Assessment of Snow Crab (Chionoecetes opilio) stocks in Newfoundland in 1980

by

D.M. Taylor and P.G. O'Keefe
Fisheries Research Branch
Department of Fisheries and Oceans
P.O. Box 5667
St. John's, Newfoundland A1C 5X1

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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 ranged from 105.6 to 14,166.4 MT.

RESUME

Nous présentons dans l'article qui suit des estimations d'effectifs de populations de crabes des neiges (Chionoecetes opilio) au large de la côte est de Terre-Neuve, fondées sur les recaptures de marques de Peterson et des analyses de Leslie. Ces estimations varient de 105,6 à 14 166,4 TM, selon la zone de gestion.

INTRODUCTION

Biomass estimates for Newfoundland snow crab (Chionoecetes opilio) management areas were first calculated for 1979 data and presented in 1981 (Taylor and O'Keefe). Methodology employed in this study is similar to that used by Bailey 1978a and Elner and Robichaud 1980.

Landings for Newfoundland peaked in 1979 at 11,000 metric tons. Landings for 1980 fell to 9,100 metric tons, primarily due to a two month long inshore fishery dispute as well as poor market conditions.

Fifty-one vessels are engaged in the fishery and range in length from 40 to 65 ft. Most vessels are capable of landing far greater amounts of snow crab than plant imposed quotas permit. Therefore, landings in Newfoundland are largely a reflection of market conditions and processing capacity.

"Japanese-style" conical traps are used exclusively in the Newfoundland fishery. Traps are baited with frozen squid and/or mackerel and set in longline fleets of 35-75 traps attached at 15-20 fm intervals. Soak time of gear will vary due to many factors but is generally of 24-48 hr duration.

In Newfoundland, as in the Maritime Provinces and Quebec, the fishery is restricted to male snow crab having a minimum carapace width of 95 mm. This hopefully ensures that there will be sufficient sexually mature males on the grounds to maintain snow crab populations (Watson 1970). The only seasonal restriction on the Newfoundland fishery is that fishing is prohibited during the month of January. Traditionally, the fishery is conducted from April until November. In CAFSAC Advisory Document 81/1 (CAFSAC 1981) it has been recommended that exploitation rates on various populations not exceed 50-60%.

MATERIALS AND METHODS

In 1979, a mandatory log book was issued to all licensed crab fishermen. The data obtained from the returned log books included, number of traps hauled per day, catch per day, and fishing position. From these data CPUE and cumulative catch were calculated for each management area. Daily catch figures from log books were checked against processor's sales slips to ensure the accuracy of the data. CPUE and cumulative catch data were used to perform Leslie analyses for each management area (Fig. 1) (Taylor and O'Keefe 1981).

During the spring of 1980 a tagging program was again (Taylor and O'Keefe 1981) conducted in three management areas, 18, 24 and 26. Information from tag returns was used to generate biomass estimates using Petersen's method (Ricker 1975) and to gain insight into snow crab movements in these areas.

Crabs were captured using standard "Japanese-style" conical traps baited with squid and set in longline fleets of twelve. Traps were fished for approximately 24 hr before hauling. Animals were removed from the traps immediately after hauling, measured (maximum carapace width) to the nearest mm with vernier calipers and classified by shell condition. Hard-shelled, legal sized animals were tagged using a Floy vinyl "spaghetti" tag tied around the body and returned to the fishing grounds. Tags from recaptured animals were obtained from fishermen either by field personnel or by mail.

RESULTS AND DISCUSSION

Areas currently fished in Newfoundland are divided into two zones at the line separating management areas 26 and 28 (Fig. 1). Although vessels licensed to fish either zone are permitted to fish in the other, historically this has rarely occurred. Vessels in the southern zone (Areas 2-26) 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, southern zone vessels haul more traps per day and venture farther offshore than do those in the northern zone.

The mandatory log book regulation again worked extremely well. Approximately 95% of the fishermen maintained good records in their log books. However, fluctuations in weekly effort due to weather conditions caused gaps in the data which made Leslie analyses based on weekly CPUE difficult. Therefore, effort and landings data for most 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 - Areas 26 and 24 (Fig. 2)

Area 26 - Western Bonavista Bay

Historical data on landings (MT), mean CPUE (kg/trap haul) and effort (trap hauls) are summarized below.

	1974[1]	1975	1976	1977	1978	1979	1980	1981
Landings	105	-	300	490	676	744	651	635
CPUE	-	-	7.7	11.3	14.5	10.9	11.5	8
Effort	-	-	38,875	43,254	46,599	67,690	56,724	79,250

The total biomass available (B) in area 26 as calculated by Leslie analysis (Fig. 3) was 841 MT with 95% confidence limits of 694.1 MT and 1149.7 MT; $r^2 = 0.81$. The exploitation rate for this area in 1980 was 78%.

Commercial biomasses available in area 26 for each fishing period, assuming that catchability (q) is constant are calculated by the following formula and presented in Table 1.

[1] Data on effort prior to 1974 are not available.

$$\frac{CPUE_t}{q} = B_t$$

The exceedingly high exploitation rate in this area appears to confirm the authors' assertion that fishing pressure is too high (Taylor and O'Keefe 1981). In fact, it appears that all that kept the fishery from collapsing during the latter part of the fishing season were animals which had moulted and recently recovered to a commercially acceptable shell condition.

The authors (Taylor and O'Keefe 1981) expressed optimism that new grounds, first exploited during the 1980 fishing season would considerably lessen fishing pressure on the traditional fishing areas. This has not occurred. The resource near Cabot Island appears to be nothing more than an isolated population of crab which was soon depleted by one vessel which then resumed fishing on its traditional grounds.

Area 24 - Eastern Bonavista Bay

Historical data on landings (MT), mean CPUE (kg/trap haul) and effort (trap hauls) are summarized below.

	1973	1974	1975	1976	1977	1978	1979	1980	1981
Landings	-	11	40	370	567	1,077	842	1,254	741
CPUE	-	4.1	5.9	7.7	10.4	12.7	8.4	9.29	8
Effort	-	2,724	6,851	47,941	54,369	84,804	105,615	135,030	92,435

The total available biomass (B) for area 24 as estimated by Leslie analysis (Fig. 4) was 1929 MT with 95% confidence limits of 1680 MT and 2329 MT; $r^2 = 0.91$. The exploitation rate for this area in 1980 was 65%. Biomass estimates for each fishing period are calculated $\frac{CPUE_t}{q} = B_t$ and presented in Table 2.

Comparison with 1979 data would indicate that in 1980 exploitation rates dropped by 5% despite an increase in trap hauls of 29,415. However, the authors do not view this as a recovery of the stocks. Rather, it is probable that the cessation of fishing effort due to the fishery dispute gave soft-shelled animals time to become commercially acceptable. This would appear to be supported by the fact that CPUE in this area did not crash halfway through the fishing season as it did in 1979 (Table 2).

Petersen Estimates 1980 - Areas 24 and 26

A total of 2999 hard-shelled commercial sized snow crab were tagged with a vinyl body tag and released off the commercial crab grounds; 1752 on the western side of the bay, and 1247 on the eastern side.

A "Reward" poster which illustrated the position of the tag on the crab's body and detailed what information was required was sent to all licenced crab fishermen. Reward posters were also displayed in public buildings in fishing communities and at several locations in processing plants. A total of 1320 tags was returned by crab fihermen or processing plant employees - 578 from the eastern side of the bay and 742 from the western side.

The data generated as a result of this study were used to perform a Petersen's estimate of usable biomass:

$$B = \frac{(M)\ (n)}{m}\ ^{2} \qquad (1)$$

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 of crab in lbs. after release of tagged animals)

m = the number of marked animals in the second sample (number of tagged crabs caught)

The approximate 95% confidence limits for these estimates for $m > 50$ are $m + 1.92 \pm 1.96 \sqrt{m + 1}$, Ricker (1975). Solved for m, the value is re-entered into equation (1).

In 1980, as in 1979, the commercial fishery commenced before the tagging program was implemented, therefore, the amount of snow crab caught before tagging is subtracted from the total catch in each area to provide a true value for B.

The snow crab population on the eastern side of Bonavista Bay (area 24) is therefore given by:

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

$$= \frac{(1247)\ (2,450,281)}{578}$$

$$= 5,286,332 \text{ lbs.}$$

$$= 2,397.9 \text{ MT}$$

with 95% confidence limits of 2210.2 MT and 2601.5 MT. In 1980, 142,797 kg were landed before tagging began in area 24. Therefore, initial biomass = 2,397,870 + 142,797 = 2,540,667 kg (2540.67 MT).

[2] A legal-sized snow crab weighs approximately 0.45 kg.

Area 26

As previously mentioned, in 1980 commercial fishing was initiated near Cabot Island, a previously unexploited area. We were unaware of commercial quantities of snow crab existing in this area and therefore did not tag snow crab there. Therefore, in an attempt to make Petersen's analysis as valid as possible, landings from this area as well as landings prior to commencement of tagging have been subtracted from the total catch in order to give a more reasonable "n".

The snow crab population in the western side of Bonavista Bay is calculated as:

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

$$= \frac{(1752)\ (1,201,190)}{742}$$

$$= 2,836,233 \text{ lbs.}$$

$$= 1287 \text{ MT}$$

Initial biomass in Area 26 (including Cabot Island) is 1,287.0 + 102.6[3] + 4.0 MT[4] = 1393.6 MT with 95% confidence limits of 1195.7 MT and 1382.5 MT.

The estimate of available biomass as generated by Petersen's analysis is in all probability an overestimate. The period during which the fishery dispute took place (Table 1) coincided with the time when moulting incidence is highest in Area 26 (personal communication with local fishermen). In all probability many tags which would have been recaptured had the fishery not shut down were lost during moulting, thus causing biomass estimates to be inflated.

Area 26 - Western Bonavista Bay - 1981

Historical data for this area are presented in the text table on page 3.

The total initial biomass available (B) in area 26 as calculated by Leslie analysis (Fig. 5) was 647 MT with 95% confidence limits of 537 MT and 854 MT; $r^2 = 0.85$. The exploitation rate for the initial commercial population in this area in 1981 was 98%. However, as illustrated in Fig. 5 there was a substantial rise in CPUE during the latter part of the summer.

The exploitation rate in this area is much higher than in 1980. The limited distribution of snow crab makes the stock very vulnerable to overfishing. Calculation of biomass for 1981 includes landings from the Cabot Island area.

Biomass estimates for each fishing period are calculated ($B_t = \frac{CPUE_t}{q}$) and presented in Table 3.

[3] Cabot Island landings; [4] Landings prior to tagging.

As only 3 vessels fish in this area it would appear that the snow crab population must have quite a limited distribution in order for a comparatively small amount of effort to result in such a high exploitation rate.

Area 24 - Eastern Bonavista Bay - 1981

This area, like area 26, has been subjected to an extremely high degree of fishing pressure for the past three years. Since 1979, catch rates early in the fishing season have been quite acceptable. However, soon after fishing commences CPUE has rapidly declined to extremely low levels. This decline in CPUE caused most vessels to leave the area to fish in area 22 (Fig. 1). In 1981, new crab grounds approximately 100 km east of the Avalon Peninsula were fished by several vessels from area 24. Although this relieved much of the fishing pressure on the snow crab population in area 24, there is no evidence in Table 4 that a rise in CPUE for this area resulted from this transfer of effort.

Leslie analysis of the logbook data (Fig. 6) gives a total useable biomass (B) of 941.0 MT with 95% confidence limits of 870.0 MT and 1039.8 MT; $r^2 = 0.94$. The exploitation rate in this area was 79%. Biomass estimates for each fishing period are calculated ($B_t = \frac{CPUE_t}{q}$) and presented in Table 4.

The exploitation rate in this area is excessive and is higher than that experienced in 1979. The prolonged fishery dispute in 1980 makes comparison with that year difficult. Incidence of soft-shelled animals is extremely high for most of the fishing season (personal communication with fishermen who traditionally fish in this area). Strict quality control by fishermen and processors have kept this from becoming a processing problem. However, since fishing continues despite the high incidence of soft-shell we must assume that mortality among discarded animals is probably quite high. The fact that several vessels from this area will fish the newly discovered area off the Avalon Peninsula in 1982 will probably not significantly ease this problem because these vessels will fish in Bonavista Bay until catch rates become unacceptable.

Area 22 - Trinity Bay (outer portion)

This area situated at the mouth of Trinity Bay is fished exclusively by vessels from area 24. 1979 was the first year that the fishery was prosecuted.

Leslie analysis of the logbook data for this area (Fig. 7) gives a total useable biomass (B) of 912.3 MT with 95% confidence limits of 788 MT and 1103 MT; $r^2 = 0.95$. The exploitation rate for this area in 1980 was 54%. In 1979, the snow crab population was subjected to a high degree of fishing pressure due to a dramatic drop in CPUE in area 24. The commercial fishing grounds cover a comparatively small area. Therefore, it is not surprising that biomass estimates have dropped from 1467 MT in 1979 to 912 MT in 1980. In

1979, the exploitation rate for this area was only 39% while $\bar{x}$ CPUE was 10 kg/trap haul. Biomass estimates for each fishing period are calculated ($B_t = \frac{CPUE_t}{q}$) and presented in Table 5. If fishing pressure in this area had not been disrupted by the fishery dispute, it is probable that the exploitation rate would have been higher while $\bar{x}$ CPUE would have been lower (Table 5). It is noteworthy that despite the fishery dispute, effort (trap hauls) increased while landings declined.

Area 20 - Trinity Bay (inner portion)

In 1980, only one vessel fished this area. Logbook data were insufficient for Leslie analysis.

The historical data on landings (MT), mean CPUE (kg/trap haul) and effort (trap hauls) are summarized below.

	1973	1974	1975	1976	1977	1978	1979	1980
Landings	48	31	16	45	63	56	67	59
CPUE	14.5	11.3	10.4	11.3	9.5	17.2	16.0	12.9
Effort	3,305	2,716	1,494	3,926	6,647	3,249	4,165	4,550

Although CPUE for this area is commercially acceptable, snow crab distribution is patchy making fishing this population unattractive to most fishermen. It is anticipated that effort will continue at a very low level and will be concentrated at the mouth of the bay where the two crab processing plants are located. Catch/effort data for seasonal fishing periods are presented in Table 6.

Area 16 - Conception Bay

The snow crab fishery began in this area in 1970. During the early 1970's this area was quite productive and, until CPUE became quite low in 1975-76, it was the mainstay of the fishery. Recently, CPUE has risen to acceptable commercial levels (Table 7) and there has been a significant increase in the level of effort in the Bay (see text table). Fishermen exploiting this population also fish in area 18 (Fig. 1).

The historical data on landings (MT), mean CPUE (kg/trap haul) and effort (trap hauls) are summarized below.

	1973	1974	1975	1976	1977	1978	1979	1980
Landings	779	235	46	56	174	81	464	868.7
CPUE	-	6.8	5.0	9.1	8.6	10.9	16.1	15.4
Effort	-	34,492	9,152	6,205	20,171	7,414	28,845	56,393

Leslie analysis of the logbook data for this area (Fig. 8) provides a useable biomass (B) of 1571 MT with 95% confidence limits of 1214 MT and 2890 MT; $r^2 = 0.70$. The exploitation rate in this area in 1980 was 55%. Effort and landings were greatly increased over 1979 levels. This was principally due to the poor market conditions which forced most processors to place severe catch quotas on all vessels. This quota reduction (often by as much as 1/3) made fishing in the more distant area 18 uneconomical for many vessels and therefore much of their effort was transferred to area 16. Biomass estimates for each fishing period are calculated ($B_t = \frac{CPUE_t}{q}$) and presented in Table 7.

Fishermen in this area reported that soft-shell incidence was higher than usual during the latter part of the season. This is probably reflective of the higher degree of fishing pressure.

Area 18 - Northeastern Avalon

This area continues to be the most productive of all commercial fishing areas. Fishing is conducted over a large area, from 2 to 64 km offshore. Vessels fishing this area tend to be larger than those in the other areas and have a much greater catching and carrying capacity than is indicated by their daily landings.

The historical data on landings (MT), mean CPUE (kg/trap haul) and effort (trap hauls) are summarized below.

	1973	1974	1975	1976	1977	1978	1979	1980
Landings	805	473	181	444	1,480	3,646	6,870	4,944
CPUE	15.9	6.4	6.4	10.4	13.2	13.6	17.2	20.91
Effort	50,736	74,428	28,442	42,596	112,522	267,933	398,939	236,417

Leslie analysis of logbook data (Fig. 9) provides an estimate of useable biomass (B) of 14,166.4 MT with 95% confidence limits of 9,348.4 MT and 59,867.4 MT; $r^2 = 0.46$. The exploitation rate in this area in 1980 was 35%.

Due to the fishery dispute, effort in this area decreased sharply in 1980. Effort levels were particularly low on crab grounds 40 to 70 km offshore.

Biomass estiamtes for each fishing period are calculated ($B_t = \frac{CPUE_t}{q}$) and presented in Table 8.

In 1981, commercial fishing began in a previously unexploited area located approximately 100 km southeast of the Avalon Peninsula. CPUE in this area has been extremely high often exceeding 45 kg/trap. The size of these new crab grounds is not known, however, they are believed to be extensive. Exploratory surveys conducted in the area during 1981 located commercial quantities of snow

crab up to 155 km offshore. The authors propose that this area be considered as a separate management area (area 19) as it appears to contain a distinct population of snow crab, being isolated from other crab grounds by shallow water.

Petersen's estimate.

A total of 1941 snow crab were tagged and released at 20 tagging sites over a large portion of area 18. The procedure used was identical to that followed in the Bonavista Bay tagging studies. A total of 971 tags was recovered. Data generated from this study were used to calculate available biomass using Petersen's method.

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

$$= \frac{(1941)\ (10,900,160)}{971}$$

$$= 21,789,094 \text{ lbs.}$$

$$= 9,883.5 \text{ MT}$$

Approximate 95% confidence limits are 9281 MT and 10,525 MT.

A number of factors cause the authors to question the reliability of the Petersen estimate for area 18. Although almost as many randomly chosen sampling sites were used in 1980 as in 1979 (20 vs 22) most tagging was done within 30 km of land where fishing pressure was especially intense in 1980. Therefore, percentage of tags recaptured was probably higher than would normally be expected.

Area 14 - Eastern Avalon

In 1980, fishing effort in this area was greatly reduced (Table 9), much of it being transferred to area 12.

The historical data on landings (MT), mean CPUE (kg/trap haul) and effort (trap hauls) are summarized below.

	1973	1974	1975	1976	1977	1978	1979	1980
Landings	49	366	659	655	167	824	762	120.9
CPUE	-	8.2	9.1	11.3	9.9	15.9	20.1	20.6
Effort	-	44,840	72,589	57,718	16,761	51,888	37,950	5,860

Log book data are insufficient for Leslie analysis.

There is no apparent reason for the shift in fishing effort from area 14

to area 12 as the $\bar{X}$ CPUE in each area is quite similar.

Area 12 - Southeastern Avalon

After a lapse of one year, fishing activity resumed in area 12 on a modest scale.

Historical data on landings (MT), mean CPUE (kg/trap haul) and effort (trap hauls) are summarized below.

	1973	1974	1975	1976	1977	1978	1979	1980
Landings	547	749	337	212	457	276	-	292
CPUE	-	13.6	8.6	16.8	14.9	14.1	-	21.1
Effort	-	55,045	39,153	12,643	30,562	19,643	-	13,825

The increased CPUE in this area in 1980 is possibly a reflection of the lack of fishing activity in 1979.

Leslie analysis of the logbook data (Fig. 10) for this area provides a total useable biomass estimate (B) of 376.7 MT, with 95% confidence limits of 311.3 MT and 728.2 MT; $r^2 = 0.67$. The exploitation rate in this area was 78%.

Although this exploitation rate would appear to be excessive, $\bar{x}$ CPUE was fairly high (21.2 kg/trap haul). It should also be noted that effort in this area was low and restricted to a very small portion of the potential fishing grounds.

Biomass estimates for each fishing period are calculated ($B_t = \frac{CPUE_t}{q}$) and presented in Table 10.

Northern Zone

Area 36 - White Bay

White Bay, situated on the northeast coast of the Island (Fig. 1), is a deep narrow bay. The fishery in this area began in 1973. Although effort is low, CPUE is also quite low. This is probably due to the fact the crab grounds are quite small, being restricted to the near shore areas.

The small area suitable for snow crab in White Bay is also the most productive groundfish gillnet grounds. This results in competition between the two types of fishermen for grounds in which to set gear.

The historical data on landings (MT), mean CPUE (kg/trap haul) and effort (trap hauls) for this area are summarized below.

	1973	1974	1975	1976	1977	1978	1979	1980
Landings	62	-	45	48	52	169	156	158
CPUE	-	-	-	-	16.3	-	7.3	8.8
Effort	-	-	-	-	3210	-	21,298	17,864

Leslie analysis of logbook data (Fig. 11) provides a biomass estimate (B) of 276.4 MT, with 95% confidence limits of 218.1 MT and 412.1 MT; $r^2 = 0.83$. The exploitation rate for this area was 57%.

Biomass estimates for each fishing period are calculated ($B_t = \frac{(CPUE_t)}{q}$) and presented in Table 11.

Area 34 - Horse Islands

The historical data on landings (MT), mean CPUE (kg/trap haul) and effort (trap hauls) are summarized below.

	1973	1974	1975	1976	1977	1978	1979	1980
Landings	-	46	347	92	62	98	141	96
CPUE	-	-	-	-	9.1	-	11.9	14.3
Effort	-	-	-	-	6,842	-	11,830	7,330

Leslie analysis of logbook data (Fig. 12) from this area provides a biomass estimate (B) of 105.6 MT, with 95% confidence limits of 744.3 MT and 272.6 MT; $r^2 = 0.80$. The exploitation rate for this area was 91%.

This would appear to be a biased estimate caused by the very low level of effort restricted to a small section of this management area. CPUE in this area was higher in 1980 than in 1979. This is due to the fact that one vessel was fishing virgin stock north of the Horse Islands. Exploratory fishing surveys have indicated that snow crab are found in commercial quantities over a wide area north of the Horse Islands.

Biomass estimates for each fishing period are calculated ($B_t = \frac{(CPUE_t)}{q}$) and presented in Table 12.

Area 32 - Notre Dame Bay

The fishery in Notre Dame Bay began in 1972 and is primarily prosecuted from Little Bay Islands. Fishing is conducted at depths ranging from 256 to 476 m. Fishing areas have a patchy distribution and at present only the western half of Notre Dame Bay is fished.

The historical data on landings (MT), mean CPUE (kg/trap haul) and effort (trap hauls) are summarized below.

	1973	1974	1975	1976	1977	1978	1979	1980
Landings	83	49	117	173	232	340	491	374
CPUE	-	-	-	-	6.4	8.7	10.6	9.9
Effort	-	-	-	-	36,477	39,008	46,183	33,261

Leslie analysis of logbook data (Fig. 13) from this area provides a biomass estimate (B) of 786.7 MT with 95% confidence limits of 583.4 MT and 1228.6 MT; $r^2 = 0.78$. The exploitation rate for this area was 43%.

Biomass estimates for each fishing period are calculated ($B_t = \frac{CPUE_t}{q}$) and presented in Table 13.

Reliability of Leslie and Petersen's Analyses

Leslie Analysis

The reliability of Leslie analysis in relation to Newfoundland snow crab populations has been previously discussed by Taylor and O'Keefe, 1981. While Leslie analyses appear to provide reasonable biomass estimates for many management areas, in those with very high exploitation rates, e.g. Bonavaista Bay (Areas 24 and 26), it is apparent that Leslie analysis only provides an estimate of initial biomass. Examination of Fig. 3, 4, 5 and 6 shows that in these areas there is a sharp increase in CPUE in the fall of the year. This increase in CPUE is caused by animals that had molted in the summer recovering to an acceptable quality and entering the fishery. As a result, catch/effort data from the latter part of the fishing season are not suitable for Leslie analysis. However, although the exploitation rates calculated by Leslie anlayses for these areas may be overestimates they, along with the high incidence of soft shell, are indicative of an excessive degree of fishing pressure.

Petersen's Estimate

The applicability of Petersen's estimate to the Newfoundland snow crab fishery has previously been examined and discussed by the authors (Taylor and O'Keefe, 1981). It was concluded that although the fishery did not satisfy Chapman's (1951) criterion that $M+N \geq B$, that Robson and Regiers' (1964:217) conditions that "...Mn must exceed 4 times the estimated population size B" was easily met.

On the western side of Bonavista Bay Mn=(1752) (1,201.90) = 1,505 B (as determined by Leslie analysis).

On the eastern side of Bonavista Bay Mn=(1,247) (2,450,281) = 688 B.

In area 18, Mn=(1941) (10,900,160) = 677 B.

Therefore in all three areas where tagging was conducted in 1980 bias can be considered as being negligible.

Although both methods have shortcomings with regard to accuracy and reliability, the authors feel that in view of the fact that management of the fishery is not dependent on TAC allocation both methods served as excellent indicators of the degree of fishing pressure various populations are subject to. However, since Leslie analysis is by far the least expensive of the two methods it is felt that this method should be the preferred one.

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Table 1. Catch and effort statistics for the snow crab fishery in western Bonavista Bay (Area 26), Newfoundland, 1980.

Two-Week Period	Effort (Trap hauls)	Cumulative Effort	CPUE kg/trap haul	Catch M.T.	Cumulative Catch M.T.	Estimated biomass CPUE/q M.T.
Apr. 7-20	525	525	7.66	4.02	4.02	394.85
Apr. 21-May 4	2065	2590	11.62	24.00	28.02[a]	598.97
May 5-18	3640	6230	16.14	58.76	86.78[a]	831.96
May 19-June 1	6260	12490	15.18	95.05	181.83[a]	782.47
June 2-15	6285	18775	10.49	65.94	247.77[a]	540.72
June 16-29	5369 (805)	24144 (805)	9.43 (10.9)	50.61 (54.14)	298.39[a] (8.78)	486.08
June 30-July 13	5440 (625)	29584 (1430)	8.59 (14.8)	46.72 (9.27)	345.11[a] (62.38)	442.78
July 14-27	1960 (1075)	31544 (2505)	8.93 (24.4)	17.50 (26.27)	362.61 (44.33)	460.31
July 28-Aug. 10	FISHERY DISPUTE					
Aug. 11-24	245 (170)	31789 (2675)	8.87 (13.2)	2.17 (2.24)	364.78[a] (46.57)	457.20
Aug. 25-Sept. 7	3330 (1620)	35119 (4295)	10.11 (17.7)	33.65 (28.73)	398.43[a] (75.30)	521.13
Sept. 8-21	2235 (1200)	37354 (5495)	8.76 (16.0)	19.59 (19.22)	417.99[a] (94.52)	451.55
Sept. 22-Oct. 5	2695 (300)	40049 (5795)	8.55 (9.1)	23.04 (2.73)	441.03[a] (97.24)	440.72
Oct. 6-19	2835 (390)	42884 (6185)	8.58 (13.6)	24.34 (5.31)	465.37[a] (102.56)	442.27
Oct. 20-Nov. 2	3370	46254	10.12	34.12	499.48	521.65
Nov. 3-16	2760		12.04	33.23	532.71	620.62
Nov. 17-30	1525		10.60	16.17	548.88	546.39

$\bar{X}$ CPUE = 11.48 kg/trap haul

[a]:cumulative catches used in Leslie Analysis

Figures in brackets represent landings from the virgin stock of Cabot Island

Table 2. Catch and effort statistics for the snow crab fishery in eastern Bonavista Bay (Area 24), Newfoundland, 1980.

Two-Week period	Effort (Trap hauls)	Cumulative effort	CPUE kg/trap haul	Catch M.T.	Cumulative catch M.T.	Estimated biomass (CPUE/q) M.T.
Apr. 7-20	10210	10210	13.99	142.80	142.80[a]	1912.51
Apr. 21-May 4	15830	26040	11.65	184.36	327.16[a]	1592.62
May 5-18	13295	39335	11.15	148.28	475.44[a]	1524.27
May 19-31	15210	54545	10.63	161.61	637.05[a]	1453.18
June 1-14	17655	72200	8.20	144.72	781.77[a]	1120.98
June 15-28	8550	80750	9.68	82.73	864.50[a]	1323.31
June 29-July 13	6560	87310	6.71	44.00	908.50[a]	917.29
July 14-27	1425	88735	7.50	10.69	919.19[a]	1075.29
July 28-Aug. 10		FISHERY DISPUTE				
Aug. 11-24		FISHERY DISPUTE				
Aug. 25-Sept. 7	8145	96880	6.60	53.76	972.95[a]	902.26
Sept. 8-21	11190	108070	6.27	70.18	1045.13[a]	857.14
Sept. 22-Oct. 5	7440	115510	7.04	52.37	1095.50[a]	962.41
Oct. 6-19	9245	124755	7.96	73.60	1169.10	1088.17
Oct. 20-Nov. 2	7295	132050	8.89	64.82	1233.92	1215.31
Nov. 3-16	1965	134015	7.44	14.62	1248.54	1017.09
Nov. 17-29	1015	135030	5.62	5.70	1254.24	768.28

$\bar{X}$ CPUE = 9.29 kg/trap haul

[a]: cumulative catches used in Leslie Analysis

Table 3. Catch and effort statistics for snow crab fishery in western Bonavista Bay (Area 26), Newfoundland, 1981.

Two-Week period	Effort (Trap hauls)	Cumulative effort	CPUE kg/trap haul	Catch M.T.	Cumulative catch M.T.	Estimated biomass (CPUE/q) M.T.
Mar. 30-Apr. 11	1050	1050	15.3	16.11	16.11[a]	742.72
Apr. 13-25	1425	2475	13.0	18.55	34.66[a]	631.07
Apr. 30-May 9	6495	8970	9.0	58.70	93.36[a]	436.89
May 11-23	6565	15535	10.0	65.88	159.24[a]	485.44
May 25-June 6	6180	21715	10.3	63.46	222.70[a]	500.00
June 8-20	5315	27030	8.5	45.44	268.14[a]	412.62
June 22-July 4	5590	32620	7.3	40.89	309.03[a]	354.37
July 6-18	4530	37150	7.5	33.99	343.02[a]	364.08
July 20-Aug. 1	6075	43225	6.3	38.43	381.45[a]	305.83
Aug. 3-15	6175	49400	4.2	25.63	407.08[a]	203.88
Aug. 17-29	5010	54410	4.7	23.47	430.55[a]	228.16
Aug. 31-Sept. 12	4290	58700	6.5	27.93	458.48	315.53
Sept. 14-26	4945	63645	8.1	40.17	498.65	393.20
Sept. 28-Oct. 10	4265	67910	7.3	31.08	529.73	354.37
Oct. 12-24	5585	73495	8.3	46.51	576.24	402.91
Oct. 26-Nov. 7	4015	77510	10.6	42.46	618.70	514.56
Nov. 9-21	1740	79250	9.4	16.29	634.99	456.31

$\bar{X}$ CPUE = 8.01 kg/trap haul

[a] :cumulative catches used in Leslie Analysis

Table 4. Catch and effort statistics for the snow crab fishery in eastern Bonavista Bay (Area 24), Newfoundland, 1981.

Two-Week period	Effort (Trap hauls)	Cumulative effort	CPUE kg/trap haul	Catch M.T.	Cumulative catch M.T.	Estimated biomass (CPUE/q) M.T.
Mar. 2-14	3960	3960	10.8	42.58	42.58	701.75
Mar. 16-28	7725	11685	12.5	96.78	139.36 [a]	812.22
Mar. 30-Apr. 11	14015	25700	11.2	157.40	296.76 [a]	727.75
Apr. 13-25	9710	35410	9.7	94.59	391.34 [a]	630.28
Apr. 27-May 9	23060	58470	7.0	160.62	551.96 [a]	454.84
May 11-23	9765	68235	5.8	57.06	609.02 [a]	376.87
May 25-June 6	8150	76385	6.3	51.16	660.19 [a]	409.36
June 8-20	5460	81845	5.0	27.18	687.36 [a]	324.89
June 22-July 4	2655	84500	4.1	10.76	698.12 [a]	266.41
July 6-18	1185	85685	3.0	3.51	701.63 [a]	194.93
July 20-Aug. 1	1980	87665	3.4	6.70	708.32 [a]	220.92
Aug. 3-15	1200	88865	3.6	4.32	712.64 [a]	233.92
Aug. 17-29	1030	89895	1.6	1.65	714.29 [a]	103.96
Aug. 31-Sept. 12		FISHERY DISPUTE				
Sept. 14-26	370	90265	3.2	1.18	715.47	207.93
Sept. 28-Oct. 10	370	90635	1.6	0.60	716.07	103.96
Oct. 12-Oct. 24		FISHERY DISPUTE				
Oct. 26-Nov. 7		FISHERY DISPUTE				
Nov. 9-21	1050	91685	15.3	16.12	732.18	994.15
Nov. 23-Dec. 5	750	92435	12.0	8.83	741.01	779.73

$\bar{X}$ CPUE = 8.02 kg/trap haul

[a]:cumulative catches used in Leslie Analysis

Table 5. Catch and effort statistics for the snow crab fishery in Trinity Bay (Outer portion, Area 22), Newfoundland, 1980.

Two-Week period	Effort (Trap hauls)	Cumulative effort	CPUE kg/trap haul	Catch M.T.	Cumulative catch M.T.	Estimated biomass (CPUE/q) M.T.
May 5-17	100	100	2.6	0.26	0.26	208.17
May 19-31	300	400	17.2	5.17	5.43	1377.10
June 2-14	1335	1735	11.4	15.23	20.66[a]	912.73
June 16-28	10645	12380	10.0	106.04	126.70[a]	800.64
June 30-July 12	10540	22920	9.2	97.24	223.94[a]	736.59
July 14-26	5275	28195	8.6	45.45	269.39[a]	688.55
July 28-Aug. 9		FISHERY DISPUTE				
Aug. 11-23		FISHERY DISPUTE				
Aug. 25-Sept. 6	4650	32845	7.9	36.63	306.02[a]	632.51
Sept. 8-20	6400	39245	7.9	50.39	356.41[a]	632.51
Sept. 22-Oct. 4	5215	44460	6.5	33.88	390.29[a]	520.42
Oct. 6-18	4170	48630	5.9	24.63	414.92[a]	472.38
Oct. 20-Nov. 1	5490	54120	7.9	43.44	458.36	632.51
Nov. 3-15	2940	57060	9.4	27.60	485.96	752.60
Nov. 17-29	300	57360	9.3	2.80	488.76	744.60
Dec. 1-13	800	58160	6.1	4.87	493.63	488.39

$\bar{X}$ CPUE = 8.49 kg/trap haul

[a]: cumulative catches used in Leslie Analysis.

Table 6. Catch and effort statistics for the snow crab fishery in Trinity Bay (Inner portion, Area 20), Newfoundland, 1980.

Two-Week period	Effort (Trap hauls)	Cumulative effort	CPUE kg/trap haul	Catch M.T.	Cumulative catch M.T.	Estimated biomass (CPUE/q) M.T.
Apr. 21-May 3	650	650	13.3	8.67	8.67	INSUFFICIENT DATA
May 5-17	300	950	14.7	4.42	13.09	
May 19-31	300	1250	15.6	4.68	17.77	
June 2-14	450	1700	14.4	6.48	24.25	
June 16-28		FISHERY DISPUTE				
June 30-July 12		FISHERY DISPUTE				
July 14-26		FISHERY DISPUTE				
July 28-Aug. 9		FISHERY DISPUTE				
Aug. 11-23		FISHERY DISPUTE				
Aug. 25-Sept. 6		FISHERY DISPUTE				
Sept. 8-20	450	2150	9.2	4.16	28.41	
Sept. 22-Oct. 4	300	2450	12.1	3.62	32.03	
Oct. 6-18	300	2750	10.4	3.12	35.15	
Oct. 20-Nov. 1	600	3350	10.8	6.46	41.61	
Nov. 3-15	900	4250	16.2	14.60	56.21	
Nov. 17-29	300	4550	8.3	2.48	58.69	

$\bar{X}$ CPUE = 12.90 kg/trap haul

Table 7. Catch and effort statistics for the snow crab fishery in Conception Bay (Area 16), Newfoundland, 1980.

Two-Week period	Effort (Trap hauls)	Cumulative effort	CPUE kg/trap haul	Catch M.T.	Cumulative catch M.T.	Estimated biomass (CPUE/q) M.T.
Apr. 7-20	3491	3491	19.38	67.65	67.65	1257.63
Apr. 21-May 4	11617	15108	18.34	213.10	280.75	1190.14
May 5-18	8340	23448	14.31	119.38	400.13	928.62
May 19-June 1	2160	25608	20.01	43.22	443.35[a]	1298.51
June 2-15	3280	28888	16.48	54.04	497.39[a]	1069.44
June 16-29	1145	30033	15.76	18.05	515.44[a]	1022.71
June 30-July 13		FISHERY DISPUTE				
July 14-27		FISHERY DISPUTE				
July 28-Aug. 10		FISHERY DISPUTE				
Aug. 11-24		FISHERY DISPUTE				
Aug. 25-Sept. 7	1815	31848	14.95	27.14	542.58[a]	970.15
Sept. 8-21	4680	36528	13.83	64.73	607.31[a]	897.47
Sept. 22-Oct. 5	5540	42068	13.84	76.67	683.98[a]	898.12
Oct. 6-19	5585	47653	14.26	79.67	763.65[a]	925.37
Oct. 20-Nov. 2	4680	52333	14.02	65.60	829.25[a]	909.80
Nov. 3-16	3460	55793	9.67	33.45	862.70[a]	627.52
Nov. 17-30	600	56393	10.00	6.00	868.70	648.93

$\bar{X}$ CPUE = 15.00 kg/trap haul

[a]: cumulative catches used in Leslie Analysis

Table 8. Catch and effort statistics for the snow crab fishery in northeastern Avalon (Area 18), Newfoundland, 1980.

Two-Week period	Effort (Trap hauls)	Cumulative effort	CPUE kg/trap haul	Catch M.T.	Cumulative catch M.T.	Estimated biomass (CPUE/q) M.T.
Apr. 7-20	3600	3600	24.33	87.57	87.57	13902.86
Apr. 21-May 4	8930	12530	22.81	203.68	291.25	13034.29
May 5-18	22386	34916	20.63	461.72	752.97	11788.57
May 19-June 1	27510	62426	22.06	606.75	1359.72	12605.71
June 2-15	24870	87296	24.08	598.87	1958.59[a]	13760.00
June 16-29	16595	103891	22.20	368.42	2345.01[a]	12685.71
June 30-July 13	2210	106101	19.14	42.29	2387.30[a]	10937.14
July 14-27	910	107011	23.74	21.60	2408.90[a]	13565.71
July 28-Aug. 10		FISHERY DISPUTE				
Aug. 11-24	240	107251	28.29	6.79	2415.69	16165.71
Aug. 25-Sept. 7	22749	130000	18.54	421.82	2837.51[a]	10594.29
Sept. 8-21	28404	158404	19.31	548.51	3386.02[a]	11034.29
Sept. 22-Oct. 5	21100	179504	20.26	427.56	3813.58[a]	11577.14
Oct. 6-19	22258	201762	20.59	458.31	4271.89[a]	11594.29
Oct. 20-Nov. 2	22356	224118	20.07	448.74	4720.63[a]	11468.57
Nov. 3-16	9329	233447	19.66	183.44	4904.07[a]	11234.29
Nov. 17-30	1390	234837	14.35	19.95	4924.02[a]	8200.00
Nov. 31-Dec. 13	1580	236417	12.82	20.26	4944.28[a]	7325.71

$\bar{X}$ CPUE = 20.91 kg/trap haul

[a]: cumulative catches used in Leslie Analysis

Table 9. Catch and effort statistics for the snow crab fishery in Eastern Avalon (Area 14), Newfoundland, 1980.

Two-Week period	Effort (Trap hauls)	Cumulative effort	CPUE kg/trap haul	Catch M.T.	Cumulative catch M.T.	Estimated biomass (CPUE/q) M.T.
April 7-19	340	340	6.5	2.21	2.21	INSUFFICIENT DATA
April 21-May 3	300	640	12.9	3.88	6.09	
May 5-17	580	1220	17.9	10.39	16.48	
May 19-31	1700	2920	19.8	33.60	50.09	
June 2-14	1120	4040	27.3	30.58	80.67	
June 16-28	980	5020	21.2	20.77	101.44	
June 30-July 12	120	5140	42.4	5.09	106.53	
July 14-26		FISHERY DISPUTE				
July 28-Aug. 9		FISHERY DISPUTE				
Aug. 11-23		FISHERY DISPUTE				
Aug. 25-Sept. 6		FISHERY DISPUTE				
Sept. 8-20	480	5620	16.2	7.77	114.30	
Sept. 22-Oct. 4	240	5860	27.3	6.55	120.85	

$\bar{X}$ CPUE = 20.62 kg/trap haul

Table 10. Catch and effort statistics for the snow crab fishery in Southeastern Avalon (Area 12), Newfoundland, 1980.

Two-Week period	Effort (Trap hauls)	Cumulative effort	CPUE kg/trap haul	Catch M.T.	Cumulative catch M.T.	Estimated biomass (CPUE/q) M.T.
April 7-19	1160	1160	29.7	34.41	34.41	255.81
April 21-May 3	770	1930	28.0	21.53	55.94	241.17
May 5-17	1480	3410	23.6	34.96	90.90	203.27
May 19-31	1455	4865	27.4	39.87	130.77	236.00
June 2-14	1320	6185	30.1	39.68	170.45[a]	259.59
June 16-28	1360	7545	24.6	33.43	203.88[a]	211.89
June 30-July 12		FISHERY DISPUTE				
July 14-26		FISHERY DISPUTE				
July 28-Aug. 9		FISHERY DISPUTE				
Aug. 11-23		FISHERY DISPUTE				
Aug. 25-Sept. 6	480	8025	12.9	6.17	210.05[a]	111.11
Sept. 8-20	1620	9645	13.1	21.25	231.30[a]	112.83
Sept. 22-Oct. 4	1180	10825	16.3	19.24	250.54[a]	140.40
Oct. 6-18	1500	12325	15.1	22.67	273.21[a]	130.06
Oct. 20-Nov. 1	840	13165	14.2	11.93	285.14[a]	122.31
Nov. 3-15	660	13825	10.4	6.83	291.97[a]	89.58

$\bar{X}$ CPUE = 21.12 kg/trap haul

[a]: cumulative catches used in Leslie Analysis

Table 11 Catch and effort statistics for the snow crab fishery in White Bay (Area 36), Newfoundland, 1980.

Two-Week period	Effort (Trap hauls)	Cumulative effort	CPUE kg/trap haul	Catch M.T.	Cumulative catch M.T.	Estimated biomass (CPUE/q) M.T.
May 19-31	197	197	11.4	2.25	2.25	240.71
June 2-14	1144	1341	13.3	15.27	17.52[a]	280.83
June 16-28	358	1699	13.3	4.78	22.30[a]	280.83
June 30-July 12		FISHERY DISPUTE				
July 14-26	100	1799	14.00	1.4	23.70	295.61
July 28-Aug. 9		FISHERY DISPUTE				
Aug. 11-23	150	1949	12.7	1.9	25.60	540.54
Aug. 25-Sept. 6	2955	4904	9.0	26.47	52.07[a]	190.03
Sept. 8-20	2777	7681	9.3	25.83	77.90[a]	196.37
Sept. 22-Oct. 4	2568	10249	9.7	25.00	102.90[a]	204.81
Oct. 6-18	2692	12941	7.7	20.73	123.63[a]	162.59
Oct. 20-Nov. 1	2843	15784	7.1	20.27	143.90[a]	149.92
Nov. 3-15	1630	17414	7.3	11.94	155.84[a]	154.14
Nov. 17-29	450	17864	4.3	1.93	157.78[a]	90.79

$\bar{X}$ CPUE = 8.83 kg/trap haul

[a]: cumulative catches used in Leslie Analysis

Table 12. Catch and effort statistics for the snow crab fishery off the Horse Islands (Area 34), Newfoundland, 1980.

Two-Week period	Effort (Trap hauls)	Cumulative effort	CPUE kg/trap haul	Catch M.T.	Cumulative catch M.T.	Estimated biomass (CPUE/q) M.T.
May 19-31	510	510	13.0	6.62	6.62	59.88
June 2-14	400	910	24.3	9.73	16.35[a]	111.93
June 16-28	FISHERY DISPUTE					
June 30-July 12	FISHERY DISPUTE					
July 14-26	150	1060	18.9	2.83	19.18[a]	87.06
July 28-Aug. 9	FISHERY DISPUTE					
Aug. 11-23	300	1360	16.0	4.81	23.99[a]	73.70
Aug. 25-Sept. 6	1900	3260	12.0	22.81	46.80[a]	55.27
Sept. 8-20	1690	4950	11.0	18.54	65.34[a]	50.53
Sept. 22-Oct. 4	1140	6090	9.2	10.43	75.77[a]	42.15
Oct. 6-18	740	13120	17.1	12.69	88.46	78.77
Oct. 20-Nov. 1	200	7030	13.7	2.75	91.21	63.11
Nov. 3-15	306	7330	14.3	4.38	95.59	65.87

$\bar{X}$ CPUE = 13.04 kg/trap haul

[a]: Cumulative catches used in Leslie Analysis.

Table 13 Catch and effort statistics for the snow crab fishery in Notre Dame Bay (Area 32), Newfoundland, 1980.

Two-Week period	Effort (Trap hauls)	Cumulative effort	CPUE kg/trap haul	Catch M.T.	Cumulative catch M.T.	Estimated biomass (CPUE/q) M.T.
May 5-17	500	500	13.4	6.70	6.70[a]	807.23
May 19-31	4115	4615	11.2	45.89	52.59[a]	674.70
June 2-14	4460	9075	12.0	53.35	105.94[a]	722.89
June 16-28	1530	10605	12.2	18.68	124.62[a]	734.94
June 30-July 12	3630	14235	9.0	32.78	157.40[a]	542.17
July 14-26	225	14460	16.0	3.61	161.01	963.86
July 28-Aug. 9	300	14760	17.0	5.09	166.10	1024.10
Aug. 11-23		FISHERY DISPUTE				
Aug. 25-Sept. 6		FISHERY DISPUTE				
Sept. 8-20		FISHERY DISPUTE				
Sept. 22-Oct. 4	4605	19365	9.3	42.61	208.71[a]	560.24
Oct. 6-18	5435	24800	9.3	50.47	259.18[a]	560.24
Oct. 20-Nov. 1	5825	30625	8.6	50.23	309.41[a]	518.07
Nov. 3-15	858	31483	8.5	7.30	316.71[a]	512.05
Nov. 17-29	1778	33261	6.2	10.94	327.65[a]	373.49

$\bar{X}$ CPUE = 9.85 kg/trap haul

[a]: cumulative catches used in Leslie Analysis

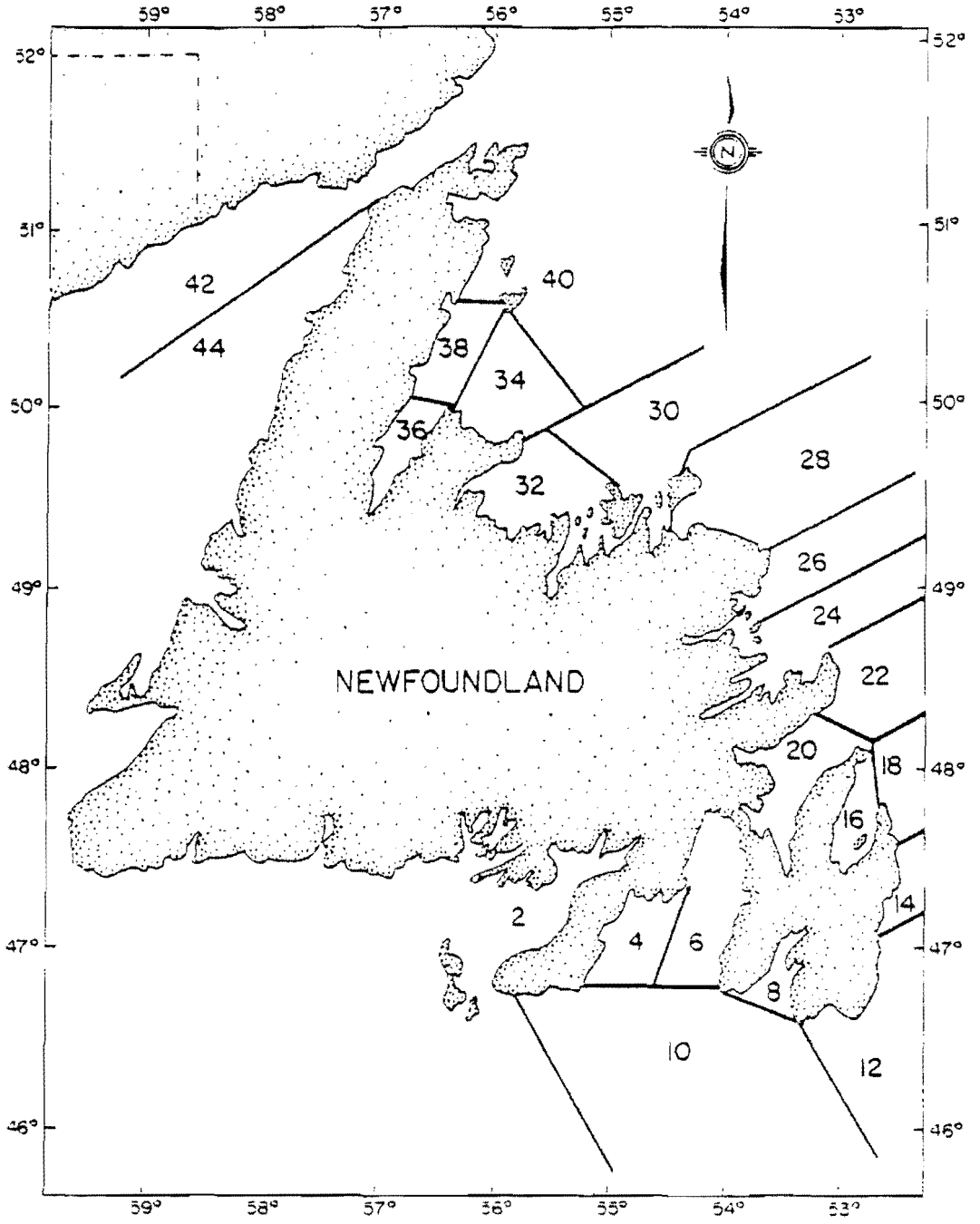

Fig. 1. Newfoundland snow crab management areas (after Miller, unpublished).

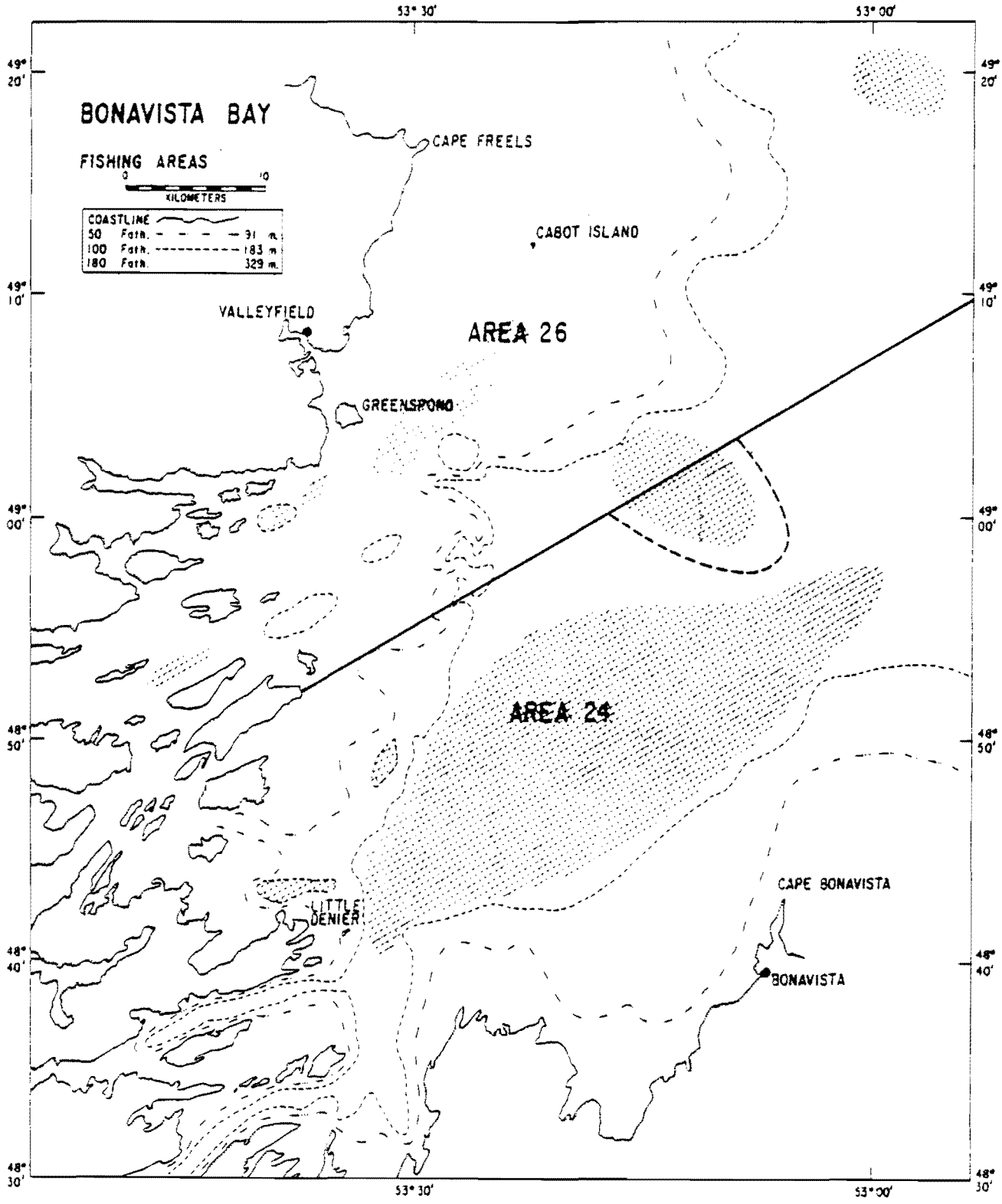

Fig.2 Snow crab fishing areas in Bonavista Bay, 1980. Note Dashed line indicates a portion of Area 24 which should be included in Area 26.

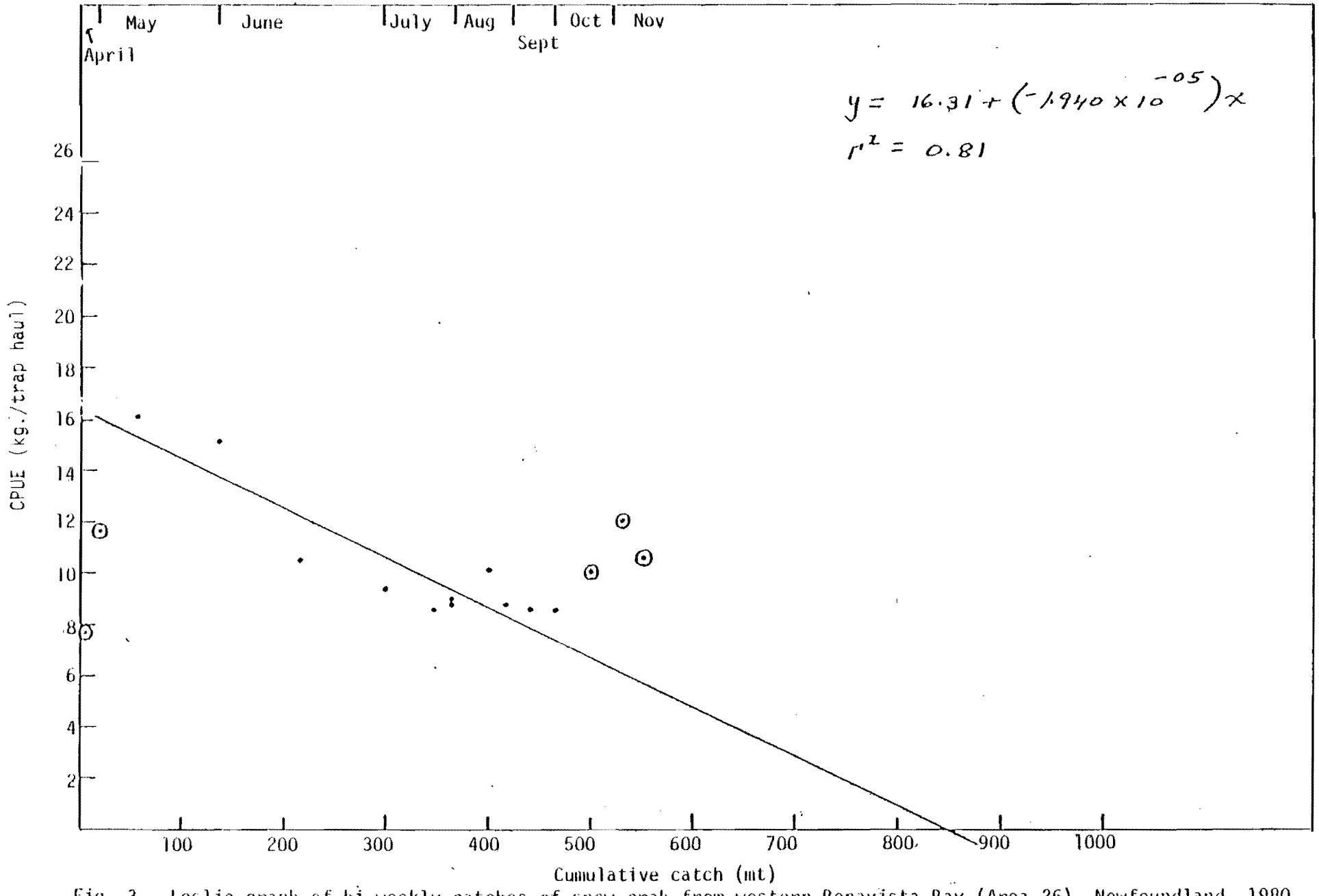

Fig. 3. Leslie graph of bi-weekly catches of snow crab from western Bonavista Bay (Area 26), Newfoundland, 1980.

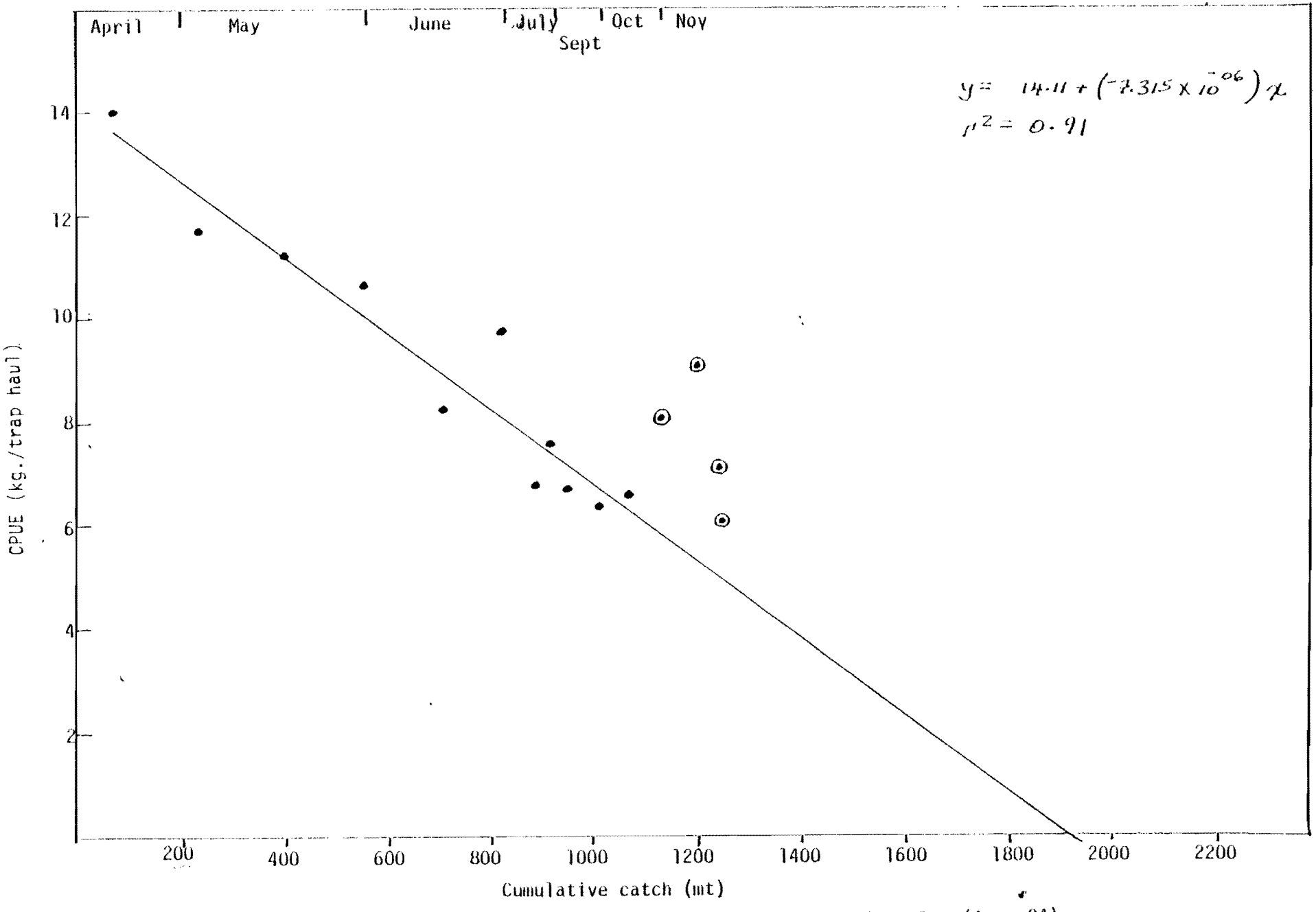

Fig. 4. Leslie graph of bi-weekly catches of snow crab from eastern Bonavista Bay (Area 24), Newfoundland, 1980.

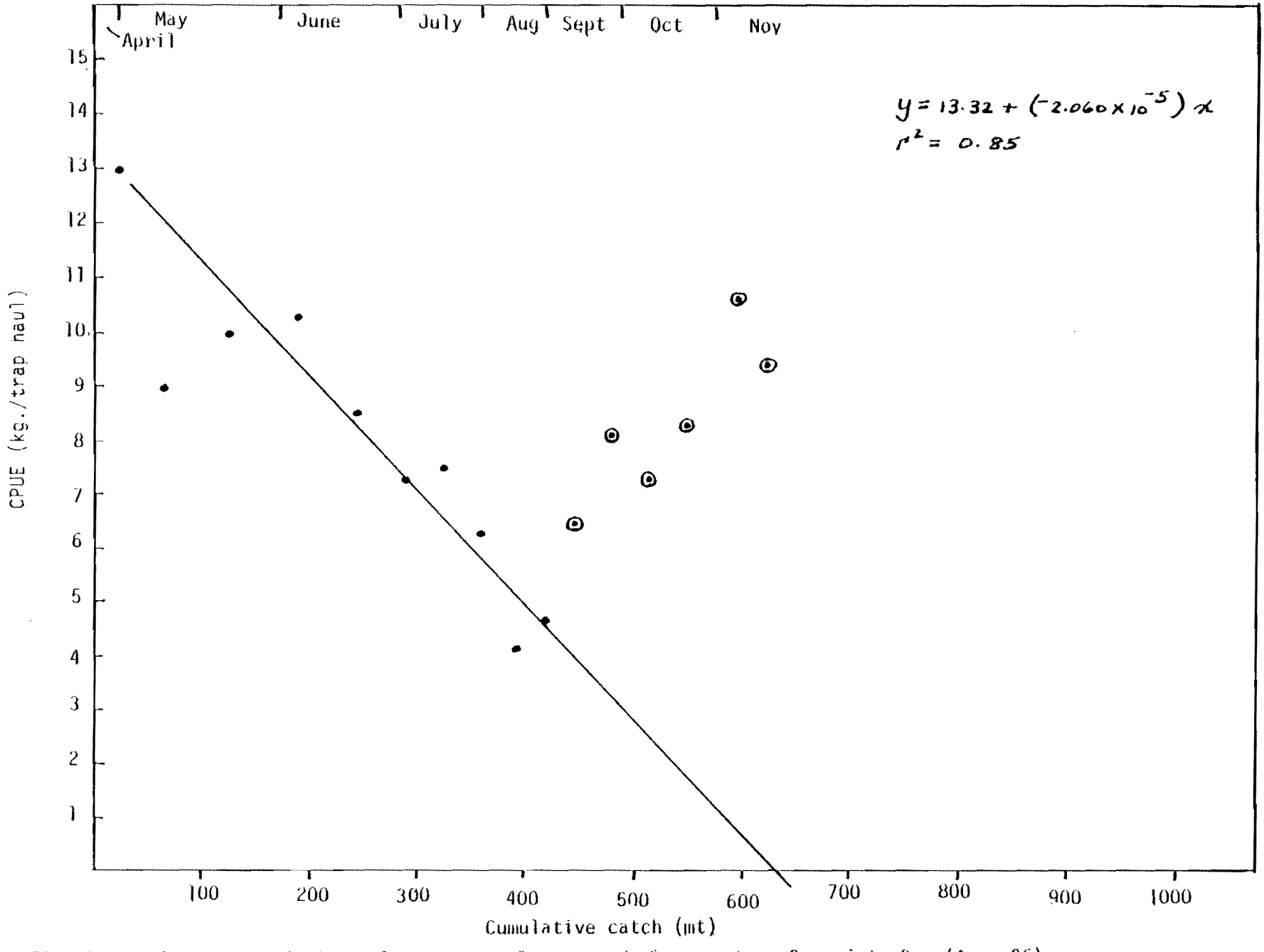

Fig. 5. Leslie graph of bi-weekly catches of snow crab from western Bonavista Bay (Area 26), Newfoundland, 1981.

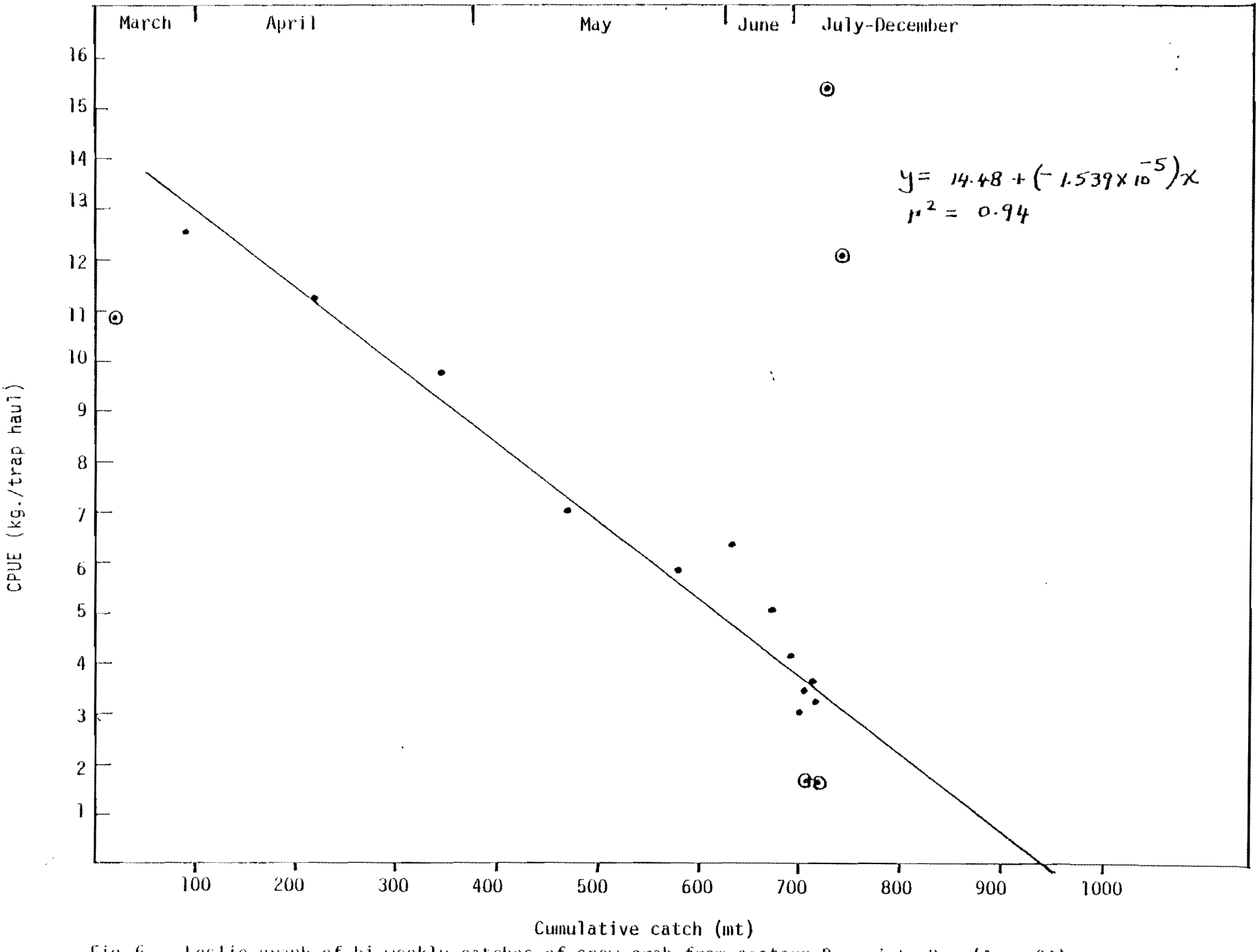

Fig. 6. Leslie graph of bi-weekly catches of snow crab from eastern Bonavista Bay (Area 24), Newfoundland, 1981.

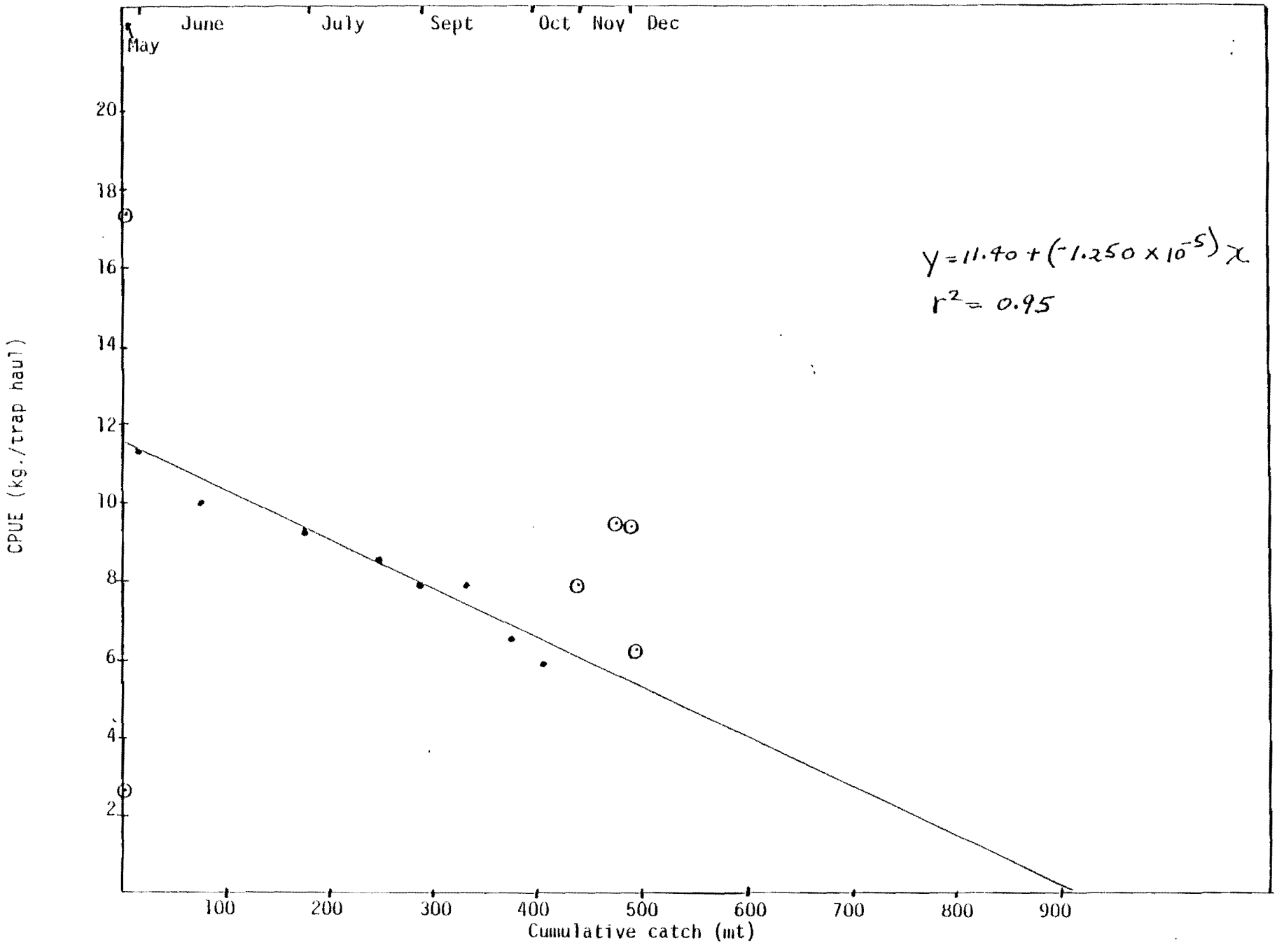

Fig. 7 . Leslie graph of bi-weekly catches of snow crab from outer Trinity Bay (Area 22), Newfoundland, 1980.

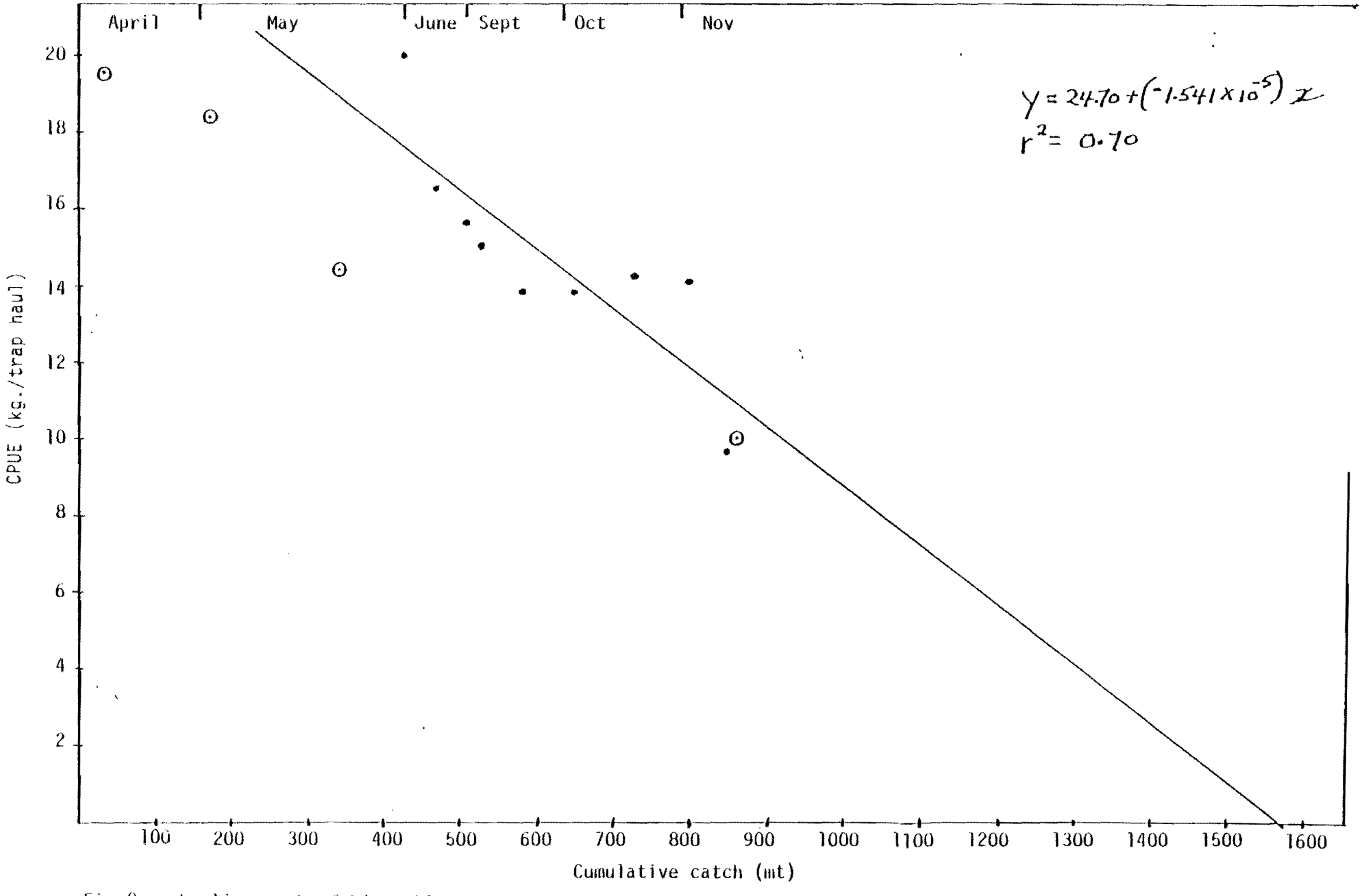

Fig. 8 . Leslie graph of bi-weekly catches of snow crab from Conception Bay (Area 16), Newfoundland, 1980.

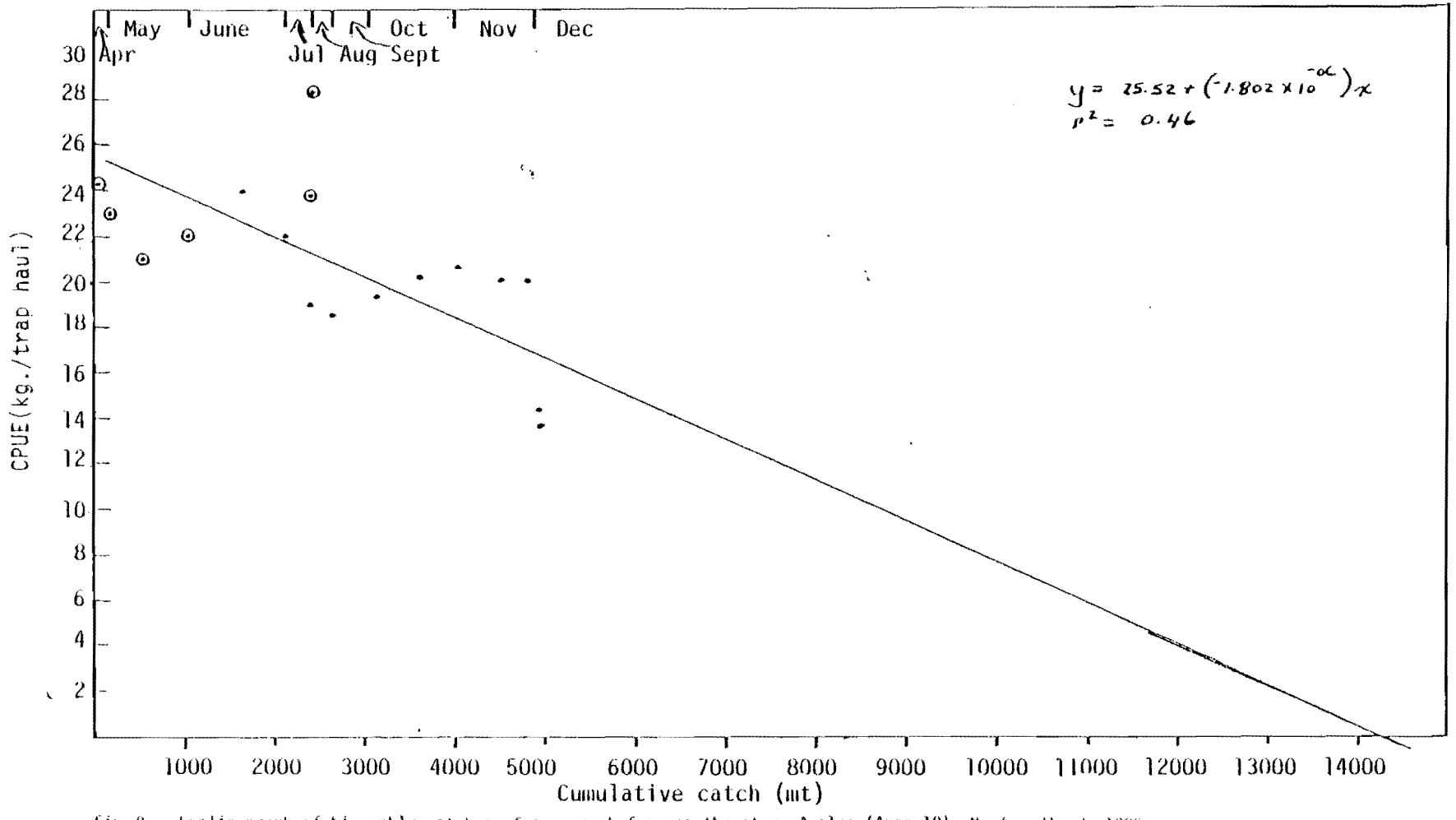

Fig. 9. Leslie graph of bi-weekly catches of snow crab from northeastern Avalon (Area 18), Newfoundland, 1980.

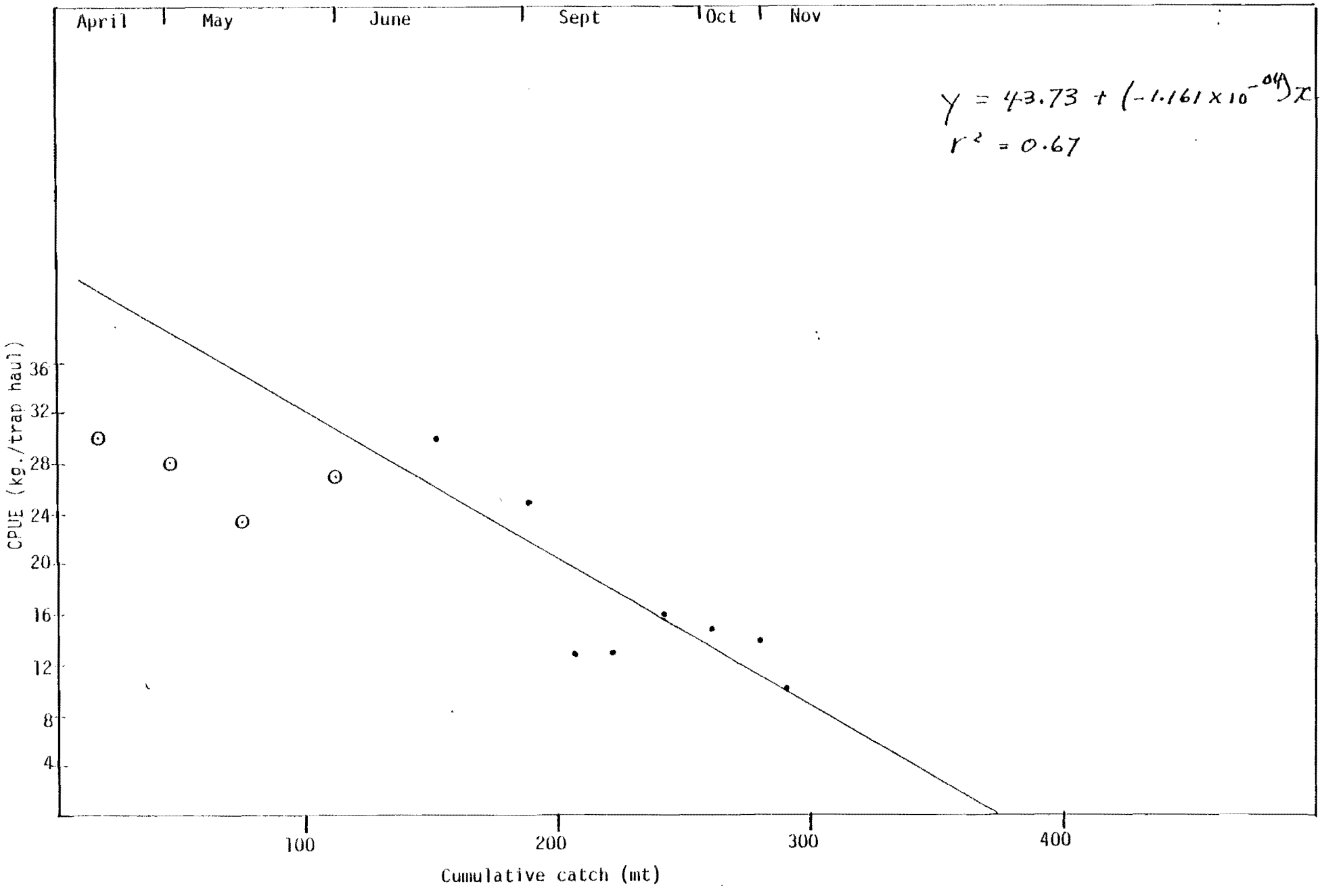

Fig. 10. Leslie graph of bi-weekly catches of snow crab from southeastern Avalon (Area 12), Newfoundland, 1980.

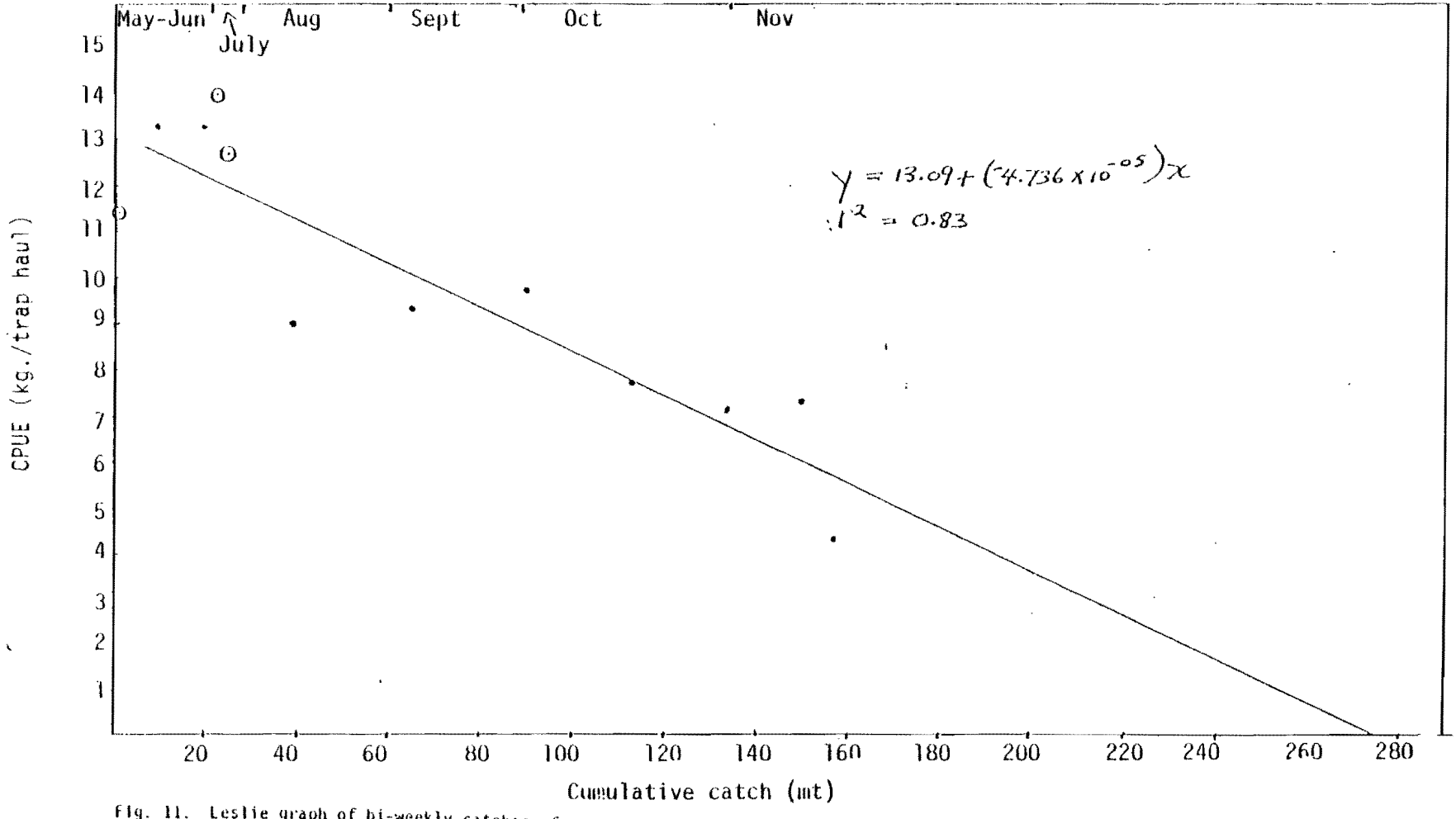

Fig. 11. Leslie graph of bi-weekly catches of snow crab from White Bay (area 36) Newfoundland 1980.

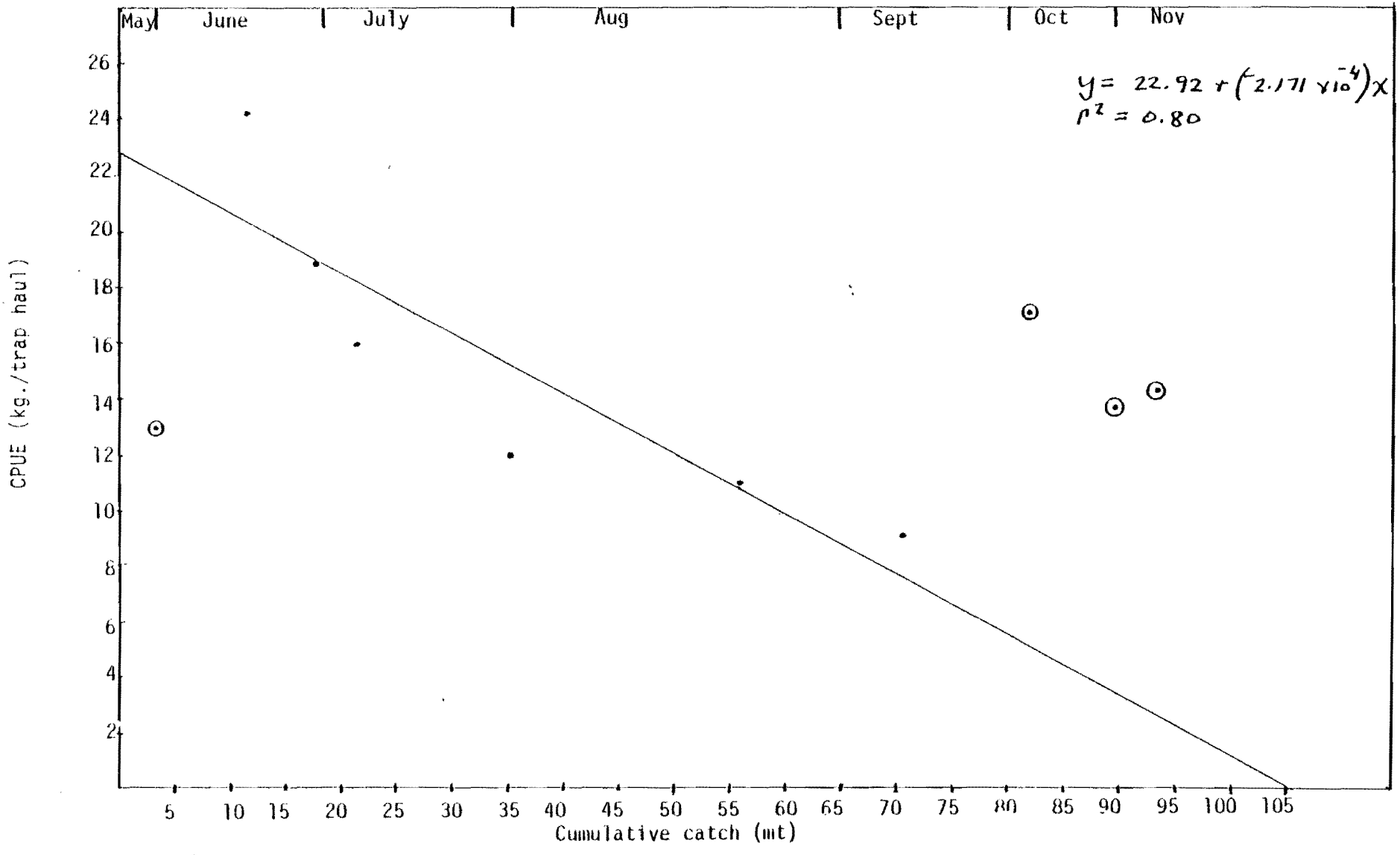

Fig. 12. Leslie graph of bi-weekly catches of snow crab from the Horse Islands (Area 34), Newfoundland, 1980.

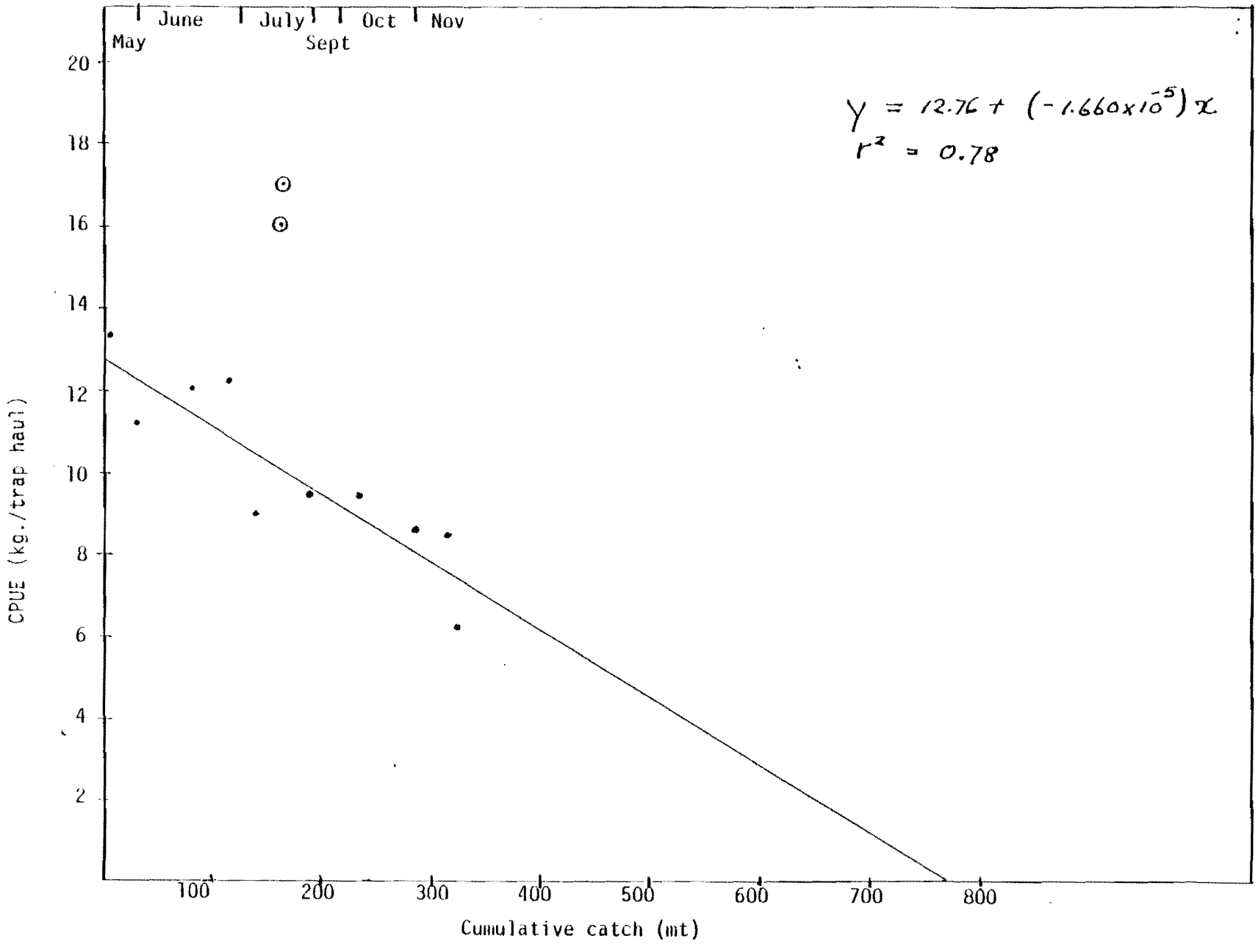

Fig. 13. Leslie graph of bi-weekly catches of snow crab from Notre Dame Bay (Area 32), Newfoundland, 1980.