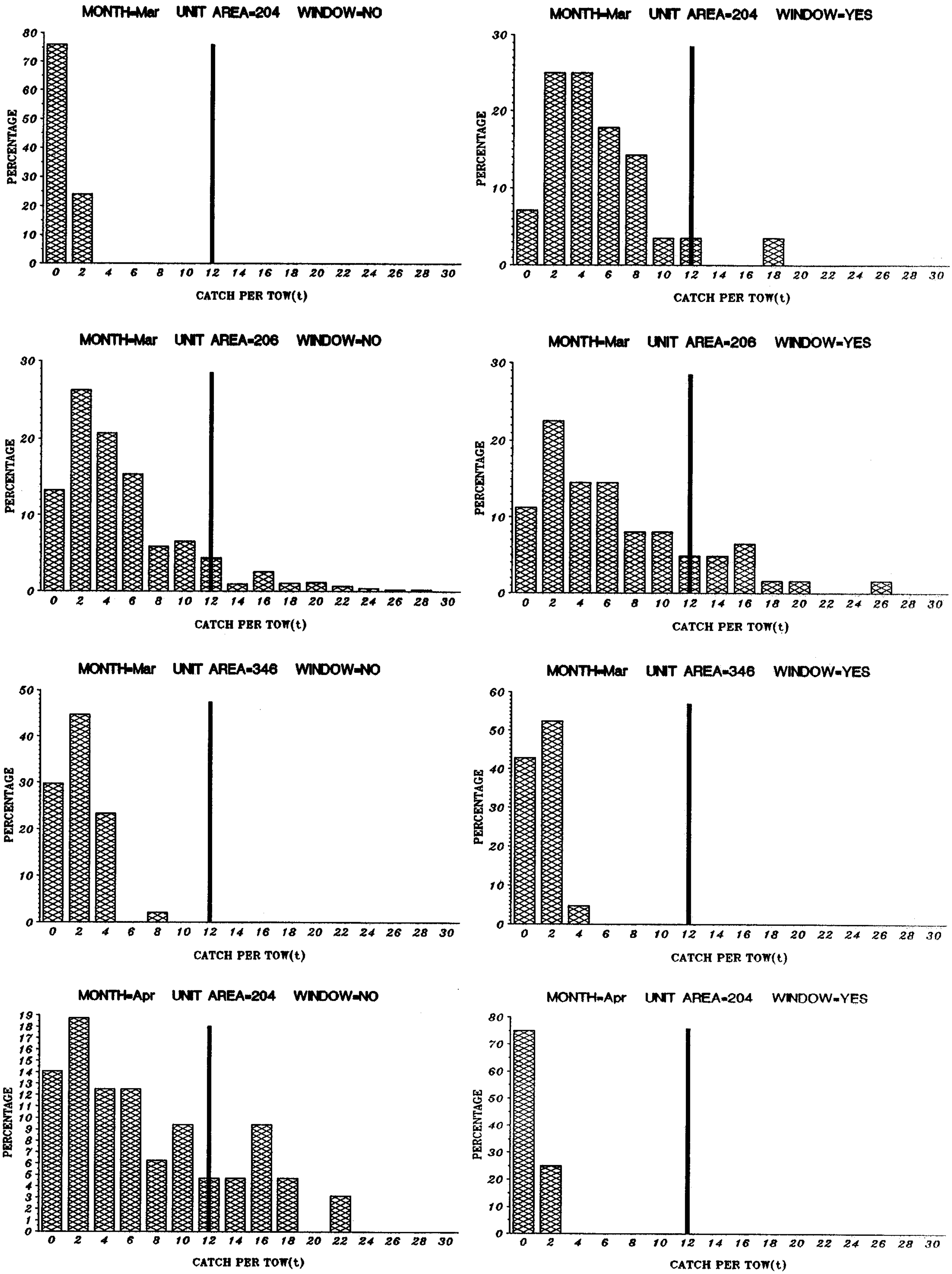
Fig. 5. Cont'd.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MONTH=Apr UNIT AREA=204 WINDOW=NO
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PERCENTAGE
CATCH PER TOW(t)
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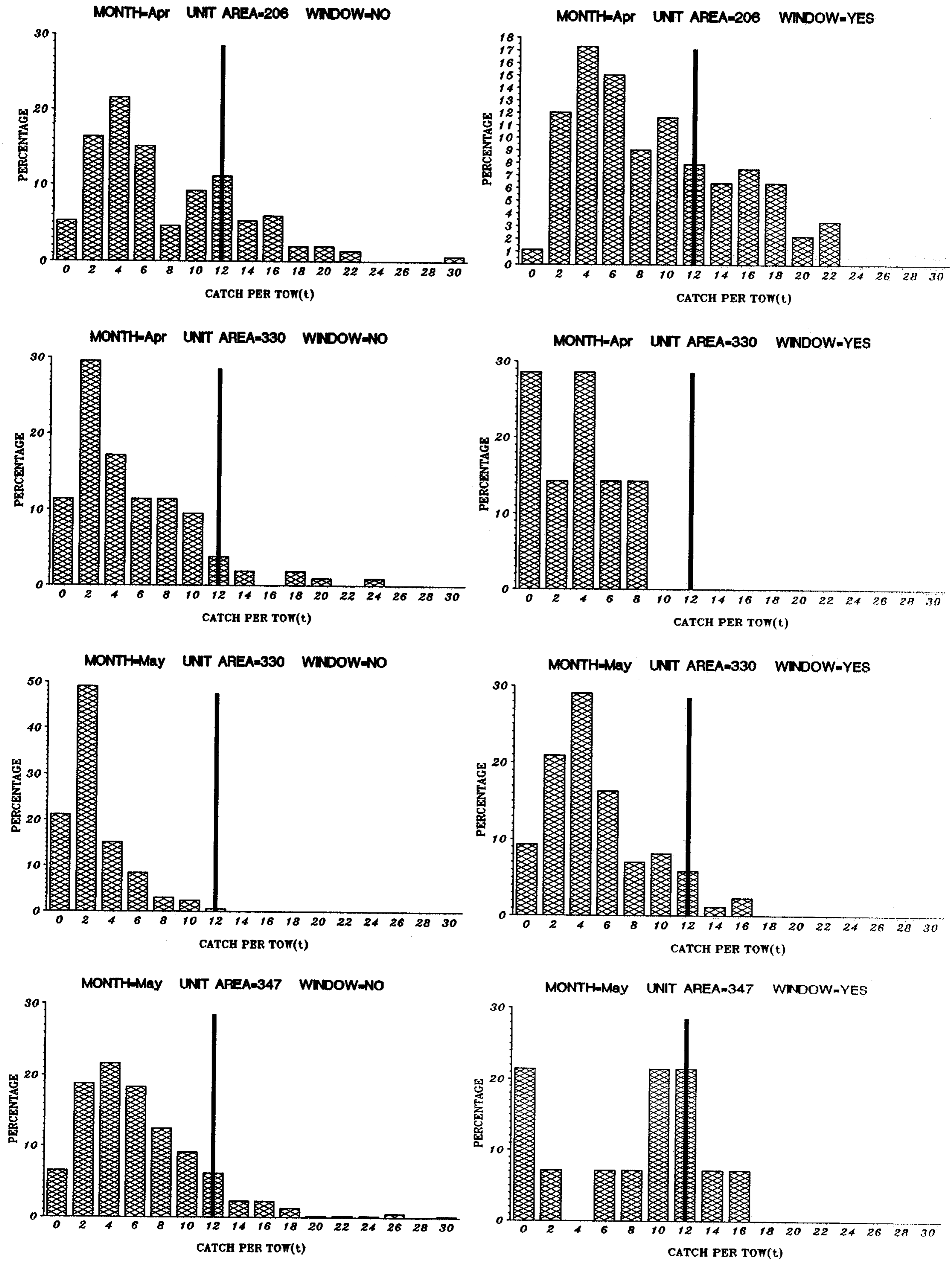
Fig. 5. Cont'd.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PERCENTAGE
CATCH PER TOW(t)

Fig. 5. Cont'd.

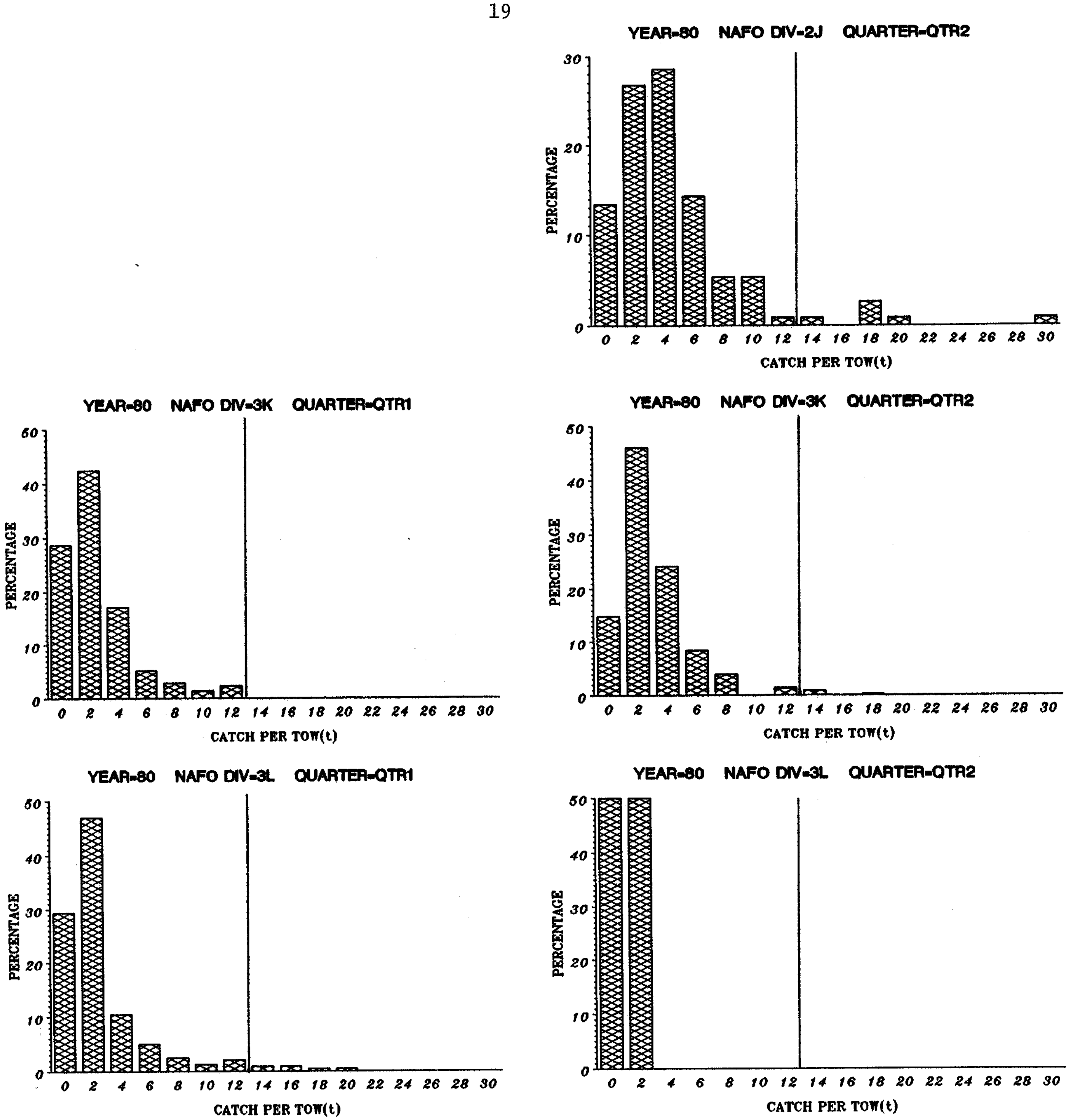

Fig. 6. Frequency of catch per tow by NAFO division and quarter for 2J3KL cod 1980-87.

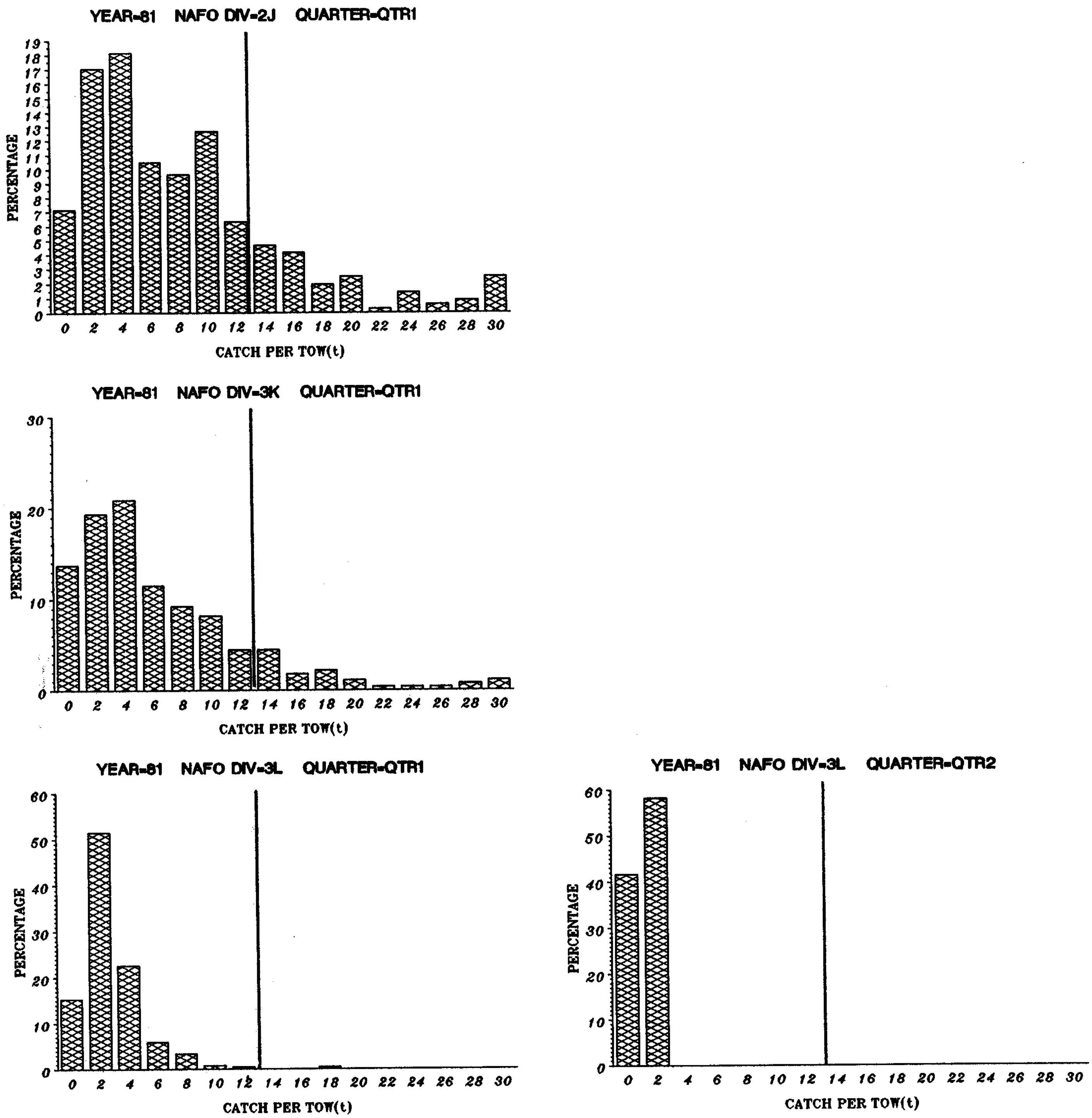
YEAR=81 NAFO DIV=2J QUARTER=QTR1
PERCENTAGE
CATCH PER TOW(t)
YEAR=81 NAFO DIV=3K QUARTER=QTR1
PERCENTAGE
CATCH PER TOW(t)
YEAR=81 NAFO DIV=3L QUARTER=QTR1
PERCENTAGE
CATCH PER TOW(t)
YEAR=81 NAFO DIV=3L QUARTER=QTR2
PERCENTAGE
CATCH PER TOW(t)

Fig. 6 (Cont'd.).

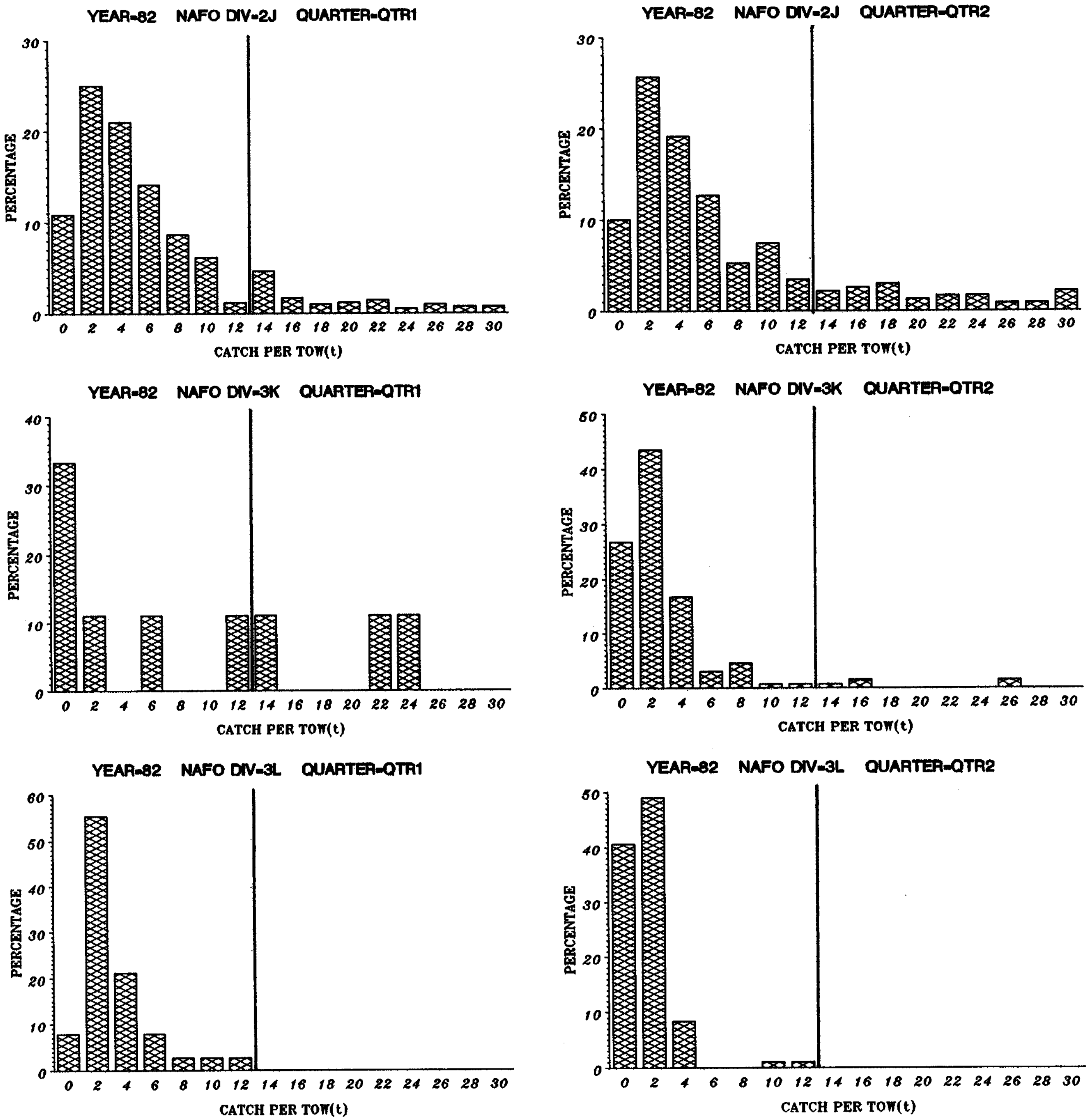
YEAR=82 NAFO DIV=2J QUARTER=QTR1
PERCENTAGE
CATCH PER TOW(t)
YEAR=82 NAFO DIV=2J QUARTER=QTR2
PERCENTAGE
CATCH PER TOW(t)
YEAR=82 NAFO DIV=3K QUARTER=QTR1
PERCENTAGE
CATCH PER TOW(t)
YEAR=82 NAFO DIV=3K QUARTER=QTR2
PERCENTAGE
CATCH PER TOW(t)
YEAR=82 NAFO DIV=3L QUARTER=QTR1
PERCENTAGE
CATCH PER TOW(t)
YEAR=82 NAFO DIV=3L QUARTER=QTR2
PERCENTAGE
CATCH PER TOW(t)

Fig. 6 (Cont'd.).

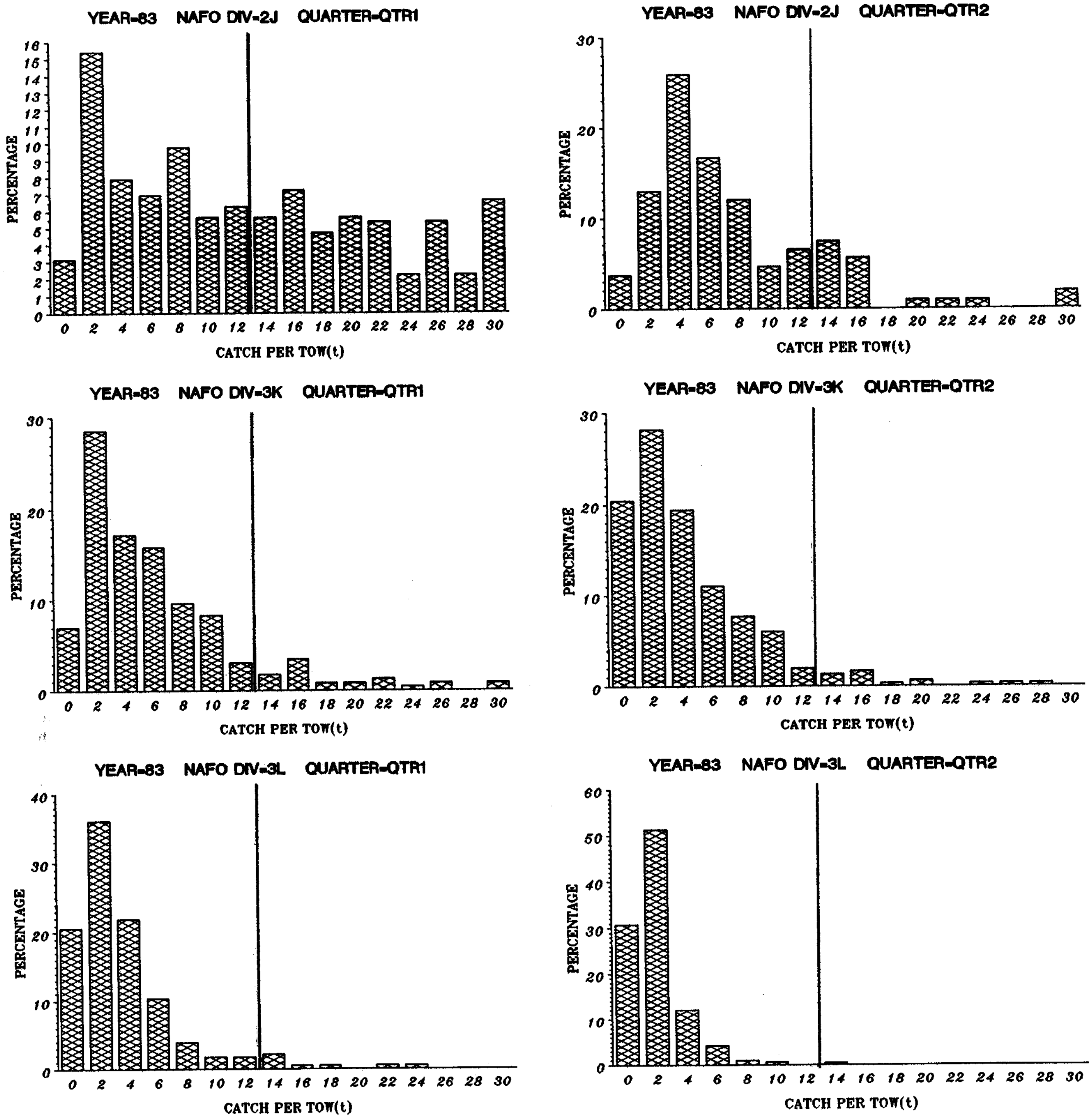
YEAR=83 NAFO DIV=2J QUARTER=QTR1
YEAR=83 NAFO DIV=2J QUARTER=QTR2
YEAR=83 NAFO DIV=3K QUARTER=QTR1
YEAR=83 NAFO DIV=3K QUARTER=QTR2
YEAR=83 NAFO DIV=3L QUARTER=QTR1
YEAR=83 NAFO DIV=3L QUARTER=QTR2
PERCENTAGE
CATCH PER TOW(t)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30

Fig. 6 (Cont'd.).

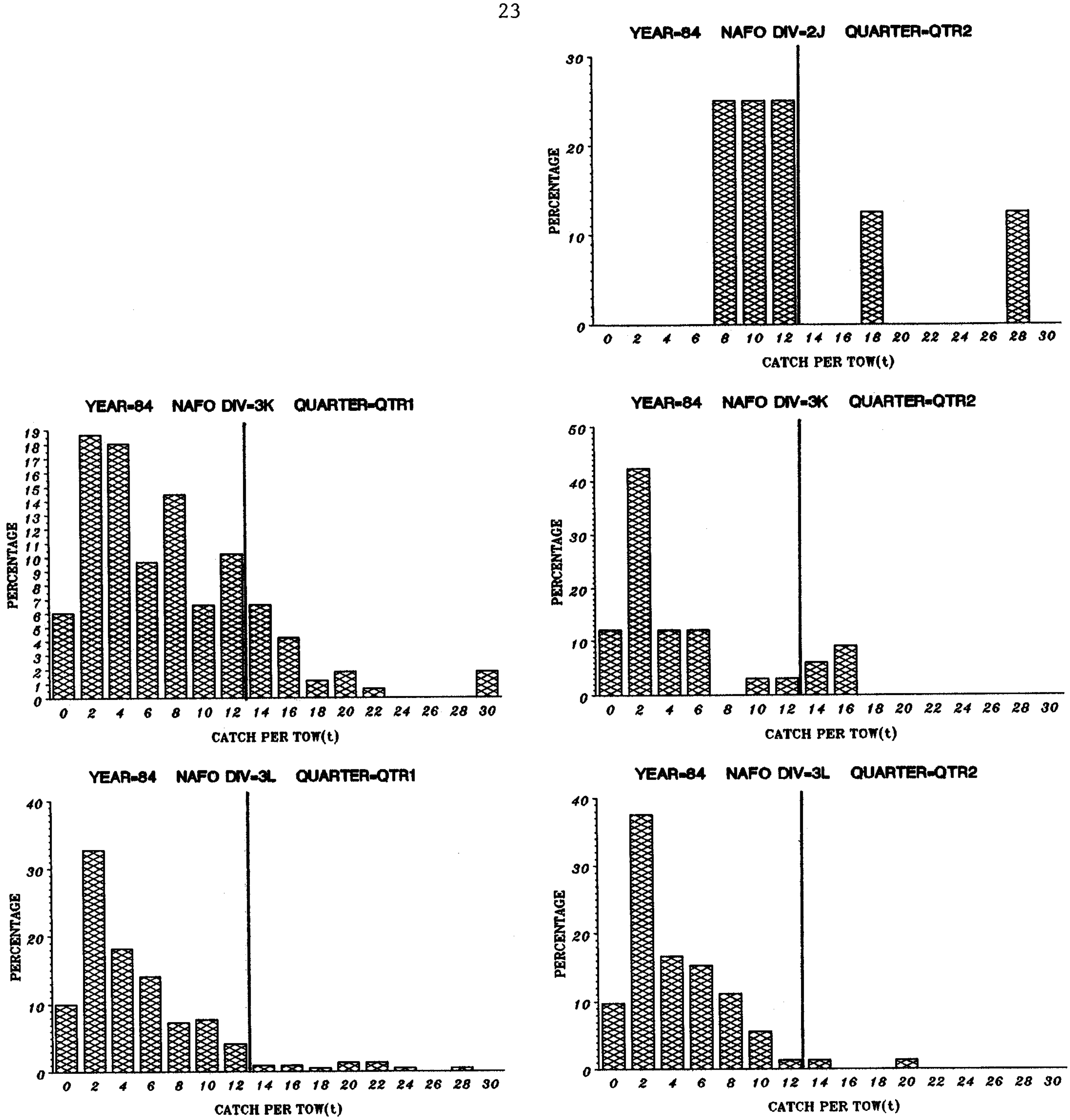
YEAR=84 NAFO DIV=2J QUARTER=QTR2
PERCENTAGE
CATCH PER TOW(t)
YEAR=84 NAFO DIV=3K QUARTER=QTR1
PERCENTAGE
CATCH PER TOW(t)
YEAR=84 NAFO DIV=3K QUARTER=QTR2
PERCENTAGE
CATCH PER TOW(t)
YEAR=84 NAFO DIV=3L QUARTER=QTR1
PERCENTAGE
CATCH PER TOW(t)
YEAR=84 NAFO DIV=3L QUARTER=QTR2
PERCENTAGE
CATCH PER TOW(t)

Fig. 6 (Cont'd.).

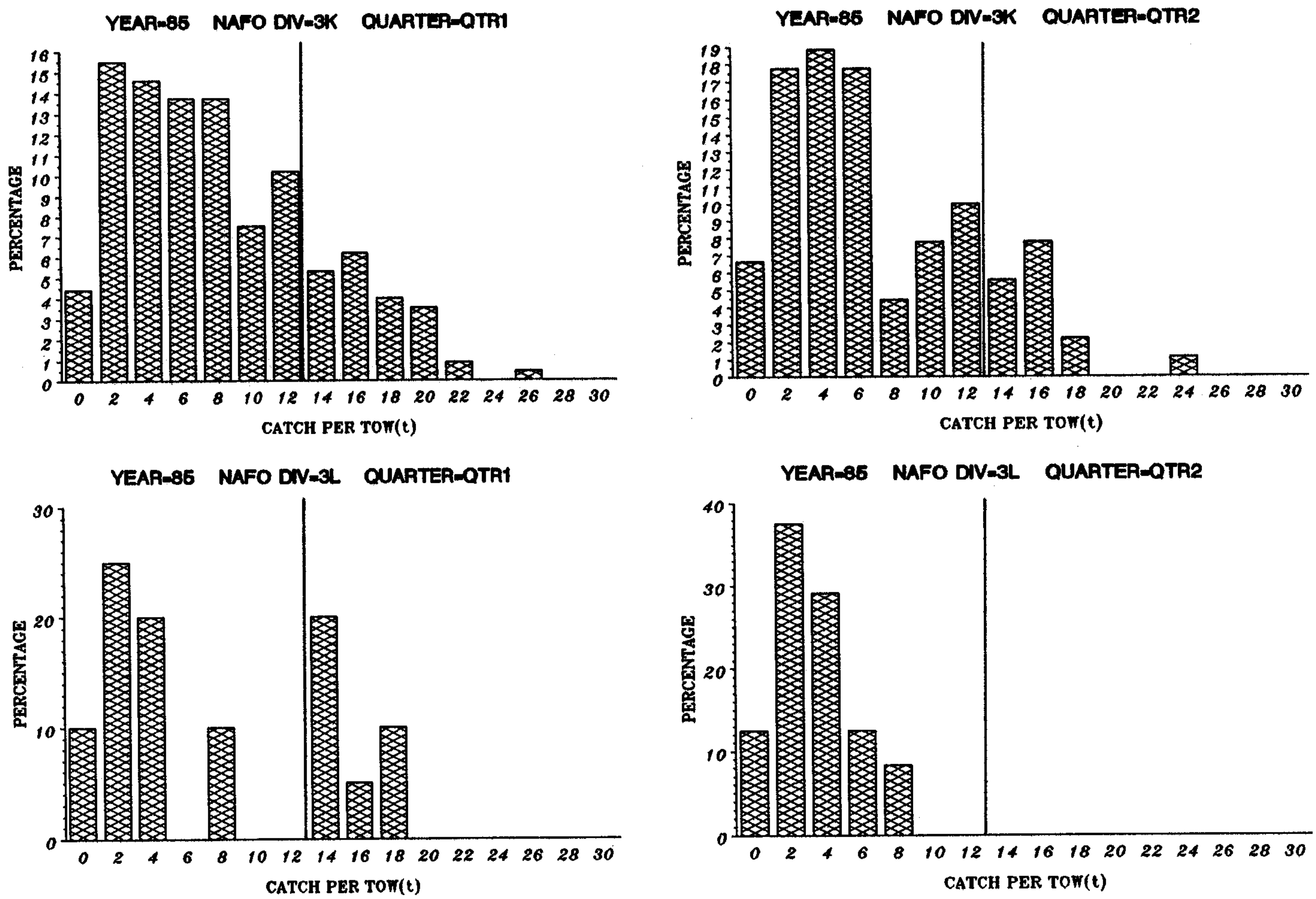
YEAR=85 NAFO DIV=3K QUARTER=QTR1
PERCENTAGE
CATCH PER TOW(t)
YEAR=85 NAFO DIV=3K QUARTER=QTR2
PERCENTAGE
CATCH PER TOW(t)
YEAR=85 NAFO DIV=3L QUARTER=QTR1
PERCENTAGE
CATCH PER TOW(t)
YEAR=85 NAFO DIV=3L QUARTER=QTR2
PERCENTAGE
CATCH PER TOW(t)

Fig. 6 (Cont'd.).

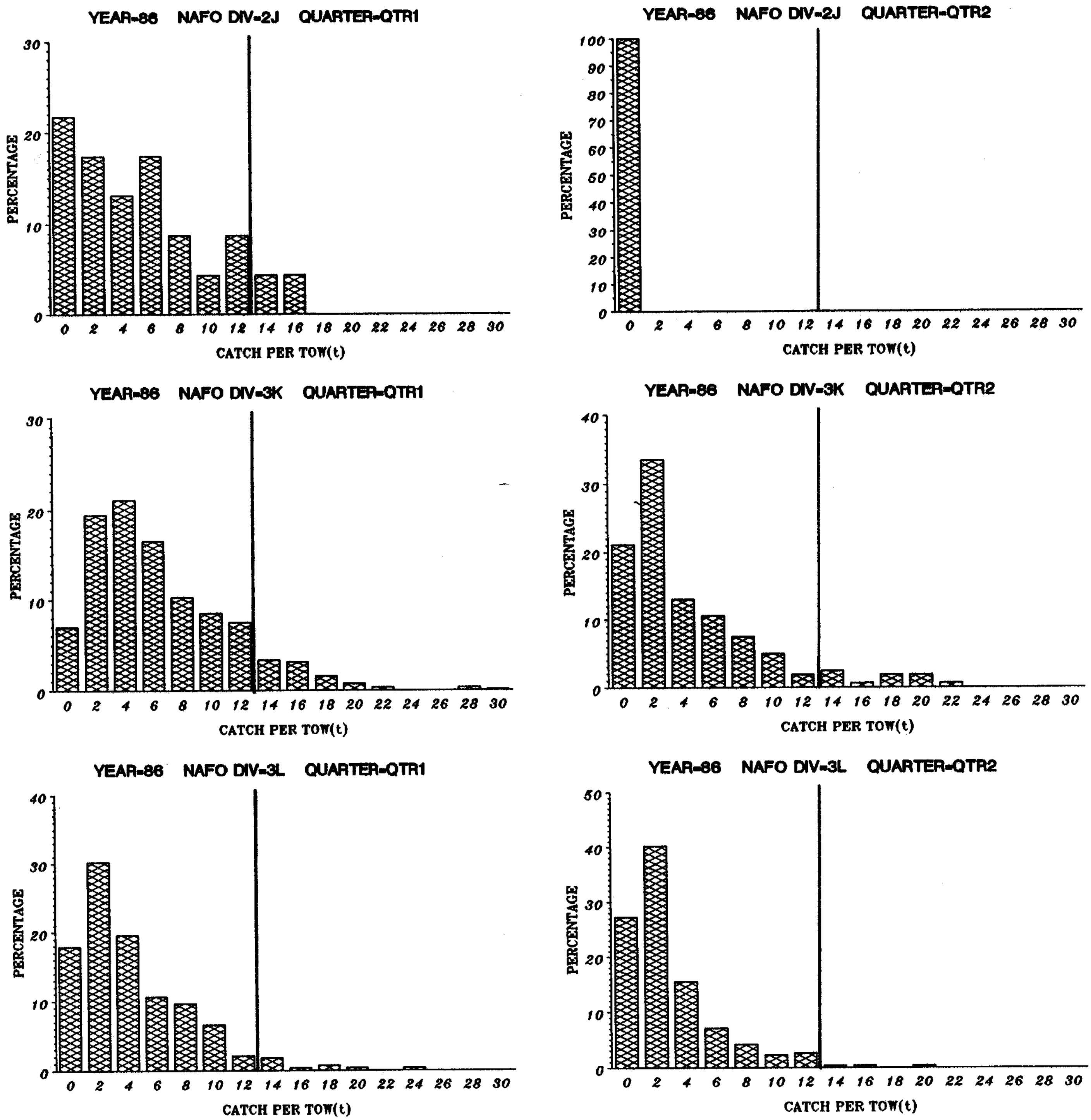
YEAR=86 NAFO DIV=2J QUARTER=QTR1
YEAR=86 NAFO DIV=2J QUARTER=QTR2
YEAR=86 NAFO DIV=3K QUARTER=QTR1
YEAR=86 NAFO DIV=3K QUARTER=QTR2
YEAR=86 NAFO DIV=3L QUARTER=QTR1
YEAR=86 NAFO DIV=3L QUARTER=QTR2
PERCENTAGE
CATCH PER TOW(t)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30

Fig. 6 (Cont'd.).

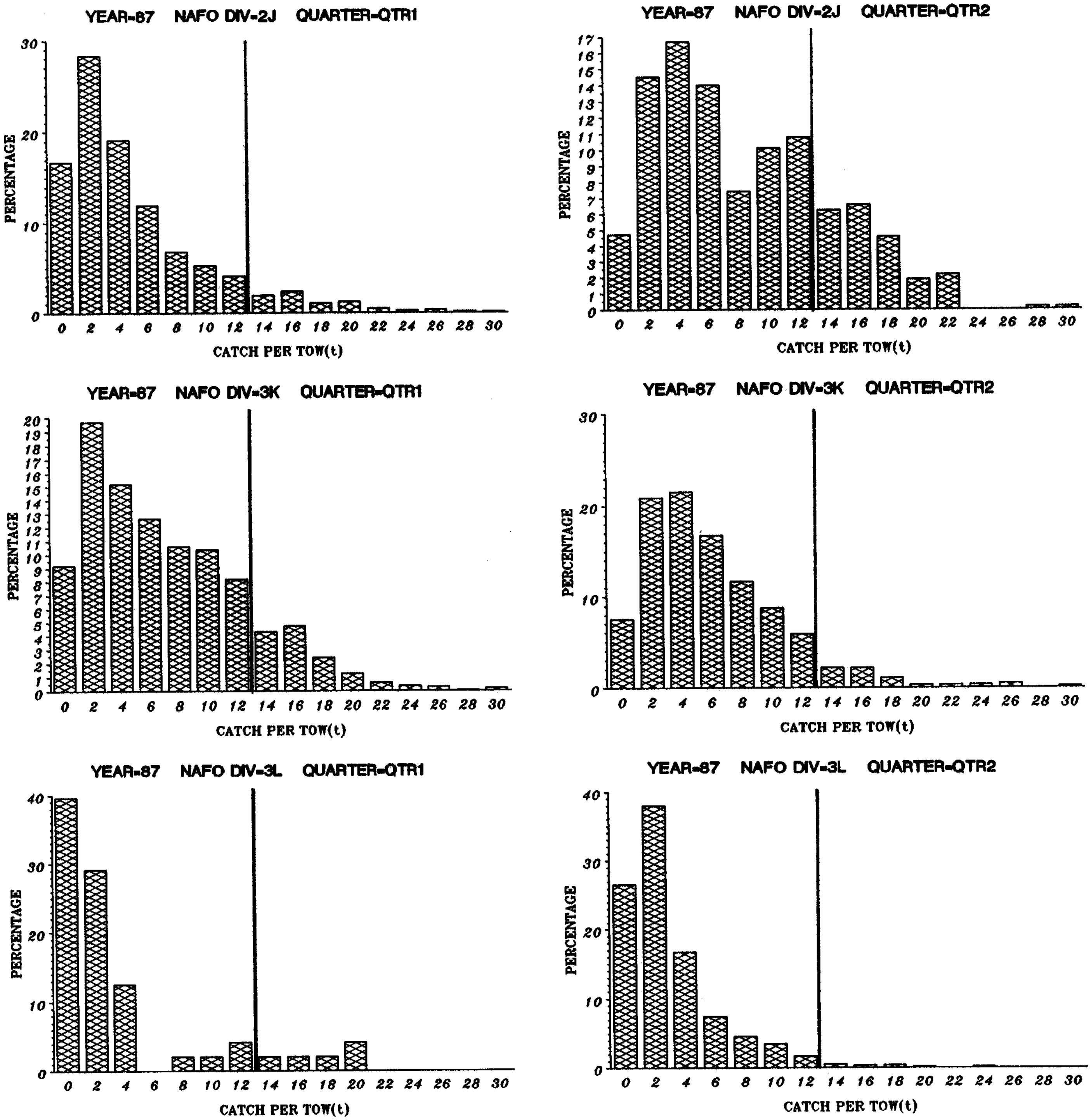
YEAR=87 NAFO DIV=2J QUARTER=QTR1
YEAR=87 NAFO DIV=2J QUARTER=QTR2
YEAR=87 NAFO DIV=3K QUARTER=QTR1
YEAR=87 NAFO DIV=3K QUARTER=QTR2
YEAR=87 NAFO DIV=3L QUARTER=QTR1
YEAR=87 NAFO DIV=3L QUARTER=QTR2
PERCENTAGE
CATCH PER TOW(t)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30

Fig. 6 (Cont'd.).

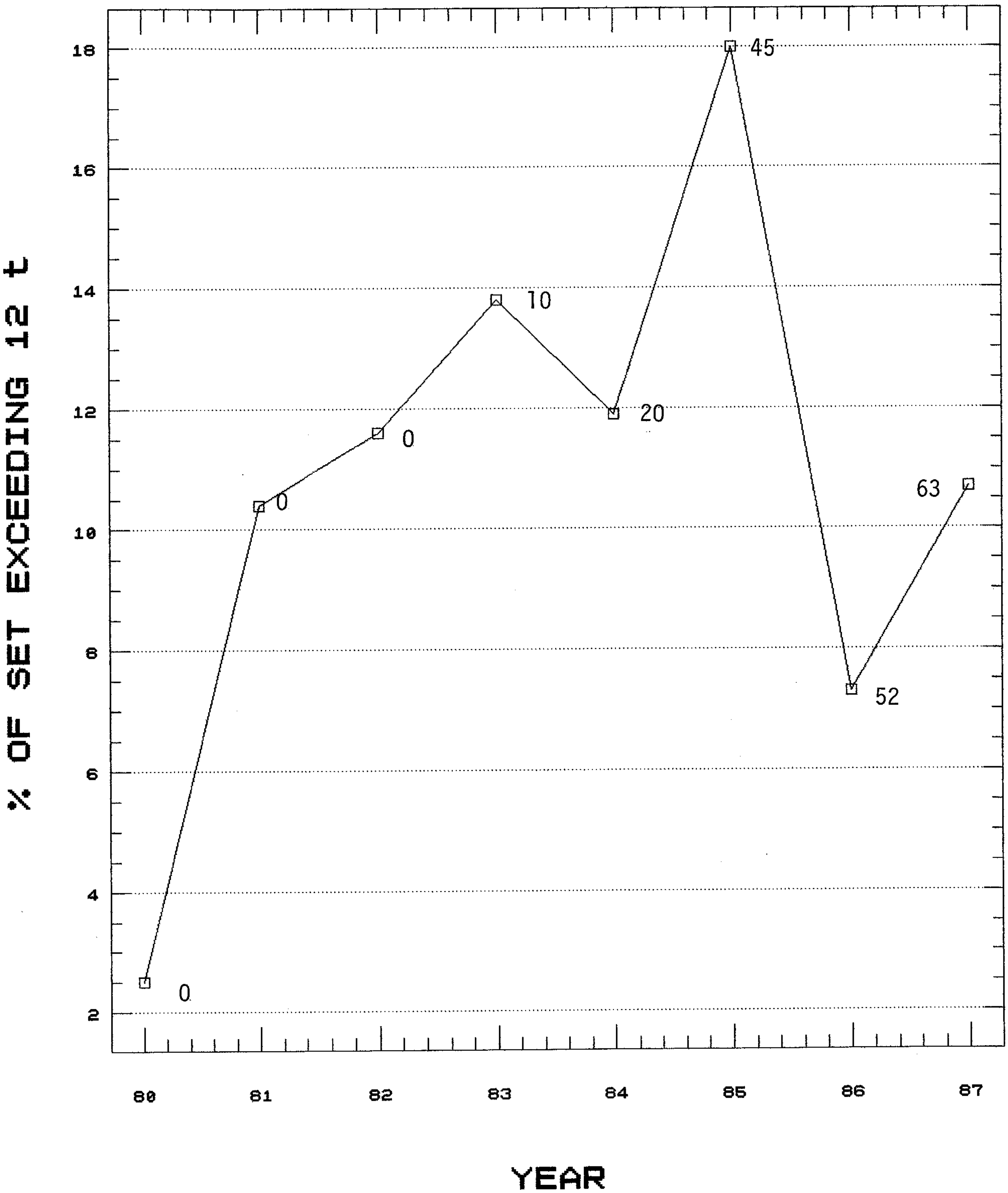

Fig. 7. Percent of observed sets exceeding 12 t for the 1980-87 Newfoundland offshore fishery. Number beside each data point is the percent usage of windows.

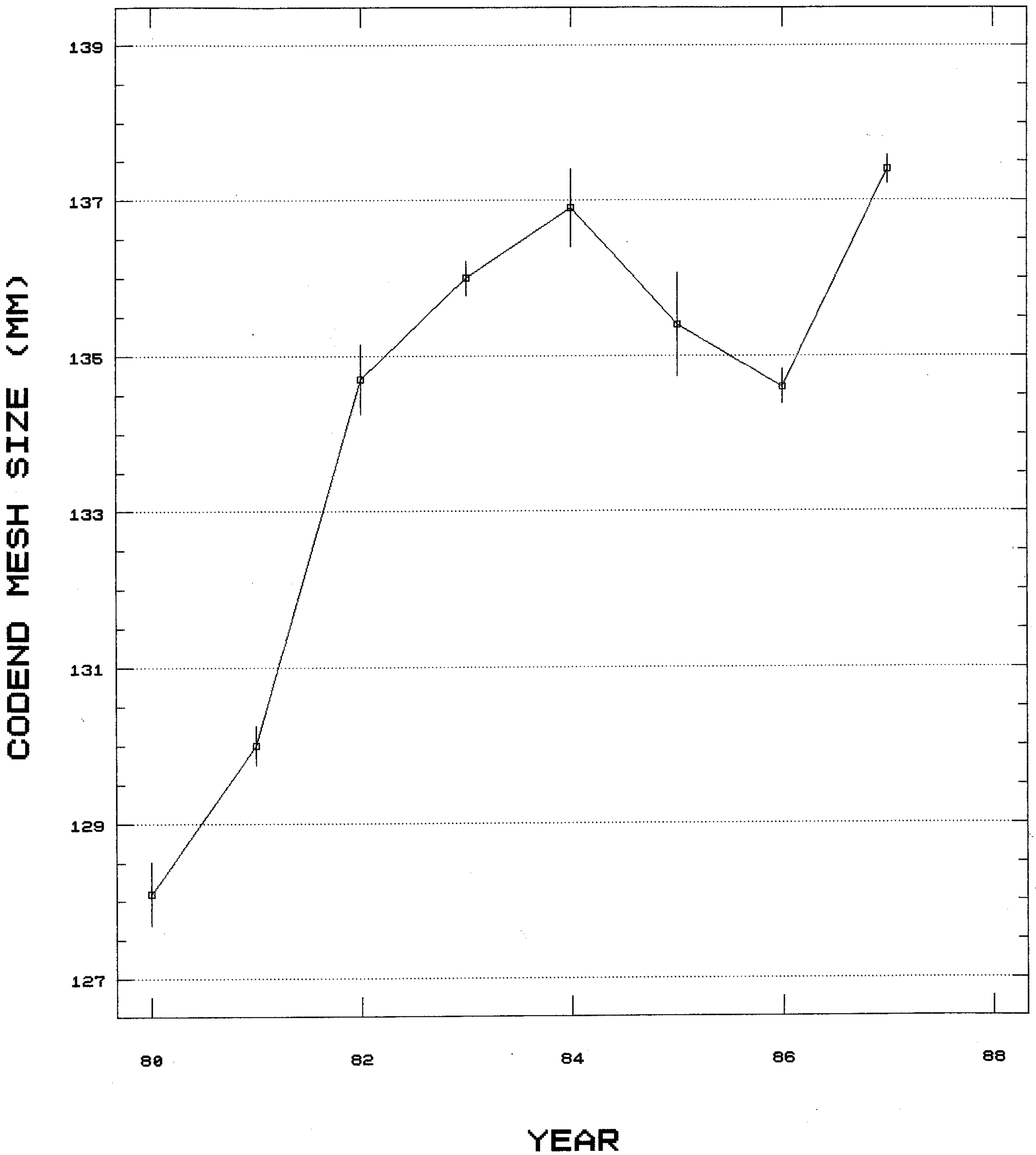

Fig. 8. Average size of mesh in the codend of trawls used for the 2J3KL cod fishery by the Newfoundland fleet, 1980-87. Bar represents two standard errors.