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Assessment of Snow Crab (Chionoecetes opilio)  
Stocks in Newfoundland for 1981

by

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## ABSTRACT

Population size estimates for snow crab (Chionoecetes opilio) off the east coast of Newfoundland, based on Leslie and Petersen mark recapture analyses are presented. Within given crab management areas, estimates of population size ranged from 504 to 11,289 MT and exploitation rates from 35 to 73%.

## RÉSUMÉ

Nous présentons des estimations d'effectifs de populations de crabe des neiges (Chionoecetes opilio) au large de la côte est de Terre-Neuve, estimations fondées sur des analyses des recaptures de marques de Leslie et Petersen. Ces estimations varient de 504 à 11 289 tm selon la zone de gestion; quant aux taux d'exploitation, ils se situent entre 35 et 73 pour cent.

## INTRODUCTION

After a year of poor market conditions and long labour disputes, the Newfoundland snow crab fishery made a strong recovery in 1981 with total landings of ~14,000 MT. Increased demand for snow crab as well as increased processing capacity are largely responsible for this increase in landings.

As in previous assessments (Taylor and O'Keefe 1981; 1983) commercial biomass available in each management area (Fig. 1) has been calculated, where possible, using Leslie analysis and Petersen's mark recapture method.

## MATERIALS AND METHODS

Information was obtained from individual fishermen's logbooks and verified by examination of processors sales slips. From these data CPUE and cumulative catch were calculated for each management area. Summaries of the weekly catch/effort data for most management areas are given and Leslie graphs of bi-weekly catches for most management areas are found in Fig. 2-10.

In areas where tagging was conducted (Areas 18, 24 and 26) the methodology as described by Taylor and O'Keefe (1981) was followed exactly.

## RESULTS AND DISCUSSION

### SOUTHERN ZONE

#### Areas 26 Western Bonavista Bay

Historical data on landings (MT), mean CPUE (kg/trap haul) and effort (trap hauls) are summarized below. A graph of Leslie analysis is depicted in Fig. 2 while a summary of bi-weekly catch/effort data is presented in Table 2.

|          | 1973 | 1974 | 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 |

#### 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 |

1981 data for these management areas have been presented previously (Taylor and O'Keefe 1983). Both areas have exceeded the exploitation rates recommended by CAFSAC (Taylor and O'Keefe 1983). As in 1980 the fishery virtually collapsed in June in both Area 24 and Area 26.  $\bar{X}$  CPUE in both Area 26 and Area 24 was 8 kg/trap. For a summary of Leslie analysis and catch/effort data see Fig. 3 and Table 3.

Effort in this area was substantially reduced in 1981 due to the discovery of a significant snow crab resource in Area 19. Vessels from Bonavista Bay began to fish in Area 19 at a high level of activity for much of the remainder of the fishing season. Although a "spaghetti" tagging program was carried out in Areas 24 and 26 during 1981 calculation of a biomass based on Petersen's mark-recapture method was impractical due to the shift in effort away from Bonavista Bay to Area 19. Many tagged animals that would have been recaptured probably moulted and lost their tags making Petersen's analysis impractical.

#### Area 20 - Trinity Bay

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  | 1981   |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|--------|
| Landings | 48    | 31    | 16    | 45    | 63    | 56    | 67    | 59    | 110    |
| CPUE     | 14.5  | 11.3  | 10.4  | 11.3  | 9.5   | 17.2  | 16.0  | 12.9  | 6.9    |
| Effort   | 3,305 | 2,716 | 1,494 | 3,926 | 6,647 | 3,249 | 4,165 | 4,550 | 15,790 |

In 1981 very little fishing effort was expended in this area with only three vessels fishing there late in the season. Although effort increased threefold over 1979 and 1980; CPUE was reduced to its lowest recorded level. Fishermen presently restrict their activity to the mouth of the Bay; however, early exploratory fishing cruises conducted during the late 1960's and early 1970's found commercial quantities of crab at the head of this bay. It is apparent that if fishermen wish to continue fishing in this area profitably they will have to expand their fishing grounds.

Data for this area are insufficient for Leslie Analysis.

#### Area 16 - Conception Bay

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   | 1981   |
|----------|------|--------|-------|-------|--------|-------|--------|--------|--------|
| Landings | 779  | 235    | 46    | 56    | 174    | 81    | 464    | 868.7  | 502    |
| CPUE     | -    | 6.8    | 5.0   | 9.1   | 8.6    | 10.9  | 16.1   | 15.4   | 11.5   |
| Effort   | -    | 34,492 | 9,152 | 6,205 | 20,171 | 7,414 | 28,845 | 56,393 | 43,546 |

In 1981 the fishery in this area began in mid-February. CPUE was initially quite high, 23.5 kg/trap haul. However, even though effort was reduced (see Table 4) X CPUE also fell.

Leslie analysis of the 1981 data for this management area provides a usable biomass of 689.3 MT with 95% confidence limits of 618.9 MT and 747.4 MT;  $r^2 = 0.85$ ;  $q = -3.074 \times 10^{-5}$  (Fig. 4).

Problems experienced with soft shelled crab during the latter part of the 1981 fishing season caused some fishermen to transfer effort from Conception Bay to Area 18.

Exploitation rates have risen steadily in this area: 1979 - 35%; 1980 - 55%; peaking in 1981 at 73%. This level of exploitation exceeds that recommended by CAFSAC and effort should therefore be reduced to 1979 levels.

#### Area 18 - Northeastern Avalon

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    | 1981    |
|----------|--------|--------|--------|--------|---------|---------|---------|---------|---------|
| Landings | 803    | 473    | 181    | 444    | 1,480   | 3,646   | 6,870   | 4,944   | 6,769   |
| CPUE     | 15.9   | 6.4    | 6.4    | 10.4   | 13.2    | 13.6    | 17.2    | 20.91   | 16.4    |
| Effort   | 50,736 | 74,428 | 28,442 | 42,596 | 112,522 | 267,933 | 398,939 | 236,417 | 413,815 |

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 tend to be larger than those in other areas and have a much greater catching capacity than is indicated by their daily landings. A total of 24 vessels presently fish in this area.

The upswing in markets in 1981 meant increased plant-imposed vessel-quotas for the crab fleet making fishing in the offshore area economically attractive. Much of the effort expended in Area 16 in 1980 was transferred to Area 18 in 1981.

Leslie analysis of the data for this area provides a usable biomass (B) of 11,289.3 MT with 95% confidence limits of 909.6 MT and 17,067.4 MT;  $r^2 = 0.83$ ;  $q = -2.248 \times 10^{-6}$  (Fig. 5). The 1981 exploitation rate was 60%; as compared to 44% in 1979 and 35% in 1980. It appears that effort in this area has reached

the optimum level and should not exceed 1981 levels. A summary of the 1981 catch/effort statistics for this management area is provided in Table 5.

#### PETERSEN'S ESTIMATE

During March and April of 1981 a total of 2437 legal sized snow crab were tagged using Floy vinyl "Spaghetti" tags and released at 17 randomly selected stations on the commercial fishing grounds.

Tagging locations were depth stratified in order to ensure that all animals were released in depths > 170 mm. All tagging was conducted in exactly the same manner as that described for previous tagging studies (Taylor and O'Keefe 1981). A total of 1460 (60%) tags were returned by commercial fishermen or processing plant employees during 1981. As in previous snow crab tagging studies, these data were used to calculate a biomass estimate using Petersen's mark recapture methodology;

$$B = \frac{(M) (N)}{m} \quad (1)$$

where:

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

N = the number of animals examined for marks in the second sample (total catch of crab 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 when  $m > 50$  are calculated  $m \pm 1.92 \pm 1.96 \sqrt{m+1}$ ; Ricker (1975). Solved for m, the value is re-entered into equation (1).

The snow crab population in the northwestern Avalon area is calculated by:

$$\begin{aligned} B &= \frac{(M) (N)}{m} \\ &= \frac{(2437) (6,577,795)}{1460} \\ &= 10,979,511 \text{ kg (10,980 MT)} \end{aligned}$$

with 95% confidence limits of 10,430,569 kg (10,431 MT) and 11,557,364 kg (11,557 MT). Since 191,334 kg were landed prior to commencement of tagging, initial biomass is calculated as 10,979,511 kg + 191,334 kg = 11,170,845 kg (11,171 MT). Using the Robson and Regier (1974) criteria that (M) (N) must exceed 4 times the estimated population size B (in this case based on Leslie analysis) we find the Petersen's estimate for this area is unbiased (1375 B).

### Area 14 - Eastern Avalon

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  | 1981   |
|----------|------|--------|--------|--------|--------|--------|--------|-------|--------|
| Landings | 49   | 366    | 659    | 655    | 167    | 824    | 762    | 120.9 | 434    |
| CPUE     | -    | 8.2    | 9.1    | 11.3   | 9.9    | 15.9   | 20.1   | 20.6  | 16.0   |
| Effort   | -    | 44,840 | 72,589 | 57,718 | 16,761 | 51,888 | 37,950 | 5,860 | 27,113 |

In 1981 effort in this area increased markedly as did landings. This was due in large part to the opening of a new crab processing plant in St. Mary's, a community very close to these grounds. Data obtained from log books indicates that in 1981 fishermen fished a greater area than they had previously. This is perhaps why (although landings increased by a factor of four)  $\bar{X}$  CPUE was still quite acceptable. A summary of bi-weekly catch/effort data is provided in Table 6.

Leslie analysis based on 1981 log books provides a usable biomass of 614.3 MT with 95% confidence limits of 506.1 MT and 1,043 MT;  $r^2 = 0.64$ ;  $q = -5.115 \times 10^{-5}$  (Fig. 6). Exploitation rates for this area have not changed significantly since 1979, 71% in 1981, 70% in 1980.

As the effort in this area has increased, so too have the number of reports of soft shell occurrence. It is felt that the grounds are presently fully exploited and further increases in effort should be avoided. In fact, if catch rates again decrease significantly in 1982, effort should be reduced.

### Area 12 - Southeastern Avalon

|          | 1973 | 1974   | 1975   | 1976   | 1977   | 1978   | 1979 | 1980   | 1981   |
|----------|------|--------|--------|--------|--------|--------|------|--------|--------|
| Landings | 547  | 749    | 337    | 212    | 457    | 276    | -    | 292    | 854    |
| CPUE     | -    | 13.6   | 8.6    | 16.8   | 14.9   | 14.1   | -    | 21.1   | 18.8   |
| Effort   | -    | 55,045 | 39,153 | 12,643 | 30,562 | 19,643 | -    | 13,825 | 45,455 |

The increased CPUE in this area in 1980 is probably the result of the lack of fishing activity in 1979. A summary of bi-weekly catch/effort data is provided in Table 7.

The high catch rates in 1980 appear to have given fishermen incentive to increase both the effort expended and the grounds fished in this area.

Leslie analysis of log book data provides a usable biomass of 1,291 MT with 95% confidence limits of 1,114 MT and 1,639 MT;  $r^2 = 0.88$ ;  $q = -2.526 \times 10^{-5}$  (Fig. 7).

The 1981 exploitation rate for snow crab stocks in this area was 66% down from the 78% experienced in 1980. This reduction in exploitation rate for 1981

is probably a function of fishermen expanding their fishing grounds and encountering new unfished populations of crabs.

#### Area 8 - St. Mary's Bay

In 1981, very little fishing effort was expended in St. Mary's Bay (11,150 trap hauls) landings were very low (167.7 MT) but  $\bar{X}$  CPUE was quite acceptable (15.0 kg/trap haul).

Data are insufficient to perform Leslie analysis for this area.

#### Area 6 - Eastern Placentia Bay

Although this area was heavily fished when the crab fishery began, the resource has been largely ignored. Recent exploratory surveys carried out by the Provincial Department of Fisheries have been very disappointing. Crab in this area are old, small and difficult to process.

In 1981 only 31.8 MT were landed from this area from 2,120 trap hauls.  $\bar{X}$  CPUE was 15.0 kg/trap haul.

Despite the high CPUE processors refused to purchase crab from this area and fishermen abandoned the grounds.

#### Northern Zone

##### Area 36 - White Bay

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   | 1981   |
|----------|------|------|------|------|-------|------|--------|--------|--------|
| Landings | 62   | -    | 45   | 48   | 52    | 169  | 156    | 158    | 230    |
| CPUE     | -    | -    | -    | -    | 16.3  | -    | 7.3    | 8.8    | 11.6   |
| Effort   | -    | -    | -    | -    | 3,210 | -    | 21,298 | 17,864 | 19,840 |

In 1981 a new processing plant opened in Jackson's Arm. This resulted in individual vessels being given higher daily "quotas" due to the increased processing capacity. A vessel which had traditionally fished White Bay, shifted its effort to the Horse Islands area leaving extra fishing grounds for those remaining which resulted in an increased CPUE in 1981. A summary of bi-weekly catch/effort data is provided in Table 8.

Leslie analysis of the log book data for this area provides a usable biomass (B) of 503.7 MT with 95% confidence limits of 402.8 MT and 710.1 MT;  $r^2 = 0.85$ ,  $q = 3.095 \times 10^{-5}$  (Fig. 8).



The exploitation rate for this area in 1981 was 46%. This is somewhat reduced from the 1980 level of exploitation even though landings are substantially higher, which is perhaps indicative of a high level of recruitment between the 1980 and 1981 fishing seasons.

#### Area 34 - Horse Islands

|          | 1973 | 1974 | 1975 | 1976 | 1977  | 1978 | 1979   | 1980  | 1981   |
|----------|------|------|------|------|-------|------|--------|-------|--------|
| Landings | -    | 46   | 347  | 92   | 62    | 98   | 141    | 96    | 322    |
| CPUE     | -    | -    | -    | -    | 9.1   | -    | 11.9   | 14.3  | 16.7   |
| Effort   | -    | -    | -    | -    | 6,842 | -    | 11,830 | 7,330 | 19,250 |

In 1981, three vessels fished this area. Fishing was conducted up to 12 nautical miles northeast of the outer island. Much of the grounds fished in 1981 are virgin grounds and catch rates are higher than those experienced in 1979 and 1980. As a result of the excellent market conditions in 1981 and the opening of the new processing plant in Jackson's Arm both effort and landings approximately tripled from 1980 levels. A summary of bi-weekly catch/effort data is provided in Table 9.

Leslie analysis of log book data provides a usable biomass (B) 604.1 MT with 95% confidence limits of 501.7 MT and 792.3 MT;  $r^2 = 0.90$ ;  $q = 3.842 \times 10^{-5}$  (Fig. 9).

Due to the great expansion of commercially fished grounds, the exploitation rate has dropped from 91% in 1980 to a more acceptable level of 53% in 1981.

#### Area 32 - Notre Dame Bay

|          | 1973 | 1974 | 1975 | 1976 | 1977   | 1978   | 1979   | 1980   | 1981   |
|----------|------|------|------|------|--------|--------|--------|--------|--------|
| Landings | 83   | 49   | 117  | 173  | 232    | 340    | 491    | 374    | 650    |
| CPUE     | -    | -    | -    | -    | 6.4    | 8.7    | 10.6   | 9.9    | 11.9   |
| Effort   | -    | -    | -    | -    | 36,477 | 39,008 | 46,183 | 33,261 | 54,416 |

In 1979 and 1980 fishermen generally restricted themselves to fishing their traditional grounds. However, in 1981 increased demand for crab from the processor in Little Bay Islands provided the incentive for two vessels to fish more distant grounds. CPUE was slightly higher than in the two previous years and landings rose appreciably. A summary of bi-weekly catch/effort data is provided in Table 10.

Leslie analysis of log book data for this area provides a usable biomass (B) of 1,845.5 MT with 95% confidence limits of 1,193.4 MT and 6,614.5 MT;  $r^2 = 0.63$ ;  $q = 8.125 \times 10^{-6}$  (Fig. 10). CPUE in this area was very stable (probably a reflection of the outward expansion of the fishing fleet) over the

course of the season, making Leslie analysis difficult as evidenced by the wide confidence limits. Although effort and landings have increased over 1979 and 1980 levels, the 1981 exploitation rate dropped to 35% compared to 56% in 1979 and 43% in 1980.

#### New Fishing Areas

In 1981 fishing commenced in two previously unexploited areas; area 15, approximately 40-50 nautical miles due east of St. John's, and Area 19, approximately 60-100 nautical miles northeast of St. John's, (Fig. 1). Fishing began in Area 15 during the late summer and early fall, while in Area 19, vessels from Area 24 began fishing in June.

#### Area 15 - Danger Zone

This area (Fig. 1) is situated southwest of the main fishing grounds in Area 18. It is fortuitous that fishing even started here as the water is much more shallow than fishermen used to deem necessary for commercial concentrations of crab.

#### Area 19 - Northeastern Grand Banks

Fishermen from Area 24 first began fishing in 1981 after the fishery on their traditional grounds collapsed. Catch rates in 1981 were quite high, often exceeding 50 kg/trap haul. These high catch rates attracted many fishermen from Area 18 and as a result landings from this area reached 1,796 t.

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Table 1. Summary of catch/effort data for the Newfoundland snow crab fishery, 1981.

| Management area | Effort (trap hauls) | Landings (MT) | X CUPE (kg/trap haul) | Biomass (MT) | Exploitation rate (%) |
|-----------------|---------------------|---------------|-----------------------|--------------|-----------------------|
| 6               | 2,120               | 31.8          | 15.0                  | -            | -                     |
| 8               | 11,150              | 167.8         | 15.0                  | -            | -                     |
| 12              | 45,455              | 853.7         | 18.8                  | 1,290.5      | 66                    |
| 14              | 27,113              | 434.4         | 16.0                  | 614.3        | 71                    |
| 15              | 18,128              | 404.3         | 22.3                  | -            | -                     |
| 16              | 43,546              | 502.0         | 11.5                  | 689.0        | 73                    |
| 18              | 413,815             | 6,769.1       | 16.4                  | 11,289.3     | 60                    |
| 19              | 64,208              | 1,795.6       | 28.0                  | -            | -                     |
| 20              | 15,970              | 110.3         | 6.9                   | -            | -                     |
| 24              | 92,435              | 741.0         | 8.0                   | 941.0        | 79                    |
| 26              | 79,250              | 635.0         | 8.0                   | 646.8        | 98                    |
| 32              | 54,416              | 649.5         | 11.9                  | 1,845.5      | 35                    |
| 34              | 19,250              | 321.8         | 16.7                  | 604.1        | 53                    |
| 36              | 19,840              | 230.3         | 11.6                  | 503.7        | 46                    |
| Totals          | 906,696             | 13,646.6      |                       |              |                       |

Table 2. Catch and effort statistics for the snow crab fishery in western Bonavista Bay (Area 26). Newfoundland 1981.

| Two-week period  | Effort<br>trap hauls | Cumulative<br>effort | CPUE<br>kg/trap haul | Catch<br>(mt) | Cumulative<br>catch (mt) | Estimated<br>biomass<br>(mt) (CPUE/q) |
|------------------|----------------------|----------------------|----------------------|---------------|--------------------------|---------------------------------------|
| Mar. 30-Apr. 11  | 1,050                | 1,050                | 15.3                 | 16.11*        | 16.11                    | 742.72                                |
| Apr. 13-25       | 1,425                | 2,475                | 13.0                 | 18.55*        | 34.66                    | 631.07                                |
| Apr. 27-May 9    | 6,495                | 8,970                | 9.0                  | 58.70*        | 93.36                    | 436.89                                |
| May 11-23        | 6,565                | 15,535               | 10.0                 | 65.88*        | 159.24                   | 485.44                                |
| May 25-June 6    | 6,180                | 21,715               | 10.3                 | 63.46*        | 222.70                   | 500.00                                |
| June 8-20        | 5,315                | 27,030               | 8.5                  | 45.44*        | 268.14                   | 412.62                                |
| June 22-July 4   | 5,590                | 32,620               | 7.3                  | 40.89*        | 309.03                   | 354.37                                |
| July 6-18        | 4,530                | 37,150               | 7.5                  | 33.99*        | 343.02                   | 364.08                                |
| July 20-Aug. 1   | 6,075                | 43,225               | 6.3                  | 38.43*        | 381.45                   | 305.83                                |
| Aug. 3-15        | 6,175                | 49,400               | 4.2                  | 25.63*        | 407.08                   | 203.88                                |
| Aug. 17-29       | 5,010                | 54,410               | 4.7                  | 23.47*        | 430.55                   | 228.16                                |
| Aug. 31-Sept. 12 | 4,290                | 58,700               | 6.5                  | 27.93*        | 458.48                   | 315.53                                |
| Sept. 14-26      | 4,945                | 63,645               | 8.1                  | 40.17*        | 498.65                   | 393.20                                |
| Sept. 28-Oct. 10 | 4,265                | 67,910               | 7.3                  | 31.08*        | 529.73                   | 354.37                                |
| Oct. 12-24       | 5,585                | 73,495               | 8.3                  | 46.51*        | 576.24                   | 402.91                                |
| Oct. 26-Nov. 7   | 4,015                | 77,510               | 10.6                 | 42.46*        | 618.70                   | 514.56                                |
| Nov. 9-21        | 1,740                | 79,250               | 9.4                  | 16.29*        | 634.99                   | 456.31                                |

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

\* cumulative catches used in Leslie analysis

Table 3. Catch and effort statistics for the snow crab fishery in eastern Bonavista Bay (Area 24) Newfoundland 1981.

| Two-week period  | Effort<br>trap hauls | Cumulative<br>effort | CPUE<br>kg/trap haul | Catch<br>(mt) | Cumulative<br>catch (mt) | Estimated<br>biomass<br>(mt) (CPUE/q) |
|------------------|----------------------|----------------------|----------------------|---------------|--------------------------|---------------------------------------|
| Mar. 2-14        | 3960                 | 3960                 | 10.8                 | 42.58         | 42.58                    | 701.75                                |
| Mar. 16-28       | 7725                 | 11,685               | 12.5                 | 96.78         | 139.36*                  | 812.22                                |
| Mar. 30-Apr. 11  | 14,015               | 25,700               | 11.2                 | 157.40        | 296.76*                  | 727.75                                |
| Apr. 13-25       | 9710                 | 35,410               | 9.7                  | 94.59         | 391.34*                  | 630.28                                |
| Apr. 27-May 9    | 23,060               | 58,470               | 7.0                  | 160.62        | 551.96*                  | 454.84                                |
| May 11-23        | 9765                 | 68,235               | 5.8                  | 57.06         | 609.02*                  | 376.87                                |
| May 25-June 6    | 8150                 | 76,385               | 6.3                  | 51.16         | 660.19*                  | 409.36                                |
| June 8-20        | 5460                 | 81,845               | 5.0                  | 27.18         | 687.36*                  | 324.89                                |
| June 22-July 4   | 2655                 | 84,500               | 4.1                  | 10.76         | 698.12*                  | 266.41                                |
| July 6-18        | 1185                 | 85,685               | 3.0                  | 3.51          | 701.63*                  | 194.93                                |
| July 20-Aug. 1   | 1980                 | 87,665               | 3.4                  | 6.70          | 708.32*                  | 220.92                                |
| Aug. 3-15        | 1200                 | 88,865               | 3.6                  | 4.32          | 712.64*                  | 233.92                                |
| Aug. 17-29       | 1030                 | 89,895               | 1.6                  | 1.65          | 714.29*                  | 103.96                                |
| Aug. 31-Sept. 12 |                      |                      |                      |               |                          |                                       |
| Sept. 14-26      | 370                  | 90,265               | 3.2                  | 1.18          | 715.47                   | 207.93                                |
| Sept. 28-Oct. 10 | 370                  | 90,635               | 1.6                  | 0.60          | 716.07                   | 103.96                                |
| Oct. 12-24       |                      |                      |                      |               |                          |                                       |
| Oct. 26-Nov. 7   |                      |                      |                      |               |                          |                                       |
| Nov. 9-21        | 1050                 | 91,685               | 15.3                 | 16.12         | 732.18                   | 994.15                                |
| Nov. 23-Dec. 5   | 750                  | 92,435               | 12.0                 | 8.83          | 741.01                   | 779.73                                |

X CPUE = 8.02 kg/trap haul

\* cumulative catches used in Leslie analysis

Table 4. Catch and effort statistics for the snow crab fishery in Conception Bay (Area 16) Newfoundland 1981.

| Two-week period  | Effort<br>trap hauls | Cumulative<br>effort | CPUE<br>kg/trap haul | Catch<br>(mt) | Cumulative<br>catch (mt) | Estimated<br>biomass<br>(mt)(CPUE/q) |
|------------------|----------------------|----------------------|----------------------|---------------|--------------------------|--------------------------------------|
| Feb. 13-28       | 240                  | 240                  | 23.45                | 5.63          | 5.63                     | 762.85                               |
| Mar. 2-14        | 2,340                | 2580                 | 21.12                | 49.42*        | 55.04                    | 687.05                               |
| Mar. 16-28       | 3,360                | 5940                 | 19.82                | 66.59*        | 121.63                   | 644.76                               |
| Mar. 30-Apr. 11  | 3,180                | 9120                 | 17.74                | 56.41*        | 178.05                   | 577.10                               |
| Apr. 13-25       | 2,340                | 11,460               | 12.89                | 30.16*        | 208.21                   | 419.32                               |
| Apr. 27-May 9    | 6,220                | 17,680               | 10.21                | 63.48*        | 271.69                   | 332.14                               |
| May 11-23        | 5,320                | 23,000               | 9.76                 | 51.92*        | 323.62                   | 317.50                               |
| May 25-June 6    | 2,430                | 25,430               | 9.88                 | 24.01*        | 347.63                   | 321.41                               |
| June 8-20        | 496                  | 25,926               | 13.42                | 6.66*         | 354.28                   | 436.56                               |
| June 22-July 4   | 1,290                | 27,216               | 10.55                | 13.62*        | 367.90                   | 343.20                               |
| July 6-18        | 3,210                | 30,426               | 13.26                | 42.55*        | 410.45                   | 431.36                               |
| July 20-Aug. 1   | 2,700                | 33,126               | 9.94                 | 26.83*        | 437.28                   | 323.36                               |
| Aug. 3-15        | 540                  | 33,666               | 6.82                 | 3.68*         | 440.96                   | 221.86                               |
| Aug. 17-29       | 1,080                | 34,746               | 6.19                 | 6.68*         | 447.65                   | 201.37                               |
| Aug. 31-Sept. 12 | 2,910                | 37,656               | 6.65                 | 19.34*        | 466.99                   | 216.33                               |
| Sept. 14-26      | 2,280                | 39,936               | 5.59                 | 12.76*        | 479.29                   | 181.85                               |
| Sept. 28-Oct. 10 | 2,070                | 42,006               | 6.23                 | 12.89*        | 492.18                   | 202.67                               |
| Oct. 12-24       | 760                  | 42,766               | 6.92                 | 5.26*         | 497.43                   | 225.11                               |
| Oct. 26-Nov. 7   | 660                  | 43,426               | 5.08                 | 3.36*         | 500.79                   | 165.26                               |
| Nov. 9-21        | -                    | -                    | -                    | -             | -                        | -                                    |
| Nov. 23-Dec. 5   | 120                  | 43,546               | 9.96                 | 1.20          | 501.98                   | 324.00                               |

$\bar{x}$  CPUE = 11.53 kg/trap haul

\* cumulative catches used in Leslie analysis

Table 5. Catch and effort statistics for the snow crab fishery in the Northeastern Avalon (Area 18) Newfoundland 1981.

| Two-week period  | Effort<br>trap hauls | Cumulative<br>effort | CPUE<br>kg/trap haul | Catch<br>(mt) | Cumulative<br>catch (mt) | Estimated<br>biomass<br>(mt)(CPUE/q) |
|------------------|----------------------|----------------------|----------------------|---------------|--------------------------|--------------------------------------|
| Mar. 2-14        | 1,865                | 1,865                | 14.31                | 26.69         | 26.69                    | 6365.66                              |
| Mar. 16-28       | 5,218                | 7,083                | 18.75                | 97.85         | 124.54                   | 8340.75                              |
| Mar. 30-Apr. 11  | 8,040                | 15,123               | 19.93                | 160.26        | 284.80                   | 8865.66                              |
| Apr. 13-25       | 7,976                | 23,099               | 15.31                | 122.08        | 406.88                   | 6810.50                              |
| Apr. 27-May 9    | 17,367               | 40,466               | 15.03                | 260.96        | 667.83                   | 6685.94                              |
| May 11-23        | 37,319               | 77,785               | 16.41                | 612.52        | 1280.36                  | 7299.82                              |
| May 25-June 6    | 47,416               | 125,201              | 18.17                | 861.38        | 2141.73                  | 8082.74                              |
| June 8-20        | 32,937               | 158,138              | 21.40                | 704.72*       | 2846.46                  | 9519.57                              |
| June 22-July 4   | 42,394               | 200,532              | 16.83                | 713.45*       | 3559.91                  | 7486.66                              |
| July 6-18        | 34,062               | 234,594              | 16.33                | 556.38*       | 4116.29                  | 7264.23                              |
| July 20-Aug. 1   | 43,030               | 277,624              | 14.64                | 629.86*       | 4746.15                  | 6512.46                              |
| Aug. 3-15        | 14,900               | 292,524              | 14.01                | 208.79*       | 4954.94                  | 6232.21                              |
| Aug. 17-29       | 20,615               | 313,139              | 13.46                | 277.54*       | 5232.48                  | 5987.54                              |
| Aug. 31-Sept. 12 | 20,049               | 333,188              | 15.14                | 303.55*       | 5536.03                  | 6734.88                              |
| Sept. 14-26      | 28,983               | 362,171              | 12.49                | 378.74*       | 5914.77                  | 5556.05                              |
| Sept. 28-Oct. 10 | 19,049               | 381,220              | 16.44                | 313.13        | 6227.90                  | 7313.17                              |
| Oct. 12-24       | 13,520               | 394,740              | 15.26                | 206.28        | 6434.18                  | 6788.26                              |
| Oct. 26-Nov. 7   | 7,510                | 402,250              | 16.43                | 123.42        | 6557.59                  | 7308.72                              |
| Nov. 9-21        | 5,255                | 407,505              | 16.22                | 85.23         | 6642.83                  | 7215.30                              |
| Nov. 23-Dec. 5   | 5,110                | 412,615              | 19.69                | 100.62        | 6743.83                  | 8758.90                              |
| Dec. 7-19        | 1,200                | 413,815              | 21.40                | 25.68         | 6769.13                  | 9519.57                              |

X CPUE = 16.36 kg/trap haul

\* cumulative catches used in Leslie analysis

Table 6. Catch and effort statistics for the snow crab fishery in Eastern Avalon (Area 14) Newfoundland 1981.

| Two-week period  | Effort<br>trap hauls | Cumulative<br>effort | CPUE<br>kg/trap haul | Catch<br>(mt) | Cumulative<br>catch (mt) | Estimated<br>biomass<br>(mt) (CPUE/q) |
|------------------|----------------------|----------------------|----------------------|---------------|--------------------------|---------------------------------------|
| Mar. 14-28       | 1,060                | 1,060                | 19.81                | 20.99         | 20.99                    | 387.29                                |
| Mar. 30-Apr. 11  | 2,560                | 3,620                | 13.99                | 35.81         | 56.81                    | 273.51                                |
| Apr. 13-25       | 2,460                | 6,080                | 20.78                | 51.12         | 107.93                   | 406.26                                |
| Apr. 27-May 9    | 5,573                | 11,653               | 22.10                | 123.18        | 231.11*                  | 432.06                                |
| May 11-23        | 3,834                | 15,487               | 16.17                | 61.96         | 293.10*                  | 316.13                                |
| May 25-June 6    | 2,410                | 17,897               | 13.88                | 33.45         | 326.55*                  | 271.36                                |
| June 8-20        | 1,596                | 19,493               | 16.84                | 26.84         | 353.42*                  | 329.23                                |
| June 22-July 4   | 950                  | 20,443               | 19.89                | 18.90         | 372.32*                  | 388.86                                |
| July 6-18        | 520                  | 20,963               | 14.06                | 7.31          | 379.64*                  | 274.88                                |
| July 20-Aug. 1   | 2,660                | 23,623               | 9.92                 | 26.40         | 406.03*                  | 193.94                                |
| Aug. 3-15        | 1,320                | 24,943               | 6.52                 | 8.60          | 414.63*                  | 127.47                                |
| Aug. 17-29       | 1,020                | 25,963               | 9.05                 | 9.23          | 423.86*                  | 176.93                                |
| Aug. 30-Sept. 12 | 960                  | 26,923               | 8.28                 | 7.95          | 431.81*                  | 161.88                                |
| Sept. 14-26      | 190                  | 27,113               | 13.51                | 2.57          | 434.38                   | 264.13                                |

$\bar{x}$  CPUE = 16.02 trap/haul

\* cumulative catches used in Leslie analysis



Table 7. Catch and effort statistics for the snow crab fishery in at Southeastern Avalon (Area 12) Newfoundland 1981.

| Two-week period  | Effort<br>trap hauls | Cumulative<br>effort | CPUE<br>kg/trap haul | Catch<br>(mt) | Cumulative<br>catch (mt) | Estimated<br>biomass<br>(mt) (CPUE/q) |
|------------------|----------------------|----------------------|----------------------|---------------|--------------------------|---------------------------------------|
| Mar. 14-28       | 1,010                | 1,010                | 20.30                | 20.50         | 20.50                    | 803.64                                |
| Mar. 30-Apr. 11  | 990                  | 2,000                | 20.43                | 20.22         | 40.73                    | 808.79                                |
| Apr. 13-25       | 1,360                | 3,360                | 21.68                | 29.48         | 70.21                    | 858.27                                |
| Apr. 27-May 9    | 3,320                | 6,680                | 22.30                | 74.02         | 144.23                   | 882.82                                |
| May 11-23        | 3,740                | 10,420               | 21.21                | 79.32         | 223.56                   | 839.67                                |
| May 25-June 6    | 4,670                | 15,090               | 19.08                | 89.12         | 312.67                   | 755.34                                |
| June 8-20        | 4,940                | 20,030               | 23.12                | 114.22        | 426.90*                  | 915.28                                |
| June 22-July 4   | 3,370                | 23,400               | 22.15                | 74.63         | 501.53*                  | 876.88                                |
| July 6-18        | 710                  | 24,110               | 18.49                | 13.13         | 514.66*                  | 731.99                                |
| July 20-Aug. 1   | 3,890                | 28,000               | 17.35                | 67.48         | 582.14*                  | 686.86                                |
| Aug. 3-15        | 3,090                | 31,090               | 17.13                | 52.92         | 635.06*                  | 678.15                                |
| Aug. 17-29       | 2,450                | 33,540               | 18.32                | 44.90         | 679.96*                  | 725.26                                |
| Aug. 30-Sept. 12 | 1,970                | 35,510               | 15.35                | 30.24         | 710.20*                  | 607.68                                |
| Sept. 14-26      | 2,650                | 38,160               | 13.07                | 34.63         | 744.84*                  | 517.42                                |
| Sept. 28-Oct. 10 | 2,185                | 40,345               | 11.43                | 24.97         | 769.81*                  | 452.49                                |
| Oct. 12-24       | 1,510                | 41,855               | 14.51                | 21.90         | 791.71                   | 574.43                                |
| Oct. 26-Nov. 7   | 1,650                | 43,505               | 16.60                | 27.40         | 819.12                   | 657.17                                |
| Nov. 9-21        | 1,360                | 44,865               | 17.52                | 23.82         | 842.93                   | 693.59                                |
| Nov. 23-Dec. 5   | 590                  | 45,455               | 18.30                | 10.80         | 853.73                   | 724.47                                |

$\bar{x}$  CPUE = 18.78 kg/trap haul

\* cumulative catches used in Leslie analysis

Table 8. Catch and effort statistics for the snow crab fishery in White Bay (Area 36) Newfoundland 1981.

| Two-week period | Effort<br>trap hauls | Cumulative<br>effort | CPUE<br>kg/trap haul | Catch<br>(mt) | Cumulative<br>catch (mt) | Estimated<br>biomass<br>(mt) (CPUE/q) |
|-----------------|----------------------|----------------------|----------------------|---------------|--------------------------|---------------------------------------|
| June 1-13       | 802                  | 802                  | 16.28                | 13.06*        | 13.06                    | 526.01                                |
| June 15-27      | 2,147                | 2,949                | 15.14                | 32.51*        | 45.57                    | 489.18                                |
| June 29-July 11 | 1,751                | 4,700                | 13.72                | 24.02*        | 69.59                    | 443.30                                |
| July 13-25      | 2,639                | 7,339                | 11.47                | 30.27*        | 99.86                    | 370.60                                |
| July 27-Aug. 8  | 2,390                | 9,729                | 10.72                | 25.62*        | 125.47                   | 346.37                                |
| Aug. 10-22      | 2,440                | 12,169               | 10.94                | 26.70*        | 152.17                   | 353.47                                |
| Aug. 24-Sept. 5 | 2,050                | 14,219               | 12.34                | 25.90*        | 177.46                   | 398.71                                |
| Spet. 7-19      | 2,842                | 17,061               | 10.02                | 28.48*        | 205.94                   | 323.75                                |
| Sept. 21-Oct. 3 | 1,588                | 18,649               | 9.36                 | 14.87*        | 220.80                   | 302.42                                |
| Oct. 5-17       | 991                  | 19,640               | 8.03                 | 7.96*         | 228.76                   | 259.45                                |
| Oct. 19-31      | 200                  | 19,840               | 7.47                 | 1.49          | 230.25                   | 241.36                                |

$\bar{x}$  CPUE = 11.61 kg/trap haul

\* cumulative catches used in Leslie analysis

Table 9. Catch and effort statistics for the snow crab fishery in Horse Islands (Area 34) Newfoundland 1981.

| Two-week period  | Effort<br>trap hauls | Cumulative<br>effort | CPUE<br>kg/trap haul | Catch<br>(mt) | Cumulative<br>catch (mt) | Estimated<br>biomass<br>(mt) (CPUE/q) |
|------------------|----------------------|----------------------|----------------------|---------------|--------------------------|---------------------------------------|
| June 8-20        | 1,335                | 1,335                | 22.68                | 30.28*        | 30.28                    | 590.32                                |
| June 22-July 4   | 1,445                | 2,780                | 21.43                | 30.97*        | 61.25                    | 557.78                                |
| July 6-18        | 2,145                | 4,925                | 19.20                | 41.18*        | 102.43                   | 499.74                                |
| July 20-Aug. 1   | 4,265                | 9,190                | 17.73                | 75.62*        | 178.04                   | 461.48                                |
| Aug. 3-15        | 3,440                | 12,630               | 15.91                | 54.72*        | 232.77                   | 414.11                                |
| Aug. 17-29       | 565                  | 13,195               | 18.95                | 10.71         | 243.47                   | 493.23                                |
| Aug. 30-Sept. 12 | 2,445                | 15,640               | 16.77                | 41.01*        | 284.49                   | 436.49                                |
| Sept. 14-26      | 1,450                | 17,090               | 10.53                | 15.27*        | 299.76                   | 274.08                                |
| Sept. 28-Oct. 10 | 890                  | 17,980               | 10.39                | 9.25*         | 309.00                   | 269.11                                |
| Oct. 12-24       | 820                  | 18,800               | 10.38                | 8.51*         | 317.52                   | 270.17                                |
| Oct. 26-Nov. 7   | 450                  | 19,250               | 9.50                 | 4.28          | 321.79                   | 247.27                                |

$\bar{x}$  CPUE = 16.72 kg/trap haul

\* cumulative catches used in Leslie analysis

Table 10. Catch and effort statistics for the snow crab fishery in Notre Dame Bay (Area 32) Newfoundland 1981.

| Two-week period  | Effort<br>trap hauls | Cumulative<br>effort | CPUE<br>kg/trap haul | Catch<br>(mt) | Cumulative<br>catch (mt) | Estimated<br>biomass<br>(mt) (CPUE/q) |
|------------------|----------------------|----------------------|----------------------|---------------|--------------------------|---------------------------------------|
| Apr. 27-May 9    | 2,802                | 2,802                | 13.58                | 38.06         | 38.06                    | 1671.38                               |
| May 11-23        | 4,617                | 7,419                | 11.63                | 53.71         | 91.77                    | 1431.38                               |
| May 25-June 6    | 5,044                | 12,463               | 14.25                | 71.88*        | 163.75                   | 1753.85                               |
| June 8-20        | 4,352                | 16,815               | 13.24                | 57.62*        | 221.26                   | 1629.54                               |
| June 22-July 4   | 5,343                | 22,158               | 11.43                | 61.06*        | 282.32                   | 1406.77                               |
| July 6-18        | 4,845                | 27,003               | 13.33                | 64.59*        | 346.91                   | 1640.62                               |
| July 20-Aug. 1   | 5,598                | 32,601               | 12.27                | 68.67*        | 415.58                   | 1510.15                               |
| Aug. 3-15        | 5,428                | 38,029               | 11.93                | 64.73*        | 480.31                   | 1468.31                               |
| Aug. 17-29       | 4,327                | 42,456               | 11.82                | 51.13*        | 531.44                   | 1454.77                               |
| Aug. 31-Sept. 12 | 8,115                | 50,571               | 9.02                 | 73.21*        | 604.65                   | 1110.15                               |
| Sept. 14-26      | 2,395                | 52,966               | 12.10                | 28.99         | 633.64                   | 1489.23                               |
| Sept. 28-Oct. 10 | 475                  | 53,441               | 15.59                | 7.51          | 641.14                   | 1918.77                               |
| Oct. 12-24       | 975                  | 54,416               | 8.61                 | 8.39          | 649.53                   | 1059.69                               |

X CPUE = 11.94 kg/trap haul

\* cumulative catches used in Leslie analysis

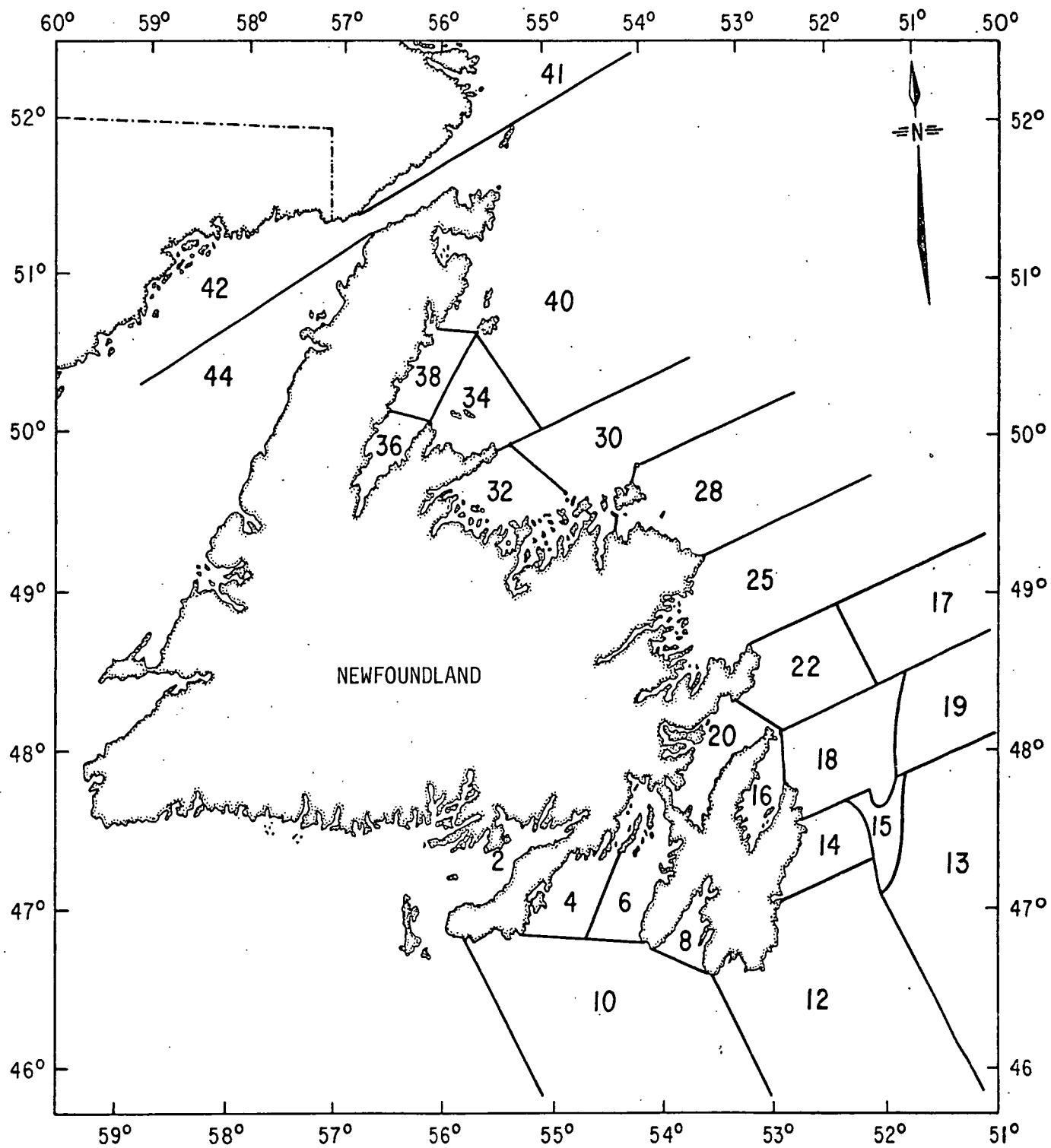


Fig. 1. Newfoundland snow crab management zones.

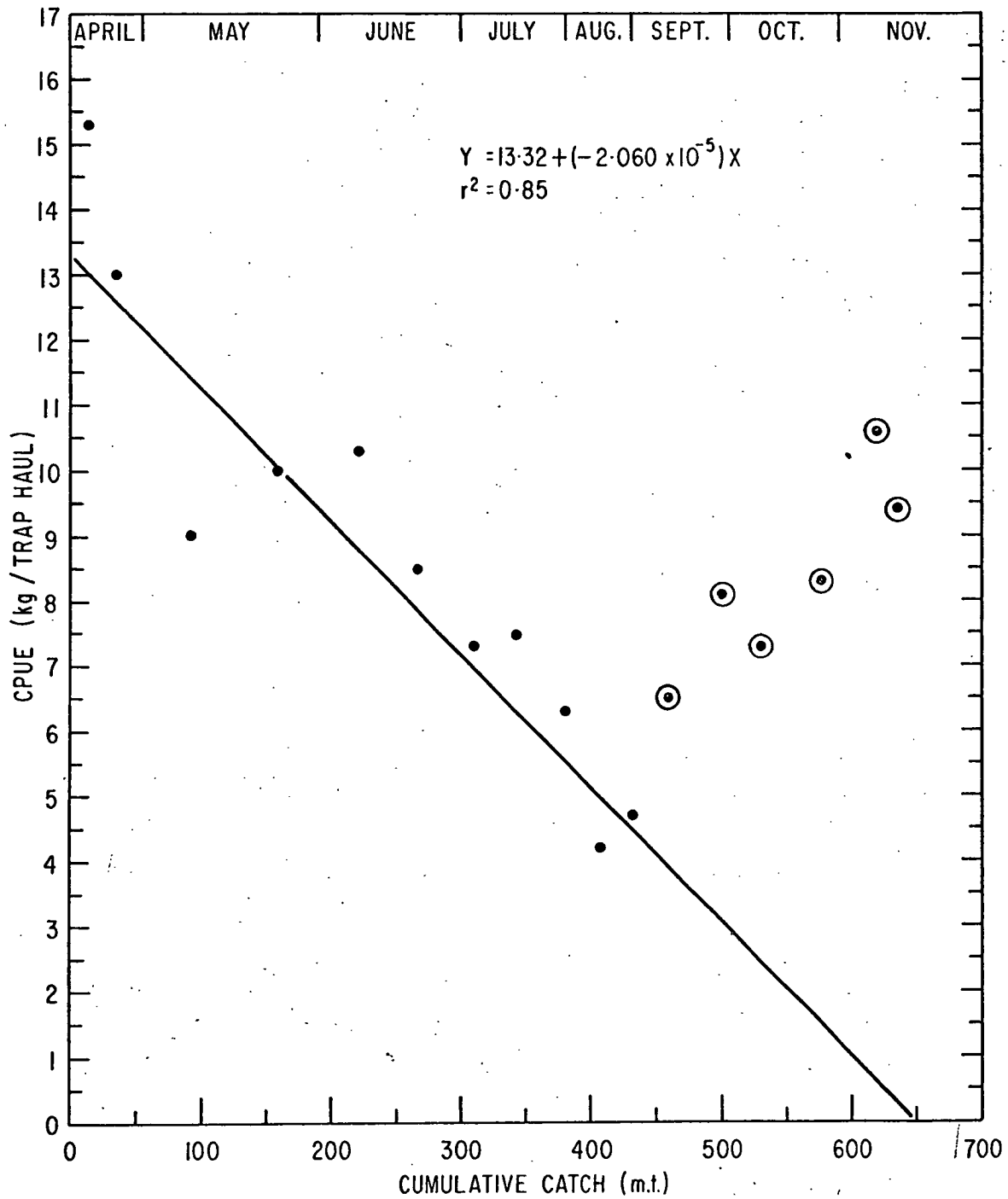


Fig. 2. Leslie graph of bi-weekly catches of snow crab from western Bonavista Bay (Area 26) Newfoundland, 1981.

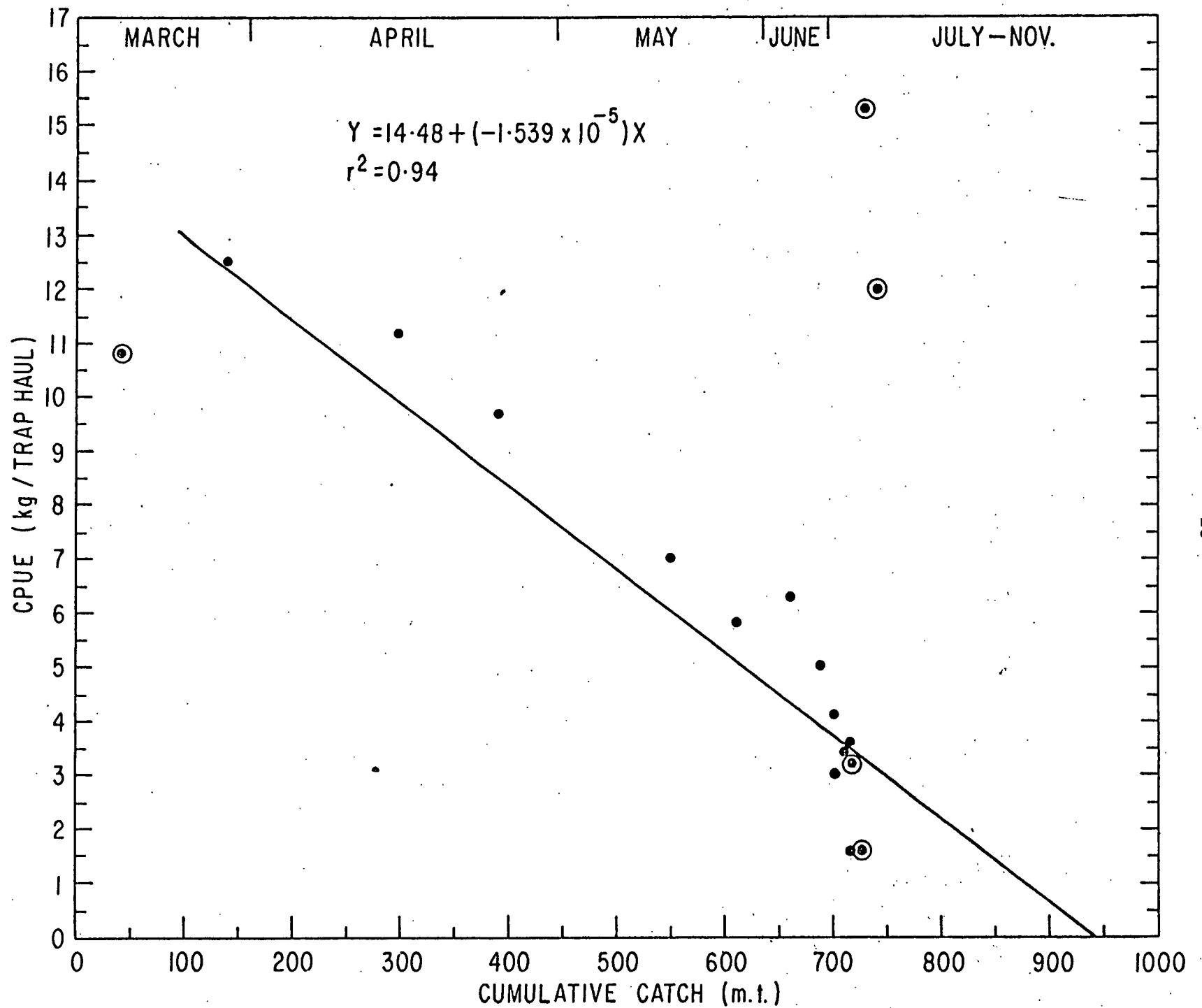


Fig. 3. Leslie graph of bi-weekly catches of snow crab from eastern Bonavista Bay (Area 24) Newfoundland, 1981.

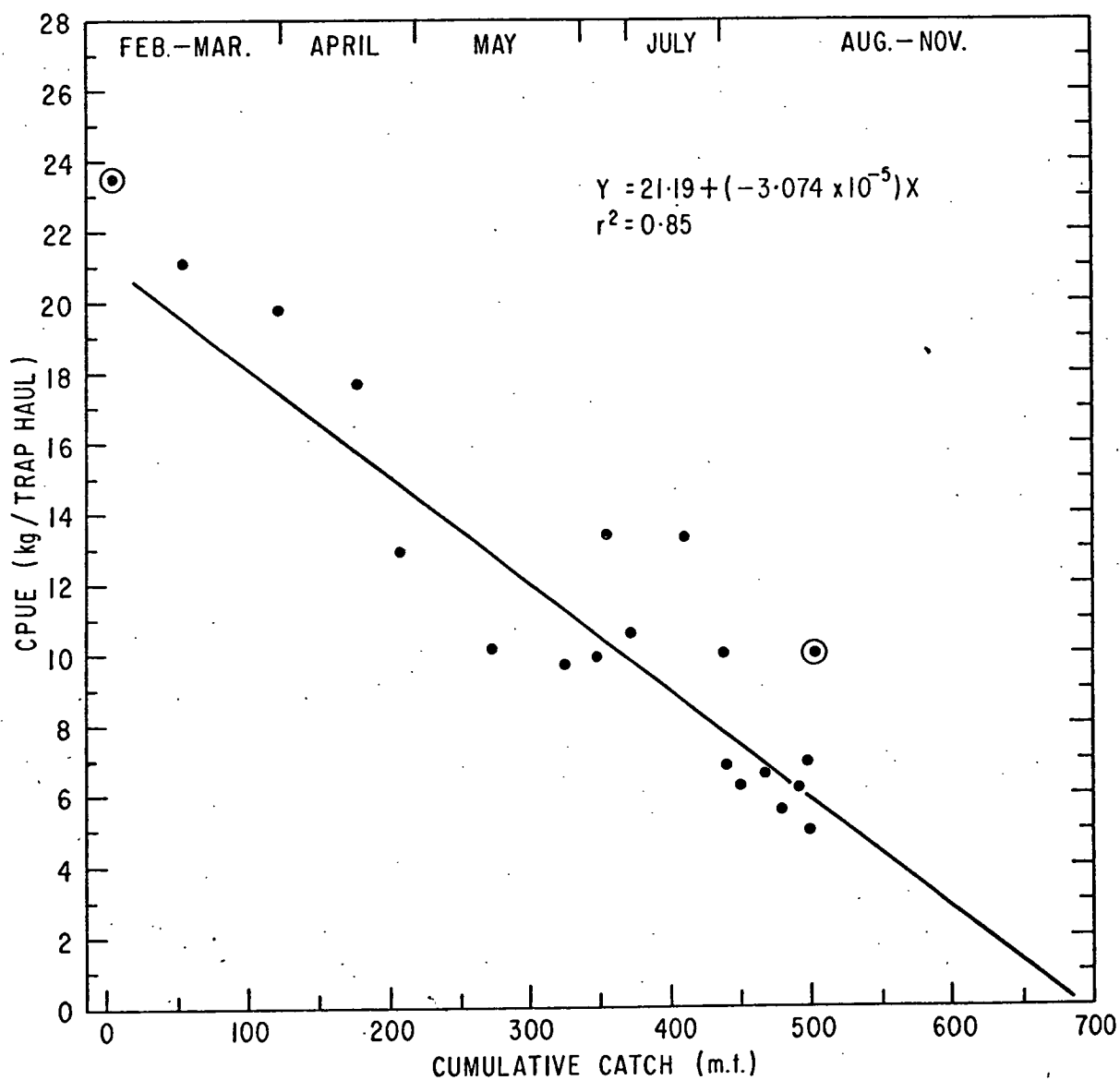


Fig. 4. Leslie graph of bi-weekly catches of snow crab from Conception Bay (Area 16) Newfoundland, 1981.



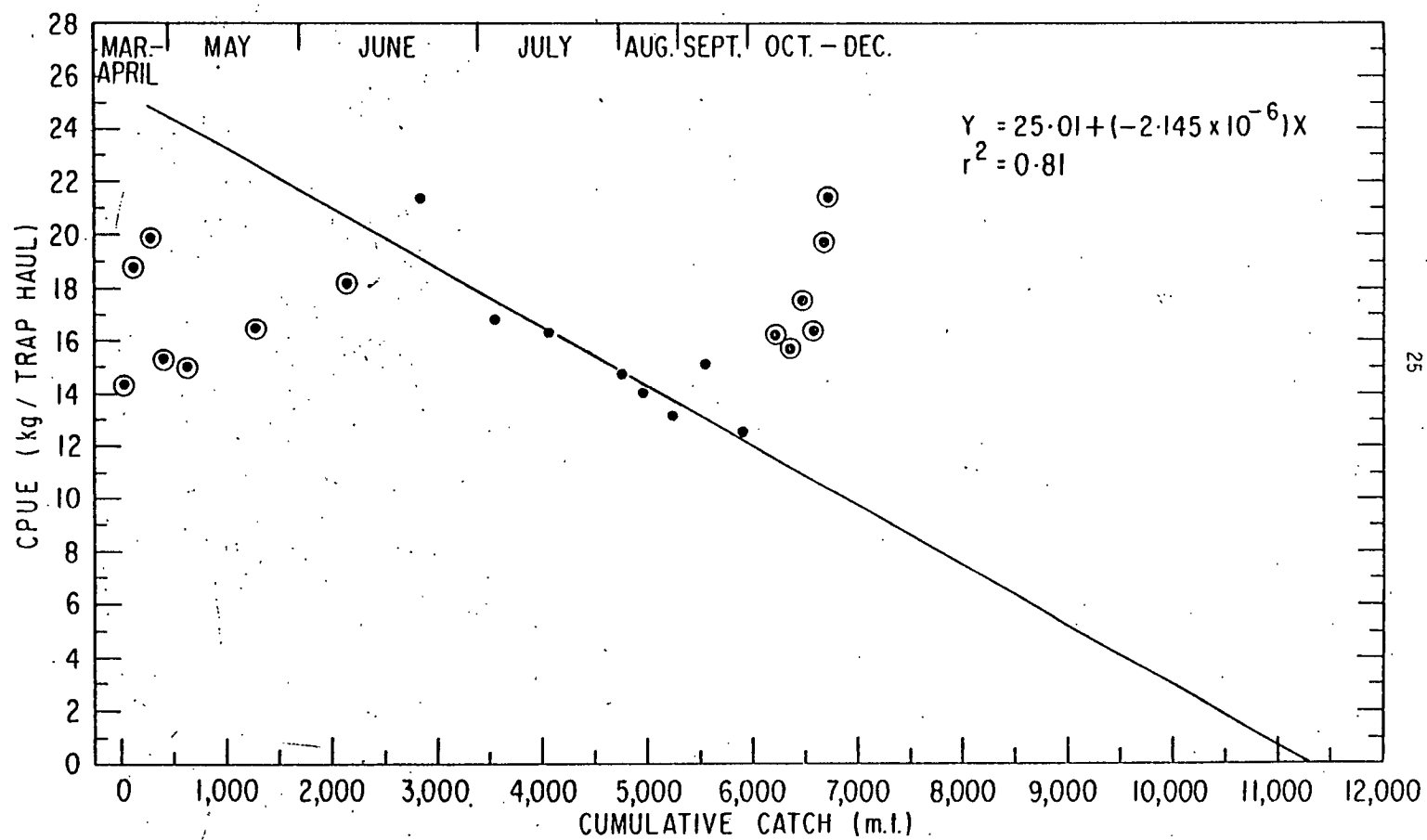


Fig. 5. Leslie graph of bi-weekly catches of snow crab from the northeastern Avalon (Area 18) Newfoundland, 1981.

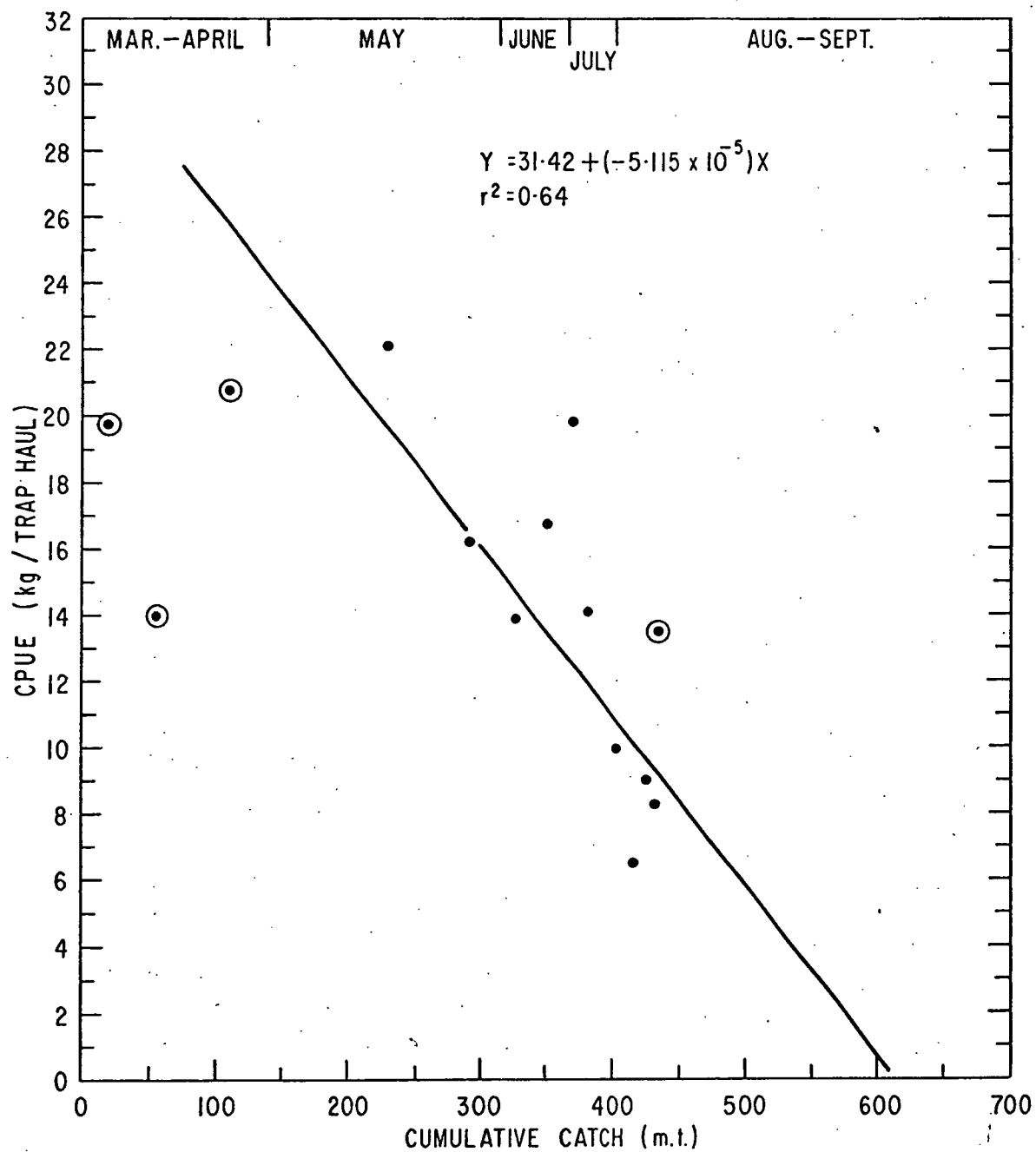


Fig. 6. Leslie graph of bi-weekly catches of snow crab from Eastern Avalon (Area 14) Newfoundland, 1981.

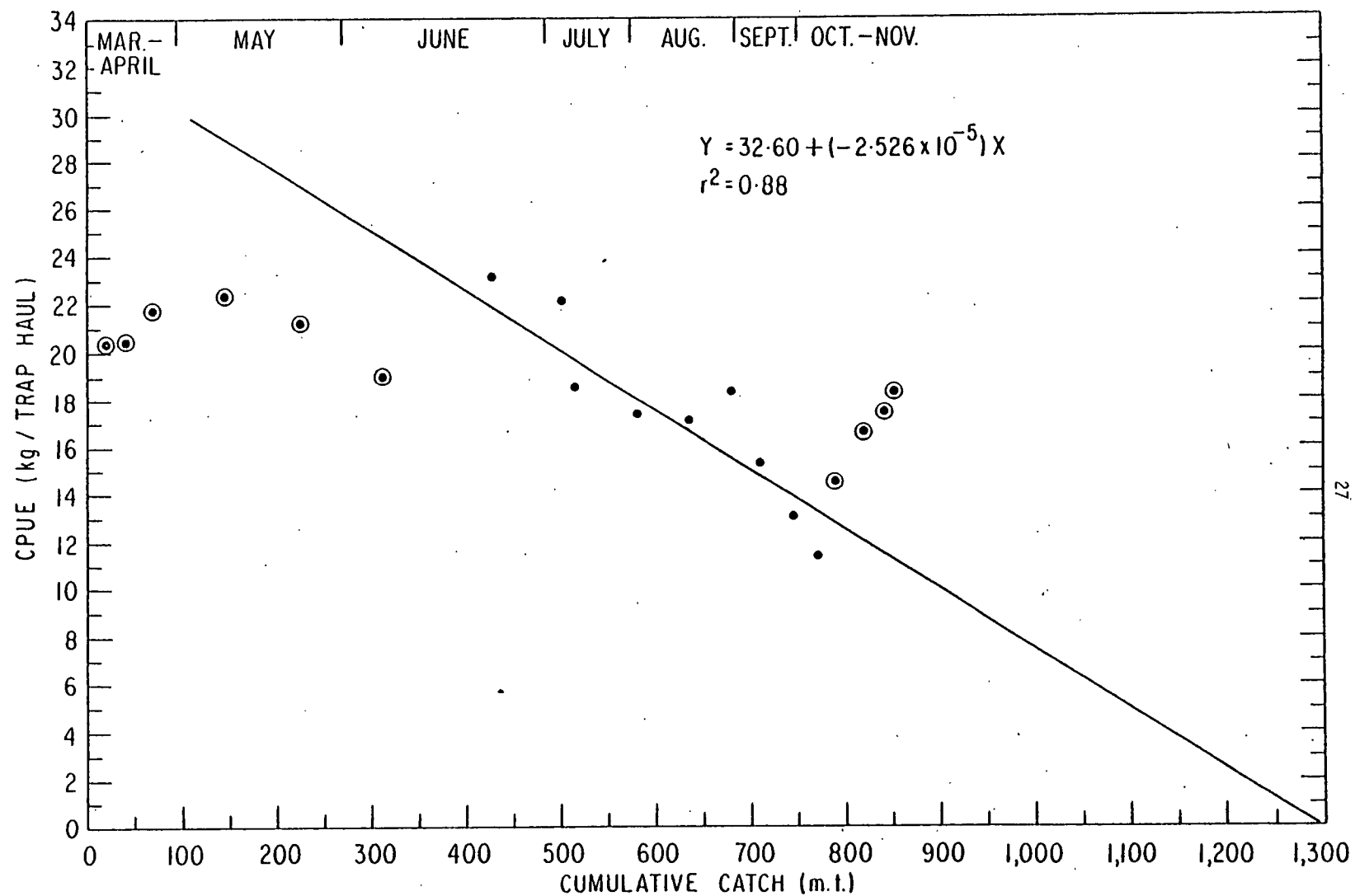


Fig. 7. Leslie graph of bi-weekly catches of snow crab from southeastern Avalon (Area 12) Newfoundland, 1981.

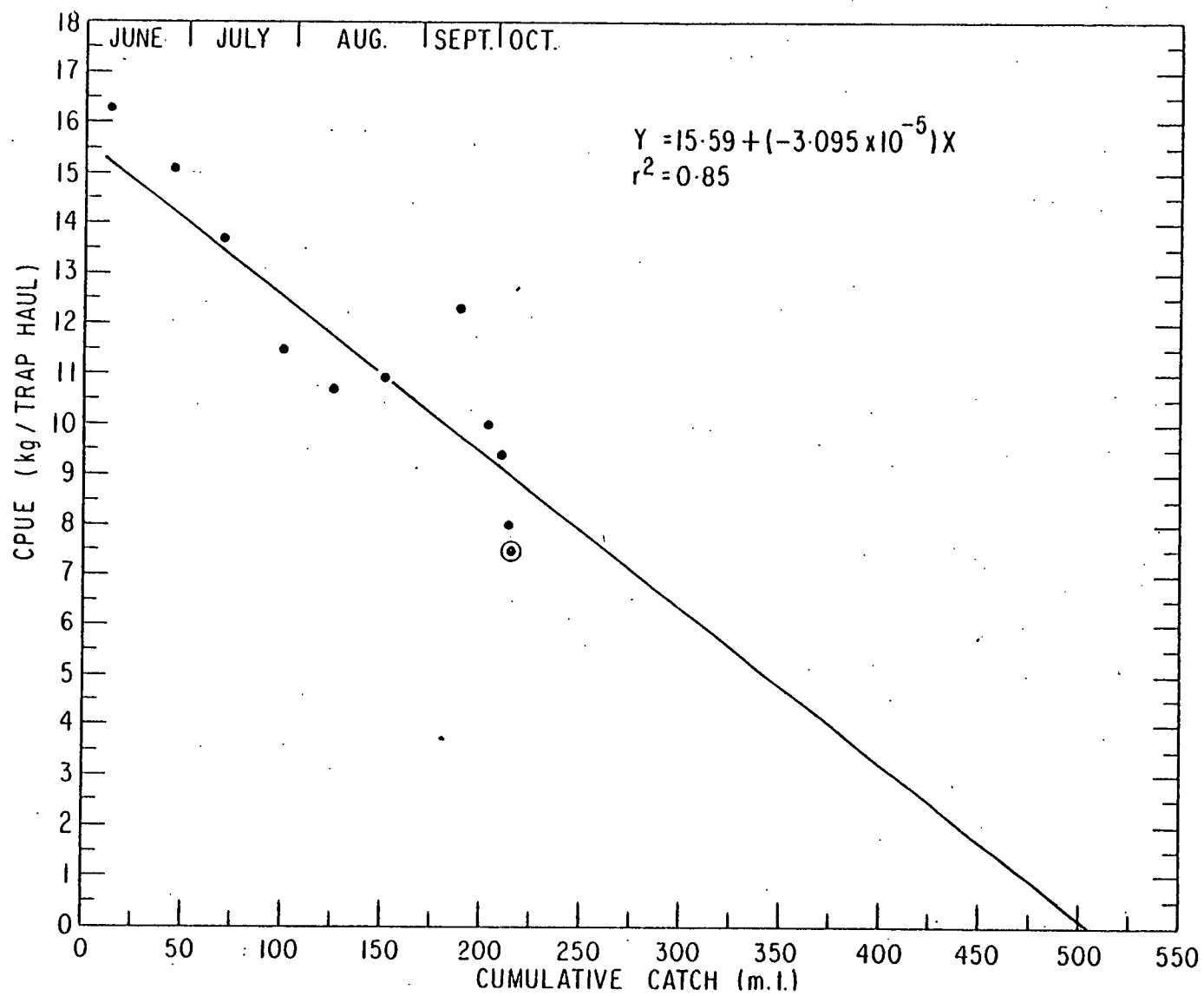


Fig. 8. Leslie graph of bi-weekly catches of snow crab from White Bay (Area 36) Newfoundland, 1981.

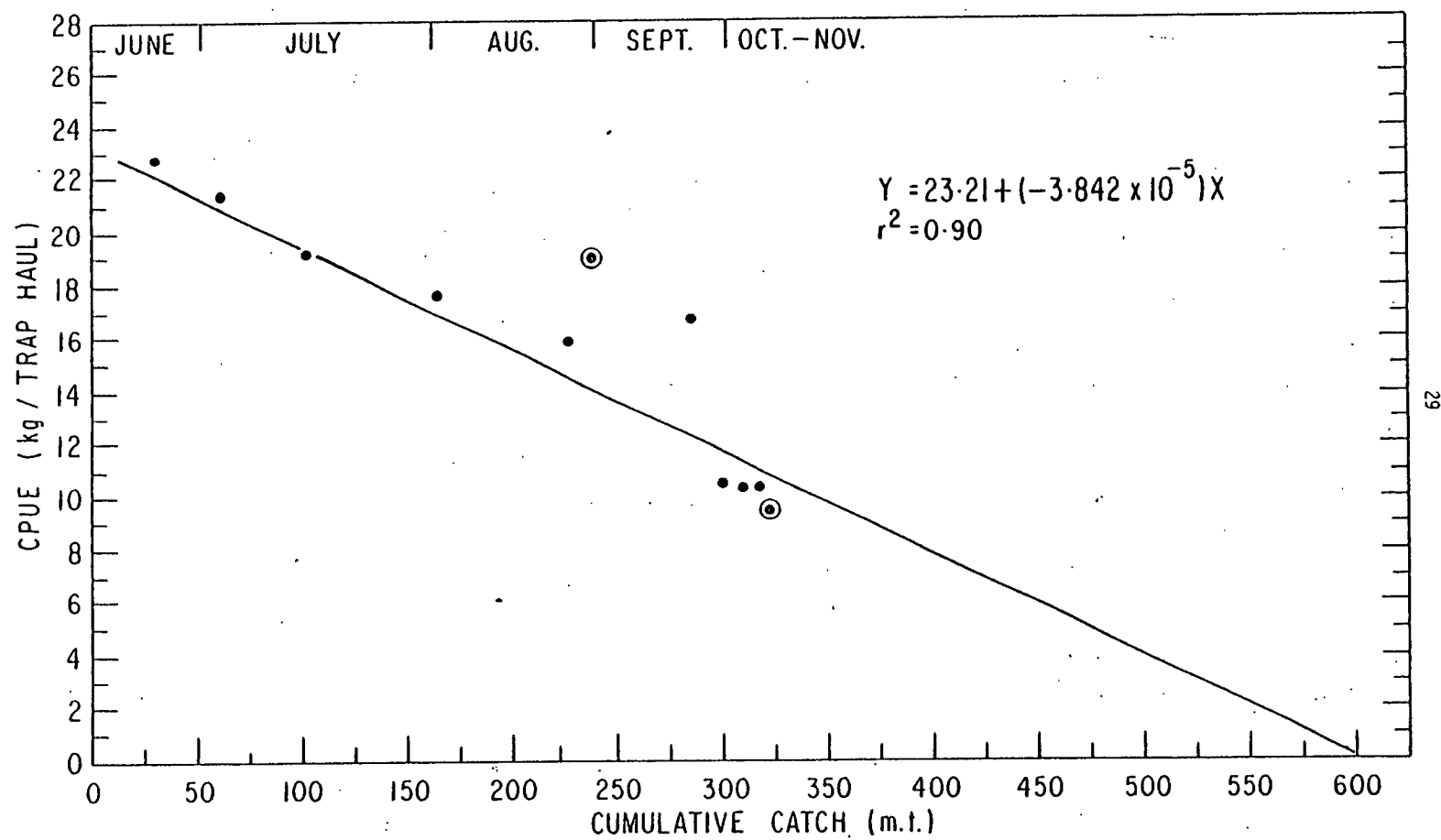


Fig. 9. Leslie graph of bi-weekly catches of snow crab from the Horse Islands (Area 34) Newfoundland, 1981.

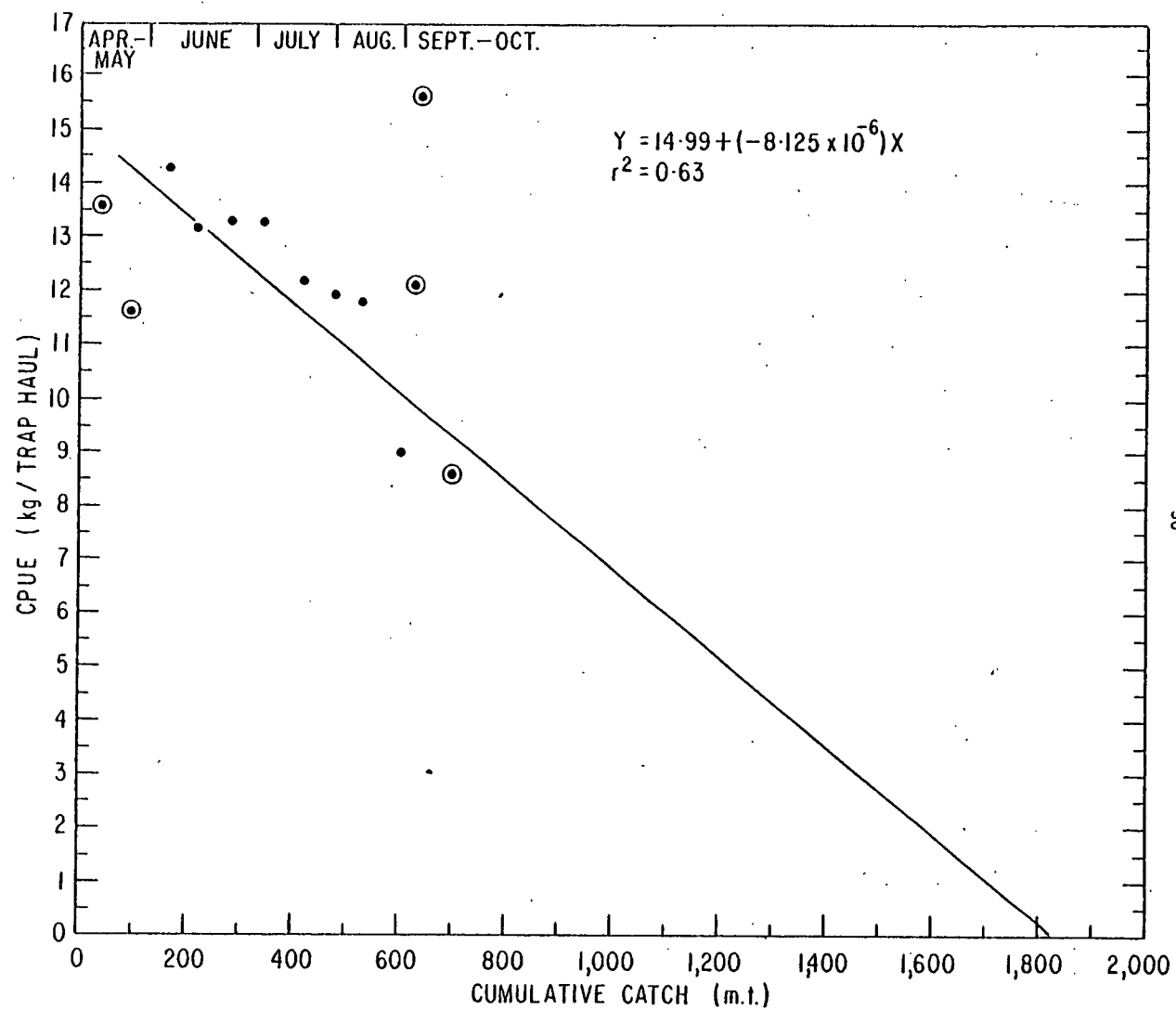


Fig. 10. Leslie graph of bi-weekly catches of snow crab from Green Bay (Area 32) Newfoundland, 1981.