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FOURTH SURVEY OF EEL RIVER COVE, N.B. SOFT-SHELL CLAM (*MYA ARENARIA*) POPULATION

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ABSTRACT

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The Eel River Cove soft-shell clam population was surveyed for the fourth time since 1963. The Cove is slowly converting to a salt marsh and the clam producing grounds have considerably diminished in size. The soft-shell clam population has a very high density at the present time, but only 15% of the total population constitutes market-size clams. This size is reached after six growing seasons. Clams slightly smaller than market size account for the most abundant size classes of the actual population.

Key words: Environmental ecology, fishery, invertebrates, shellfish, soft-shell clam.

RESUME

On inventoria la population de myes d'Eel River Cove pour la quatrième fois depuis 1963. Le Cove se transforme lentement en marais salant et la myère a considérablement rétréci. La population de myes a une densité très élevée à l'heure actuelle. Mais suelement 15% de la population totale est constituée de myes de taille légale. Six saisons de croissance sont requises pour atteindre cette taille. Des quantités de myes juste sous la taille légale font présentement partie des classes de taille les plus abundantes.

INTRODUCTION

This is the fourth survey in fifteen years of the soft-shell clam (*Mya arenaria*) population of Eel River Cove, New Brunswick. The three previous surveys were concerned with the impact of the construction of a dam on the clam producing grounds in the Cove. Prior to the construction of the dam, MacPhail (1964a) reported that the area remained submerged at low tide except for the gravel bars at the outlet of the Cove. Clam digging was entirely under water. While the dam construction was underway another study was conducted (MacPhail, 1964b) which indicated that little water remained on the flats at low tide. Under these conditions, digging could proceed more easily and increased. However, it was still too early to notice other consequences of the damming. A third survey (Medcof, 1967) showed that the clam producing area was reduced in size, and that both the increase in landings and resultant indirect fishing mortalities had reduced clam densities. Larval recruitment seemed to be reduced, presumably because of increased siltation.

Water pollution by domestic sewage contamination was later added to the unfavorable environmental conditions. A shellfish closure was put in effect in 1973 and prohibited any further digging in the Cove (deMestral and Legault, 1972). Sewage treatment has improved the bacteriological quality of the water in the past years; and a recent (August, 1978) survey (Environmental Protection Service, unpubl. data) indicates that it might be possible to remove a portion of the shellfish closure and allow the harvesting of the clam stocks.

In 1978, the Resource Branch was asked to perform a fourth survey of Eel River Cove to determine the present extent of the clam producing grounds. This report is the result of our findings.

Eel River Cove is located on the south shore of Bay of Chaleur, near the town of Dalhousie, N.B. A barrier beach over 1 km long delimits the Cove eastward. Highway No. 134 passes along this beach. At the northern end, a channel connects the Cove with the sea. The lowland area surrounding the Cove is well treed. A dam restricts river flow into the Cove (Fig. 1). The total area of the Cove is approximately 36 ha (90 acres).

METHODS

Sampling Procedures

The usual approach to an inventory survey of this nature is the establishment of transect lines with sampling at pre-fixed intervals along the line. It works satisfactorily on uniform grounds of sizeable surface. We soon realized that such an approach would not be adequate in this particular case. An overall exploration quickly identified that the clam producing grounds of the Cove were very limited and located on a short stretch of beach and along the edges of the gravel bars which are not extensive area-wise.

Such small scale clam flats could easily be under-represented by transect lines. We therefore modified the transect approach to take into consideration that over the shore and along most of the bars' edges the soft-shell clams are distributed in a band fashion of varying widths (3 to 7 m). To arrive at a good approximation of the extent of the different clam flats, sampling stations were never spaced more than 33 m (100 feet) from each other and the width of the clam band was monitored from station to station. The sampling baseline was determined using a Silva Type 15T Ranger Field Lighting Compass. The acreage of areas sampled was estimated by the summation of rectangles of varying length and width drawn up from station to station.

Samples were taken from one square foot (0.09 m^2) of substrate to a depth of 20 cm. This is below the maximum depth at which soft-shell clams are generally found. The substrate was dug with a square nose shovel. The sample was screened through a 6.4 mm (1/4 inch) wire mesh basket and all clams retained were collected. In all, a total of 46 samples was taken.

Treatment of Samples

Clams were later measured with a vernier caliper to the nearest mm on their longest axis and grouped in size classes (1/4 inch) to determine the size frequency distribution of the population and estimate the clam production of the area. On the eastern shore of New Brunswick, the minimum size at which clams may be harvested is 50 mm (2 inches) long; so, quantities of market size clams were calculated considering only clams over 50 mm. Marketable clams of each size class were converted to bushel counts according to MacPhail and Medcof (1955) (Table 1). This was the conversion used in the previous studies.

TABLE 1. Number of market size soft-shell clams per bushel.

Size (length)		Clams per bushel
mm	inches	
49-54	2	1600
55-60	2 1/4	1180
61-67	2 1/2	920
68-73	2 3/4	700
≥ 74	≥ 3	560

A sample of (264) mixed size clams was also collected for the determination of growth patterns in the Cove. Because of marked seasonal variations in metabolic activity, it is possible to estimate annual growth of soft-shell clams by "shell reading" (Newcombe, 1936). The distance between pronounced etches or rings represents growth occurring over one growing season, but since growth rings are best measured in shell width it is necessary to convert shell widths to shell lengths to fit the data to a von Bertalanffy growth curve. If growth is described

as an allometric equation:

$$\text{length} = \alpha\ (\text{width})^{\beta},$$

then the linear relationship is

$$\log\ (\text{shell length}) = \log \alpha + \beta \log\ (\text{shell width}).$$

Determined over 50 cases, the expression became (Table 2)

$$\log\ (\text{shell length}) = 0.1341 + 1.039 \log\ (\text{shell width})$$

TABLE 2. Statistical parameters of the log-log regression of shell width on shell length.

95% confidence range				r^2
y-intercept		slope		
0.0736	0.1946	0.995	1.083	0.979

Using the shell length data, a von Bertalanffy growth curve was fitted to the unweighted estimates of mean length at age (Allen, 1966 and 1967)

$$L_t = L_\infty\ (1 - e^{-k(t - t_0)})$$

RESULTS

Description of Area

Since the third survey (Medcof, 1967) more than ten years ago, siltation in the southern half has significantly increased the area suitable for eelgrass (*Zostera marina*) growth, and marsh grass (*Spartina alterniflora*) is encroaching on all shore areas except that next to the highway. On this shore, the substrate is gravel and holds several small patches of clams of no significance. At the time of the survey, October, 1978, tidal exposure amounted to a few feet of shore; and the main area, the eelgrass bed, remained under water at low tide. The northern half of the Cove is similar except for the presence of gravel bars and channels near the highway bridge. The shore adjacent to the Indian Reservation is composed of gravel, sand, and sandy silt for about 250 m (800 feet). This section of shoreline and the edges of the gravel bars were the only areas where significant clam stocks were found. The three gravel bars near the outlet of the Cove are well exposed at low tide. Stands of marsh grass and of another salt marsh plant, the sandfire (*Salicornia* sp.), cover the top of the bars. The edges of the bars are of a gravelly nature at the southern end but of a mixed subtrate (gravel, sand, silt, and mussel shells) at the northern end. One main channel, 10 m wide and over 2 m deep at low tide, separates the gravel bars from the highway shore and drains the Cove with a swift current during periods of low tide. Other channels between the gravel bars are relatively shallow (less than 30 cm deep at low tide)

with silty bottoms; mussels (*Mytilus edulis*) were observed in one location. Because of the very limited access into the Cove, one channel under the highway bridge which is later fanning out over shifting bars seaward, there seems to be a well defined pattern of water circulation. Water rushes through this channel to fill up and flush out the Cove depending on the tidal cycle. Water is eventually spread out over the eelgrass bed at high tide. There would be an exchange with river waters upstream from the dam depending on what river runoff is allowed through the dam's sluices.

With the exception of soft-shell clams, the gravelly sediments of the Cove appear to deter the establishment of significant numbers of other invertebrate species. A small mussel bed set at the seaward end of one bar; in areas of finer sediment the odd *Macoma balthica* could be found. Coarse sediment also prohibits the presence of shellfish predators like the moon snail (*Lunatia heros*).

Production of Soft-Shell Clam Stocks

The shoreline near the Indian Reservation was suitable for soft-shell clam production over a short distance (250 m or 800 feet). Near the seaward end, the clam zone was 25 m (80 feet) wide on average, but it soon narrowed down to only 5 m (15 feet) then the marsh grass took over the beach. The clam producing grounds were computed at approximately 0.5 acre (Table 3).

The small bar adjacent to the shore near the Indian Reservation had nearly an acre of clam flats distributed along its edges and over its seaward end. The middle bar had clam stocks along its edges only in a very narrow band from 1.5 m to 6 m wide (5 to 20 feet) for a total area of 0.28 acres. The large bar, closest to the highway, had 0.56 acres of clam flats encircling the bar in a ring fashion slightly wider than at the previous bar.

TABLE 3. Acreage and number of sampling stations for the clam producing grounds in Eel River Cove.

	Acreage		Sampling Stations
Shore	22,750 ft^2	0.52 acres	5
Small bar	42,300 ft^2	0.97 acres	12
Middle bar	12,250 ft^2	0.28 acres	12
Large bar	24,500 ft^2	0.56 acres	17
TOTAL	101,800 ft^2	2.33 acres*	46

*2.33 acres is equivalent to 0.95 hectare.

Individual clam flats cover so little ground that data on clam samples were pooled together to analyse the nature and size frequency distribution of the present clam stocks. Table 4 gives the distribution of the different size classes of clams found. It may be noted that only 15% of the total population are market size clams with very few large ones. The most abundant size classes are just below market size (clams between 36 and 48 mm, 43% of the total population). Younger size classes are not very abundant. Small size clams less than 6 mm would not be represented due to sampling gear selectivity, but this artefact is not the sole explanation for the relatively lower abundance of clams less than 22 mm (3/4 inch) long.

TABLE 4. Size frequency distribution of the clams sampled.

Size class mm	Size class inches	Number of clams found in samples	Percentage by count
0-16	< 3/4	151	7
17-22	3/4	125	6
23-29	1	256	12
30-35	1 1/4	380	18
36-41	1 1/2	511	24
42-48	1 3/4	418	19
49-54	2	189	9
55-60	2 1/4	72	3
61-67	2 1/2	43	< 2
68-73	2 3/4	9	< 1
≥ 74	≥ 3	3	< 1
TOTAL		2,157	100

The overall mean density for the Eel River Cove clam producing grounds is approximately 50 clams (all sizes) per square foot. This high density is rarely found in the Maritimes today (unpubl. data).

Table 5 presents bushel counts for the size classes of market size clams. 231 bushels per acre is a high production figure; but with a clam producing total area of only 2.33 acres the Cove total standing crop of market size clams is only 541 bushels.

TABLE 5. Production estimates of clam stocks in Eel River Cove.

Size class		Number of clams per ft^2 (0.09 m^2)	Number of bushels per acre (0.4 ha)	Number of bushels for the area
mm	inches		market size clams	
0-16	< 3/4	3.3	-	-
17-22	3/4	2.7	-	-
23-29	1	5.6	-	-
30-35	1 1/4	8.3	-	-
36-41	1 1/2	11.1	-	-
42-48	1 3/4	9.1	-	-
49-54	2	4.1	111.9	261.8
55-60	2 1/4	1.6	57.8	135.2
61-67	2 1/2	0.9	44.3	103.6
68-73	2 3/4	0.2	12.2	28.5
≥ 74	≥ 3	0.1	5.1	11.9
TOTAL		47.0	231.3	541.0

Note: One bushel equals 60 pounds of clams in the shell, or 27 kg.

Growth Patterns

The von Bertalanffy growth equation estimates a long and continuous growth pattern for Eel River Cove clam stocks (Table 6 and Fig. 2). A market size of 50 mm is reached after six growing seasons (Table 7). Contrary to other areas of the Maritimes where growth slows down very much after this stage (unpubl. data), the Eel River Cove population is still having yearly growth increments of 5 mm. A soft-shell clam from Eel River Cove will have to reach over 18 years of age before its annual growth increment levels off at 2 mm and 24 years for 1 mm increment per year. Such long life growing patterns are frequently encountered in benthic environments of cold northern latitudes.

TABLE 6. von Bertalanffy growth equation for the Eel River Cove clam stocks.

$$L = 127.936\ (1 - e^{-0.088(t-[-0.164])})\ \text{(mm)}$$

Standard error		
L_∞	k	t_0
2.321	0.0022	0.0122

95% confidence range					
L_∞		k		t_0	
123.387	132.486	0.084	0.092	-0.188	-0.140

TABLE 7. Length estimates (mm) at age (years).

Age	Number of rings measured	Fitted length	Growth increment $L_{t+1} - L_t$	Mean length measured
1	105	12.4	10	13.5
2	251	22.2	9	21.1
3	216	31.1	8	31.7
4	175	39.2	8	39.7
5	103	46.7	7	46.3
6	38	53.5	6	53.2
7	12	59.8	6	58.8
8	5	65.6	5	65.2
9	2	70.8	5	73.0
10	-	75.6	4	-
12	-	84.1	3	-
15	-	94.2	2	-
18	-	102.1	2	-
21	-	108.2	1	-
24	-	112.7		-

DISCUSSION AND CONCLUSION

Composition of Stocks - 1978

The market size clam stocks now available for harvesting could sustain a modest exploitation taking into consideration that they are relatively abundant but in a small area. This, of course, is not possible under the present shellfish closure. Figure 3 shows that the 1974 and 1975 year classes are quite important and that the biomass of market size clams will increase by over 50% in one and two years time. Unfortunately, this will not last, the younger classes (1976 on) not being as abundant. Less intense recruitment and heavier natural mortality are possible causes. This histogram also reveals that recruitment to the population was very good and survival rate high immediately after the implementation of the shellfish closure (1974, 1975 year classes). Decreased harvesting intensity and a concommittant decrease in smothering (main cause of mortality associated with fishing) have almost certainly decreased fishing mortality. There is no clear explanation for the poor recruitment of 1976 and 1977 year classes.

Comparison of 1978 Stocks With the Ones of Previous Studies

Since the first survey in 1963 the clam producing grounds have considerably diminished in Eel River Cove. From an estimated 40 acres of flats located in the northern end of the Cove there remains a mere 2.3 acres located mainly around the gravel bars. Table 8 compares average counts of different size classes of clams per square foot (0.09 m^2) as established by the many surveys since 1963. As may be seen, the number of market size clams per unit area is higher in 1978 than at any other time after the construction of the dam even though they constitute only 15% of the total population (low figure compared to 19% and 35%). The importance of these density figures has to be weighed against the fact that they occur over clam producing grounds of such a limited size.

ACKNOWLEDGEMENTS

I express my thanks to Mr. James Young of the Invertebrates and Marine Plants Division, Resource Branch, with whom I shared survey work on those cold October days.

TABLE 8. Comparison of average counts per square foot (0.09 m^2) of the different size classes of clams in 1963 (MacPhail, 1964a), in 1964 (MacPhail, 1964b), 1967 (Medcof, 1967), and 1978.

Size class (mm)	Average count of clams 1963	1964	1967	1978
10-15	0.9	0.7	6.0	3.3
15-20	1.4	0.7	1.3	2.7
20-25	1.5	1.0	1.4	5.6
25-30	1.4	1.4	1.4	
30-35	1.8	1.5	1.1	8.3
35-40	2.2	1.4	1.3	11.1
40-45	2.2	2.0	1.7	9.1
45-50	2.7	2.2	2.0	
50-55	3.2	2.6	1.7	4.1
55-60	2.4	1.7	1.3	1.6
60-65	1.7	0.7	0.5	0.9
65-70	1.6	0.9	0.3	0.2
Total market size	8.9 (35%)	5.9 (35%)	3.8 (19%)	6.8 (15%)
Total number	23.0 (100%)	16.8 (100%)	20.0 (100%)	46.9 (100%)

REFERENCES

Allen, K.R. 1966. A method of fitting growth curves of the von Bertalanffy type to observed data. Journ. Fish. Res. Bd Can. 23(2): 163-179.

Allen, K.R. 1967. Computer programmes available at St. Andrews Biological Station. Fish. Res. Bd Can. Tech. Rep. No. 20, 32 pp.

deMestral, J. and R. Legault 1972. Bacteriological surveys, Charlo River to Miller Brook, and Eel River including Eel River Bar, Shellfish Area N.B. 1, 1972. Water Pollution Control Directorate, Environmental Protection Service Rep. No. EPS5-WP-72-8, 31 pp.

MacPhail, J.S. and J.C. Medcof 1955. 1947 Clam investigations. Fish. Res. Bd Can. Atl. Biol. Sta. MS Rep. No. 855, 98 pp.

MacPhail, J.S. 1964a. Survey of Eel River Cove, N.B. soft-shell clam (*Mya arenaria*) population. Fish. Res. Bd Can. MS Rep. No. 763, 11 pp.

MacPhail, J.S. 1964b. Second survey of Eel River Cove, N.B. soft-shell clam (*Mya arenaria*) population. Fish. Res. Bd Can. MS Rep. No. 793, 8 pp.

Medcof, J.C. 1967. Third survey of Eel River Cove, N.B. soft-shell clam (*Mya arenaria*) population. Fish. Res. Bd Can. MS Rep. No. 941, 42 pp.

Newcombe, C.L. 1936. Validity of concentric rings of *Mya arenaria* for determining age. Nature 134(3457): 191-192.

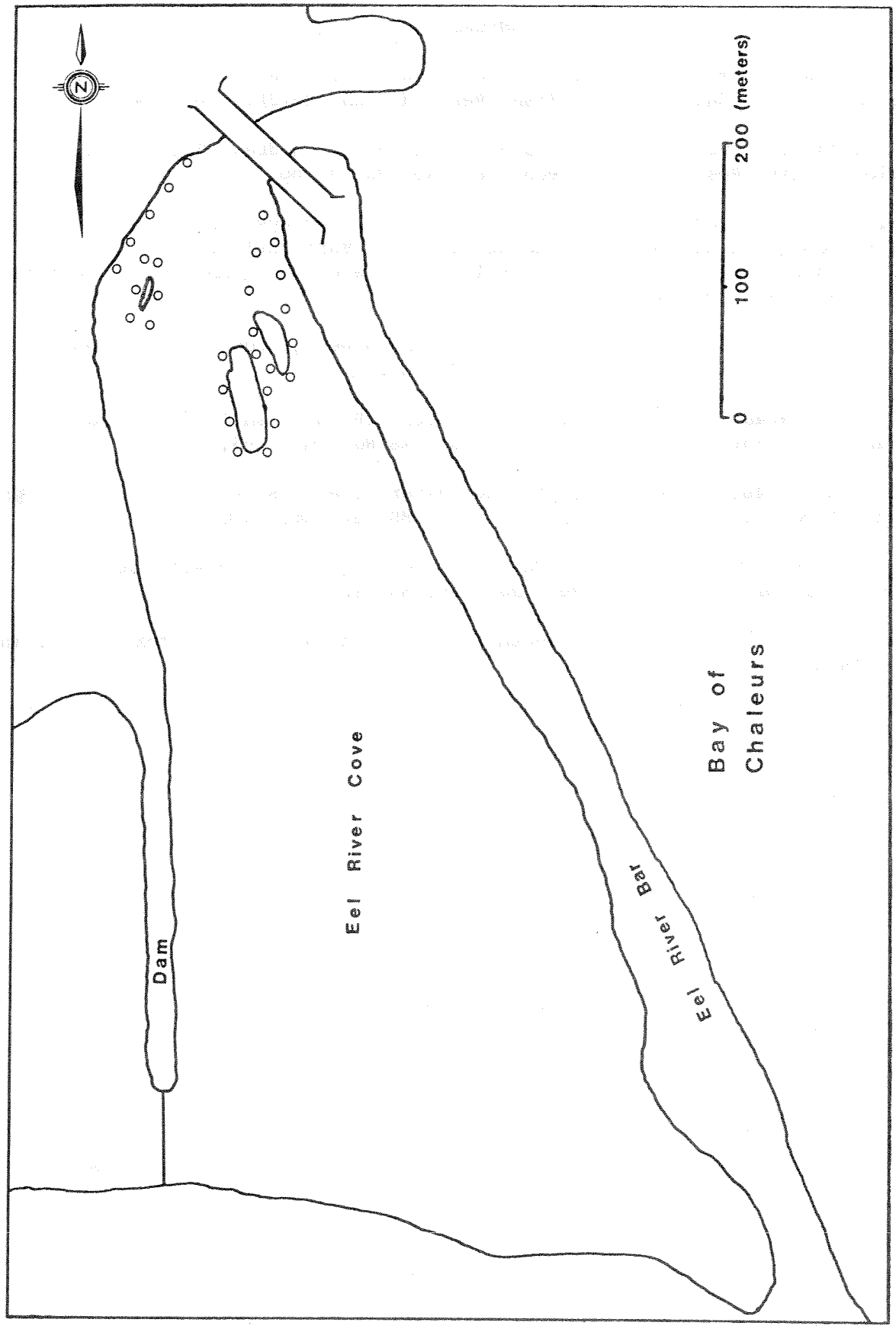

Figure 1. Eel River Cove, New Brunswick. The clam producing grounds are identified by circles.

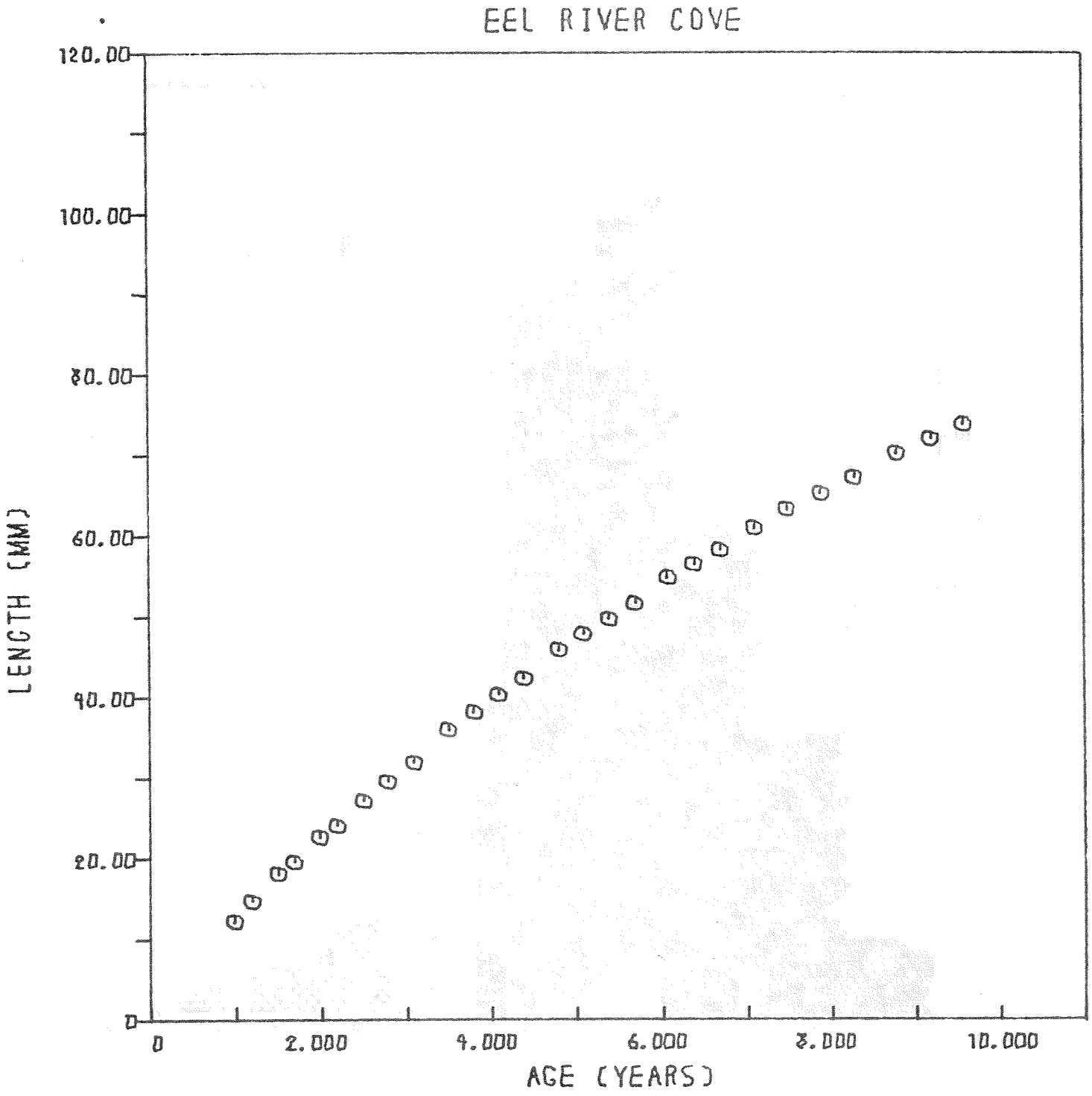

Figure 2. Growth curve of Eel River Cove clam stocks fitted by the von Bertalanffy growth equation.

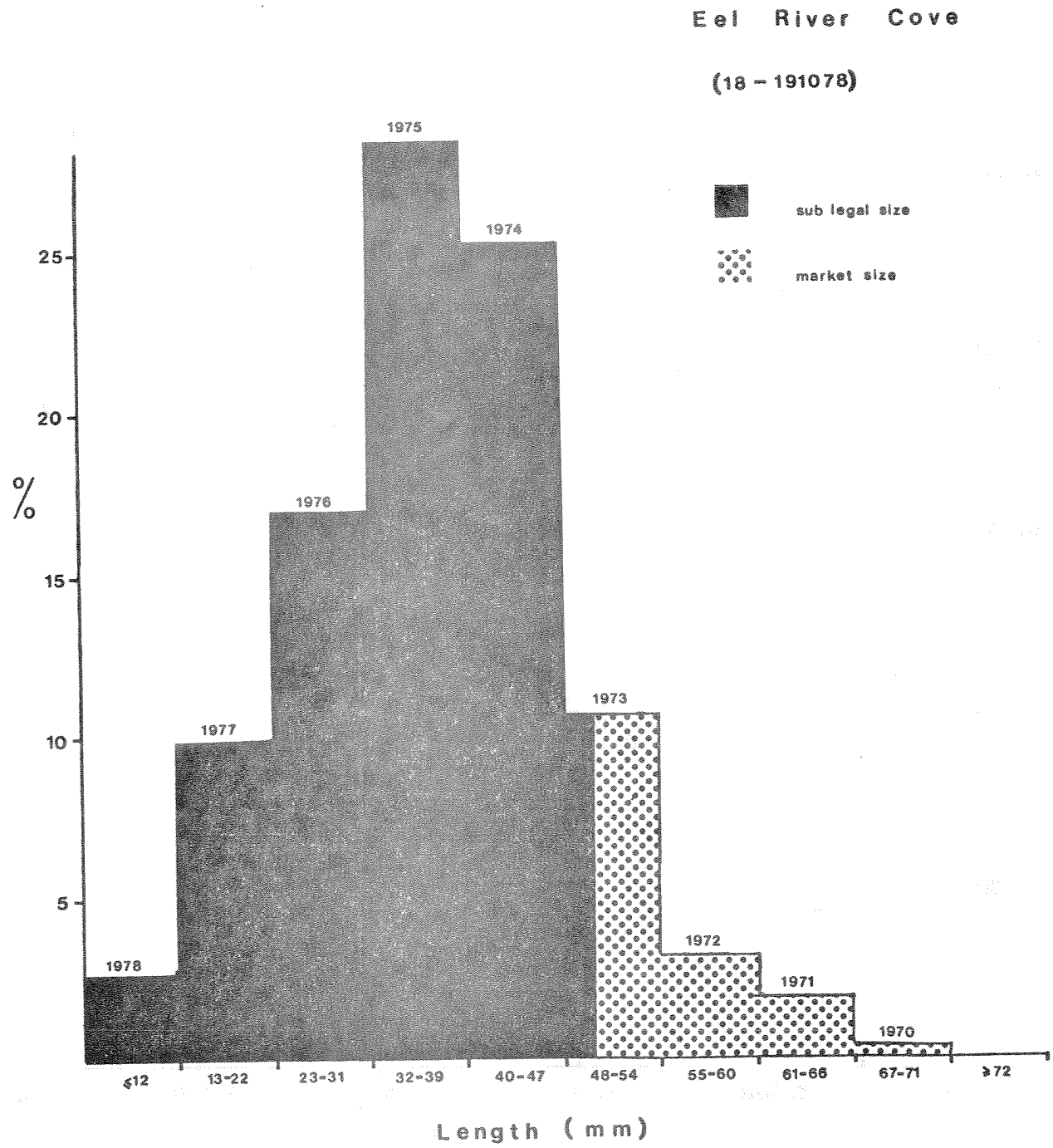

Figure 3. Histogram representing the percentage of different year classes making up the Eel River Cove clam population. Due to the nature of the sampling procedures the 1978 year class is not adequately represented.