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Assessment of Newfoundland
Snow Crab (Chionoecetes opilio) Stocks, 1982

by

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Abstract

Population size estimates for snow crab (Chionoecetes opilio) off the east coast of Newfoundland, based on Peterson mark recapture and Leslie analyses are presented. Within given crab management areas estimates of population size range from 551.4 to 7,744.0 mt while exploitation rates ranged from 42 to 92%.

Résumé

Nous présentons dans l'article qui suit des estimations sur l'importance des populations de crabes des neiges (Chionoecetes opilio) au large de la côte est de Terre-Neuve fondées sur les recaptures de crabes portant des marques de Peterson et sur les analyses de Leslie. Selon la zone de gestion considérée, ces estimations varient de 551,4 à 7 744 tm, tandis que les taux d'exploitation varient de 42 à 92 %.

Introduction

The snow crab (Chionoecetes opilio) fishery which began in 1968 has demonstrated a fairly steady increase in overall landings, peaking in 1981 at 13,838 mt. Landings for the 1982 commercial fishing season were slightly reduced at 13,178 mt despite a significant increase in area available to commercial fishing and total effort throughout the Island.

Exploitation rates in all management areas have reached or exceeded levels recommended by CAFSAC 1982 (CAFSAC Advisory Document 81/1). Logbook returns from fishermen report that many areas that have supported fisheries for a number of years had a high soft-shell incidence for an extended time period.

Materials and Methods

Analysis of logbook data was conducted in the same manner as that for previous assessments (Taylor and O'Keefe 1981, 1983). Logbook returns were compared with processors sales slips in order to ensure accuracy. Data for each management area (Fig. 1) were summarized into biweekly intervals (Tables 1-14) and where possible Leslie analyses were carried out (Fig. 2-10).

As in previous years tagging operations were conducted in Management Areas 18 and 25 with efforts extending for the first time to Notre Dame Bay (Area 32). Tagging was conducted in exactly the same manner as that described by Taylor and O'Keefe (1981, 1983).

Results and Discussion

Areas currently fished in Newfoundland are divided into two zones at the line separating Management Areas 26 and 28 (Fig. 1). Beginning in 1983, vessels licensed to fish either zone are not permitted to fish in the other. Vessels in the southern zone (Areas 2-25) are generally larger than those in the northern zone and tend to fish crab exclusively, while many northern zone vessels harvest a number of species. Also, most southern zone vessels haul more traps per day and venture farther offshore than do those in the northern zone.

The mandatory logbook regulation again worked extremely well. Approximately 95% of the fishermen maintained good records in their logbooks. However, fluctuation in weekly effort due to weather conditions caused gaps in the data which made Leslie analysis based on weekly CPUE difficult. Therefore, effort and landings data for all areas were combined into 2-week periods to facilitate analyses by providing estimates of representative effort data where gaps in effort had previously existed. This, hopefully, eliminated any bias which may have resulted due to inclement weather or minor processing disruptions.

The Leslie analyses for Newfoundland snow crab management areas are as follows.

Southern Zone

Bonavista Bay - Area 25 (Areas 24 and 26 combined in 1982 to form Area 25)

Historical data on landings (mt), mean CPUE (kg/trap haul), effort (trap hauls), and exploitation rates (%) are summarized below:

Area 24	1979	1980	1981	1982 (Area 25)
Landings	842	1254	741	905
CPUE	8.4	9.29	8.0	9.4
Effort	105,615	135,030	92,435	96,330
Exploitation rate	70	65	79	65

Area 26	1979	1980	1981
Landings	744	651	635
CPUE	10.9	11.5	8.0
Effort	67,690	56,724	79,250
Exploitation rate	74	78	98

The total available biomass (B) for Area 25 as estimated by Leslie Analysis (Fig. 2) was 1391 mt with 95% confidence limits of 1054 mt and 2445 mt; r^2 = .78. The exploitation rate for this area in 1982 was 65%. Biomass estimates for each biweekly fishing period $\dfrac{CPUE_t}{q} = B_t$ are presented in Table 1.

Comparison with historical data indicates a reduction in exploitation rates over 1981 levels. It would appear that this is due to vessels from Bonavista transferring effort from the bay to Area 19. Another contributing factor would be the fact that the three vessels that normally fish the western side of the bay fished in Notre Dame Bay (Area 32) for much of the season. Effort in 1982 was roughly half what it was in 1981 despite a slight increase in CPUE. As is usual in this management area, soft-shell incidence was extremely high, according to many logbook comments exceeding 50% in mid-summer.

Petersen Estimate

In May of 1982 tagging operations were once again carried out in Bonavista Bay. The methodology has been previously described (Taylor and O'Keefe 1981, 1983) and this was strictly adhered to during this study. A total of 2292 commercial sized hard shelled animals were tagged at 29 randomly selected locations. A total of 690 (30.1%) tags were recaptured by commercial fishermen and returned for analysis. Tag recaptures were recorded from all tagging sites indicating that all tagging was probably conducted in areas usually fished commercially.

Based on these tag returns the snow crab population is calculated by:

$$B = \frac{(M)\,(n)}{m} \qquad\qquad (1)$$

where

M = the number of marked animals released from the first sample (number tagged);

n = the numbers of animals examined for marks in the second sample (total catch);

m = the number of marked animals in the second sample (number of recaptured crabs).

The approximate 95% confidence levels for this estimate are

$m + 1.92 \pm 1.96 \sqrt{m+1}$, Ricker (1975). Solved for m, the value is re-entered into equation (1).

The snow crab population in Bonavista Bay is calculated as:
$$B = \frac{(M)\,(n)}{m}$$

$$= \frac{(2292)\,(905,050)}{690}$$

$$= 3,006.3 \text{ mt}$$

with 95% confidence limits of 2790.2 mt and 3239.2 mt. In 1982 341,605 kg were landed before tagging operations began in Area 25. Therefore, initial biomass = 3006.3 + 341.6 = 3347.9 mt. Significant changes in the fishing patterns of vessels that traditionally fish Bonavista Bay cause the authors to question the reliability of both Leslie and Petersen population estimates. Beginning in mid June most vessels on the eastern side of the bay left the area in order to prosecute the fishery in Areas 19 and 22. Similarly vessels from the western side of the bay left to fish in Area 32. Most of these vessels did not return to Bonavista Bay until mid September and then, due to inclement weather conditions, resumed fishing on a greatly reduced basis (Table 1). This behavior detrimentally affects the effort consistancy necessary in Leslie analysis. It is also probable that many tagged animals that would have been recaptured had effort remained constant probably molted and lost their tags, thus reducing the reliability of the Petersen estimate. Doubtless, this reduction in effort over 1981 levels should only serve to alleviate the serious resource overexploitation in this area, previously identified by the authors (Taylor and O'Keefe 1983).

Trinity Bay (outer portion) - Area 22

Commercial fishing began in this area in 1979. After a very promising first year, catch rates dropped to the extent that fishing is generally only

conducted here when catch rates drop in Bonavista Bay or weather conditions are too severe to fish in Area 19.

In 1982 both landings and effort dropped dramatically with only four vessels fishing in the area. In fact, effort was reduced to such an extent that CPUE was relatively constant throughout the season making Leslie analysis impractical.

The historical data on landings (mt), mean CPUE (kg/trap haul), effort (trap hauls), and exploitation rates (%) are summarized as follows:

	1979	1980	1981	1982
Landings	569	494	179	95
CPUE	10.0	8.5	7.2	6.9
Effort	56,887	58,160	25,007	13,755
Exploitation rate	39	54	55	

A biweekly breakdown of the performance of this fishery is presented in Table 2.

The consistantly low CPUE in this area will probably result in continuing low effort levels as it remains an area used to supplement landings from Areas 25 and 19.

Trinity Bay (inner portion) - Area 20

This management area, similar to Area 22 remains marginally commercial. Only three vessels fished in this area during 1982 with effort being reduced from 1981 levels. Such low effort levels resulting in a fairly constant CPUE throughout the fishing season made Leslie analysis impractical (Table 3).

The historical data on landings (mt), mean CPUE (kg/trap haul), effort (trap hauls), and exploitation rates (%) are summarized as follows:

	1979	1980	1981	1982
Landings	67	59	110	65
CPUE	16.0	12.9	7.4	6.1
Effort	4,165	4,550	14,970	10,535
Exploitation rate	-	-	-	-

Unless significant increases in CPUE occur in this area it is likely to remain a marginally viable area. The fact that a simultaneous groundfish gillnet fishery occurs on the same fishing ground as those occupied by crab fishermen means a proportion of the available commercial sized snow crab is lost as gillnet by-catch. A biweekly breakdown of the performance of this fishery is presented in Table 3.

Conception Bay - Area 16

Despite a high exploitation rate in 1981 (73%) effort increased once again in 1982 by 17,200 trap·hauls. However, even though effort increased the 1982 exploitation rate dropped to 65%. Since all commercial fishing grounds in Conception Bay have been fished for at least ten years it would appear that recruitment into the fishery must have been very strong. Fishermen complained there was a high incidence of soft-shelled animals on the fishing grounds for a large part of the fishing season. A total of 13 vessels fished in this management area during the 1982 fishing season.

The historical data on landings (mt), mean CPUE (kg/trap haul), effort (trap hauls), and exploitation rates (%) are summarized as follows:

	1979	1980	1981	1982
Landings	464	869	502	694
CPUE	16.1	15.4	11.2	11.4
Effort	28,845	56,393	43,546	60,753
Exploitation rate	34	55	73	65

The total available biomass (B) for Conception Bay in 1982 as determined by Leslie analysis was 1,073.1 mt with 95% confidence limits of 951.2 mt and 1255.0 mt; r^2 = 0.99 (Fig. 3).

Examination of Table 4 shows that CPUE decreased quite sharply early in the fishing season but remained relatively stable during the remainder of the season. This possibly reflects a situation where intensive effort quickly depleted the initial biomass at the beginning of the season while low effort levels and intraseasonal recruitment kept CPUE at a relatively constant level.

Biomass estimates for each biweekly fishing period are calculated $B_t = \frac{CPUE_t}{q}$ and presented in Table 4.

Northeastern Avalon - Area 18

Until 1982 this management area had been by far the most productive on the Island. CPUE began to decline in 1981 and continued to drop during 1982. Also in 1981 commercial exploitation of stocks in Area 19 began where CPUE was quite high. Encouraged by these high catch rates many of the fishermen traditionally fishing in Area 18 shifted their effort to the more distant Area 19. This, as the accompanying text table illustrates, resulted in a dramatic decrease in effort and landings in Area 18. A total of 23 vessels fished in Area 18 during the 1982 fishing season.

The historical data on landings (mt), mean CPUE (kg/trap haul), effort (trap hauls), and exploitation rates (%) are summarized as follows:

	1979	1980	1981	1982
Landings	6870	4944	6769	1847
CPUE	17.2	20.9	16.4	12.1
Effort	398,939	236,417	413,815	153,238
Exploitation rate	44	35	58	87

Leslie analysis of logbook data (Fig. 4) provides an estimate of usable biomass (B) of 2131.7 mt with 95% confidence limits of 2,010.8 mt and 2305.8 mt; r^2 = 0.98. Biomass estimates for each biweekly fishing period are calculated $B_t = \dfrac{CPUE_t}{q}$ and presented in Table 5.

The authors question the reliability of this Leslie estimate. With such a dramatic drop in effort over a one year period, the true picture of the scale of effort and landings for this area has been lost. The mean CPUE of 12.1 kg, although significantly reduced from 1980 levels, remained commercially attractive.

We feel that although the high level of landings since 1979 may have reduced the standing stock in Area 18, the actual commercial-sized population available to the fishery is much larger. For example, using the formula presented by Taylor et al. (1983) a mean CPUE of 12.1 kg/trap haul provides a usable biomass by:

$$B = \frac{C \times A}{a}$$

$$= \frac{12.1 \times 3572.1}{.0041}$$

$$= 10,542.1 \text{ mt}$$

where:

C = mean catch of commercial sized crabs in km/trap;

a = 0.0041 km/trap, the effective area fished per trap (Miller 1975, 1977);

A = area of fishing grounds in km^2.

Where there was reasonably good correlation between the estimates derived by the above method and Leslie analysis in the past (Taylor et al. 1983), estimates for 1982 are widely divergent.

Petersen Estimate

In the spring of 1982, 2660 commercial sized snow crab were tagged at 23 randomly selected depth (>175 m) sites. A total of 1149 (43.2%) tags were returned by crab fishermen during 1982.

Based on these data the snow crab population in this area can be calculated as:

$$B = \frac{(M)\,(n)}{m}$$

$$= \frac{(2660)\,(1{,}847{,}050)}{1149}$$

$$= 4276.0 \text{ MT}$$

with 95% confidence limits of 4035.8 mt and 4530.5 mt.

As with the Leslie population estimates for this area the authors feel that Petersen's estimate fails to accurately reflect the actual available biomass in this area. Beginning the period July 19-31 effort dropped dramatically as vessels left to fish Areas 19 and 15, thereby reducing potential landings and tag recaptures (Table 5). The only area where tagging was carried out and effort remained constant was the inshore area which is fished by smaller vessel (<15 m) which lack the capability of moving offshore. Tag recaptures for sites within the inshore area often exceeded 75%. This high tag recapture rate for the inshore sites coupled with very low recapture rates offshore and greatly reduced landings due to lack of fishing effort cause this Petersen estimate to be artificially low.

Eastern Avalon - Area 14

Effort in this area has continued to be at a low level when compared to other areas despite reasonably high CPUE levels. Although six vessels prosecuted the snow crab fishery in this area in 1982, only three fished for more than a few days.

Historical data on landings (mt), mean CPUE (kg/trap haul), effort (trap hauls), and exploitation rates (%) are summarized as follows:

	1979	1980	1981	1982
Landings	762	121	434	465
CPUE	20.1	20.6	16.0	14.4
Effort	37,950	5,860	27,113	32,320
Exploitation rate	70	70	71	-

In previous assessments for this management area (Taylor and O'Keefe 1984) the authors questioned the accuracy of the high exploitation rates, derived from Leslie analysis, of the data when effort was comparatively low. Despite the "high" exploitation rates, CPUE, although slightly reduced, has remained quite commercially acceptable. Analysis of logbook data shows that the vessels engaged in the fishery in this area restrict their activities to a relatively small proportion of the management area. This low level of effort coupled with an apparent high pulse of recruitment during the fishing season

(soft-shelled animals) kept CPUE too constant for dependable Leslie Analysis (Table 6).

Southeastern Avalon - Area 12

Five vessels fished this area in 1982, four of them on a sustained basis. Although fishing activity completely ceased in 1979 high CPUE in 1980 and 1981 encouraged fishermen to remain in this area in 1982.

Historical data on landings (mt), mean CPUE (kg/trap haul, effort (trap/hauls), and exploitation rates (%) are summarized as follows:

	1979	1980	1981	1982
Landings	-	292	854	732
CPUE	-	21.1	18.9	14.7
Effort	-	13,825	45,455	49,975
Exploitation rates	-	78	66	75

Leslie analysis of the logbook data (Fig. 5) provides usable biomass (B) of 974.0 mt, with 95% confidence limits of 937.6 mt and 1017.4 mt; $r^2 = 0.99$.

Due to an unexplained drop in effort during the period July 26-August 7 and an artificial increase in CPUE for this period these data were eliminated from the analysis.

Vessel logbooks report a high incidence of soft-shelled animals during the fishing season. Although exploitation rates may be exaggerated given the "healthy" CPUE for this area in 1982 the fact that both 1981 and 1982 assessments indicate excessive exploitation rates may provide justification for a reduction in effort to a level intermediate between those of 1980 and 1981.

Biomass estimates for each biweekly period of the fishing season are calculated $B_t = \dfrac{CPUE_t}{q}$ and are represented in Table 7.

St. Mary's Bay - Area 8

The commercial snow crab grounds are quite reduced in this management area being restricted to a small area near the mouth of the bay. Until 1981 effort was very nearly non-existent. However, the high CPUE experienced in 1981 encouraged two vessels to fish for virtually the entire season.

Historical data on landings (mt), mean CPUE (kg/trap haul), effort (trap hauls), and exploitation rates (%) are summarized as follows:

	1979	1980	1981	1982
Landings	8	-	168	506
CPUE	6.7	-	15.0	10.5
Effort	1,260	-	11,150	48,350
Exploitation rate	-	-		92

Leslie analysis of the logbook data (Fig. 6) provides a usable biomass (B) of 551.4 mt with 95% confidence limits of 500.1 mt and 645.7 mt; $r^2 = 0.88$.

Biomass estimates for each biweekly period of the fishing season are calculated $B_t = \dfrac{CPUE_t}{q}$ and presented in Table 8.

The amount of effort expended in such a small area appears to be excessive. However, since CPUE was still commercially acceptable at the end of the season the exploitation rate of 92% generated by the Leslie analysis would appear to be exaggerated. However, logbook reports from the crab fishermen continually report soft-shell crab incidence as being high from mid July onwards.

"Danger Zone" - Area 15

The fishery first began in this area in 1981. Although the area lies between Areas 14 and 18 it had not been exploited due to the fact that fishermen (and researchers) considered the area too shallow (<165 m) to support commercial quantities of snow crab. Attractive catch rates reported during the 1981 fishery encouraged an increase in effort in the area. In 1982 a total of eight vessels fished in this area.

Historical data on landings (mt), mean CPUE (kg/trap haul/, effort (trap hauls), and exploitation rates are summarized as follows:

	1979	1980	1981	1982
Landings	-	-	404	1056
CPUE	-	-	22.3	15.8
Effort	-	-	18,128	66,949
Exploitation rate	-	-	-	56

Leslie analysis of the 1982 logbook data for this management area (Fig. 7) provides a usable biomass (B) of 1861.0 mt with 95% confidence limits of 1465.0 mt and 3024.3 mt; $r^2 = 0.77$. Biomass estimates for biweekly fishing periods used in this analysis are calculated $B_t = \dfrac{CPUE_t}{q}$ and presented in Table 9.

The authors note that CPUE during the 1983 fishing season CPUE declined steadily as time progressed and that an exploitation rate of 56% after only two

years of fishing may indicate that the standing stock is quite limited. It is advised that effort in this area be held at 1982 levels.

Northeastern Avalon (offshore) - Area 19

The existance of commercial concentrations of snow crab in this area was determined in 1979 during a Department of Fisheries and Oceans research cruise (A.T. Cameron, Trip 297). However, exploitation of this resource did not begin until 1981 when vessels from the eastern side of Bonavista Bay began to fish here following the collapse of the fishery on their traditional grounds. CPUE for some vessels was often quite high often exceeding 45 kg/trap haul. These high catch rates enticed many vessels to leave traditional inshore fishing areas in order to secure higher landings. In 1982, the second year in which the fishery was prosecuted, 24 vessels, over 1/2 the entire Newfoundland crab fleet fished in this area.

Historical data on landings (mt), mean CPUE (kg/trap haul/, effort (trap hauls), and exploitation rates (%) are summarized as follows:

	1979	1980	1981	1982
Landings	-	-	1840	4194
CPUE	-	-	28.0	19.2
Effort	-	-	65,978	218,356
Exploitation rate	-	-	-	54

Leslie analysis of the logbook data for 1982 (Fig. 8) provides a usable biomass (B) of 7744.0 mt with 95% confidence limits of 5983.0 mt and 12,022.3 mt; $r^2 = 0.82$.

Estimates of biweekly biomass are calculated $B_t = \frac{CPUE_t}{q}$ and presented in Table 10. As the exploitation rate has already reached the level recommended by CAFSAC, the authors advise that effort should not exceed 1982 levels.

Downing Basin - Area 13

Commercial crab concentrations were first discovered in this area by an Industrial Development Branch exploratory survey during the fall of 1982. Catch rates encountered varied greatly within the area but generally were quite high. The lateness of the discovery and subsequent exploitation of the resource during 1982 preclude an assessment of the resource. A total of 113.5 mt was landed from this area with a mean CPUE of 15.6 kg/trap haul. Biweekly summaries catch/effort data are presented in Table 11.

Northern Zone

At present, there are three commercially fished areas in the Northern Zone which includes Management Zones 28-40. In 1982 a policy of zonal management was implemented whereby vessels were restricted to areas they had traditionally fished within their respective zones. An exception to this regulation was made for the three vessels based in Valleyfield, Bonavista Bay, allowing them to fish in the Northern Zone but restricting them to Bonavista Bay in the Southern Zone.

In general vessels in the Northern Zone are smaller and older than those in the Southern Zone. As a result effort is more restricted with regard to the distance from shore that fishing activities are conducted.

Notre Dame Bay - Area 32

During 1982 a total of ten vessels fished in this area, primarily around Green Bay on the western side of the bay. Increased processing capacity in the area as well as the exploitation of previously unfished grounds by three vessels from Bonavista Bay resulted in a great increase in landings for this area. A total of seven vessels fished the traditional fishing grounds.

	1979	1980	1981	1982	1982*
Landings	491	374	650	939.0	413.1
CPUE	10.6	9.9	11.9	10.3	10.6
Effort	46,183	33,261	54,416	91,380	38,925*
Exploitation rate	56	43	35	42	-

* data from three vessels fishing virgin populations in eastern Notre Dame Bay

Leslie analysis of the logbook data exclusive of that for the vessels fishing out of Valleyfield (Fig. 9) provides a usable biomass (B) of 2212.8 mt with 95% confidence limits of 1604.7 mt and 4284 mt; $r^2 = 0.65$. The exploitation rate for this area was 42%.

Population size estimates for biweekly fishing periods are calculated
$$B_t = \frac{CPUE_t}{q}$$
and presented in Table 12.

Apparently this area has a high standing stock of animals which has not been adversely affected by fishing pressure since 1973. Previously, processing capacity in the area severely restricted effort, a factor which kept exploitation rates low. Due to the fact that the Bonavista Bay vessels were fishing virgin grounds, data from their logbooks were not used in Leslie analysis. However, as the text table illustrates X CPUE for both components of the Notre Dame Bay fishery were almost identical.

Soft-shelled incidence in the traditionally fished area was quite high from early July-September. This factor, could not only indicate strong

recruitment but could also mean that the great increase in landings in 1981 and 1982 could be causing a phenomenon similar to that reported for overexploited Bonavista Bay.

Petersen Estimate

In May of 1982 a tagging program, identical to those carried out in Areas 18 and 25, was initiated in the western portion of Notre Dame Bay. A total of 1529 commercial sized crab were tagged at 13 sites. Although 542 tags were returned to fishermen in 1982, 29 of these tags are deleted from calculation of Petersen's estimate because they were returned by one of the Valleyfield vessels which should not have been fishing in this area. Since landings for these vessels have been deleted from all calculations these tags must also be deleted.

Therefore, the 1982 snow crab population for Notre Dame Bay (western half) as calculated by Petersen's analysis is:

$$B = \frac{(M)\ (n)}{m}$$

$$= \frac{(1529)\ (938,949)}{513}$$

$$= 2798.5 \text{ mt.}$$

95% confidence limits are 2566.6 mt and 3051.5 mt. Early reports from fishermen in 1983 indicate greatly reduced CPUE's, therefore the authors recommended that effort not exceed 1982 levels.

Horse Islands - Area 34

As in Area 32, 1981 and 1982 were years of exceptional growth in the snow crab fishery in this area. A total of five vessels fished this area in 1982. The fishing pattern adopted by this group of fishermen makes Leslie analysis quite difficult in that they invariably begin at a point inshore and move outward as they deplete the resource in local areas. This behavior pattern ensures a relatively constant CPUE which is not suitable for Leslie analysis. It is only when weather conditions during the fall deteriorate, keeping vessels within ten miles of shore that CPUE declines, making Leslie analysis possible. This occurred in 1982, however, examination of Table 13 shows that although there is a decline in CPUE, effort has dropped dramatically causing the authors to question the validity of the Leslie analysis presented below.

Historical data on landings (mt), mean CPUE (kg/trap haul), effort (trap hauls), and exploitation rates (%) are summarized as follows:

	1979	1980	1981	1982
Landings	141	96	322	735
CPUE	11.9	14.3	16.7	14.3
Effort	11,830	7,330	19,250	51,347
Exploitation rate	-	91	53	72

Leslie analysis of the 1982 logbook data (Fig. 10) provides a usable biomass (B) of 1015.7 mt with 95% confidence limits of 838.8 mt and 7423.3 mt; $r^2 = 0.68$. The exploitation rate in this area for 1982 was 72%.

White Bay - Management Area 36

Vessels fishing in this area tend to be smaller than the average crab vessel (<15 m) and fish solely within the bay. Vessels in this area lack the capability of high expenditures of effort and for this reason until 1982 catch/effort data are quite stable. Processing capacity had until 1981-82 been quite limited. An increase in processing capacity combined with good market conditions encouraged fishermen to maximize effort in 1982. This factor, plus a diversion of effort from Area 36 to Area 34 allowed remaining crab fishermen access to more area, fortunately stabilizing catch rates (Table 14), but unfortunately making execution of a valid Leslie analysis impossible. A total of four vessels fished in this area in 1982.

Historical data on landings (mt), mean CPUE (kg/trap haul), effort (trap hauls), and exploitation rates (%) are summarized as follows:

	1979	1980	1981	1982
Landings	156	158	230	418
CPUE	7.3	8.8	11.6	12.7
Effort	21,298	17,864	19,840	32,917
Exploitation rate	41	57	46	-

It would appear that 1982 was a year of strong recruitment into the fishery. Although effort and landings almost doubled over 1981, levels of CPUE actually rose slightly. However, since the 1981 exploitation rate was near 50%, the authors recommend the effort be held in 1983 to 1982 levels.

Conclusions

A review of the last three assessments for Newfoundland snow crab stocks (Taylor and O'Keefe 1981, 1983, 1984) illustrates that since 1979 the snow crab fishery has become very dynamic.

The discovery of unexploited stocks in traditional areas or in new management areas causes shifts in effort (eg. Area 18, 1982) from traditional grounds which result in violations of the basic assumptions inherent in Leslie and Petersen analyses. It is quite likely that in the near future at least, these changes in catch/effort statistics are likely to continue, resulting in

further uncertainty as to the actual status of various snow crab populations. While fishing trends during one year may result in the calculation of some population estimates which can be regarded with confidence (eg. Area 16, 1982) sudden shifts in effort, especially away from an area, make comparison of yearly assessments of an area impractical. Even short term drops in effort in an area where tagging studies are ongoing can result in inaccurate Petersen estimates due to intraseasonal molting.

While the statistical exercise of reviewing fishing effort and landings on a biweekly basis may provide valuable insights into the dynamics of fishing in a management area, to use these data to estimate population size and generate management advice based on the exploitation rates (as derived from suspect catchability coefficients) calculated from these estimates could result in serious errors that would have a long term effect on the viability of an area.

In view of the difficulty the authors have in placing a high reliability "code" on most analyses present in this assessment, it is requested that the importance of these tools in annual assessments be downgraded. We feel that thoughtful and informed analysis of the biweekly catch/effort tables also included in these assessments may be far more valuable.

Table 15 presents a summary of catch/effort statistics for the 1982 Newfoundland snow crab fishing season.

Acknowledgements

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Table 1. Catch and effort statistics for the snow crab fishery in Bonavista Bay, Newfoundland, 1982. (Management Area 25)

Two week period	Effort trap hauls	Cumulative effort	CPUE kg/trap haul	Catch (mt)	Cumulative catch (mt)	Estimated biomass (mt)	(CPUE/q)
Apr. 15-17	7,400	7,400	12.1	7.40	89.93*		1282
Apr. 19-May 1	15,286	22,686	11.2	22.69	260.58*		1186
May 3-15	15,360	38,046	9.8	38.05	411.37*		1038
May 17-29	8,805	46,851	9.9	46.85	498.72*		1049
May 31-June 12	15,404	62,255	10.1	62.26	653.85*		1070
June 14-26	4,505	66,760	6.7	66.76	684.16*		710
June 28-July 10	5,435	72,195	6.1	72.20	717.36*		646
July 12-24	2,310	74,505	4.4	74.51	727.52*		466
July 26-Aug. 7	630	75,135	5.4	75.14	730.95		572
Aug. 9-21	-	-	-	-	-		-
Aug. 23-Sept. 4	1,790	76,925	5.5	76.93	740.82		583
Sept. 6-18	2,365	79,290	9.0	79.29	762.07		953
Sept. 20-Oct. 2	5,905	85,195	9.3	85.20	816.82		985
Oct. 4-16	1,870	87,065	7.2	87.07	830.25		763
Oct. 18-30	5,720	92,785	7.8	92.79	875.07		826
Nov. 1-13	2,075	94,860	5.2	94.86	885.85		551
Nov. 15-27	1,470	96,330	13.1	96.33	905.05		1388

X̄ CPUE = 9.4

* cumulative catches used in Leslie analysis

Table 2. Catch and effort statistics for the snow crab fishery in the outer portion of Trinity Bay, Newfoundland, 1982. (Management Area 22)

Two week period	Effort trap hauls	Cumulative effort	CPUE kg/trap haul	Catch (mt)	Cumulative catch (mt)	Estimated biomass (mt) (CPUE/q)
Apr. 12-24	1,080	1,080	7.2	7.76	7.76	Insufficient data
Apr. 26-May 8	720	1,800	5.8	4.21	11.97	
May 10-22	1,275	3,075	7.9	10.03	22.00	
May 24-June 5	3,750	6,825	6.2	23.36	45.36	
June 7-19	520	7,345	7.4	3.86	49.22	
June 21-July 3	-	-	-	-	-	
July 7-17	300	7,645	8.0	2.39	51.61	
July 19-31	2,025	9,670	8.2	16.52	68.13	
Aug. 2-14	390	10,060	9.3	3.64	71.77	
Aug. 16-28	1,470	11,530	8.1	11.87	83.64	
Aug. 30-Sept. 11	1,925	13,455	4.5	8.71	92.35	
Sept. 13-25	300	13,755	9.3	2.78	95.12	

X̄ CPUE = 6.9

Table 3. Catch and effort statistics for the snow crab fishery in the inner portion of Trinity Bay, Newfoundland, 1982. (Management Area 20)

Two week period	Effort trap hauls	Cumulative effort	CPUE kg/trap haul	Catch (mt)	Cumulative catch (mt)	Estimated biomass (mt) (CPUE/q)
July 19-31	1,060	1,060	3.6	3.84	3.84	Insufficient data
Aug. 2-14	-	-	-	-	-	
Aug. 16-28	1,070	2,130	6.4	6.85	10.69	
Aug. 30-Sept. 11	2,210	4,340	7.7	16.98	27.67	
Sept. 13-25	3,235	7,575	8.3	26.95	54.62	
Sept. 27-Oct. 9	1,310	8,885	3.6	4.74	59.36	
Oct. 11-23	1,650	10,535	3.2	5.35	64.71	

X CPUE = 6.1

Table 4. Catch and effort statistics for the snow crab fishery in Conception Bay, Newfoundland, 1982. (Management Area 16)

Two week period	Effort trap hauls	Cumulative effort	CPUE kg/trap haul	Catch (mt)	Cumulative catch (mt)	Estimated biomass (mt) (CPUE/q)
Mar. 15-27	6,850	6,850	16.4	112.60	112.60*	1004
Mar. 29-Apr. 10	20,150	27,000	13.6	273.99	386.59*	832
Apr. 12-24	21,601	48,601	9.9	214.63	601.22*	606
Apr. 26-May 8	3,958	52,559	7.8	30.84	632.06*	477
May 10-22	1,984	54,543	6.4	12.71	644.78*	392
May 24-June 5	1,140	55,683	9.0	10.27	655.04	551
June 7-19	1,470	57,153	8.7	12.78	667.82	532
June 21-July 3	1,140	58,293	5.9	6.72	674.54	361
July 5-17	300	58,593	5.4	1.63	676.17	330
July 19-31	-	-	-	-	-	-
Aug. 2-14	-	-	-	-	-	-
Aug. 16-28	-	-	-	-	-	-
Aug. 30-Sept. 11	-	-	-	-	-	-
Sept. 13-25	-	-	-	-	-	-
Sept. 27-Oct. 9	-	-	-	-	-	-
Oct. 11-23	720	59,313	4.1	2.95	679.12	251
Oct. 25-Nov. 6	-	-	-	-	-	-
Nov. 8-20	-	-	-	-	-	-
Nov. 22-Dec. 4	-	-	-	-	-	-
Dec. 6-18	1,440	60,753	10.0	14.43	693.55	612

X CPUE = 11.4

* cumulative catches used in Leslie analysis

Table 5. Catch and effort statistics for the snow crab fishery in Northeastern Avalon, Newfoundland, 1982.
(Management Area 18)

Two week period	Effort trap hauls	Cumulative effort	CPUE kg/trap haul	Catch (mt)	Cumulative catch (mt)	Estimated biomass (mt) (CPUE/q)
Mar. 29–Apr. 10	7,059	7,059	12.8	90.01	90.01	795
Apr. 12–24	12,210	19,269	14.5	176.70	266.71	900
Apr. 26–May 8	22,150	41,419	11.3	250.48	517.19	701
May 10–22	14,385	55,804	12.8	184.26	701.45	795
May 24–June 5	18,535	74,339	12.7	234.77	936.22	788
June 7–19	15,025	89,364	17.2	258.72	1194.94*	1068
June 21–July 3	8,805	98,169	14.4	126.64	1321.58*	894
July 5–17	10,709	108,878	11.5	122.98	1444.56*	714
July 19–31	4,910	113,788	10.3	50.66	1495.22*	639
Aug. 2–14	6,060	119,848	10.3	62.52	1557.74*	639
Aug. 16–28	6,430	126,278	8.8	56.58	1614.32*	546
Aug. 30–Sept. 11	6,965	133,243	12.6	87.89	1702.21	782
Sept. 13–25	7,370	140,613	7.8	57.78	1759.99	484
Sept. 27–Oct. 9	2,085	142,698	8.6	17.87	1777.86	534
Oct. 11–23	780	143,478	4.1	3.20	1781.06	255
Oct. 25–Nov. 6	3,980	147,458	7.8	30.87	1811.94	484
Nov. 8–20	2,480	149,938	5.1	12.77	1824.70	317
Nov. 22–Dec. 4	2,140	152,078	7.4	15.93	1840.64	459
Dec. 6–18	1,160	153,238	5.5	6.42	1847.05	341

X̄ CPUE = 12.1

* cumulative catches used in Leslie analysis

Table 6. Catch and effort statistics for the snow crab fishery in Eastern Avalon, Newfoundland, 1982.
(Management Area 14)

Two week period	Effort trap hauls	Cumulative effort	CPUE kg/trap haul	Catch (mt)	Cumulative catch (mt)	Estimated biomass (mt) (CPUE/q)
Mar. 22–Apr. 3	6,120	6,120	11.9	72.72	72.72	
Apr. 5–17	7,680	13,800	16.7	128.45	201.16	
Apr. 19–May 1	8,660	22,460	13.5	117.03	318.19	
May 3–15	3,210	25,670	12.3	39.44	357.63	
May 17–29	1,850	27,520	14.8	27.33	384.96	
May 31–June 12	2,040	29,560	19.3	39.39	424.35	
June 14–26	840	30,400	24.2	20.35	444.70	
June 28–July 10	720	31,120	15.9	11.48	456.15	
July 12–24	660	31,780	6.8	4.48	460.67	
July 26–Aug. 7	–	–	–	–	–	
Aug. 9–21	–	–	–	–	–	
Aug. 23–Sept. 4	–	–	–	–	–	
Sept. 6–18	240	32,020	9.0	2.17	462.83	
Sept. 20–Oct. 2	60	32,080	7.7	0.47	463.30	
Oct. 4–16	240	32,320	5.1	1.23	464.52	

X̄ CPUE = 14.4

Table 7. Catch and effort statistics for the snow crab fishery in Southeastern Avalon, Newfoundland, 1982. (Management Area 12)

Two week period	Effort trap hauls	Cumulative effort	CPUE kg/trap haul	Catch (mt)	Cumulative catch (mt)	Estimated biomass (mt) (CPUE/q)
Mar. 22-Apr. 3	2,840	2,840	14.2	40.44	40.44	450
Apr. 5-17	6,435	9,275	14.4	92.43	132.87	456
Apr. 19-May 1	4,435	13,710	14.9	65.93	198.80	472
May 3-15	2,485	16,195	19.5	48.51	247.31	618
May 17-29	3,880	20,075	21.8	84.58	331.89*	691
May 31-June 12	6,330	26,405	18.2	115.07	446.96*	577
June 14-26	4,180	30,585	16.3	68.26	515.21*	516
June 28-July 10	4,125	34,710	12.9	53.34	568.56*	409
July 12-24	2,260	36,970	12.2	27.57	596.13*	386
July 26-Aug. 7	690	37,660	16.9	11.67	607.80	535
Aug. 9-21	1,600	39,260	11.2	17.98	625.78*	355
Aug. 23-Sept. 4	3,420	42,680	9.9	34.02	659.80*	314
Sept. 6-18	2,400	45,080	9.9	23.88	683.67*	314
Sept. 20-Oct. 2	630	45,710	9.7	6.11	689.78*	307
Oct. 4-16	1,295	47,005	8.7	11.29	701.07*	276
Oct. 18-30	1,920	48,925	10.6	20.38	721.45	336
Nov. 1-13	750	49,675	10.3	7.70	729.15	326
Nov. 15-27	300	49,975	9.9	2.96	732.10	314

$\bar{X}$ CPUE = 14.7

* cumulative catches used in Leslie analysis

Table 8. Catch and effort statistics for the snow crab fishery in St. Mary's, Newfoundland, 1982. (Management Area 8)

Two week period	Effort trap hauls	Cumulative effort	CPUE kg/trap haul	Catch (mt)	Cumulative catch (mt)	Estimated biomass (mt) (CPUE/q)
Mar. 22-Apr. 3	4,620	4,620	9.3	42.93	42.93	204
Apr. 5-17	2,040	6,660	13.6	27.76	70.69	298
Apr. 19-May 1	4,320	10,980	12.1	52.30	122.99	265
May 3-15	5,160	16,140	12.3	63.26	186.25	269
May 17-29	3,420	19,560	10.9	37.36	223.61	239
May 31-June 12	1,860	21,420	14.4	26.82	250.43*	315
June 14-26	1,560	22,980	12.6	19.64	270.07*	276
June 28-July 10	2,400	25,380	11.6	27.95	298.02*	254
July 12-24	3,120	28,500	12.7	39.47	337.49*	278
July 26-Aug. 7	3,540	32,040	9.9	35.02	372.50*	217
Aug. 9-21	1,470	33,510	7.3	10.71	383.21*	160
Aug. 23-Sept. 4	1,740	35,250	5.5	9.54	392.76*	120
Sept. 6-18	1,740	36,990	6.9	11.94	404.70*	151
Sept. 20-Oct. 2	2,400	39,390	7.7	18.56	423.26*	169
Oct. 4-16	2,860	42,250	5.1	14.61	437.87*	112
Oct. 18-30	1,560	43,810	7.7	11.96	449.83	169
Nov. 1-13	2,520	46,330	11.1	27.95	477.78	243
Nov. 15-27	1,800	48,130	11.6	20.82	498.60	254
Nov. 29-Dec. 11	720	48,850	10.3	7.43	506.03	225

$\bar{X}$ CPUE = 10.5

* cumulative catches used in Leslie analysis

Table 9. Catch and effort statistics for the snow crab fishery in the "Danger Zone", Newfoundland, 1982. (Management Area 15)

Two week period	Effort trap hauls	Cumulative effort	CPUE kg/trap haul	Catch (mt)	Cumulative catch (mt)	Estimated biomass (mt) (CPUE/q)
Apr. 5-17	3,075	3,075	20.1	61.71	61.71	1534
Apr. 19-May 1	4,320	7,395	13.4	57.89	119.60	1023
May 3-15	1,110	8,505	13.3	14.72	134.32	1015
May 17-29	6,225	14,730	22.4	139.15	273.46*	1710
May 31-June 12	11,885	26,615	19.0	225.33	498.80*	1450
June 14-26	5,914	32,529	14.4	85.13	583.93*	1099
June 28-July 10	3,656	36,185	17.4	63.72	647.64*	1328
July 12-24	3,742	39,927	16.7	62.60	710.24*	1275
July 26-Aug. 7	7,882	47,809	15.9	125.00	835.24*	1214
Aug. 9-21	4,680	52,489	13.7	64.25	899.49*	1046
Aug. 23-Sept. 4	5,340	57,829	12.9	68.76	968.25*	985
Sept. 6-18	2,160	59,989	8.5	18.41	986.66*	649
Sept. 20-Oct. 2	1,500	61,489	10.4	15.59	1002.24	794
Oct. 4-16	360	61,849	9.8	3.52	1005.76	748
Oct. 18-30	2,220	64,069	11.8	26.20	1031.96	901
Nov. 1-13	360	64,429	14.8	5.31	1037.27	1130
Nov. 15-27	2,160	66,589	7.9	16.97	1054.25	603
Nov. 29-Dec. 11	360	66,949	3.8	1.38	1055.63	290

X CPUE = 15.8

* cumulative catches used in Leslie analysis

Table 10. Catch and effort statistics for the snow crab fishery in the outer portion of Northeastern Avalon, Newfoundland, 1982. (Management Area 19)

Two week period	Effort trap hauls	Cumulative effort	CPUE kg/trap haul	Catch (mt)	Cumulative catch (mt)	Estimated biomass (mt) (CPUE/q)
Apr. 26-May 8	6,735	6,735	19.0	128.13	128.13	5401
May 10-22	6,010	12,745	19.2	115.54	243.68*	5458
May 24-June 5	8,110	20,855	29.8	241.86	485.53*	8471
June 7-19	15,760	36,615	23.6	372.09	857.62*	6708
June 21-July 3	16,696	53,311	22.9	382.18	1239.80*	6509
July 5-17	24,590	77,901	19.1	469.86	1709.66*	5429
July 19-31	24,230	102,131	19.1	463.36	2173.02*	5429
Aug. 2-14	27,500	129,631	19.1	524.84	2697.86*	5429
Aug. 16-28	18,805	148,436	17.9	336.56	3034.42*	5088
Aug. 30-Sept. 11	26,990	175,426	17.1	460.99	3495.41*	4861
Sept. 13-25	16,615	192,041	14.4	239.62	3735.03*	4093
Sept. 27-Oct. 9	6,000	198,041	17.9	107.67	3842.70	5088
Oct. 11-23	5,620	203,661	14.9	83.58	3926.28	4235
Oct. 25-Nov. 6	9,180	212,841	19.6	179.9	4106.19	5571
Nov. 8-20	1,300	214,141	13.8	17.96	4124.15	3923
Nov. 22-Dec. 4	3,075	217,216	15.6	47.85	4171.99	4434
Dec. 6-18	1,140	218,356	19.6	22.35	4194.34	5571

X CPUE = 19.2

* cumulative catches used in Leslie analysis

Table 11. Catch and effort statistics for the snow crab fishery In Downing Basin, Newfoundland, 1982. (Management Area 13)

Two week period	Effort trap hauls	Cumulative effort	CPUE kg/trap haul	Catch (mt)	Cumulative catch (mt)	Estimated biomass (mt) (CPUE/q)
Aug. 9-21	480	480	12.3	5.92	5.92	Insufficient data
Aug. 23-Sept. 4	-	-	-	-	-	
Sept. 6-18	380	860	15.7	5.96	11.88	
Sept. 20-Oct. 2	2,120	2,980	12.4	26.33	38.20	
Oct. 4-16	450	3,430	7.3	3.27	41.47	
Oct. 18-30	3,075	6,505	19.0	58.57	100.04	
Nov. 1-13	-	-	-	-	-	
Nov. 15-27	790	7,295	17.0	13.43	113.47	

$\bar{X}$ CPUE = 15.6

Table 12. Catch and effort statistics for the snow crab fishery In Green Bay, Newfoundland, 1982. (Management Area 32)

Two week period	Effort trap hauls	Cumulative effort	CPUE kg/trap haul	Catch (mt)	Cumulative catch (mt)	Estimated biomass (mt) (CPUE/q)
May 17-29	2,955	2,955	10.8	31.90	31.90	1800
May 31-June 12	7,642	10,597	13.3	101.37	133.27*	2217
June 14-26	7,866	18,463	13.5	105.96	239.23*	2250
June 28-July 10	9,242	27,705	11.6	106.73	345.96*	1934
July 12-24	9,107	36,812	10.6	96.94	442.90*	1767
July 26-Aug. 7	4,502	41,314	7.3	32.74	475.64*	1217
Aug. 9-21	10,443	51,757	9.3	96.90	572.54*	1550
Aug. 23-Sept. 4	9,100	60,857	10.3	93.50	666.04*	1717
Sept. 6-18	8,631	69,488	9.9	85.06	751.12*	1650
Sept. 20-Oct. 2	11,092	80,580	9.2	101.45	852.55*	1534
Oct. 4-16	6,605	87,185	8.2	54.33	906.88*	1367
Oct. 18-30	4,195	91,380	7.6	32.10	938.95*	1267

$\bar{X}$ CPUE = 10.3

* cumulative catches used In Leslie analysis

Table 13. Catch and effort statistics for the snow crab fishery off the Horse Islands, Newfoundland, 1982. (Management Area 34)

Two week period	Effort trap hauls	Cumulative effort	CPUE kg/trap haul	Catch (mt)	Cumulative catch (mt)	Estimated biomass (mt) (CPUE/q)
May 29-June 5	2,225	2,225	17.6	39.12	39.12	407
June 7-19	2,330	4,555	11.1	25.76	64.88	257
June 21-July 3	6,188	10,743	9.9	61.31	126.19	229
July 5-17	6,541	17,284	12.9	84.68	210.87	298
July 19-31	4,720	22,004	11.9	55.99	266.86	275
Aug. 2-14	6,576	28,580	15.2	99.77	366.63	352
Aug. 16-28	5,524	34,104	15.0	83.14	449.76	347
Aug. 30-Sept. 11	2,885	36,989	14.0	40.29	490.05	324
Sept. 13-25	5,705	42,694	19.6	111.62	601.67*	453
Sept. 27-Oct. 9	2,133	44,827	17.4	37.05	638.72*	403
Oct. 11-23	2,740	47,567	15.5	42.39	681.10*	359
Oct. 25-Nov. 6	2,540	50,107	16.3	41.29	722.39*	377
Nov. 8-20	370	50,477	13.7	5.08	727.48*	317
Nov. 22-Dec. 4	870	51,347	8.7	7.56	735.04*	201

X CPUE = 14.3

* cumulative catches used in Leslie analysis

Table 14. Catch and effort statistics for the snow crab fishery in White Bay, Newfoundland, 1982. (Management Area 36)

Two week period	Effort trap hauls	Cumulative effort	CPUE kg/trap haul	Catch (mt)	Cumulative catch (mt)	Estimated biomass (mt) (CPUE/q)
May 24-June 5	2,850	2,850	12.0	34.11	34.10	
June 7-19	1,750	4,600	12.9	22.62	56.73	
June 21-July 3	2,040	6,640	13.5	27.48	84.21	
July 5-17	2,924	9,564	15.3	44.65	128.86	
July 19-31	1,951	11,515	11.8	22.94	151.80	
Aug. 2-14	2,608	14,123	11.2	29.12	180.91	
Aug. 16-28	2,966	17,089	12.4	36.81	217.72	
Aug. 30-Sept. 11	2,263	19,352	13.3	30.17	247.87	
Sept. 13-25	2,174	21,526	12.2	26.59	274.48	
Sept. 27-Oct. 9	2,246	23,772	13.8	31.06	305.54	
Oct. 11-23	3,460	27,232	11.3	38.97	344.50	
Oct. 25-Nov. 6	3,800	31,032	12.5	47.64	392.12	
Nov. 8-20	1,630	32,662	12.7	20.74	412.86	
Nov. 22-Dec. 4	255	32,917	18.9	4.81	417.67	
Dec. 6-18						

X CPUE = 12.7

Table 15. Summary of catch/effort data for the Newfoundland snow crab fishery, 1982.

Management area	Effort (trap hauls)	Landing (mt)	CPUE X̄ (kg/trap haul)	Biomass (mt)	Exploitation rate (%)
6	-	-	-	-	-
8	48,350	506.0	10.5	551.4	92
10	3,360	51.6	15.4	-	-
12	49,975	732.1	14.7	974.0	75
13	7,295	113.5	15.6	-	-
14	32,320	464.5	14.4	-	-
15	66,949	1,055.6	15.8	1,870.0	56
16	60,753	693.6	11.4	1,073.1	65
18	153,238	1,847.1	12.1	2,131.7	87[a]
19	218,356	4,194.3	19.2	7,744.0	54
20	10,535	64.7	6.1	-	-
22	13,755	95.1	6.9	-	-
25	96,330	905.1	9.4	1,390.8	65
32	91,380	939.0	10.3	2,212.8	42[a]
	38,925	413.1	10.6	-	-
34	51,347	735.0	14.3	1,015.7	72
36	32,917	417.7	12.7	-	-

[a]Due to fluctuating effort patterns during the season, Leslie estimates generated for these areas are highly suspect.
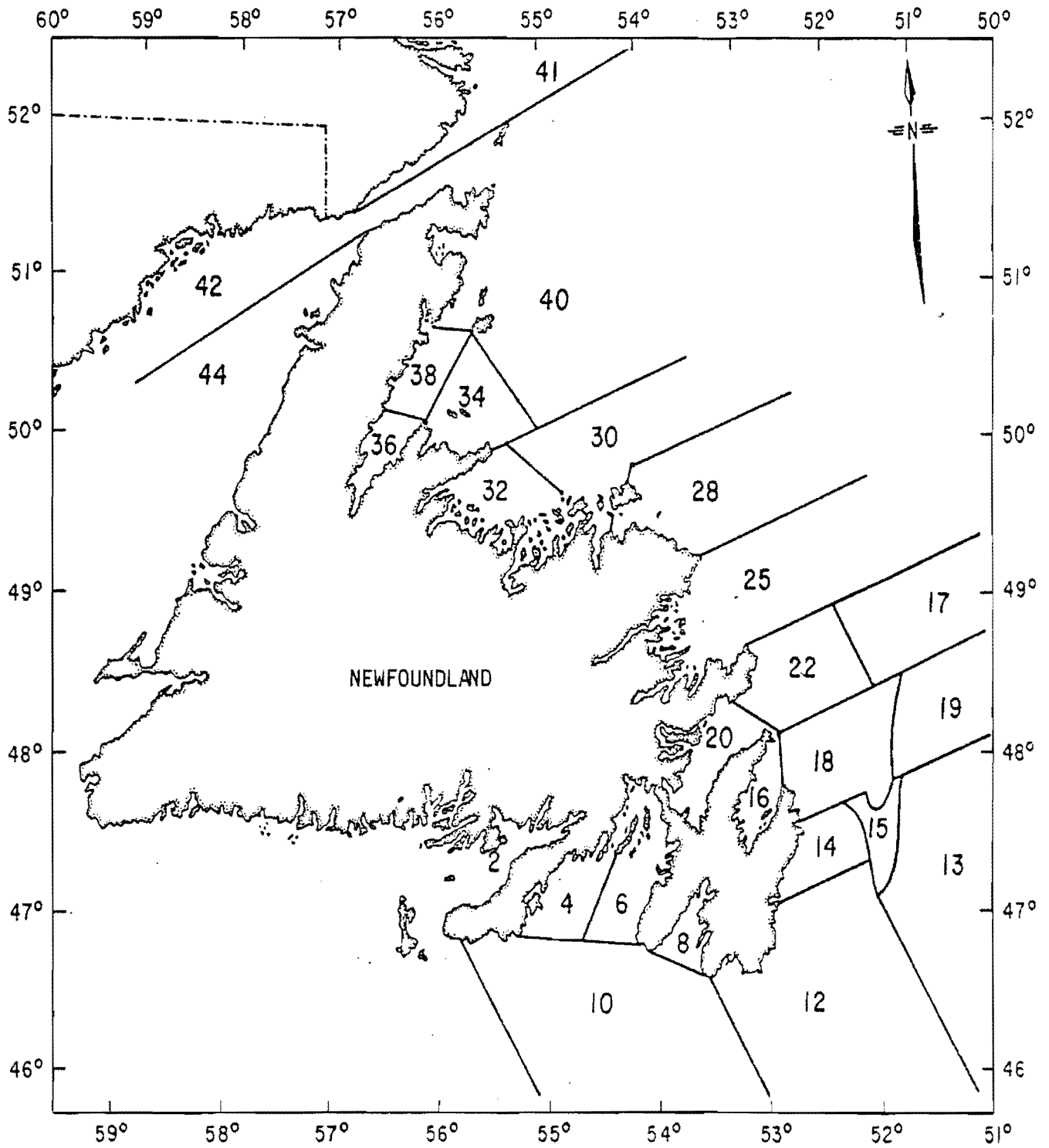
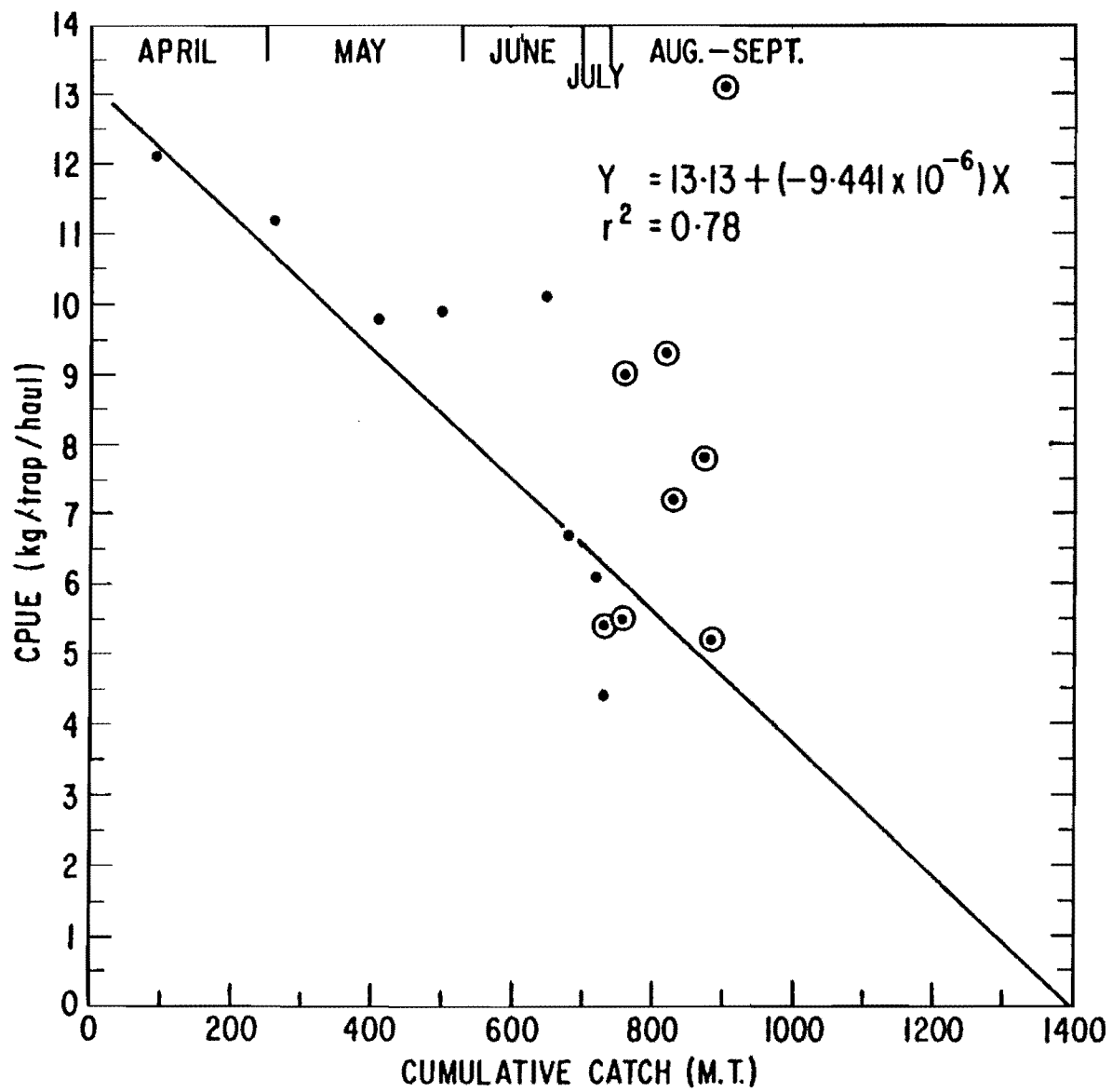Figure 1. Snow crab management areas.

Fig. 2. Leslie graph of biweekly catches of snow crab from Bonavista Bay (Area 25), Newfoundland, 1982.
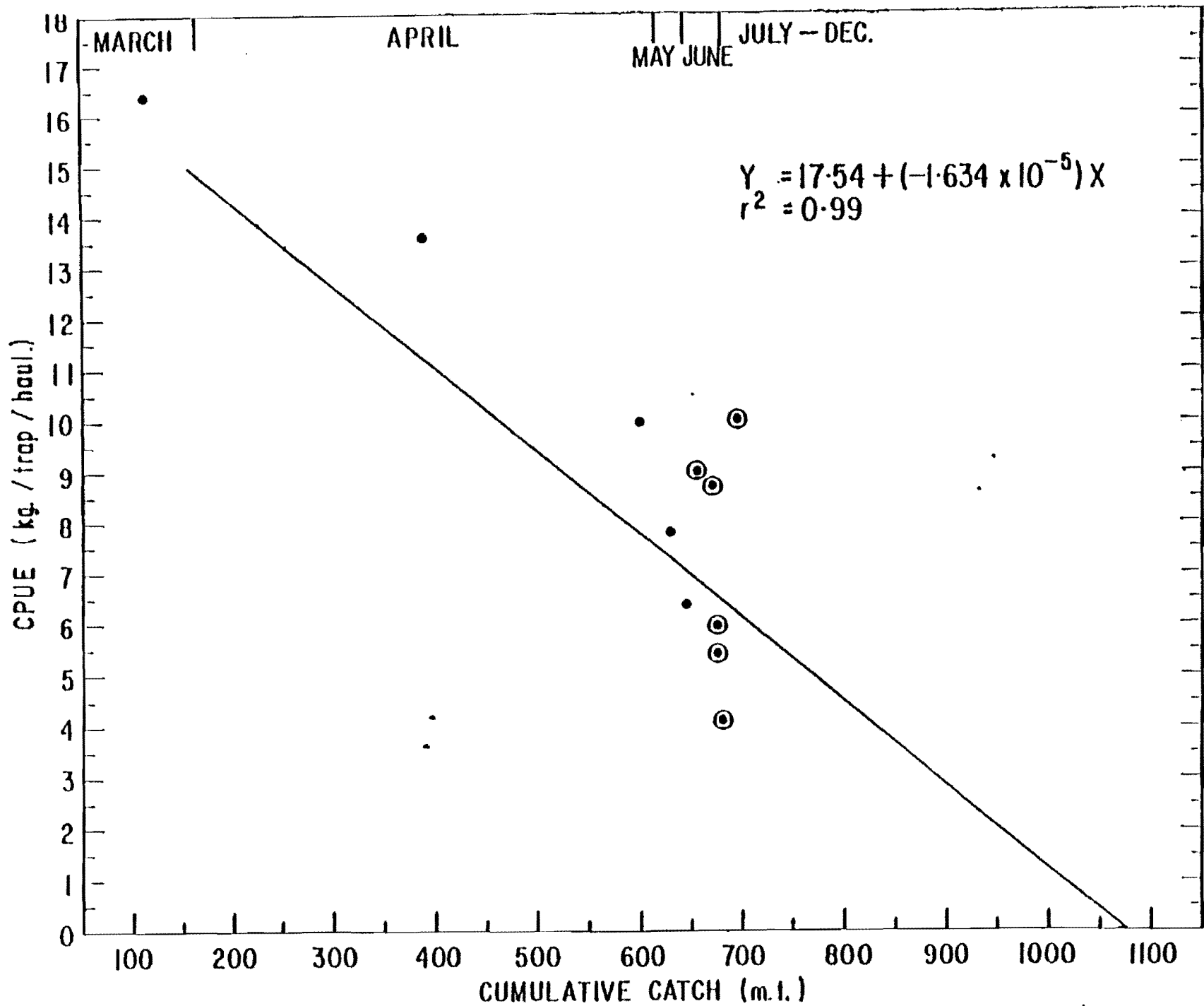
Fig. 3. Leslie graph of biweekly catches of snow crab from Conception Bay (Area 16), Newfoundland, 1982.
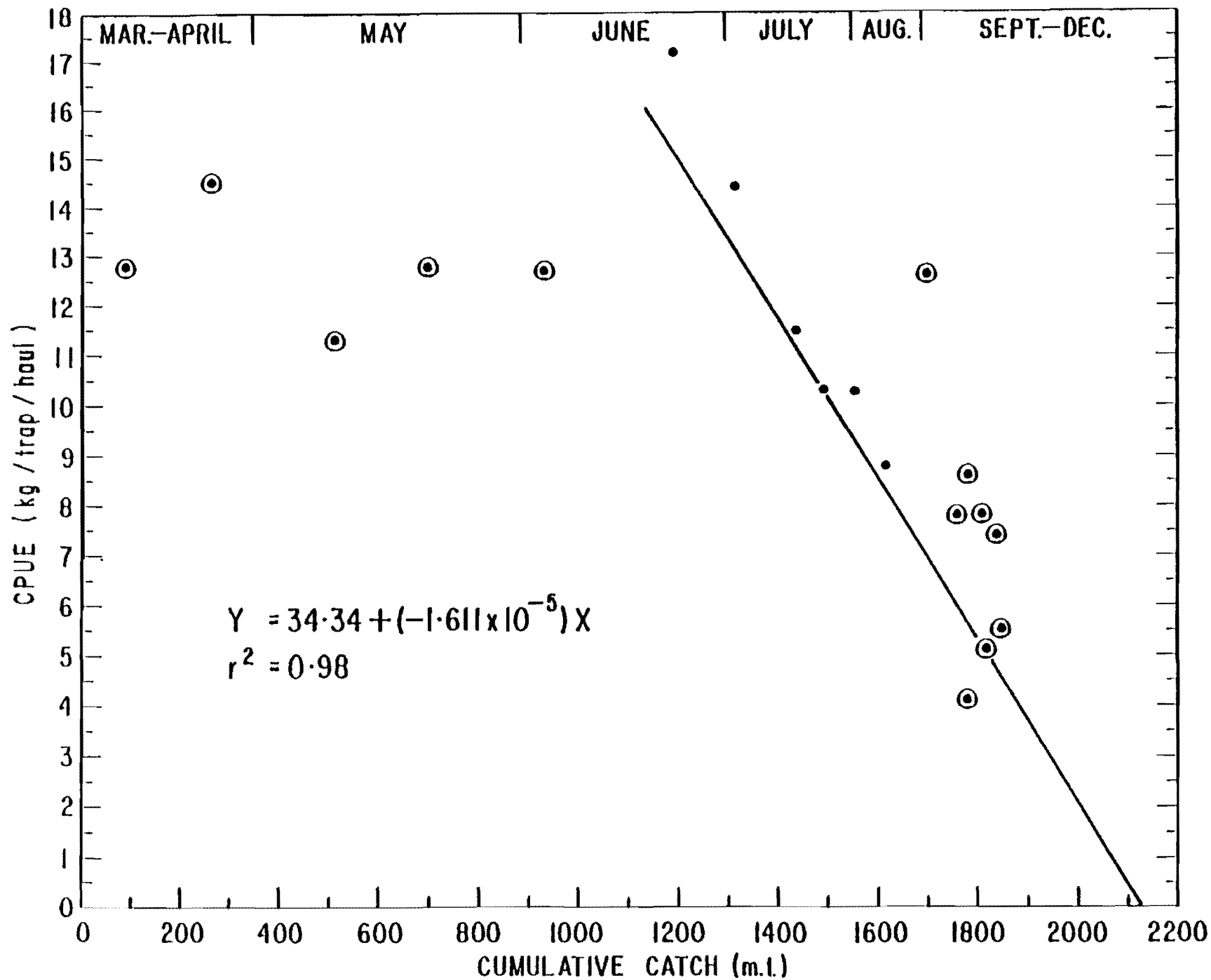
The figure shows a scatter plot with axes labeled CPUE (kg / trap / haul.) on the vertical axis and CUMULATIVE CATCH (m.t.) on the horizontal axis. Time periods MARCH, APRIL, MAY, JUNE, JULY—DEC. are marked along the top. The regression equation shown is:

$$Y = 17.54 + (-1.634 \times 10^{-5})X$$
$$r^2 = 0.99$$

Fig. 4. Leslie graph of biweekly catches of snow crab from Northeastern Avalon (Area 18) Newfoundland, 1982.
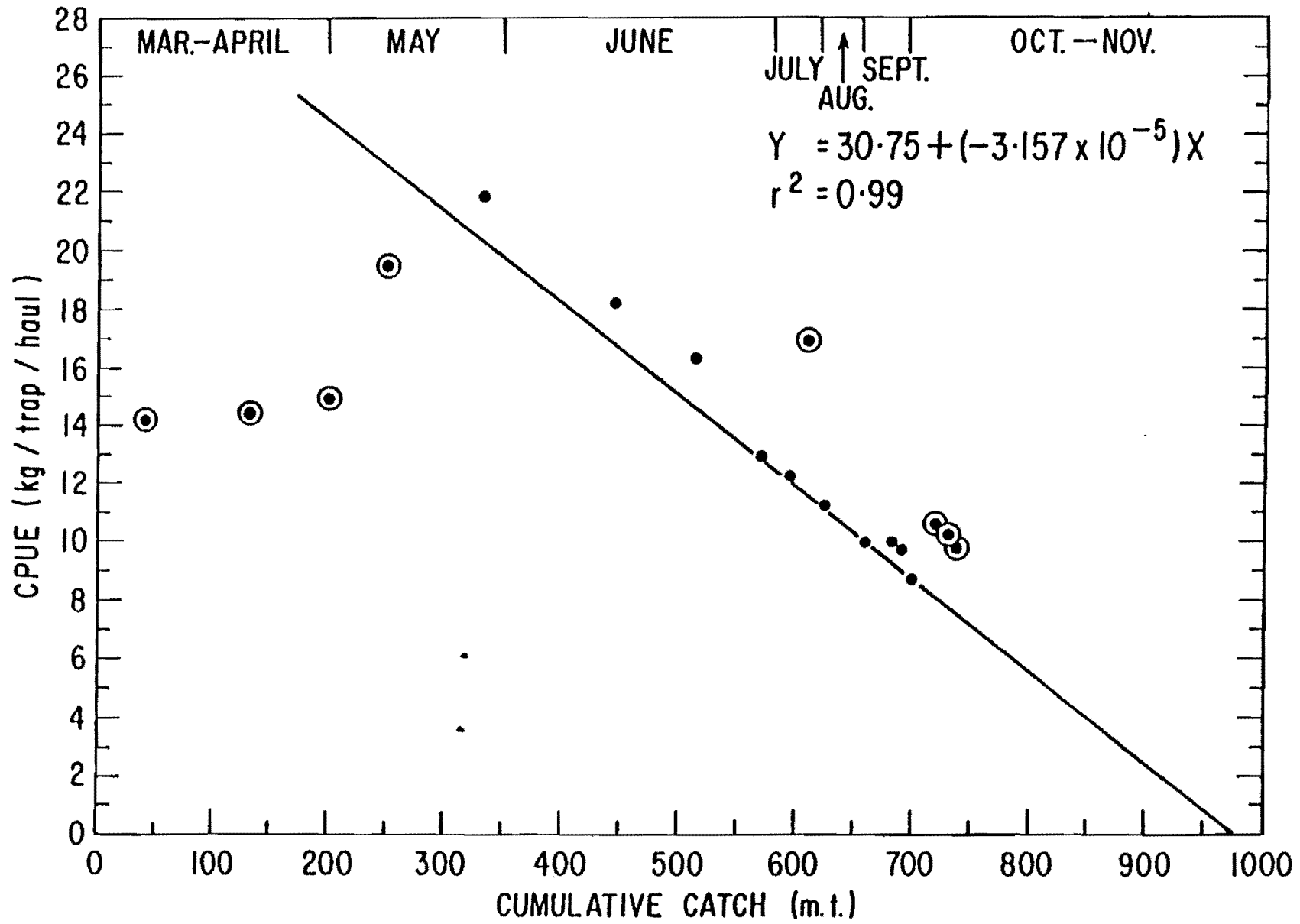
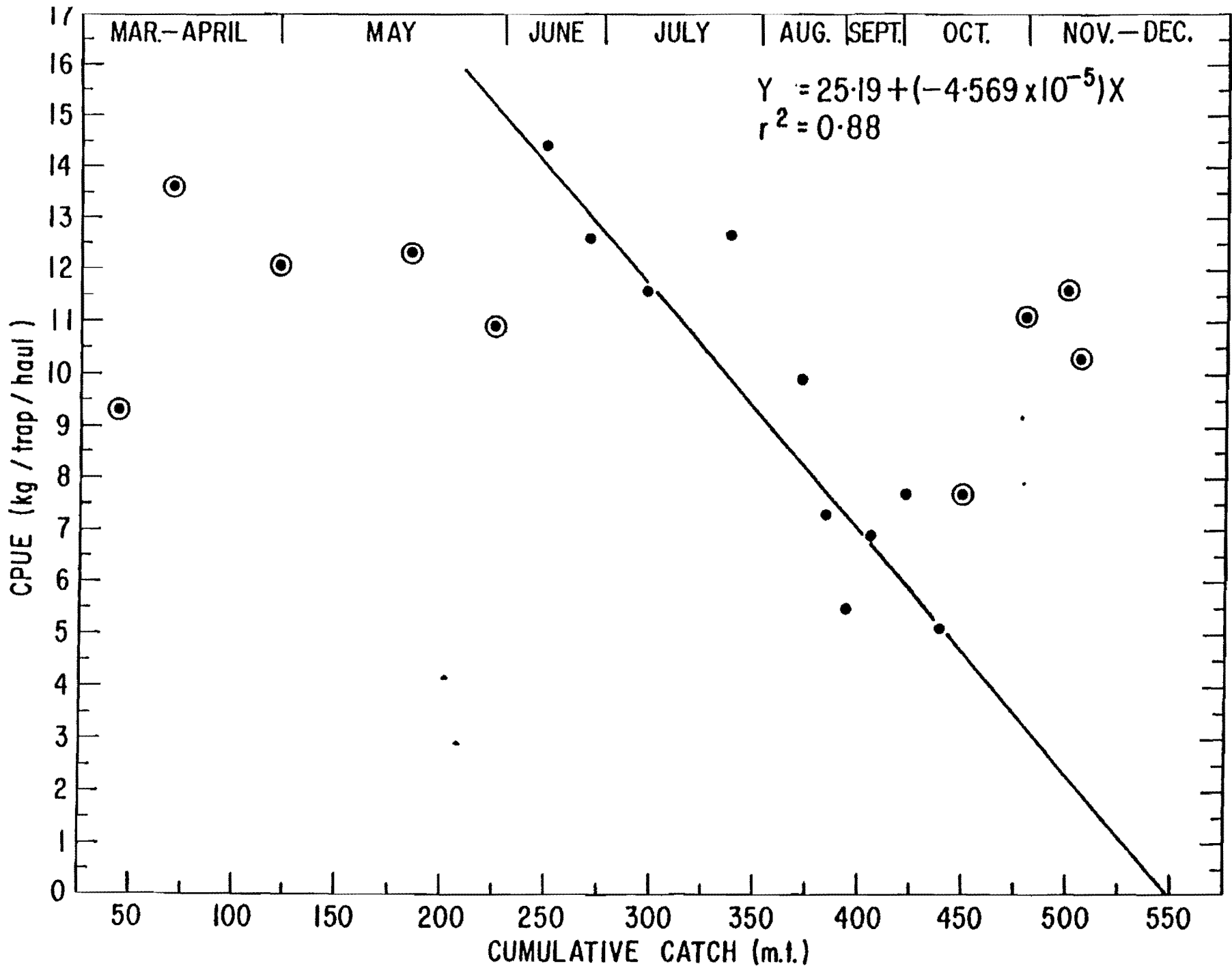Fig. 5. Leslie graph of biweekly catches of snow crab from Southeastern Avalon (Area 12), Newfoundland, 1982.

Fig. 6. Leslie graph of biweekly catches of snow crab from St. Mary's Bay (Area 8), Newfoundland, 1982.

The figure shows CPUE (kg / trap / haul) on the y-axis versus CUMULATIVE CATCH (m.t.) on the x-axis. Months MAR.–APRIL, MAY, JUNE, JULY, AUG., SEPT., OCT., NOV.–DEC. are labeled across the top.

$$Y = 25.19 + (-4.569 \times 10^{-5})X$$
$$r^2 = 0.88$$

The graph shows CPUE (kg/trap/haul) versus CUMULATIVE CATCH (m.t.) with the regression equation:

$$Y = 24 \cdot 49 + (-1 \cdot 310 \times 10^{-5})X$$
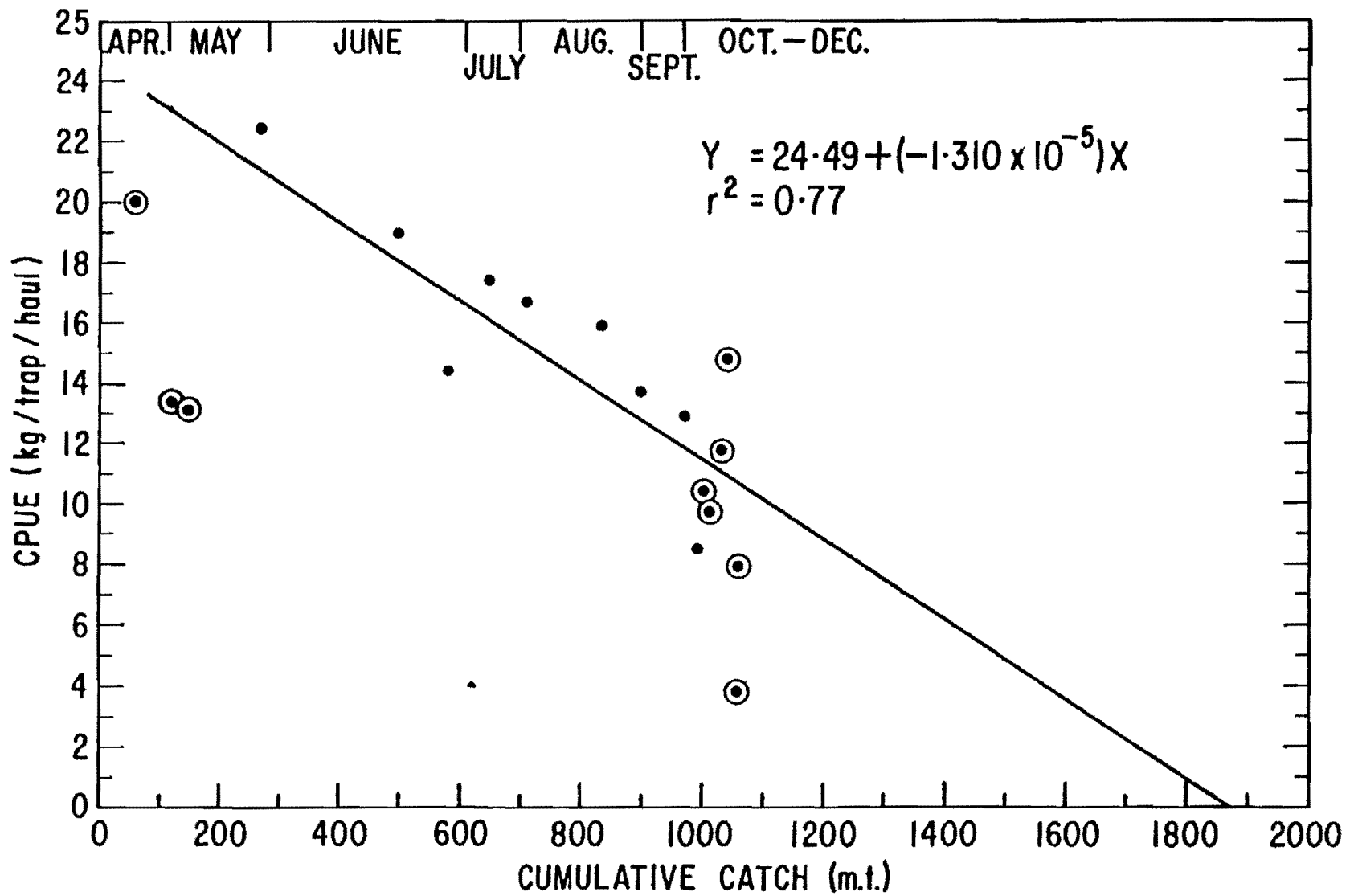$$r^2 = 0 \cdot 77$$

Fig. 7. Leslie graph of biweekly catches of snow crab from the "Danger Zone" (Area 15), Newfoundland, 1982.
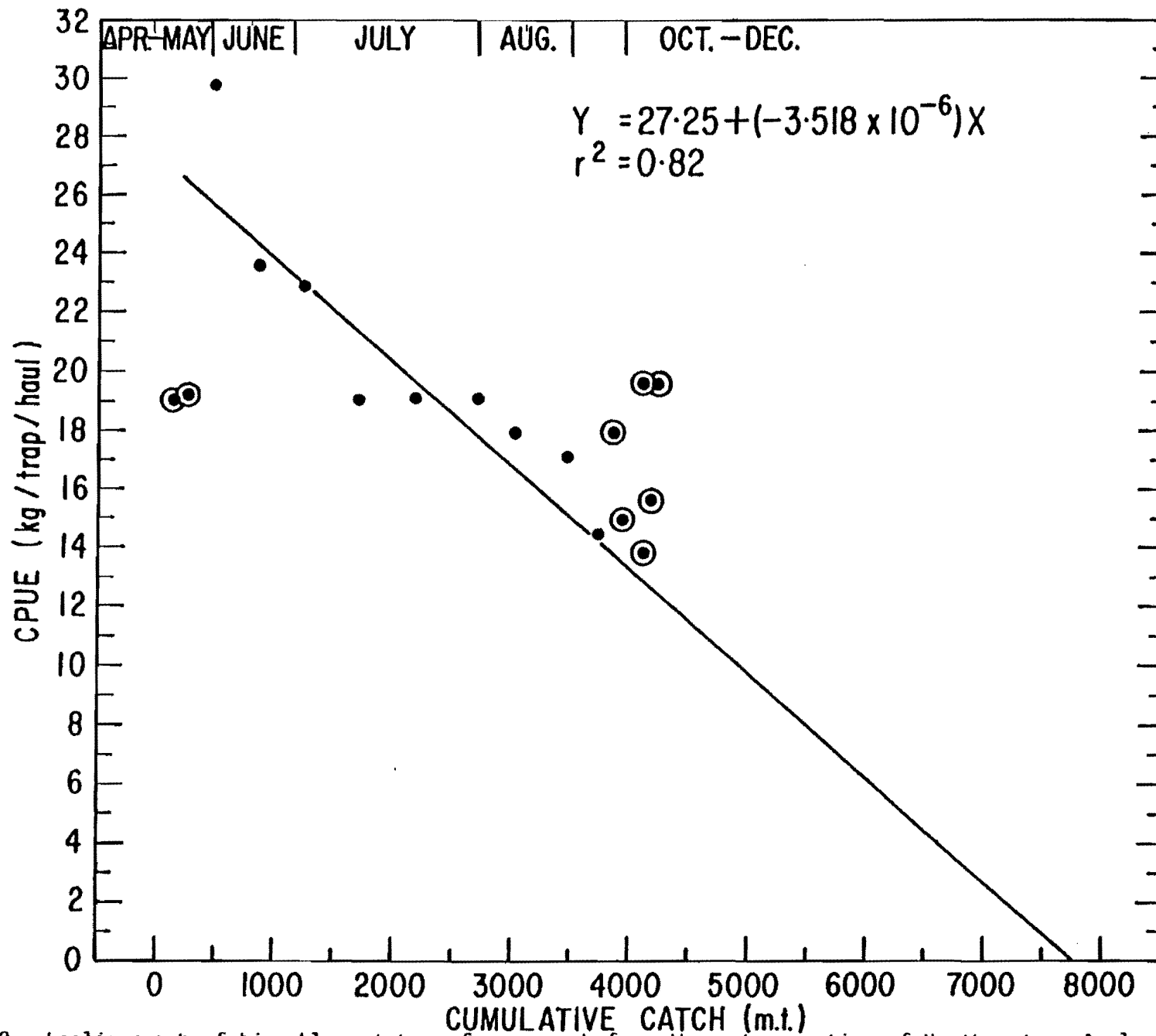
Fig. 8. Leslie graph of biweekly catches of snow crab from the outer portion of Northeastern Avalon (Area 19) Newfoundland, 1982.
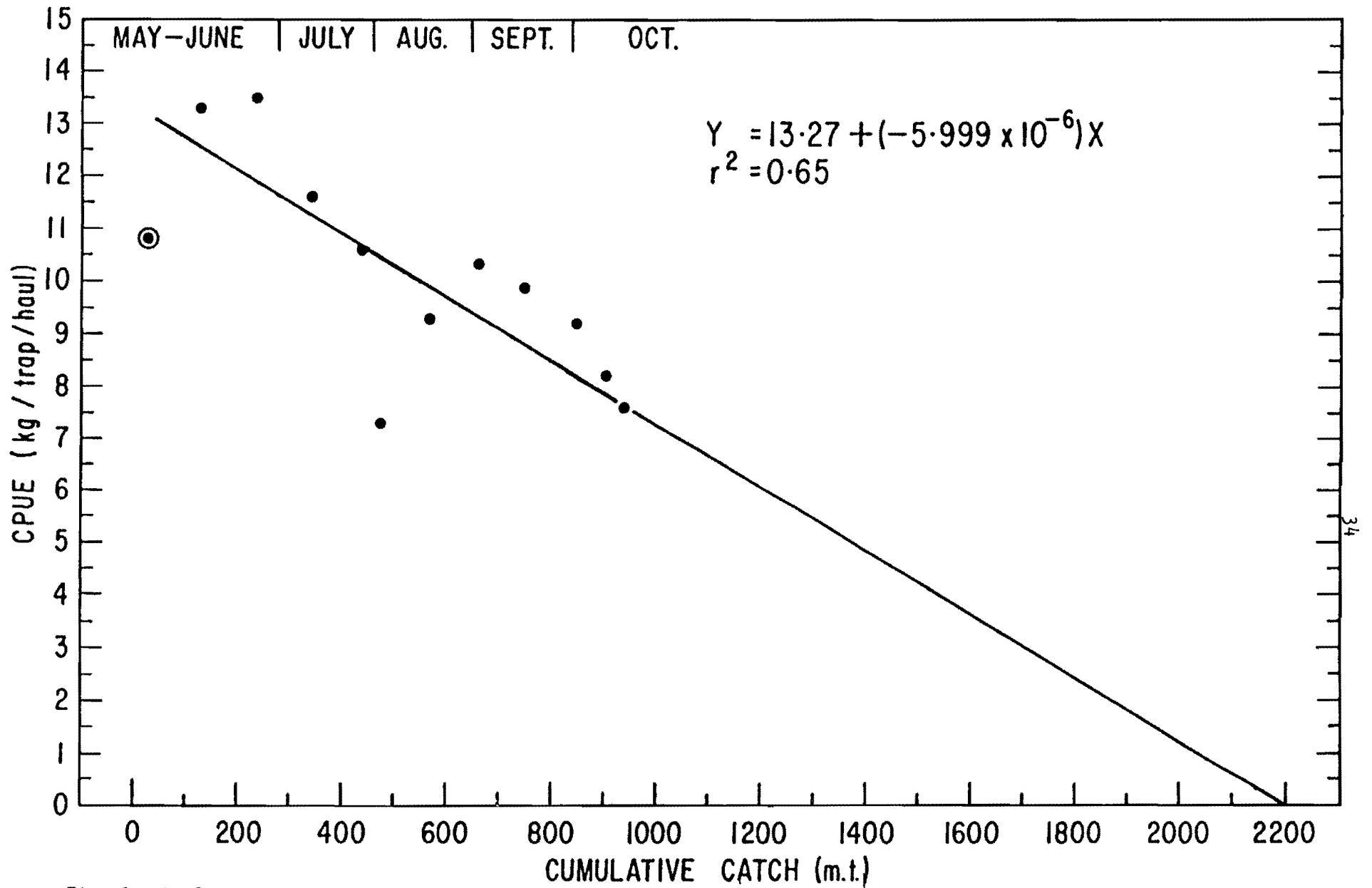
Fig. 9. Leslie graph of biweekly catches of snow crab from Notre Dame Bay (Area 32) Newfoundland, 1982.

The figure shows a Leslie graph with:
- X-axis: CUMULATIVE CATCH (m.t.) ranging from 0 to 1100
- Y-axis: CPUE (kg/trap/haul) ranging from 0 to 28
- Top axis labels: MAY-JUNE | JULY | AUG. | SEPT. | OCT. | NOV.-DEC.

$$Y = 43 \cdot 90 + (-4 \cdot 322 \times 10^{-5})X$$
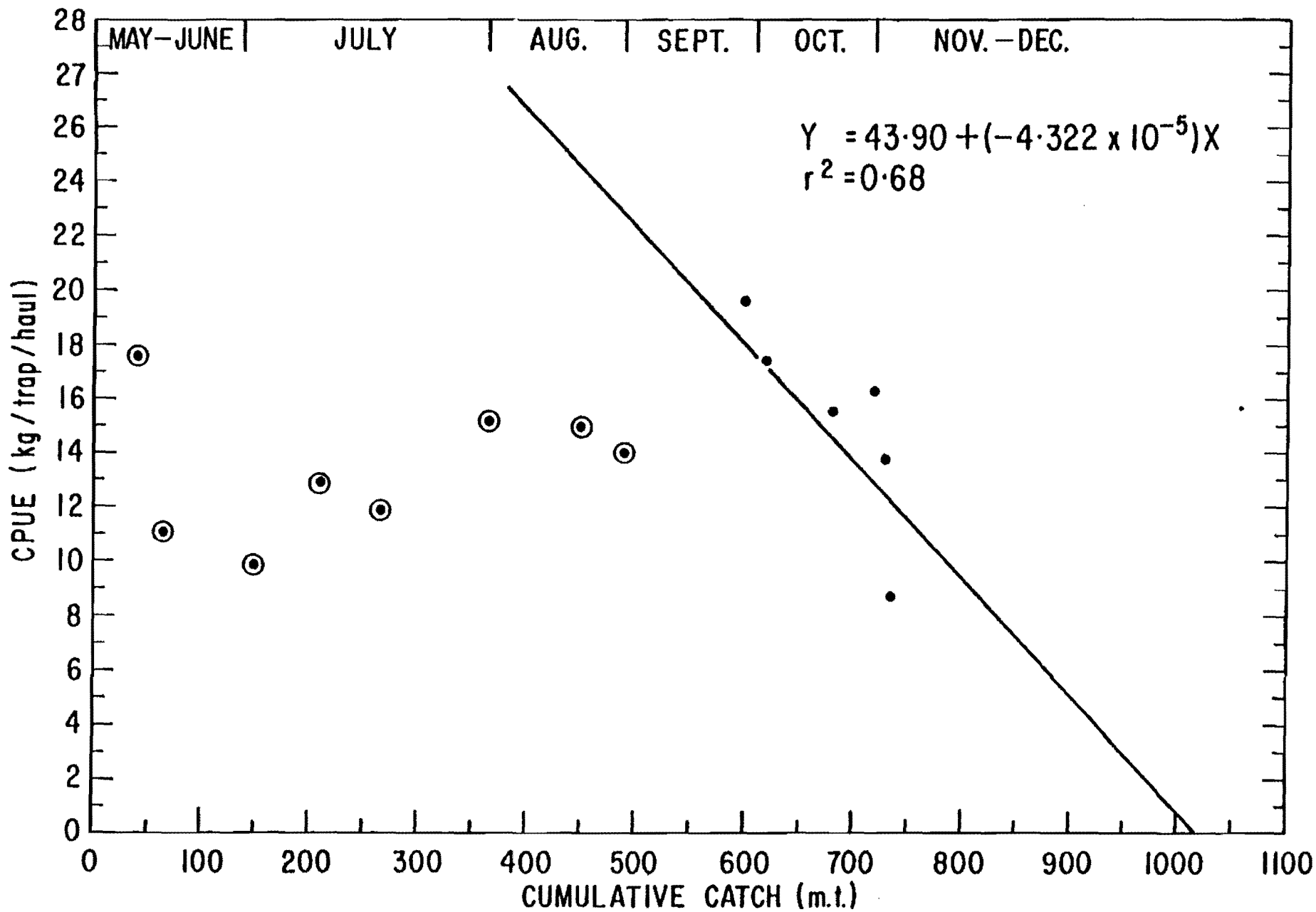$$r^2 = 0 \cdot 68$$

Fig. 10. Leslie graph of biweekly catches of snow crab from Horse Islands (Area 34) Newfoundland, 1982.