Stock Assessment of Soft-Shell Clams In Open Shellfish Growing Areas Of Prince Edward Island

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ABSTRACT

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Assessment of stocks of soft-shell clams were carried out at 29 locations in Prince Edward Island, Canada, during the ice-free season from 1976 to 1978. Biomass estimates, size-frequency distribution and growth-rate were determined at most locations. Clams from Mill, Foxley, and Souris Rivers, and Rollo and Fortune Bays were sampled at regular intervals for analysis of meat condition. Optimal yields per recruit were determined for these sites. Different harvesting options are presented.

RÉSUMÉ

Robert, G. 1981. Stock assessment of soft-shell clams in open shellfish growing areas of Prince Edward Island. Can. MS Rep. Fish. Aquat. Sci. 1606: xiv + 47 p.

On a évalué les stocks de myes de 29 localités à l'Ile-du-Prince-Edouard, Canada, au cours de la belle saison de 1976 à 1978. On a déterminé pour la plupart des localités la biomasse de myes présente, la distribution des fréquences de taille et le taux de croissance. A intervalles réguliers on a prélevé des myes des rivières Mill, Foxley et Souris, et des baies Rollo et Fortune pour analyser la condition de la chair du mollusque. On a estimé des rendements par recrue optimals pour ces sites qui suggèrent différentes alternatives de pêche.

1. INTRODUCTION

Preliminary information from cooperative Federal and P.E.I. Department of Fisheries resource inventory surveys suggested that there were large quantities of stocks of soft-shell clams underutilized in Prince Edward Island; but the productivity of clam flats had never been evaluated.

The soft-shell clam fishery is a supplemental income fishery. Large quantities of clams are dug for recreational purposes and for private sale; hence, official statistics greatly underestimate the actual harvest. Landings reflect the effort but are strongly influenced by availability of other sources of income and the availability of local buyers. During the post-war period up to 1955, an average of 400 MT were harvested annually on P.E.I. From 1955 to 1975 landings seriously declined to less than 100 MT per year.

Beginning in the late 1960's, interest developed in the use of hydraulic (mechanized) harvesters. In recognition of the potential of mechanized harvesting, the possible conflicts of this form of harvesting with traditional hand-digging, and the need to determine its impact on stocks, detailed stock assessments were carried out to estimate biomass of market-size stocks from 1976 to 1978. An attempt was made to survey clam-producing areas representing the Island's different environmental conditions. Field work was undertaken in collaboration with personnel from the Prince Edward Island Department of Fisheries. While undertaking assessment work, information was collected on pertinent biological variables such as growth-rate and meat condition throughout the harvesting season. The report examines different harvesting strategies in an attempt to optimize yields.

2. METHODS

2.1 Sampling procedures

Clam-producing areas in Prince Edward Island were investigated during the ice-free season from 1976 to 1978 to provide information on stock assessments of soft-shell clams. Areas were surveyed in all sections of the Island to give a wide geographical coverage. Survey field work was carried out by personnel of the P.E.I. Department of Fisheries in 1976 and 1977 and by Fisheries and Oceans Canada in 1978.

After a preliminary estimate of the nature and size of the clam-producing area to be surveyed, baselines were run parallel to the shore with sampling at pre-fixed intervals along the line. Baselines and sampling stations were spaced at 50, 100 or 200 feet (15, 30 or 60 m) depending on the width of the tidal flats or the surface area of the sand shoal; 100-foot spacing was most currently used. All distances were measured with a chain marked at 50 and 100-foot intervals. Baseline directions were determined by using a Silva Type 15T Ranger Field Lighting Compass or equivalent. The acreage of areas sampled was estimated by the summation of the rectangles of varying length and width drawn up from station to station.

In 1976 and 1977 samples were taken with a gasoline powered centrifugal pump (Matthew Smith, P.E.I. Dept. of Fisheries for further details). A metal circle (0.18 m^2)- was depressed at least 20 cm into the sediments; this is below the maximum depth at which soft-shell clams are generally found. The contents was completely sucked out and collected in a 1/4 inch (6 mm) mesh bag attached to the pump out flow.

In 1978, samples were dug from one square foot (0.09 m^2) of substrate to a depth of 20 cm with a square-nose shovel. The sample was screened through a 1/4 inch (6 mm) wire mesh basket and all clams retained were collected. This size mesh is not adequate to retain juvenile clams and clams $\leq$20 mm long were not reliably sampled. Therefore, juvenile size-classes are underestimated. Each area was sampled once: for logistic reasons timing of the surveys was not meant to coincide with the post-settlement phase of the early recruits.

2.2 Sediment analysis

Sediment samples were taken in many of the locations at the time of the survey. The analysis was performed on triplicate surface (upper 5 cm) samples. Sediment grain size was determined according to Morgans (1956). Median diameter, standard deviation, skewness, and kurtosis were computed from Folk's formulas (1965), cf Appendix 1.

2.3 Stock assessment and determination of growth rate

Clams were measured with a vernier caliper to the nearest mm on their longest axis and grouped in size classes (1/4 inch; 5-6 mm) to determine the size-frequency distribution of the population. In Prince Edward Island, the minimum size at which clams may be harvested is 2 inches long; (the minimum size is also qualified as market size and minimum legal size). Clams over 49 mm long are considered in this report as market size, i.e. recruited clams. Clams grouped in size-classes 36-41 and 42-48 will be considered as prerecruits to the fishery. Clams over 36 mm long are quantitatively expressed in bushel counts (60 lbs; 27 kg) according to MacPhail and Medcof (1955) (Table 1).

Table 1. Number of soft-shell clams per bushel.

Size (length) mm	inches	Clams per bushel
36-41	1 1/2	2800
42-48	1 3/4	2200
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

At most locations a random sample of mixed size clams (100 to 300) was also collected for the determination of growth patterns. Marked seasonal variations in metabolic activity make possible the estimation of annual growth of soft-shell clams by shell reading (Newcombe, 1936). The distance between pronounced rings represents growth occurring over one growing season. Growth rings are best measured in shell widths; widths were further converted to lengths (see below) before fitting the data to a von Bertalanffy growth curve. Following Newcombe and Kessler (1936) and Brousseau (1979) a linear growth dimension was chosen as it shows less variation in response to environmental influences and difference in latitudes than any other size index.

If growth is described as an allometric equation:

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

or

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

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).

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

Appendix 2 lists the parameters of the growth equation with confidence limits and standard error for each location. Fitted and measured lengths at age are presented in Appendix 3.

2.4 Condition index

Variations in weight of animal tissues (condition index) reflect the different stages of the reproduction cycle, as the majority of the visceral mass is occupied by the gonads. Tissue weight increases as the gametes mature and reaches a peak level at spawning before dropping during the spent stage. Occurrences of spawning indicate potential recruitment to the clam stocks. In this shellfish species the whole animal is used as a food product. As such it is preferable when condition is maximal rather than in the spent stage when the evacuation of the gonad products has thinned the clam considerably.

The condition of the meat was determined at least bimonthly, from May to November at a few selected locations in 1976 or 1977. These sites were Mill and Foxley Rivers in Cascumpeque Bay (western P.E.I.) and Souris River, Rollo Bay and Fortune Bay in eastern P.E.I. A minimum of 100 market size clams were dug up at each site. Shell lengths were measured to the nearest mm; meats were removed from the shell, rinsed under tap pressure and oven-dried at 65°C for 24 hours (sufficient to reach a constant weight) before being weighed to the nearest 0.01 g. Dry weights are preferred to wet weights to reduce the high variability inherent to the latter. Shells were cleaned and air-dried before being weighed to the nearest 0.01 g.

For comparison purposes the ratio meat weight/shell length is very useful. This relation is valid only when growth is allometric. The clam growth pattern was verified by relating shell weight to shell length. Analysis of variance indicated no significant differences over the sampling period (Appendix 4) therefore shell length can be used as a reliable index for meat weight. At each sampling period the variables measured were pooled to generate a linear regression of meat weight on shell length (Appendix 5). To follow seasonal changes in meat yield the meat weight (mg) of a clam of standard shell length (50 mm) was then plotted through time.

2.5 Estimation of yield per recruit

Growth parameters from fitted von Bertalanffy growth equations from Mill, Foxley, and Souris Rivers, Rollo and Fortune Bays were used to calculate yield per recruit (kg per 10^5 recruits) according to the Beverton-Holt model (Ricker, 1975). Natural mortality of recruits (M) was set at 0.1 following Brousseau (1978) study of mortality rate in a population of market clams. Another investigator (Munch-Petersen, 1973) calculated a much higher rate (0.6) from age composition; a large variance makes this estimate a little uncertain. Moreover, it is unlikely that the mortality rate is constant through life. Brousseau's findings suggest an extremely high rate in both the larval and juvenile stages, a levelling off at the prerecruit stage until old age (clams > 80 mm long) when it rises slightly.

3. RESULTS

Areas where stock assessments have been carried out are grouped geographically into Western and Eastern Prince Edward Island (Figs. 1 and 2). Survey results are discussed in order as indicated on these figures:

3.1 Western Prince Edward Island

In the western part of Prince Edward Island, major clam-producing areas are located in large embayments (Cascumpeque Bay, Malpeque Bay, Egmont Bay) with more or less limited exchange with open waters.

3.1.1 Cascumpeque Bay

Site description and stock assessment

Four kilometers of tidal flats on the lee side of the sandhills between Cascumpeque Bay and the Gulf of St. Lawrence were surveyed at the end of August, 1978 (Fig. 3). Market size clams were not abundant (16% of the population; 41 bushels per acre) (Fig. 4a). Even though juveniles are under-represented they made up 45% of the population at the time of the survey.

A site was also surveyed in September 1978, on Sandy Islands, located in Cascumpeque Bay between Alberton South and Kildare Point (Fig. 3). The clam flat covers about 18 acres (7.2 ha). About 30% of the stocks were market size; 43% were between 36 and 48 mm (Fig. 4b). Market size clams accounted for a stock density of 160 bushels per acre.

Approximately 2.8 km of shoreline was surveyed around Oulton's Island (Savage Island) (Fig. 3) in mid-September 1978. Market size clams accounted for 31% of the population (92 bushels per acre) with an important component (15%) just below market size (Fig. 4c). The past two years appears to have had heavy sets with 32% of the population under 20 mm in length.

3.1.2 Hill River

Site description and stock assessment

Stretches of beach on both shores of Hill River were surveyed in the summer of 1976. Total area of the flats covered was 6.3 acres (2.4 ha) on the west shore and 7.7 acres (3.7 ha) on the east shore (Fig. 3). A sediment sample indicated that substrate was predominantly sand with little gravel, silt or clay (Table A.1).

On the east shore, the majority of clams were larger than or equal to 49 mm, occurring at a density of 84 bushels per acre and 61% of total number (Table 2, Fig. 5a). Clams between 36 and 48 mm accounted for about 15 bushels per acre and 25% of total.

Table 2. Stocks of soft-shell clams from the east shore of Hill River surveyed in the summer of 1976. Area of bed = 6.30 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	4.2	30.1
42-48	1 3/4	11.3	86.9
49-54	2	17.2	132.1
55-60	2 1/4	23.6	181.9
61-67	2 1/2	18.0	138.5
68-73	2 3/4	18.7	143.8
≥74	≥3	6.2	47.9
TOTAL	(≥49mm)	84	644

*One bushel equals 60 pounds or 27 kg of clams in the shell.

On the west shore of Hill River, clams larger than or equal to 49 mm were abundant, 145 bushels per acre and 67% of total number (Table 3, Fig. 5b). Clams from 36 to 48 mm accounted for only 17 bushels per acre and 18% of total number.

Table 3. Stocks of soft-shell clams from the west shore of Hill River surveyed in the summer of 1976. Area of bed = 6.30 acres.

Size class mm	inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	4.8	30.1
42-48	1 3/4	12.6	79.3
49-54	2	26.3	165.4
55-60	2 1/4	41.7	262.5
61-67	2 1/2	44.0	277.0
68-73	2 3/4	16.9	106.4
⩾74	⩾3	16.1	101.5
TOTAL	(⩾49mm)	145	913

*One bushel equals 60 pounds or 27 kg of clams in the shell.

3.1.3 Mill River

Site description and stock assessment

Stretches of beach on both shores of Mill River were surveyed for stocks of soft-shell clams in the summer of 1976 (Fig. 3). Clam flats are present in a narrow discontinuous band which follows the shoreline contour. Flats extend for 2.6 km on the east shore from the bridge to a point 2.5 km upstream from Fortune Cove; they cover 3.7 km on the west shore from Meggisons Creek (next to Hill River) to a location upriver situated about 1.2 km upstream from Long Creek. The clam flats cover 5 acres (2.0 ha) on the east shore of Mill River and 7 acres (2.8 ha) on the west shore. Grain size was similar to the one in Hill River (Table A1).

Clams larger than or equal to 49 mm from east shore flats were abundant (111 bushels per acre, 47% of total) (Table 4, Fig. 7a). Clams between 36 and 48 mm accounted for only 17 bushels per acre (16% of total number). Smaller size classes were not abundant with the exception of the smaller than 16 mm size class which contained 24% of total individuals (likely attributable to sampling performed soon after setting of juveniles). On the west shore of Mill River, clams 49 mm and larger were estimated at 100 bushels per acre and made up 55% of the population. Clams 36 to 48 mm had an abundance of 17 bushels per acre (22% of total number). Smaller clams (size less than 36 mm) did not seem to be abundant (Table 5, Fig. 7b). Mill River stocks were composed largely of market size classes.

Table 4. Stocks of soft-shell clams surveyed on the east shore of Mill River in the summer of 1976. Area of bed = 4.78 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	4.9	23.3
42-48	1 3/4	11.5	55.1
49-54	2	21.4	102.3
55-60	2 1/4	28.4	135.7
61-67	2 1/2	29.4	140.5
68-73	2 3/4	20.5	98.1
⩾74	⩾3	11.5	55.2
TOTAL	(⩾49mm)	111	532

*One bushel equals 60 pounds or 27 kg of clams in the shell.

Table 5. Stocks of soft-shell clams surveyed on the west shore of Mill River in the summer of 1976. Area of bed = 6.8 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	4.7	31.8
42-48	1 3/4	12.3	83.5
49-54	2	15.5	105.5
55-60	2 1/4	27.0	183.3
61-67	2 1/2	24.1	164.2
68-73	2 3/4	17.4	118.5
⩾74	⩾3	15.6	105.8
TOTAL	(⩾49mm)	100	677

*One bushel equals 60 pounds or 27 kg of clams in the shell.

Condition index

Important fluctuations of meat weight were observed in clams from Mill River throughout the 1976 growing season. After reaching a peak in condition at the end of June meat weight dropped substantially toward the middle of July with release of gametes, to rapidly increase to a slightly higher level, to drop again by mid-August before increasing to a more stable level until the end of the sampling period (Fig. 8). This pattern of variations in meat weight illustrates that spawning has taken place on two separate occasions in 1976. At other times the meat condition is improved and maintains a minimum of 550 mg (dry weight)/clam.

Yield per recruit

Yields per 10^5 recruits were determined using von Bertalanffy growth parameters and M=0.1. Optimum yield (kg per 10^5 recruits) is achieved at age of first harvesting of 9 years and F values of about 1.2 (Fig. 9). Nine-year old clams measure 105 mm and about 500 clams would fill a bushel. Only 11-15% of market size clams are over 74 mm (Tables 4 and 5); 1%? reaches a size for best yield. Evidently the stocks are harvested well below optimal levels (from 49 mm; age at first capture of 4 years; 1,600 clams per bushel).

3.1.4 Foxley River

Site description and stock assessment

Shore sections of Foxley River were surveyed in the summer of 1976 to determine stocks of soft-shell clams in the area (Fig. 10). On the east shore, a stretch of beach in the Hardy Point area (3 acres, 1.2 ha) and another section of the beach containing 9 acres (3.6 ha) from McNally's Point upstream to Martin's Cove, were surveyed. Two other flats, one on the west shore consisting of about 8 acres (3.2 ha) of beach downstream from Kelly's Point and the other a section near Platt River (10 acres, 4.0 ha) were also investigated.

The stock on the Hardy Point flat (not including the flat southeast of Hardy Point in Cascumpeque Bay where clam density is sparse) was composed mainly of clams larger than or equal to 49 mm, many of which were over 70 mm in size (Fig. 11a). Consequently, density of market size clams was high, 238 bushels per acre or 81% of total number (Table 6). Abundance of prerecruits was insignificant. This flat has been unexploited recently, hence the high recruits biomass. Clam growth rate at this site was moderate with market size reached at about 5 years of age (Fig. 12).

Table 6. Stocks of soft-shell clams from Foxley River (Hardy Point area) surveyed in the summer of 1976. Area of bed = 2.50 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	2.0	5.1
42-48	1 3/4	4.2	10.4
49-54	2	8.4	21.1
55-60	2 1/4	29.9	74.8
61-67	2 1/2	61.1	152.7
68-73	2 3/4	56.0	140.0
≥74	≥3	82.5	206.1
TOTAL	(≥49mm)	238	595

*One bushel equals 60 lb (27 kg) of clams in the shell.

Clam flats on the east shore (McNally's Point) contained animals larger than or equal to 49 mm with significant abundance of small size classes. Abundance of clams 49 mm and larger was high (135 bushels per acre, 60% of total number) (Table 7, Fig. 11b). Those between 36 and 48 mm were present in low abundance (6 bushels per acre and 6% of total). The only other size class represented with moderate numbers was 17 to 22 mm (1-2 years old) which made up 19% of total number yet, it is underestimated by the sampling techniques used.

Table 7. Stocks of soft-shell clams from Foxley River (east shore south of McNally's Point) surveyed in summer of 1976. Area of bed = 9.15 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	0.9	8.5
42-48	1 3/4	4.6	41.7
49-54	2	11.4	104.6
55-60	2 1/4	25.8	236.4
61-67	2 1/2	32.7	298.9
68-73	2 3/4	28.6	261.9
≥74	≥3	36.6	334.5
TOTAL	(≥49mm)	135	1287

*One bushel equals 60 pounds or 27 kg of clams in the shell.

On the west shore of Foxley River tidal flats downstream from Kelly's Point (Fig. 10) have important stocks of clams of market size (101 bushels per acre and 66% of total number (Table 8, Fig. 11c). Sub-market size classes were steadily declining with no apparent recruitment.

Table 8. Stocks of soft-shell clams from Foxley River, (west shore downstream from Kelly's Point) surveyed in the summer of 1976. Area of bed = 8.25 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	3.2	26.7
42-48	1 3/4	4.9	40.3
49-54	2	12.0	99.2
55-60	2 1/4	18.7	154.3
61-67	2 1/2	27.7	228.3
68-73	2 3/4	21.0	173.4
≥74	≥3	21.7	179.2
TOTAL	(≥49mm)	101	834

*One bushel equals 60 pounds or 27 kg of clams in the shell.

Clam stocks from flats in the vicinity of Platt River were also composed primarily of larger clams. Market size clams accounted for 84 bushels per acre and 63% of total number (Table 9, Fig. 11d). Sub-market size classes do not appear better represented here than near Kelly's Point.

Table 9. Stocks of soft-shell clams from Foxley River (upstream from Trout River) surveyed in the summer of 1976. Area of bed = 10.10 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	2.2	22.0
42-48	1 3/4	6.3	64.0
49-54	2	12.5	126.5
55-60	2 1/4	15.9	160.3
61-67	2 1/2	24.6	248.7
68-73	2 3/4	20.5	207.4
≥74	≥3	10.9	110.0
TOTAL	(≥49mm)	84	853

*One bushel equals 60 pounds or 27 kg of clams in the shell.

The distribution of size classes was fairly similar throughout the river with 60 to 80% of the total population made up of marketable stocks. In many places the substrate is hard clay, which makes harvesting very difficult. Therefore, the quantity of stocks actually harvestable is less than what is available.

In Foxley River growth follows an even pattern with an asymptotic size lower than in Mill River clams. Market size is reached after 5 years (Fig. 12).

Condition index

Meat condition showed important fluctuations through the sampling season (Fig. 13). After July sampling intervals are too wide to give meaningful results though. Nevertheless serious decreases of meat weight in mid-June and mid-July suggests two spawning periods in 1976. At other times meat condition seems to be in the range of 600 mg per 50 mm clam.

Yield per recruit

Yield estimates were established using growth parameters of Table A1.1 and M set at 0.1. Yields greater than 100 kg per 10^5 recruits would be achieved with harvesting intensities ⩾0.4 of clams 8 years old at least (Fig. 14) or 70 mm long. Stocks of clams corresponding to this optimal size made up 30 to 50% of market size stocks available to a fishery at the time of the survey. Increased harvesting pressure would operate outside optimal levels once the older stocks are used up or when harvesting stocks closer to the minimum marketable size.

3.1.5 Malpeque Bay

Site description and stock assessment

About 13 acres (5.2 ha) of flats in western Malpeque Bay between Oyster Point and Gillis Point and between Crooked Creek and Red Point were surveyed in August 1977 (Fig. 15). The beach sediment was sandy with layers of clay and patches of shale and granitic pebbles. The clam zone was narrow (10 m) with eelgrass beds encroaching the tidal flats in many places. Sections of shore on Lennox Island (11 acres, 4.4 ha) facing Lennox Channel were also investigated.

In western Malpeque Bay, clams larger than or equal to 49 mm were poorly represented in terms of numbers (28% of total) (Fig. 16a), but had high stocks of 13 bushels per acre (Table 10). Clams from 36 to 48 mm accounted for only 21 bushels per acre and 11% of total number. Clams smaller than 16 mm were abundant (37% of total) as sampling took place soon after setting of juveniles.

Table 10. Stocks of soft-shell clams surveyed in Malpeque Bay, August, 1977. Area of bed = 12.47 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	6.4	79.5
42-48	1 3/4	15.1	187.7
49-54	2	23.4	292.0
55-60	2 1/4	29.9	372.9
61-67	2 1/2	31.7	395.6
68-73	2 3/4	29.3	364.7
⩾74	⩾3	18.7	232.8
TOTAL	(⩾49mm)	133	1658

*One bushel equals 60 pounds or 27 kg of clams in the shell.

On Lennox Island, clams larger than or equal to 49 mm were not abundant, 27 bushels per acre and 18% of total number

(Table 11, Fig. 16b). Sub-market size classes (36 to 48 mm) were nearly non-existent at a density of 4 bushels per acre, and 6% of total number. The majority of clams were smaller than 36 mm especially young size classes 2-3 years old and the newly settled juveniles (0-16 mm class).

Table 11. Stocks of soft-shell clams surveyed on the shores of Lennox Island in Malpeque, August, 1977. Area of bed = 11.23 acres.

Size class		bushels*/acre	bushels/area
mm	inches	(0.4 ha)	
36-41	1 1/2	2.0	22.7
42-48	1 3/4	2.0	22.2
49-54	2	5.2	58.1
55-60	2 1/4	8.5	95.4
61-67	2 1/2	8.5	95.7
68-73	2 3/4	3.7.	41.9
≥74	≥3	0.8	8.7
TOTAL	(≥49mm)	27	300

*One bushel equals 60 pounds or 27 kg of clams in the shell.

Clam growth is slower in Malpeque Bay than in Cascumpeque Bay and asymptotic size is reached at a shorter length. Market size is achieved in 5 to 6 years (Table A2.1).

3.1.6 Brae River

Site description and stock assessment

The area west of Brae River was surveyed for clams in July, 1978 (Fig. 17). On the stretch of shore on the mainland clams were found in an almost continuous ribbon approximately 10 m wide. Total area of the flat was about 6 acres (2.4 ha). Market size clams were scarce (7% of the population and 24 bushels per acre) but smaller sizes (less than 49 mm) were abundant (Fig. 18a).

The shoreline on the lee side of the sand barrier (Fig. 17) had concentrations of clams in a narrow band 5 m wide (2 acres, 0.8 ha). As on the mainland the clam population of the sand barrier showed a scarcity of market size clams (24 bushels per acre) with smaller sizes abundant (Fig. 18b).

The near absence of market size clams is not an indication of strong harvesting pressures but of stunted growth due to less than ideal environmental conditions, especially shale sediment substrate.

3.1.7 Wolfe Inlet

Site description and stock assessment

Sampling was conducted along the north shore of Wolfe Inlet and along the lee shore of the barrier islands (Fig. 19). In both cases, extensive stretches of shore were walked as clam flats were discontinuous. The clam zone was very narrow, 10 m at most, when present. The patchiness of clam concentrations made an assessment difficult. Clams of market size contributed only 12% of the population (Fig. 20a). Clams just below 36 mm were most important on the north shore of the inlet and clams less than 22 mm in length for the population of the barrier islands (Fig. 20b).

As was the case in Brae River, growth also appears to slow down considerably (stunted clams) and market size clams are not abundant.

3.2 Eastern Prince Edward Island

Important clam-producing areas are numerous in eastern Prince Edward Island (Fig. 2). River systems like the one in Cardigan Bay, tidal inlets such as Launching Pond, bays closed off by a sand bar (Howe Bay) or open (Rollo Bay) offer suitable clam setting grounds.

3.2.1 South Lake

Site description and stock assessment

South Lake is a salt water embayment on the northeastern tip of Prince Edward Island, separated from Northumberland Strait by a barrier of sand hills. It has limited exchange with the sea by a narrow tidal channel. Nearly 5 acres (2.0 ha) of shoreline on the mainland side of South Lake were surveyed in July, 1977 in the most upstream part, to be continued in June, 1978 over almost 9 acres (3.6 ha) (Fig. 21). Data collected on these two occasions are treated together for estimating the stocks. Market size clams accounted for nearly half (43%) the population with a modal size class just below market size at the time of the survey. There was also an appreciable quantity of large size clams, over 68 mm (Fig. 22). Even though market size clams constituted a fair portion of the population these stocks only amounted to 58 bushels per acre. However, over 13 acres of clam flats were surveyed and 1068 bushels market size clams were estimated to be present (Table 12).

Table 12. Stocks of soft-shell clams from the shore (mainland) of South Lake surveyed in July, 1977 and June, 1978. Area of bed = 13.4 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	8.0	107.2
42-48	1 3/4	13.5	180.9
49-54	2	13.9	186.3
55-60	2 1/4	18.4	246.6
61-67	2 1/2	15.0	201.0
68-73	2 3/4	7.2	96.5
≥74	≥3	3.7	49.6
TOTAL	(≥49mm)	58	1068

*One bushel equals 60 pounds or 27 kg of clams in the shell.

3.2.2 Little Harbour

Site description and stock assessment

Little Harbour Pond is a small inlet connected to the Northumberland Strait through a narrow channel 0.8 km long (Fig. 23). Tidal flats suitable for soft-shell clams cover approximately 5 acres (2.0 ha) of the inlet while the remainder is slightly deeper, silted and covered with eel-grass.

Stocks of clams larger than or equal to 49 mm were very abundant, 131 bushels per acre and 31% of total number (Table 13, Fig. 24). The size class just below market size constitutes a mode and would bring an additional 30 bu + per acre to the fishery.

Table 13. Stocks of soft-shell clams from Little Harbour surveyed in July, 1976. Area of bed = 5.28 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	20.9	110.1
42-48	1 3/4	33.9	178.8
49-54	2	30.5	161.0
55-60	2 1/4	45.8	241.7
61-67	2 1/2	35.5	187.5
68-73	2 3/4	18.1	95.3
≥74	≥3	0.8	4.1
TOTAL	(>49mm)	131	690

*One bushel equals 60 pounds or 27 kg of clams in the shell.

In Little Harbour Pond soft-shell clams reach market size in approximately 5 years (Fig. 25). Growth rate drops steadily for 2 more years to become marginal afterward.

3.2.3 Souris River

Site description and stock assessment

Souris River was investigated for stocks of soft-shell clams in that section of the river upstream from closure line P.E.I. 5-1 (E.P.S. Marine Surveillance Report 5-AR-77-2) and on the shoal near the Souris bridge (Fig. 26). These areas are conditionally opened to shellfish harvesting. Clams were distributed in a band which followed the contour of the shore and on a central shoal. Along the east shore, flats extended for nearly 3 km and the clam-producing area covered 11 acres (4.4 ha). The west shore had nearly 2 km of clam-producing area for an estimated acreage of about 8 acres (3.2 ha). The shoal area just inside the sand bar contained a crescent-shaped clam bed about 8 acres (3.2 ha) in area. The remainder of the shoal became silty toward its eastern end and was exposed to strong wave action toward the channel. These two factors seriously limit possible extension of the clam bed. Sediment grain size determination from the shoal indicated that the substrate was predominantly sand with very little gravel, silt or clay mixed in (Table A1).

On the east shore, the most important size class was the one just below market size with nearly 25% of total number (Fig. 27a) and 75 bushels per acre (Table 14). This size class would complement market size stocks already quite abundant (168 bushels per acre). Younger size classes were not as impressive but seem to appear on a regular basis.

Table 14. Stocks of soft-shell clams surveyed on the east shore of Souris River in the fall of 1976. Area of bed = 11.02 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	37.8	416.6
42-48	1 3/4	74.8	824.8
49-54	2	68.9	759.1
55-60	2 1/4	52.8	581.7
61-67	2 1/2	33.1	365.2
68-73	2 3/4	11.2	123.4
≥74	≥3	1.6	17.1
TOTAL	(≥49mm)	168	1847

*One bushel equals 60 pounds or 27 kg of clams in the shell.

Table 15. Stocks of soft-shell clams surveyed on the west shore of Souris River in the fall of 1976. Area of bed = 8.26 acres.

Size class mm	inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	43.4	358.7
42-48	1 3/4	74.5	615.6
49-54	2	65.4	540.3
55-60	2 1/4	51.3	423.5
61-67	2 1/2	25.7	211.8
68-73	2 3/4	4.3	35.7
≥74	≥3	0.5	4.5
TOTAL	(≥49mm)	147	1216

*One bushel equals 60 pounds or 27 kg of clams in the shell.

The clam-producing area located on the shoal near the Souris bridge had a very high clam abundance, 269 bushels per acre for clams larger than or equal to 49 mm and 130 bushels per acre for those from 36 to 48 mm (Table 16) of potential interest to the fishery. Market size classes represented only 19% of total number (Fig. 27c). The youngest size class even though under-represented was the most important with a progressive decline in older size classes.

Table 16. Stocks of soft-shell clams surveyed on the shoal of Souris River in the fall of 1976. Area of bed = 8.00 acres.

Size class mm	inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	52.3	418.2
42-48	1 3/4	77.8	622.5
49-54	2	79.8	638.2
55-60	2 1/4	98.9	791.5
61-67	2 1/2	63.5	507.6
68-73	2 3/4	21.2	169.3
≥74	≥3	5.5	43.6
TOTAL	(≥49mm)	269	2150

*One bushel equals 60 pounds or 27 kg of clams in the shell.

Growth rate in the Souris River was moderate with clams of marketable size produced after 4 to 5 years (Table

A2.1). This soft-shell clam population has an active growth pattern through an extensive period reaching an asymptotic size of 130 mm.

Condition index

The collection of samples for meat analysis was conducted regularly every two weeks from late May to mid-November. Meat weight varied according to a repetitive pattern through the sampling period (Fig. 28). Peaks in condition were followed by a gradual drop in weight lasting about a month indicating that release of gametes happened twice in 1977. Consumer demand is greatest during the summer months; unfortunately meat quality of Souris River clams was poor through most of this period.

Yield per recruit

Yield per recruit under different conditions of t_r and F is presented in Fig. 29. To sustain harvesting at an optimal level clams 12 years old having reached 80 mm in length should be harvested at F of about 0.8. Only slight differences in yield would occur by harvesting 11 or 12 year old clams at F=0.6. The size-frequency distribution of the stocks indicated that very few clams belonged to older size classes, at best only 5.5 bushels per acre of stocks $\geq$74 mm were estimated to be present on the shoal. By cropping size classes <74 mm; <8 year old clam stocks the yield is reduced to 130-140 kg/10^5 recruits a decrease of 21% regardless of the harvesting mortality.

3.2.4 Rollo Bay

Site description and stock assessment

Rollo Bay was investigated for stocks of soft-shell clams in early summer 1976. On the north shore of the Bay clam flats were found to follow the shoreline for a considerable distance, over 2 km and to occupy an extensive area of sand shoals (55 acres, 24.0 ha) at the entrance to the Bay (Fig. 30). Nearly 19 acres (7.6 ha) of clam flats were surveyed along the south shore; they occurred in a band fashion contouring the shoreline. Particle size analysis of Rollo Bay sediments revealed that the substrate was mainly sand with a small percentage of silt and clay (Table A.1).

Soft-shell clams on the north shore were not distributed uniformly. Young subpopulations composed mainly of small size clams were found on flats immediately adjacent to the shore while older subpopulations with a fair proportion of large size clams occurred a little distance from shore. The majority of clams present were below market size. Clams larger than or equal to 49 mm accounted for 44 bushels per acre and 11% of total number (Table 17, Fig. 31a). Harvesting pressure seemed significant on these stocks.

Table 17. Stocks of soft-shell clams surveyed on the north shore of Rollo Bay in early summer, 1976. Area of bed = 10.33 acres.

Size class mm	inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	26.5	273.2
42-48	1 3/4	32.7	337.5
49-54	2	24.2	250.3
55-60	2 1/4	12.9	133.5
61-67	2 1/2	3.8	39.1
68-73	2 3/4	1.9	19.3
≥74	≥3	0.8	8.0
TOTAL	(≥49mm)	44	450

*One bushel equals 60 pounds or 27 kg of clams in the shell.

Soft-shell clams were distributed in patches on the south side of Rollo Bay with size-frequencies similar to the North shore ones. Abundance of clams larger than or equal to 49 mm was only 27 bushels per acre (7% of total number) (Table 18, Fig. 31b). Stocks just below market size were only slightly more abundant at 48 bushels per acre and 23% of total number. The 1975 set seems to have been quite important.

Table 18. Stocks of soft-shell clams surveyed on the south shore of Rollo Bay in early summer, 1976. Area of bed = 18.75 acres.

Size class mm	inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	23.3	437.6
42-48	1 3/4	25.2	471.6
49-54	2	14.2	265.5
55-60	2 1/4	6.6	124.5
61-67	2 1/2	3.8	71.1
68-73	2 3/4	0.6	11.6
≥74	≥3	1.6	29.3
TOTAL	(≥49mm)	27	502

*One bushel equals 60 pounds or 27 kg of clams in the shell.

The Rollo Bay shoal area was represented mostly by intermediate sizes of clams. Moderate quantities of clams larger than or equal to 49 mm were observed (76 bushels per acre) (Table 19) although this group accounted for only 17% of total number (Fig. 31c). The shoal is accessible at low tide from the north shore and seems to be fished to the extent of the shore area. Clams 36 to 48 mm accounted for 69 bushels per acre (31% of total number). A modal class grouped 1-inch (23-29 mm) clams.

Table 19. Stocks of soft-shell clams from the shoal in Rollo Bay surveyed in June, 1976. Area of bed = 56.01 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	25.2	1411.3
42-48	1 3/4	43.8	2450.5
49-54	2	27.2	1524.6
55-60	2 1/4	25.3	1419.3
61-67	2 1/2	16.1	901.5
68-73	2 3/4	5.6	313.6
≥74	≥3	1.6	87.1
TOTAL	(≥49mm)	76	4246

*One bushel equals 60 pounds or 27 kg of clams in the shell.

Growth rates in the Rollo Bay area were such that market size was reached in 5 to 6 years (Table A2.1).

Condition index

Condition as expressed by the dried meat weight of a 50 mm clam displayed high amplitude fluctuations through the sampling period (Fig. 32). Peaks in dried meat weight appeared in late June, mid-August and mid-September. High meat condition was followed by spawning periods in the latter part of July and near the end of August. The fall sampling was too limited to explain the downward trend in October.

Yield per recruit

Estimated yield was highest when clams 9 to 10 years of age (65 to 70 mm) are harvested with intensities of about 0.7-0.8 (Fig. 33). This would mean harvesting clams 3 years older than market size ones (50 mm; 6 years old). The size frequency distributions indicated significant harvesting as soon as new recruits entered the fishery. A loss of about 14% in yield occurs by reducing the size of first capture to market size.

3.2.5 Fortune Bay

Site description and stock assessment

Clam flats were surveyed on the south shore of Fortune Bay and on a sand shoal located at the entrance of the Bay, above the wharf in early summer, 1976 (Fig. 34). Bottom type was sandy with small amounts of silt and clay present (Table A.1). Acreage of clam flats on the sand shoal was approximately 11 acres (4.4 ha) and on the south shore, 3 acres (1.2 ha).

On the south shore of Fortune Bay, stocks of clams larger than or equal to 49 mm were moderately abundant at 91 bushels per acre (Table 20) and 21% of total number. Clams from 36 to 48 mm, the most abundant size classes, contributed 91 bushels per acre (42% of total number). The next size class, 30-35 mm, had another 21% of total number.

Table 20. Stocks of soft-shell clams surveyed on the south shore of Fortune Bay in early summer, 1976. Area of bed = 2.60 acres.

Size class		bushels*/acre	bushels/area
mm	inches	(0.4 ha)	
36-41	1 1/2	39.1	101.5
42-48	1 3/4	52.7	136.9
49-54	2	39.2	101.9
55-60	2 1/4	25.1	65.3
61-67	2 1/2	19.4	50.5
68-73	2 3/4	3.1	8.1
≥74	≥3	3.9	10.1
TOTAL	(≥49mm)	91	236

*One bushel equals 60 pounds or 27 kg of clams in the shell.

At the time of the survey the shoal population was made up of a modal size class (42-48 mm) followed closely by the 36-41 mm class. These sub-market size classes amounted to 138 bushels per acre and 50% of total abundance (Table 21, Fig. 35). Younger and older size classes were considerably less numerous; market size clams totaled 85 bushels per acre (18% of total number).

Table 21. Stocks of soft-shell clams surveyed in Fortune Bay (shoal area), early summer, 1976. Area of bed = 10.75 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	54.0	580.3
42-48	1 3/4	84.4	906.8
49-54	2	51.5	553.1
55-60	2 1/4	20.7	222.2
61-67	2 1/2	10.9	117.1
68-73	2 3/4	1.2	13.4
≥74	≥3	0.8	8.4
TOTAL	(≥49mm)	85	914

*One bushel equals 60 pounds or 27 kg of clams in the shell.

According to the von Bertalanffy equation Fortune Bay clams have a moderate growth pattern, reaching market size after 5 growing seasons (Fig. 25). Growth examined as length increments makes marginal gains beyond market size.

Condition index

Meat quality experienced a progressive decrease through the sampling season (Fig. 36), from very well meated clams in May, 900 mg dry weight for 50 mm clam to thin ones, 600 mg dry weight after October, a 33% reduction in meat weight. These are the most important fluctuations in meat condition observed through the 2-year study in Prince Edward Island. Condition peaked near the end of June and in early September. As gravid clams released gametes all through July they gradually became thinner at a time when market demand is heavy. This is partially offset by the fact that Fortune Bay clams condition index is unusually high to start with. The first trough (Fig. 36) in early June might not coincide with spawning considering environmental variables at this point.

Yield per recruit

In Fortune Bay, best yields of clams are predicted for year classes just above market size, 5-7 years old at harvesting intensities of 0.5-0.6 (Fig. 37). Therefore the exploitation of market size classes, the current strategy is the optimal condition for this fishery. Since prerecruits to the fishery accounted for 50% of the total population, harvesting could provide maximum yields for a few years to come.

3.2.6 Eglington Cove

Site description and stock assessment

The sand shoal in Eglington Cove was surveyed for stocks of soft-shell clams in August, 1976. Clam flats occupy 18 acres (7.2 ha) of the shoal (Fig. 38).

The survey revealed a low level of market size stocks (51 bushels per acre and 12% of total population, Table 22, Fig. 39). Clams just below market size were slightly more numerous at 60 bushels per acre and 26% of total number. The 1-inch (23-29 mm) size class constitute a mode suggesting an important set, a few years previous to the survey.

Table 22. Stocks of soft-shell clams from Eglington Cove collected in August, 1976. Area of bed = 18.37 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	25.1	460.1
42-48	1 3/4	35.1	643.8
49-54	2	22.6	415.1
55-60	2 1/4	19.2	352.6
61-67	2 1/2	8.1	147.9
68-73	2 3/4	1.2	22.9
≥74	≥3		
TOTAL	(≥49mm)	51	939

*One bushel equals 60 pounds or 27 kg of clams in the shell.

The growth rate of clams in the area was moderate and market size of 49 mm is reached at an age of approximately 5 years (Fig. 25). As was the case in Fortune Bay, gains in growth are very marginal beyond market size.

3.2.7 Howe Bay - Little River

Site description and stock assessment

A sand bar divides this area into an outer beach, Howe Bay and an inner section of sand flats, eelgrass beds and meandering streams, Little River (Fig. 40). The outer beach in Howe Bay has an important clam flat of approximately 10 acres (4.0 ha) to the right of the channel coming out from Little River. The inner section, Little River, surveyed in

1976, has patches of clam flats covering an area slightly less than 12 acres (4,8 ha). A sediment grain size determination made from a Little River sample on the inside of the sand bar indicated that substrate was predominantly sand with little gravel, silt and clay present (Table A.1).

When surveyed in 1977, market size clams were quite abundant in Howe Bay (137 bushels per acre and 14% of total number) (Table 23, Fig. 41a). The size class just below market size (42 to 48 mm) was just as numerous (130 bushels per acre) leading to potential high yields. It appears that recruitment is a more or less regular process with some excellent years.

Table 23. Stocks of soft-shell clams from Howe Bay surveyed in 1977. Area of bed = 9.64 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	79.5	766.4
42-48	1 3/4	129.5	1248.3
49-54	2	80.6	776.9
55-60	2 1/4	36.2	348.8
61-67	2 1/2	11.4	109.5
68-73	2 3/4	5.6	54.0
≥74	≥3	3.1	30.0
TOTAL	(≥49mm)	137	1319

*One bushel equals 60 pounds or 27 kg of clams in the shell.

In Little River stocks were not abundant compared to what they were outside the sand bar with a small percentage representing each size class. Clams larger than or equal to 49 mm were low in abundance (36 bushels per acre and 6% of total number) (Table 24, Fig. 41b). Prerecruits to the fishery were slightly more numerous at 60 bushels per acre and 19% of total number. The population was composed mainly of small size individuals with a high proportion of newly set clams. However, the youngest size classes are not adequately represented by the sampling techniques used. Environmental conditions in Little River do not seem to favor the development of abundant stocks of soft-shell clams in comparison with Howe Bay.

Table 24. Stocks of soft-shell clams from Little River (Howe Bay) surveyed in 1976. Area of bed = 11.71 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	23.7	276.9
42-48	1 3/4	36.7	428.9
49-54	2	20.4	239.1
55-60	2 1/4	10.0	116.7
61-67	2 1/2	4.7	55.4
68-73	2 3/4	0.6	7.3
⩾74	⩾3		
TOTAL	(⩾49mm)	36	419

*One bushel equals 60 pounds or 27 kg of clams in the shell.

3.2.8 Spry Cove

Site description and stock assessment

Twenty acres (8.0 ha) of sand flats were identified as soft-shell clam-producing areas in a survey in July 1976. Clam stocks are distributed unevenly over sand flats shaped by numerous meandering channels (Fig. 42). Sediment grain size analysis indicated that the substrate was mainly sand with very little gravel, silt or clay present (Table A.1).

At the time of the survey this soft-shell clam population was composed mainly of very small size individuals, less than 16 mm long (Fig. 43a). Stocks over 49 mm made up only 6% of the total population with less than 20 bushels per acre (Table 25). Twenty-three percent of total number represented stocks between 36 and 48 mm but there was only 28 bushels per acre present. Recruitment appears to have been heavy prior to the survey as the abundant small size classes testify.

Table 25. Stocks of soft-shell clams from Spry Cove surveyed in July, 1976. Area of bed = 20.40 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	13.1	266.6
42-48	1 3/4	15.1	307.0
49-54	2	8.4	172.2
55-60	2 1/4	7.4	150.6
61-67	2 1/2	2.8	58.0
68-73	2 3/4	0.6	12.7
⩾74	⩾3	0.8	15.9
TOTAL	(⩾49mm)	20	409

*One bushel equals 60 pounds or 27 kg of clams in the shell.

Growth is average, clams requiring 5 growing seasons to reach market size (Fig. 25).

3.2.9 Boughton Bay

Site description and stock assessment

A section of the north shore of Boughton Bay from Blackett's Creek to near MacFarlane Cove was surveyed for stocks of soft-shell clams in August, 1977 (Fig. 42). The beach is rocky in many places, and soft-shell clams occurred in patches no more than 5 m wide along the shore. Total area of the clam flat is approximately 3.5 acres (1.4 ha).

Clams stocks in the area were of moderate density. Clams 49 mm and larger made up about 12 per cent of the population at a density of 78 bushels per acre (Table 26, Fig. 43b). Of the remaining clams, those from 36 to 48 mm accounted for 17 per cent of the population and a stock density of 62 bushels per acre. Clams smaller than 36 mm (roughly 1 to 3 years old) were the main size grouping with a mode made up of the latest set. These may not be adequately represented by the sampling techniques used.

Table 26. Stocks of soft-shell clams surveyed in Boughton Bay, August, 1977. Area of bed = 3.48 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	24.0	83.4
42-48	1 3/4	38.4	133.7
49-54	2	35.1	122.2
55-60	2 1/4	29.2	101.5
61-67	2 1/2	11.4	39.5
68-73	2 3/4	1.9	6.5
≥74	≥3	0.0	
TOTAL	(≥49mm)	78	270

*One bushel equals 60 pounds or 27 kg of clams in the shell.

Marketable size of clams in the area (≥ 49 mm) was reached at about 6 years of age (Table A2.1). Growth is fairly marginal beyond market size.

3.2.10 Launching Pond

Site description and stock assessment

Launching Pond is a small embayment located between Boughton and Cardigan Bays. It is almost completely closed off except for a small navigation channel (Fig. 44). Clam flats in the Pond cover about 8 acres (3.2 ha).

Clams larger than or equal to 49 mm were abundant on this flat, the stock amounting to 110 bushels per acre and 21% of total number (Table 27, Fig. 45a). This population had a bimodal distribution; one mode composed of 15% of total individuals, prerecruits to the fishery (42 bushels per acre) and another mode made up of newly set clams.

Table 27. Stocks of soft-shell clams from Launching Pond surveyed in June, 1977. Area of bed = 8.26 acres.

Size class mm	inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	17.0	140.1
42-48	1 3/4	42.4	350.0
49-54	2	39.2	323.8
55-60	2 1/4	39.1	323.2
61-67	2 1/2	22.7	187.7
68-73	2 3/4	6.9	56.5
⩾74	⩾3	2.3	19.3
TOTAL	(⩾49mm)	110	911

*One bushel equals 60 pounds or 27 kg of clams in the shell.

Marketable size of 49 mm was achieved by clams from the Pond in approximately five years (Fig. 25). Growth was still important beyond market size with an asymptotic length defined as 88 mm in this case.

3.2.11 Boughton Island

Site description and stock assessment

A strip of beach on the northwest side of Boughton Island, facing Launching Bay, was surveyed for stocks of soft-shell clams in July 1977 (Fig. 44). The sand shoal, which connects Boughton Island to the mainland at low tide was also examined but was not found to have clams. It is swept by strong currents and gets exposed for only a short time at low tide. The clam flat on Boughton Island covers three acres (1.2 ha).

Abundance of clams in the area was high. Clams 49 mm and larger were present with an abundance of 115 bushels per acre, accounting for 24% of the total population (Table 28, Fig. 45b). However, prerecruits to the fishery were almost nonexistent, about 7 bushels per acre. Clams smaller than 23 mm (1 inch) made up about 65% of the population; even though they are under-represented.

Table 28. Stocks of soft-shell clams from Boughton Island, July, 1977. Area of bed = 3.00 acres.

Size class mm	inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	2.8	8.4
42-48	1 3/4	4.8	14.3
49-54	2	12.5	37.6
55-60	2 1/4	22.9	68.7
61-67	2 1/2	42.1	126.4
68-73	2 3/4	22.4	67.2
≥74	≥3	14.8	44.3
TOTAL	(≥49mm)	115	344

*One bushel equals 60 pounds or 27 kg of clams in the shell.

Market size of clams in the area was reached at about 5 years of age (Fig. 25). The rate of growth is still important for quite awhile after that.

3.2.12 Cardigan River

Site description and stock assessment

The south shore of Cardigan River, from the village downstream to Morrison Beach, and several flats on the north shore of Cardigan River as far as Maitland Point were surveyed for stocks of soft-shell clams in the summer of 1976 (Fig. 46). On the south shore (17 acres, 6.8 ha) the beach substrate is hard in some places with rocks, pebbles and coarse gravel present. Soft-shell clams occurred in patches where the substrate was soft enough to permit setting. Grain size analysis of the flat sediments indicated that it was composed of silty sand (Table A.1). North shore flats occupy 20 acres (8.0 ha).

On the south shore flats, market size stocks were low, averaging 35 bushels per acre and 4% of the population (Table 29, Fig. 47a). However, the prerecruits to the fishery (36 to 48 mm size classes) were abundant at 119 bushels per acre. The small size classes (< 36 mm) made up 72% of total number with 2 modes (30-35 mm and 0-16 mm).

Table 29. Stocks of soft-shell clams surveyed on the south shore of Cardigan River in the summer, 1976. Area of bed = 17.10 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	61.5	1050.8
42-48	1 3/4	57.6	985.3
49-54	2	21.2	363.1
55-60	2 1/4	8.5	145.2
61-67	2 1/2	3.8	64.8
68-73	2 3/4	1.9	31.9
≥74	≥3		
TOTAL	(≥49mm)	35	605

*One bushel equals 60 pounds or 27 kg of clams in the shell.

The distribution of stocks was fairly similar on the north shore with market size class accounting for 44 bushels per acre and 4% of the population. (Table 30). Prerecruits were moderately abundant, 76 bushels per acre and 13% of the population. Those smaller than 36 mm made up 61% of the population, the youngest size class being especially important.

Table 30. Stocks of soft-shell clams surveyed on the north shore of Cardigan River in the summer of 1976. Area of bed = 20.20 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	36.9	744.8
42-48	1 3/4	38.2	771.9
49-54	2	21.2	429.0
55-60	2 1/4	13.3	268.5
61-67	2 1/2	6.6	133.9
68-73	2 3/4	2.5	50.3
≥74	≥3	0.8	15.7
TOTAL	(≥49mm)	44	897

*One bushel equals 60 pounds or 27 kg of clams in the shell.

Growth of clams is slow in Cardigan River (Table A2.1). Six growing seasons are required to reach market size and the growth rate becomes minimal even before this point (L_∞=57 mm). The hard beach substrate does not allow much room to grow and stunted clams were a regular feature of the samples.

3.2.13 Montague River

Site description and stock assessment

Both shores of Montague River, from Brudenell Point to Thompson's Pond on the north shore and from St. Andrews Point to a point across from Thompson's Pond on the south shore were examined to assess soft-shell clam stocks. Shellfish harvesting is prohibited on the north shore flats because of domestic pollution; on the south shore the closure extends to the mouth of the river (Fig. 46). The clam flats surveyed cover approximately 10 acres (4.0 ha) on each shore.

On the north shore, the abundance of clams larger than or equal to 49 mm was high (132 bushels per acre and 13% of total number). Abundance of prerecruits was also high (163 bushels per acre and 30% of total number) (Table 31).

Table 31. Stocks of soft-shell clams from the north shore (closed to direct harvesting) of Montague River surveyed in the summer of 1977. Area of bed = 9.92 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	66.1	655.3
42-48	1 3/4	97.1	963.0
49-54	2	64.0	634.7
55-60	2 1/4	45.3	448.9
61-67	2 1/2	14.5	143.5
68-73	2 3/4	5.8	57.8
≥74	≥3	1.9	18.8
TOTAL	(≥49mm)	132	1304

*One bushel equals 60 pounds or 27 kg of clams in the shell.

On the south shore, market-size clams were distributed similarly between the different size classes but were more numerous (151 bushels per acre) (Table 32). The prerecruits size class and the class of newly set clams gave 2 modes to the distribution of this population (Fig. 47b).

Table 32. Stocks of soft-shell clams from the south shore of Montague River surveyed in the summer of 1977. Area of bed = 11.43 acres.

Size class mm	inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2		
42-48	1 3/4		
49-54	2	65.6	749.8
55-60	2 1/4	49.1	561.2
61-67	2 1/2	26.5	303.0
68-73	2 3/4	7.5	85.7
≥74	≥3	2.3	26.3
TOTAL	(≥49mm)	151	1726

*One bushel equals 60 pounds or 27 kg of clams in the shell.

It takes 6 years to reach market size in Montague River (Table A2.1). These clams have a continuous growth rate until quite late in life with L_∞ at 97 mm.

3.2.14 Panmure Island

Site description and stock assessment

A section of tidal flats on Panmure Island, Cardigan Bay, was identified as an important clam flat. The flat follows the shoreline from Billhook Point through a small cove to a wharf at the end of the road (Fig. 48). Area of the flat was 11 acres (4.4 ha). Sediment grain size determination indicated that the substrate was predominantly sand (> 95%) with little gravel, silt or clay present (Table A.1).

Market size clams made up a small proportion of the clam population (12%) (Fig. 49a) but were present in moderate abundance (96 bushels per acre) (Table 33). This exploitation pattern may be explained by the proximity of a camping site and the favors of local residents which make the Billhook Point area a popular clam-digging site. There are appreciable amounts of stocks just below market size (109 bushels per acre). The size-frequency distribution suggests that recruitment to these stocks would be regular and stable even if the small size classes are underestimated.

Table 33. Stocks of soft-shell clams surveyed on the shores of Panmure Island in July, 1976. Area of bed = 10.90 acres.

Size class		bushels*/acre	bushels/area
mm	inches	(0.4 ha)	
36-41	1 1/2	51.0	556.2
42-48	1 3/4	58.0	632.4
49-54	2	37.3	406.6
55-60	2 1/4	24.0	261.5
61-67	2 1/2	11.8	129.0
68-73	2 3/4	12.5	135.7
≥74	≥3	10.1	110.2
TOTAL	(≥49mm)	96	1043

*One bushel equals 60 pounds or 27 kg of clams in the shell.

This clam population reaches market size at about 5 years of age (Table 2A.1), growth slowing down beyond this stage.

3.2.15 St. Mary's Bay

Site description and stock assessment

The south shore of St. Mary's Bay was surveyed for stocks of soft-shell clams in the summer of 1976. The survey included about 1050 m of shoreline east of Hicken Point and 500 m to the west of Hicken Point. Nearly 12 acres (4.8 ha) of beach were covered by clam flats (Fig. 48). Sediment grain size analysis indicated that the bottom substrate was predominantly sand with a small amount of gravel present (Table A.1).

Clam stocks were composed primarily of clams of intermediate sizes with a mode by 30-35 mm size class. Clams larger than or equal to 49 mm were present with an abundance of 74 bushels per acre (9% of total number) (Table 34, Fig. 49b). Clam digging is as popular here as on Panmure Island. Clams 36 to 48 mm were abundant at 135 bushels per acre (30% of total abundance).

Table 34. Stocks of soft-shell clams from the shores of Saint Mary's Bay surveyed in the summer of 1976. Area of bed = 11.71 acres.

Size class		bushels*/acre	bushels/area
mm	inches	(0.4 ha)	
36-41	1 1/2	67.8	794.3
42-48	1 3/4	66.9	783.7
49-54	2	43.3	506.9
55-60	2 1/4	19.9	233.4
61-67	2 1/2	9.9	116.4
68-73	2 3/4	1.2	14.6
≥74	≥3		
TOTAL	(≥49mm)	74	871

*One bushel equals 60 pounds or 27 kg of clams in the shell.

Growth rate is almost identical to the one observed at Panmure Island; market size being reached one year later though (Table 2A.1).

3.2.16 Greek River

Site description and stock assessment

Shores of the downstream portion of Greek River (Murray Harbour north) were investigated for stocks of soft-shell clams in the summer of 1976 (Fig. 50). The clam flats occupy a narrow strip of beach following the contour of the shore and covering 11 acres (4.4 ha). Substrate sampled on the flat was predominantly sand with a small amount of silt and clay included (Table A.1).

Clam stocks in the area were moderately abundant. Market size clams were present at 80 bushels per acre and 11% of total number (Table 35, Fig. 51a). There were about as many prerecruits (the 36 to 48 mm size classes). The majority of clams present were in the 23 to 35 mm size classes (2 to 3 year old clams), comprising 40% of the total number. The abundance of small size clams suggests that there was a good potential for harvesting in a few years time.

Table 35. Stocks of soft-shell clams surveyed in Greek River, summer 1976. Area of bed = 11.09 acres.

Size class mm	inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	39.5	438.2
42-48	1 3/4	41.2	456.7
49-54	2	27.5	304.9
55-60	2 1/4	22.2	245.6
61-67	2 1/2	20.4	225.8
68-73	2 3/4	5.0	55.2
≥74	≥3	4.7	51.8
TOTAL	(≥49mm)	80	883

*One bushel equals 60 pounds or 27 kg of clams in the shell.

The von Bertalanffy growth curve fitted to clams from the Greek River flats indicated that marketable size of 49 mm is reached in 5 to 6 years (Fig. 52) with marginal growth beyond this size.

3.2.17 Murray Harbour

Site description and stock assessment

Shores in the Murray Harbour area were surveyed in the summer of 1977. The survey area included flats on the lee side of the barrier beach called Poverty Beach (27 acres, 10.8 ha); from the end of Poverty Beach to Indian Point (15 acres, 6.0 ha); in Murray River from Fairchild Point to Log Cove (11 acres, 4.4 ha); and on the north shore of Reynold's Island (3 acres, 1.2 ha) (Fig. 50).

In the Poverty Beach area clam stocks larger than or equal to 49 mm were abundant (99 bushels per acre, Table 36) but made up only 19% of the total number (Fig. 51b). Clams from 36 to 48 mm were considerably less numerous at 29 bushels per acre (11% of total number). The two youngest size classes made up 60% of the total population. Survey work was performed soon after larvae set.

Table 36. Stocks of soft-shell clams from Poverty Beach in Murray Harbour surveyed in the summer 1977. Area of bed = 27.00 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	9.5	256.2
42-48	1 3/4	18.8	507.9
49-54	2	26.1	705.7
55-60	2 1/4	27.0	727.6
61-67	2 1/2	27.9	754.3
68-73	2 3/4	13.7	369.6
≥74	≥3	4.7	126.0
TOTAL	(≥49mm)	99	2683

*One bushel equals 60 pounds or 27 kg of clams in the shell.

The flat from Poverty Beach to Indian Point had a small quantity of clam stocks larger than or equal to 49 mm (52 bushels per acre and 14% of total number) (Table 37, Fig. 51c). The 36 to 48 mm clams were also not abundant (35 bushels per acre, 18% of total number). Similarly to the Poverty Beach population the youngest size classes made up the bulk with 57% of total number.

Table 37. Stocks of soft-shell clams surveyed from Poverty Beach to Indian Point in Murray Harbour during the summer of 1977. Area of bed = 14.81 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	11.8	175.0
42-48	1 3/4	23.3	345.5
49-54	2	22.0	325.1
55-60	2 1/4	18.7	277.6
61-67	2 1/2	8.6	127.7
68-73	2 3/4	1.9	27.7
≥74	≥3	0.6	8.9
TOTAL	(≥49mm)	52	767

*One bushel equals 60 pounds or 27 kg of clams in the shell.

Stocks from Fairchild Point to Log Cove along Murray river contained mainly clams 29 mm and smaller with poor representation from the larger size classes; prerecruits, 11 bushels per acre and 7% of total number, market size 26 bushels per acre and 8% of total number (Table 38, Fig. 51d).

Table 38. Stocks of soft-shell clams surveyed from Fairchild Point to Log Cove in Murray Harbour during the summer of 1977. Area of bed = 11.48 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	4.7	53.6
42-48	1 3/4	6.3	72.7
49-54	2	8.9	101.6
55-60	2 1/4	8.3	95.4
61-67	2 1/2	4.7	54.4
68-73	2 3/4	2.5	28.6
≥74	≥3	1.9	22.3
TOTAL	(≥49mm)	26	302

*One bushel equals 60 pounds or 27 kg of clams in the shell.

Tidal flats on Reynold's Island had poor representation of clams larger than or equal to 49 mm. These accounted for only 39 bushels per acre and 9% of total number (Table 39, Fig. 51e). Clams from 37 to 48 mm were present at a density of 33 bushels per acre and 18% of total number. The majority of the clam population (> 40%) was represented by the newly set as the survey occurred soon after larval settlement.

Table 39. Stocks of soft-shell clams from Reynold's Island, Murray Harbour surveyed in the summer of 1977. Area of bed = 2.75 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	18.8	51.7
42-48	1 3/4	14.9	40.8
49-54	2	11.3	31.2
55-60	2 1/4	10.0	27.5
61-67	2 1/2	9.9	27.1
68-73	2 3/4	2.6	7.1
≥74	≥3	4.9	13.4
TOTAL	(≥49mm)	39	106

*One bushel equals 60 pounds or 27 kg of clams in the shell.

In general, Murray Harbour clam stocks had abundant to poor quantities of market size clams, low amounts of pre-recruits and a high number of juveniles (and this despite the inadequacy of the sampling to represent them fully).

Growth rates of clams in the Murray Harbour area were relatively low with clams reaching market size at approximately 6 years (Fig. 52).

3.2.18 Flat River - Gascoigne Cove

Site description and stock assessment

A 300 m section of the north shore of Flat River and the shoal adjacent to the sand bar at the river mouth were surveyed for stocks of soft-shell clams in the summer of 1977 (Fig. 53). The shores of Gascoigne Cove were also investigated at this time. Clam flats in the latter area extend along the shore in a band and comprise nearly nine acres (3.6 ha).

On Flat River, market size stocks were very abundant, 144 bushels per acre and 17% of the population (Table 40, Fig. 54a). Prerecruits (42-48 mm) gave a mode to the distribution (78 bushels, 15% of total number). Half of the population was smaller than 36 mm. Flat River offered excellent harvesting possibilities. Light digging activity takes place in the area.

Table 40. Stocks of soft-shell clams from Flat River collected in the summer of 1977. Area of bed = 11.71 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	38.3	448.1
42-48	1 3/4	78.0	913.5
49-54	2	69.7	816.1
55-60	2 1/4	44.3	518.7
61-67	2 1/2	21.3	249.5
68-73	2 3/4	6.9	80.2
≥74	≥3	1.6	18.2
TOTAL	(≥49mm)	144	1683

*One bushel equals 60 pounds or 27 kg of clams in the shell.

Growth rate for these clams was slow so that market size was not reached until an age of 8 years (Table A2.1) when growth increments had become marginal.

In Gascoigne Cove, market size clams were present in large quantities, 121 bushels per acre (Table 41) and 23% of the population. A modal distribution by the prerecruits occurred like in Flat River (Fig. 54b). It appears that recruitment was negligible for a few consecutive years before becoming important a year previous.

Table 41. Stocks of soft-shell clams in Gascoigne Cove collected in the summer of 1977. Area of bed = 8.95 acres.

Size class		bushels*/acre	bushels/area
mm	inches	(0.4 ha)	
36-41	1 1/2	30.8	275.7
42-48	1 3/4	67.3	602.5
49-54	2	63.4	567.7
55-60	2 1/4	42.5	380.0
61-67	2 1/2	14.2	127.1
68-73	2 3/4	1.2	11.1
≥74	≥3		
TOTAL	(≥49mm)	121	1086

*One bushel equals 60 pounds or 27 kg of clams in the shell.

3.2.19 Pinette Harbour

Site description and stock assessment

Tidal flats in the Pinette Harbour area were investigated in June, 1978 (Fig. 55). Clams occurred in patches as the substrate was sandstone ledge or sandstone covered by less than 10 cm of sand or silty sand. Small (stunted) clams were abundant but their growth was limited by the shallow soft sediment. Where the layer of silt-sand was more than superficial, clams were plentiful in a 10 m ribbon along the shore.

A clam flat a little over an acre in size between Stewart Cove and the Trans Canada Highway causeway on the south shore had moderate density of market size clams (49 bushels per acre) (Table 42) with a comparable amount of prerecruits. Upstream from the causeway, clam flats were of minor importance. A section of shoreline along the Trans Canada Highway had high concentrations of small clams but few of market size. Market size clams were not abundant on the 4 acres (1.6 ha) of flats on the north shore from the causeway to McCauley's Wharf (73 bushels per acre) (Table 43). Clam stocks around Holm Cove on the north shore of Pinette Harbour were of minor importance.

Table 42. Stocks of soft-shell clams surveyed from the Trans Canada Highway to Stewart Cove in Pinette Harbour, June 1978. Area of bed = 1.24 acres.

Size class mm	inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	35.2	43.7
42-48	1 3/4	44.5	55.2
49-54	2	21.2	26.3
55-60	2 1/4	12.2	15.1
61-67	2 1/2	10.4	12.9
68-73	2 3/4	1.2	22.9
≥74	≥3		
TOTAL	(≥49mm)	4.7	5.8

*One bushel equals 60 pounds or 27 kg of clams in the shell.

Table 43. Stocks of soft-shell clams surveyed from the Trans Canada Highway causeway to McCauley's Wharf, Pinette Harbour, June 1978. Area of bed = 3.65 acres.

Size class mm	inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	40.0	146.0
42-48	1 3/4	53.9	196.8
49-54	2	25.3	92.4
55-60	2 1/4	24.7	90.3
61-67	2 1/2	15.6	57.0
68-73	2 3/4	6.2	22.7
≥74	≥3	1.6	5.7
TOTAL	(≥49mm)	73	268

*One bushel equals 60 pounds or 27 kg of clams in the shell.

The population for the area as a whole consisted mainly of clams smaller than market size (Fig. 56) with an estimated large proportion smaller than 23 mm (1 inch). This does not necessarily reflect heavy settings; stuntiness causes clams to accumulate in the smaller size classes. Stunted clams are a serious drawback to a fishery in Pinette Harbour.

Market size in the Pinette Harbour area is reached at an age of about 7 years (Table A2.1) for clams that have set in patches of soft sediments. Unfortunately, the majority of clam stocks in Pinette Harbour may never grow to that size; developing a thick, stunted shell instead.

3.2.20 Clyde River

Site description and stock assessment

The southwest shore of Clyde River from where it joins the West River to a point approximately 1.6 km upstream, was investigated for stocks of soft-shell clams in late 1976 (Fig. 57). The beach substrate was hard clay over most of this clam flat of less than 3 acres (1.2 ha).

Stocks of clams in the area occurred in good concentrations but the distribution was patchy. Abundance of clams greater than or equal to 49 mm was high, 177 bushels per acre and 46% of the total population (Table 44, Fig. 58). The distribution had one important mode centered around the minimum market size (49 mm). Numbers of prerecruits was moderate and younger size-classes were not estimated to be important. Because of a hard clay substrate, stuntiness in clams is occurring but is not as detrimental as in Pinette Harbour.

Table 44. Stocks of soft-shell clams surveyed in Clyde River in 1976. Area of bed = 2.79 acres.

Size class mm	Size class inches	bushels*/acre (0.4 ha)	bushels/area
36-41	1 1/2	21.2	59.0
42-48	1 3/4	51.9	144.7
49-54	2	65.9	183.8
55-60	2 1/4	65.0	181.3
61-67	2 1/2	34.6	96.4
68-73	2 3/4	8.7	24.3
≥74	≥3	3.1	8.7
TOTAL	(≥49mm)	177	495

*One bushel equals 60 pounds or 27 kg of clams in the shell.

3.3 Summary

Many clam-producing areas had high concentrations (> 100 bushels/acre) of market-size stocks. These tidal flats are listed in order of decreasing abundance in Table 45.

Table 45. Clam-producing areas where market size stocks are greater than 100 bushels per acre listed in order of decreasing abundance.

Location	bushels*/acre (0.4 ha)	Total Standing crop (bu.)
Souris River, shoal	269	2,150
Foxley River, Hardy Point	238	595
Clyde River	177	595
Souris River, east shore	168	1,847
Montague River, south shore	151	1,726
Souris River, west shore	147	1,216
Hill River, west shore	145	913
Flat River	144	1,683
Howe Bay	137	1,319
Foxley River, east shore	135	1,287
Malpeque Bay	133	1,658
Montague River, north shore	132	1,304
Little Harbour	131	690
Gascoigne Cove	121	1,086
Boughton Island	115	349
Mill River, east shore	111	532
Launching Pond	110	911
Foxley River, west shore	101	839
Mill River, west shore	100	677
TOTAL		21,267

Most sites investigated in Cascumpeque Bay had moderate stocks of market size clams (Mill and Foxley Rivers excepted). Cardigan Bay (Panmure Island and St. Mary's Bay), Murray and Pinette Harbours also contain between 50 and 100 bushels per acre (15,685 bushels were estimated to be present at those sites). Some other locations had considerably less market size stocks (Lennox Island, Brae River, Wolfe Inlet); low abundance of these size classes was usually associated with stuntedness (9,050 bushels were estimated from the less productive locations). The overall biomass for the areas inventoried was assessed at 41,002 bushels or 1,118 MT of market size stocks.

Some areas with or without fair quantities of market size stocks had important stocks of prerecruits (36 to 48 mm) extending the harvesting or allowing new grounds to be dug. The shores of Souris River, Fortune Bay or Spry Cove populations are in this category. By comparison, other sites such as Cascumpeque or Malpeque Bay lacked prerecruit stocks and harvesting could seriously decline for awhile. (One should note that a bushel of prerecruits to the fishery will yield more than a bushel of market size clams (Table 1).)

Concurrently to the beginning of the surveys in 1976 landings increased (Table 46) to 200-300 MT per year. Renewed interest from conventional clam diggers and mechanized harvesting contributed to the higher levels. It is unlikely that such harvesting intensities can be maintained. A previously low exploitation rate had allowed stocks to build up to the point they could support these levels of harvest for a period. Moreover, the extent of harvestable areas is threatened by domestic pollution due to feacal contamination. The 1980 harvest suggests a downward trend.

Table 46. Annual landings (MT) of soft-shell clams, P.E.I.

Year	1975	1976	1977	1978	1979	1980
Harvest	46	127	202	340	250	106

Most soft-shell clam populations achieved market size after 5 or 6 years in Prince Edward Island waters. In some cases the growth rate was exceptionally high; only 3 growing seasons were necessary to reach 49 mm in Mill River. Slow growth rates were also observed, the extreme in Flat River being 8 years to market size.

According to the Beverton and Holt yield per recruit model optimal yields range widely between the locations under investigation. Based on 10^5 recruits, Fortune Bay gave an optimal yield of 70 kg; Mill River: 310 kg; Foxley River: 100 kg; Souris River: 170 kg; Rollo: 105 kg. Fortune Bay is the only location where the present harvesting strategy, (minimum market size set at 49 mm) brings optimal yield to the fishery. In Rollo Bay, Souris River and Foxley River yields are reduced by 14%, 21% and 20% respectively by harvesting market size stocks; (they remain greater than in Fortune Bay however). Optimisation of the yield would mean that stocks > 70 mm or 90 mm (Souris River) recruit to the fishery.

Mill River could provide high yields but with fairly large clams; 11 to 15% of the population is over 74 mm and a very small proportion would reach a size (105 mm) for best yield. The yield of market size stocks from Mill River is estimated at 100 kg per 10^5 recruits. It is well below optimal but compares well with yields from other sites studied.

4. DISCUSSION

Stocks assessed over Prince Edward Island represent different growing conditions. The composition of clam populations may vary greatly even when they are located in close proximity, e.g. the shores of 2 rivers emptying in the same bay, as the size-frequency distributions attest. The heterogeneity of populations is greatest when the substrate is hard, the distribution becomes patchy and the growth stunted. Clam-producing areas were visited only once through the three-year study; therefore, only instantaneous stock estimates were obtained. Production response of clam populations to harvesting pressure were not examined. The sampling methods used and timing of the survey work were not adequate to fully represent the youngest size-classes of the populations; they are very likely underestimated.

The average growth rate compare relatively well with other areas of the Maritimes. In the northern section of New Brunswick, soft-shell clams from Eel River Cove reached a shell length of 49 mm after 5 to 6 growing seasons (Robert, 1979). In the Minas Basin at the upper end of Bay of Fundy, Medcof (1949) had established 8 years at Five Islands, 5 to 6 years at Economy Point (unpubl. data). Of course warmer waters and longer growing season favour tidal flats to the south. Brousseau (1979) has established that only 2 years are required in northern Massachusetts. The von Bertalanffy model used show that asymptotic size has a wide range of values. It is highly probable that it is influenced by local conditions (Swan, 1952; Spear & Glude, 1957). Some populations L_∞ such as Cardigan River or Fortune Bay are small and growth slows down considerably or increments are marginal beyond market size while others (Montague, Souris River) are large, growth still being an active process well after reaching harvestable size. This may lead to different harvesting strategies when meat yields versus size are also considered. Some locations will never carry important quantities of market size stocks because clam growth becomes stunted prior to this size. Two alternatives exist to utilize those small size stocks; first, use them as transplant seeds in more suitable locations; (such experiments have met with relative success in Maine); second, find market openings for thick-shelled small clams and allow harvesting of under size (<49 mm) clams.

The monitoring of meat condition from May to November covered the digging season in its full extent. By comparing the meat yield (dry weight) of a minimum market size clam at different locations it may be seen that environmental conditions and food supply at any one site influence meat quality; population gene pool may also play a part. Superimposed on this component, fluctuations related to spawning and the transition from ripe to spent clams alter the meat yield once or more through the digging season. Some other variations of smaller amplitude belong to the active growth and rest phases common to shallow water bivalve molluscs (Dare, 1976). For a clam shucking facility, processing clams from Fortune Bay was more profitable than clams from the nearby Souris River in 1977 (Fortune Bay, 600-900 mg dry weight/50 mm clam; Souris River, 500-700 mg dry weight/50 mm clam).

The major drop(s) in meat yield during the summer months corresponding to the release of gametes happens at a peak time for consumer demand. At the sites investigated spawning usually takes place through July with minor occurrences before or after. It is a considerable advantage that clam larvae be at the planktonic stage when food supply is abundant. McIver (1972) has suggested that the reproduction cycle of inshore molluscs is time related to primary production blooms in southern Gulf of St.Lawrence. One major spawning per year has also been reported for the Bay of Fundy by Battle (1933) and for New England waters (Brousseau, 1978b; Ropes and Stickney, 1965).

Battle (1933) has studied the reproduction cycle of soft-shell clams in the Bay of Fundy. She attributed the initiation of the process to increased temperatures. In Gulf of St. Lawrence as in Bay of Fundy spawning is not a continuous process but appears to be of an intermittent nature associated with some cyclic environmental conditions. Losanoff and Davis (1950) have reported similar importance of maturation temperature for the American oyster, *Crassostrea virginica*.

If one is trying to optimize the yield harvested on these clam flats it appears the present size limit (minimum market size = 49 mm) is not suitable except in Fortune Bay. It should be set higher allowing clams additional growing seasons before they recruit to the fishery. Losses to natural mortality which remains constant for these size-classes (Brousseau, 1978a), would not outweigh possible meat gains. However, the actual consumer demand favors small size clams. Because of the popularity of small clams it is sometimes requested to harvest undersize clams (<49 mm). With the exclusion of stunted clams, which are not widespread by any means, this option should not be favored; not only because of poor yields but mainly because of the minimum size at maturity. In a study of spawning cycle, fecundity and recruitment in a Massachusetts soft-shell clam population, Brousseau (1978b) has determined that 40 mm was the minimum size for gravid females; the largest females producing the largest number of eggs. Some unpublished data collected in Cascumpeque Bay in 1979 concur with Brousseau's findings. The size limit maximizes removal of larger and more fecund individuals.

Such harvesting practice carries the threat of depletion of large individuals and the reduction of overall reproductive capacity to the point where the long-term stock stability may be endangered.

One limitation of the yield model is the assumption of constant recruitment. Logistic difficulties in the survey design led to an underrepresentation of the youngest size-classes. Stock-recruitment dependence or density dependent growth rate factors were also not taken into account. The yields given should only be considered for short term harvestability.

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Appendix 1

Sediment particle size analysis for some Prince Edward Island clam-producing flats.

Table A1. Sediment parameters of some locations surveyed resulting from the mean of triplicate samples. Median and standard deviation are expressed in phi units, 10x $-\log_2$ grain size in mm.

Location	Percentages by weight			Median (Phi)	Standard Dev. (Phi)	Skewness	Kurtosis
	Gravel	Sand	Silt & Clay				
Cardigan River	8.38	90.32	1.30	1.44	0.78	-0.3608	1.23
Eglinton Cove	0.47	86.29	13.24	2.44	1.31	0.2931	1.39
Fortune Bay	0.15	96.63	3.22	2.28	1.02	0.0447	1.19
Greek River	3.81	87.00	9.19	2.01	1.07	0.0198	1.29
Hill River	0.76	95.17	4.07	2.17	1.00	-0.0549	1.43
Little River	0.08	97.88	2.04	2.30	0.91	0.0674	1.08
Mill River	2.01	93.51	4.48	2.38	0.98	-0.1713	1.68
Panmure Island	0.82	97.55	1.63	1.72	0.93	-0.0327	1.08
Rollo Bay	1.87	90.44	7.69	2.28	1.05	-0.1130	1.51
Saint Mary's Bay	7.82	90.96	1.22	1.37	0.44	-0.3121	2.25
Souris River	0.06	98.15	1.79	2.51	0.90	-0.1271	1.27
Spry Cove	0.06	98.22	1.72	2.25	0.88	-0.0087	1.10

APPENDIX 2

Parameters of Von Bertalanffy growth equations for soft-shell clams collected in Prince Edward Island, 1976 to 1978.

Table A2.1. Parameters for Von Bertalanffy growth equations for soft-shell clams from Prince Edward Island, 1976 to 1978.

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

Location	Year	L_∞	K	t_0
Boughton Bay	1977	65.849	0.247	0.648
Boughton Island	1977	93.647	0.175	0.568
Cardigan River	1976	57.140	0.392	0.720
Cascumpeque Bay	1976	78.683	0.242	0.767
Eglington Cove	1976	60.201	0.397	0.548
Flat River	1977	58.497	0.244	0.468
Fortune Bay	1976	62.462	0.334	0.451
Foxley River	1976	89.831	0.195	0.495
Greek River	1976	62.407	0.296	0.437
Hill River	1978	130.000	0.135	0.343
Howe Bay	1977	110.653	0.151	0.341
Launching Pond	1977	87.933	0.173	0.334
Little Harbour	1976	69.441	0.316	0.751
Malpeque Bay	1977	77.864	0.203	0.432
Mill River	1976	130.221	0.205	0.669
Montague River	1977	97.184	0.119	0.192
Murray Harbour				
Downstream	1977	83.102	0.170	0.343
Upstream	1977	96.811	0.108	-0.084
Panmure Island	1976	67.425	0.288	0.346
Pinette Harbour	1978	68.153	0.177	-0.091
Rollo Bay	1976	82.702	0.183	0.341
Saint Mary's Bay	1976	71.767	0.211	0.289
Souris River	1977	130.446	0.114	0.302
South Lake	1978	217.469	0.058	0.152
Spry Cove	1976	79.318	0.233	0.617

Table A2.2. 95% confidence limits and standard error of estimates of parameters for Von Bertalanffy growth equations.

		95% confidence limits						standard error		
Location	Year	L_{∞}		K		t_0		L_{∞}	K	t_0
Boughton Bay	1977	64.962	66.736	0.240	0.254	0.626	0.671	0.452	0.0036	0.0115
Boughton Island	1977	91.936	95.359	0.169	0.181	0.539	0.596	0.873	0.0031	0.0144
Cardigan River	1976	51.171	63.109	0.283	0.501	0.498	0.942	3.045	0.0557	0.1133
Cascumpeque Bay	1976	74.723	82.643	0.215	0.270	0.663	0.872	2.020	0.0140	0.0531
Eglington Cove	1976	57.146	63.257	0.338	0.457	0.407	0.689	1.559	0.0306	0.0719
Flat River	1977	56.914	60.080	0.231	0.257	0.434	0.503	0.808	0.0065	0.0177
Fortune Bay	1976	60.965	63.959	0.311	0.356	0.378	0.523	0.764	0.0116	0.0368
Foxley River	1976	87.091	92.572	0.182	0.207	0.430	0.560	1.398	0.0064	0.0332
Greek River	1976	60.702	64.112	0.276	0.316	0.374	0.500	0.870	0.0101	0.0323
Hill River	1978	124.237	135.763	0.126	0.145	0.303	0.383	2.940	0.0048	0.0203
Howe Bay	1977	105.307	115.998	0.141	0.161	0.319	0.362	2.727	0.0052	0.0110
Launching Pond	1977	86.365	89.501	0.168	0.178	0.317	0.352	0.800	0.0027	0.0089
Little Harbour	1976	68.485	70.396	0.304	0.329	0.709	0.794	0.488	0.0064	0.0218
Malpeque Bay	1977	76.004	79.723	0.194	0.211	0.403	0.462	0.949	0.0045	0.0151
Mill River	1976	126.535	133.907	0.193	0.216	0.621	0.716	1.881	0.0059	0.0243
Montaque River	1977	95.007	99.360	0.167	0.217	0.115	0.123	1.111	0.0022	0.0128
Murray Harbour										
downstream	1977	81.740	84.464	0.164	0.175	0.315	0.372	0.695	0.0028	0.0145
upstream	1977	93.318	100.304	0.102	0.113	-0.117	-0.050	1.782	0.0030	0.0170
Panmure Island	1976	65.801	69.048	0.271	0.304	0.291	0.402	0.828	0.0086	0.0284
Pinette Harbour	1978	66.539	69.766	0.170	0.184	-0.118	-0.064	0.823	0.0037	0.0136
Rollo Bay	1976	80.613	84.790	0.175	0.192	0.306	0.375	1.066	0.0043	0.0175
Saint Mary's Bay	1976	69.800	73.735	0.199	0.223	0.240	0.338	1.004	0.0060	0.0248
Souris River	1977	125.536	135.536	0.108	0.120	0.281	0.323	2.505	0.0030	0.0105
South Lake	1978	182.288	252.650	0.047	0.070	0.111	0.193	17.949	0.0057	0.0210
Spry Cove	1976	77.767	80.869	0.223	0.242	0.584	0.650	0.791	0.0048	0.0169

APPENDIX 3

Length at age for soft-shell clams collected in Prince Edward Island, 1976 to 1978. Locations are listed alphabetically.

Table A3.1. Length (mm) at age for soft-shell clams collected at Boughton Bay in August, 1977.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	12	5.5	13	11.9
2	158	18.7	10	17.6
3	147	29.0	8	29.1
4	115	37.1	6	37.7
5	97	43.4	5	44.1
6	63	48.3	4	47.7
7	25	52.1	3	51.0
8	2	55.1	2	53.0
9	—	57.5	2	—
10	—	59.3		—

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.2. Length (mm) at age for soft-shell clams collected at Boughton Island in July, 1977.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	17	6.8	14	12.4
2	111	20.7	12	19.4
3	95	32.4	10	31.8
4	92	42.2	8	42.7
5	82	50.4	7	51.6
6	72	57.4	6	57.9
7	54	63.2	5	62.6
8	26	68.1	4	66.6
9	5	72.2	3	71.8
10	—	75.6		—

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.3. Length (mm) at age for soft-shell clams collected at Cardigan River in the summer of 1976.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	0	5.9	17	—
2	126	22.6	11	22.5
3	123	33.8	8	33.9
4	107	41.4	5	41.3
5	38	46.5	3	46.3
6	7	49.9	2	50.6
7	1	52.3	2	54.0
8	—	53.9	1	—
9	—	54.9	1	—
10	—	55.6		—

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.4. Length (mm) at age for soft-shell clams collected at Cascumpeque Bay in late summer, 1978.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	0	4.3	16	—
2	150	20.3	13	20.2
3	145	32.9	10	33.1
4	140	42.7	8	43.0
5	118	50.5	6	50.2
6	77	56.6	5	56.2
7	37	61.3	4	61.1
8	15	65.1	3	65.6
9	8	68.0	2	69.0
10	2	70.3		73.5

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.5. Length (mm) at age for soft-shell clams collected at Eglington Cove in August, 1976.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	1	9.9	17	17.0
2	99	26.4	11	26.1
3	99	37.5	7	37.8
4	90	44.9	5	44.9
5	62	49.9	3	49.8
6	7	53.3		53.6
7	—	55.6	2	—
8	—	57.1	1	—
9	—	58.1	1	—
10	—	58.8		—

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.6. Length (mm) at age for soft-shell clams collected at Flat River, in the summer of 1977.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	9	7.1	11	12.6
2	152	18.2	9	17.3
3	131	26.9	7	27.6
4	118	33.8	5	34.3
5	57	39.1	4	38.2
6	6	43.3	3	43.0
7	—	46.6	3	—
8	—	49.2	2	—
9	—	51.2	2	—
10	—	52.8		—

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.7. Length (mm) at age for soft-shell clams collected at Fortune Bay, in early summer 1976.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	1	10.5	15	14.0
2	247	25.2	11	25.1
3	244	35.8	8	36.0
4	218	43.4	5	43.5
5	164	48.8	4	48.4
6	53	52.7	3	52.2
7	21	55.4	2	55.8
8	5	57.4	2	61.0
9	1	58.9	1	64.0
10	—	59.9		—

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.8. Length (mm) at age for soft-shell clams collected at Foxley River in the summer of 1976.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	7	8.4	14	11.4
2	199	22.8	12	22.2
3	192	34.7	10	35.3
4	172	44.5	8	44.6
5	150	52.5	7	52.7
6	108	59.1	6	58.8
7	66	64.6	4	63.1
8	31	69.0	4	69.1
9	15	72.7	3	75.1
10	4	75.7		77.5

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.9. Length (mm) at age for soft-shell clams collected at Greek River during the summer of 1976.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	4	9.6	14	12.5
2	307	23.1	10	23.0
3	303	33.2	8	33.2
4	257	40.7	6	40.8
5	140	46.3	4	46.1
6	40	50.4	3	50.4
7	15	53.5	2	52.8
8	2	55.8	2	58.5
9	1	57.5	1	57.0
10	1	58.7		60.0

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.10. Length (mm) at age for soft-shell clams collected at Hill River during the summer of 1976.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	12	11.1	15	13.7
2	34	26.1	13	24.7
3	31	39.3	12	38.6
4	25	50.8	10	51.9
5	18	60.8	9	62.2
6	11	69.6	8	69.6
7	4	77.2	7	75.0
8	2	83.9	6	80.5
9	—	89.8	5	—
10	—	94.9		—

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.11. Length (mm) at age for soft-shell clams collected at Howe Bay in 1977.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	116	10.5	14	10.6
2	199	24.5	12	24.2
3	184	36.5	10	36.9
4	55	46.9	9	46.0
5	19	55.8	8	57.4
6	4	63.5	7	61.0
7	—	70.1	6	—
8	—	75.8	5	—
9	—	80.7	4	—
10	—	84.9		—

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.12. Length (mm) at age for soft-shell clams collected at Launching Pond in June, 1977.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	83	9.6	12	10.6
2	167	22.0	11	20.9
3	78	32.5	9	32.9
4	67	41.3	7	42.6
5	59	48.7	6	49.1
6	33	54.9	5	54.3
7	14	60.2	4	59.4
8	5	64.6	4	63.0
9	1	68.3	3	68.0
10	—	71.4		—

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.13. Length (mm) at age for soft-shell clams collected at Little Harbour in July, 1976.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	5	5.3		12.6
			17	
2	177	22.7		22.2
			13	
3	175	35.3		35.4
			9	
4	141	44.6		44.8
			7	
5	132	51.3		51.7
			5	
6	90	56.2		56.0
			4	
7	57	59.8		59.8
			3	
8	35	62.4		61.9
			2	
9	14	64.3		65.1
			1	
10	6	65.7		63.8

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.14. Length (mm) at age for soft-shell clams collected at Malpeque Bay in August, 1977.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	20	8.5		10.3
			13	
2	81	21.2		20.0
			10	
3	66	31.6		32.1
			9	
4	50	40.1		40.9
			7	
5	38	47.0		46.8
			6	
6	21	52.7		52.0
			5	
7	6	57.3		57.0
			4	
8	2	61.1		61.0
			3	
9	—	64.1		—
			3	
10	—	66.7		—

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.15. Length (mm) at age for soft-shell clams collected at Mill River during the summer of 1976.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	6	8.5	23	13.0
2	196	31.1	18	30.4
3	180	49.4	15	50.1
4	169	64.4	12	65.3
5	151	76.6	10	76.0
6	102	86.5	8	85.2
7	46	94.6	7	94.8
8	22	101.2	5	102.6
9	4	106.6	4	113.3
10	1	111.0		113.0

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated form fitted length.

Table A3.16. Length (mm) at age for soft-shell clams collected at Montague River in the summer of 1977.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	35	8.9	10	10.8
2	125	18.8	9	17.8
3	89	27.6	8	27.8
4	71	35.4	7	36.0
5	57	42.4	6	43.2
6	37	48.5	6	48.3
7	14	54.0	5	52.3
8	8	58.8	4	58.3
9	6	63.1	4	62.5
10	3	67.0		68.0

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated form fitted length

Table A3.17. Length (mm) at age for soft-shell clams collected at Murray Harbour (downstream flats) in the summer of 1977.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	41	10.7	9	11.4
2	84	19.4	8	18.9
3	77	27.3	7	27.2
4	68	34.4	6	34.3
5	43	40.8	6	41.3
6	27	46.5	5	47.6
7	15	51.6	5	51.5
8	5	56.3	4	52.3
9	1	60.4	4	57.0
10	—	64.1		—

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.18. Length (mm) at age for soft-shell clams collected at Murray Harbour (upstream flats) during the summer of 1977.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	25	8.8	12	11.4
2	52	20.4	10	18.6
3	48	30.2	8	29.5
4	47	38.4	7	38.6
5	43	45.4	6	46.2
6	38	51.3	5	52.4
7	33	56.2	4	56.8
8	20	60.4	4	59.6
9	10	64.0	3	61.9
10	1	67.0		59.0

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.19. Length (mm) at age for soft-shell clams collected at Panmure Island in July, 1976.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	4	11.6	14	15.5
2	140	25.5	11	25.2
3	139	36.0	8	36.3
4	137	43.9	6	44.0
5	76	49.7	5	49.3
6	25	54.2	3	54.1
7	6	57.5	3	58.5
8	—	60.0	2	—
9	—	61.8	1	—
10	—	63.2		—

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.20. Length (mm) at age for soft-shell clams collected at Pinette Harbour in June, 1978.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	67	12.0	9	13.2
2	178	21.1	8	19.9
3	158	28.7	6	29.5
4	125	35.1	5	35.6
5	66	40.5	5	39.9
6	13	45.0	4	43.8
7	1	48.7	3	48.0
8	—	51.9	3	—
9	—	54.5	2	—
10	—	56.7		—

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.21. Length (mm) at age for soft-shell clams collected at Rollo Bay in early summer, 1976.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	19	8.6	13	10.5
2	382	21.6	10	20.9
3	377	32.1	9	33.1
4	349	40.7	7	41.0
5	231	47.6	6	46.6
6	46	53.2	5	51.4
7	9	57.7	3	53.9
8	3	61.4	3	67.7
9	2	64.4	3	82.0
10	1	67.0		102.0

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.22. Length (mm) at age for soft-shell clams collected at St.Mary's Bay in the summer of 1976.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	11	10.0	12	13.3
2	199	21.8	10	21.2
3	192	31.3	8	31.6
4	185	39.0	6	39.5
5	147	45.2	5	44.8
6	59	50.3	4	49.6
7	16	54.4	3	55.7
8	4	57.7	3	59.3
9	—	60.4	2	—
10	—	62.5		—

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.23. Length (mm) at age for soft-shell clams collected at Souris River in the fall of 1976.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	94	10.0	13	10.5
2	180	22.9	12	22.5
3	143	34.5	10	34.5
4	92	44.8	9	45.2
5	46	54.1	8	54.6
6	20	62.3	7	62.5
7	7	69.6	7	69.3
8	2	76.2	6	68.5
9	—	82.0	5	—
10	—	87.2		—

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.24. Length (mm) at age for soft-shell clams collected at South Lake in July, 1977.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	31	12.1	12	12.2
2	81	23.8	11	20.7
3	55	34.8	10	34.5
4	34	45.1	10	44.5
5	18	54.9	9	53.2
6	2	64.1	9	61.0
7	1	72.8	8	67.0
8	—	81.0	8	—
9	—	88.8	7	—
10	—	96.1		—

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

Table A3.25. Length (mm) at age for soft-shell clams collected at Spry Cove in July, 1976.

Age	Number of rings measured	Fitted length[1]	Growth increment[2] $L_{t+1} - L_t$	Measured length
1	4	6.8		14.0
			15	
2	199	21.8		21.5
			12	
3	199	33.8		33.9
			9	
4	186	43.2		43.4
			8	
5	140	50.7		50.7
			6	
6	65	56.7		56.8
			5	
7	25	61.4		60.4
			4	
8	4	65.1		68.5
			3	
9	1	68.0		62.0
			2	
10	—	70.4		—

1. Determined from Von Bertalanffy growth equation.
2. Growth increments calculated from fitted length.

APPENDIX 4

Allometric relationships between shell length and shell weight of soft-shell clams, Prince Edward Island, 1976 and 1977.

Table A4.1. Log-log regression shell weight (g) over shell length (mm), Fortune Bay, 1977.

$\log$ (shell weight) = $\log \alpha + \beta \log$ (shell length)

Date	$\log S = \log \alpha + \beta \log L$	95% confidence limits				r^2
		y-intercept		slope		
19 05 77	log S = -3.603 + 2.509 log L	-4.146	-3.059	2.182	2.835	.703
31 05 77	log S = -3.862 + 2.646 log L	-4.317	-3.407	2.375	2.917	.793
15 06 77	log S = -4.312 + 2.918 log L	-4.808	-3.816	2.618	3.218	.792
29 06 77	log S = -4.032 + 2.756 log L	-4.389	-3.676	2.544	2.968	.871
12 07 77	log S = -4.012 + 2.735 log L	-4.440	-3.584	2.487	2.984	.829
27 07 77	log S = -3.691 + 2.553 log L	-4.094	-3.288	2.312	2.794	.818
11 08 77	log S = -4.164 + 2.828 log L	-4.672	-3.656	2.529	3.128	.781
25 08 77	log S = -4.032 + 2.778 log L	-4.549	-3.515	2.477	3.079	.774
12 09 77	log S = -3.849 + 2.699 log L	-4.339	-3.360	2.418	2.980	.787
23 09 77	log S = -3.780 + 2.634 log L	-4.351	-3.208	2.304	2.964	.719
12 10 77	log S = -3.321 + 2.363 log L	-3.775	-2.866	2.098	2.628	.762
26 10 77	log S = -4.340 + 2.961 log L	-4.952	-3.728	2.605	3.318	.734
09 11 77	log S = -3.529 + 2.495 log L	-4.038	-3.020	2.201	2.788	.746
All Samples (1977)	log S = -4.429 + 3.001 log L	-4.547	-4.311	2.932	3.071	.848

Table A4.2. Log-log regression shell weight (g) over shell length (mm), Foxley River, 1976.

log (shell weight) = log α + β log (shell length)

Date	log S = log α + β log L	95% confidence limits: y-intercept		95% confidence limits: slope		r^2
03 06 76	log S = -4.940 + 3.273 log L	-5.500	-4.379	2.967	3.579	.915
10 06 76	log S = -5.117 + 3.380 log L	-5.658	-4.577	3.081	3.678	.846
18 06 76	log S = -5.218 + 3.394 log L	-5.535	-4.900	3.214	3.574	.937
25 06 76	log S = -3.494 + 2.513 log L	-3.936	-3.051	2.266	2.759	.807
02 07 76	log S = -3.125 + 2.318 log L	-3.705	-2.544	2.000	2.636	.688
09 07 06	log S = -4.669 + 3.173 log L	-5.107	-4.230	2.926	3.421	.870
16 07 76	log S = -4.040 + 2.788 log L	-4.557	-3.522	2.499	3.076	.790
21 07 76	log S = -4.844 + 3.206 log L	-5.130	-4.559	3.045	3.368	.943
25 08 76	log S = -5.019 + 3.307 log L	-5.269	-4.769	3.166	3.448	.965
28 09 76	log S = -3.835 + 2.713 log L	-4.468	-3.202	2.364	3.061	.709
19 10 76	log S = -5.437 + 3.518 log L	-5.869	-5.005	3.278	3.757	.947
June	log S = -5.072 + 3.352 log L	-5.353	-4.790	3.195	3.509	.841
July	log S = -4.170 + 2.867 log L	-4.425	-3.914	2.725	3.010	.800
All Samples (1976)	log S = -4.611 + 3.106 log L	-4.774	-4.447	3.015	3.198	.831

Table A4.3. Log-log regression shell weight (g) over shell length (mm), Mill River, 1976.

log (shell weight) = log α + β log (shell length)

Date	log S = log α + β log L	95% confidence limits				r^2
		y-intercept		slope		
17 06 76	log S = -4.635 + 3.073 log L	-5.125	-4.144	2.796	3.349	.847
25 06 76	log S = -5.027 + 3.306 log L	-5.404	-4.650	3.097	3.516	.909
02 07 76	log S = -4.455 + 2.964 log L	-4.892	-4.018	2.720	3.209	.866
09 07 76	log S = -4.822 + 3.174 log L	-5.305	-4.339	2.908	3.439	.862
15 07 76	log S = -4.395 + 2.937 log L	-4.635	-4.156	2.801	3.074	.955
21 07 76	log S = -3.856 + 2.743 log L	-4.220	-3.492	2.527	2.960	.865
03 08 76	log S = -3.667 + 2.532 log L	-4.311	-3.024	2.166	2.899	.692
12 08 76	log S = -3.854 + 2.666 log L	-4.303	-3.405	2.420	2.912	.825
18 08 76	log S = -4.794 + 3.165 log L	-5.025	-4.564	3.038	3.293	.965
03 09 76	log S = -4.499 + 2.966 log L	-4.751	-4.247	2.817	3.114	.942
28 09 76	log S = -4.772 + 3.138 log L	-5.041	-4.503	2.980	3.295	.959
19 10 76	log S = -4.860 + 3.191 log L	-5.163	-4.556	3.022	3.361	.970
June	log S = -4.948 + 3.256 log L	-5.244	-4.652	3.091	3.422	.889
July	log S = -3.317 + 2.355 log L	-3.535	-3.098	2.230	2.479	.790
August	log S = -4.364 + 2.935 log L	-4.608	-4.119	2.799	3.071	.869
September	log S = -4.684 + 3.079 log L	-4.865	-4.503	2.973	3.186	.951
All Samples (1976)	log S = -4.225 + 2.854 log L	-4.352	-4.098	2.782	2.926	.858

Table A4.4. Log-log regression shell weight (g) over shell length (mm), Rollo Bay, 1976.

Date	log (shell weight) = log α + β log (shell length) $\log S = \log \alpha + \beta \log L$	95% confidence limits				r^2
		y-intercept		slope		
04 06 76	log S = -3.951 + 2.751 log L	-4.679	-3.223	2.322	3.181	.733
10 06 76	log S = -4.235 + 2.874 log L	-4.564	-3.906	2.680	3.069	.898
18 06 76	log S = -4.488 + 3.003 log L	-4.716	-4.259	2.862	3.143	.948
24 06 76	log S = -4.589 + 3.029 log L	-4.899	-4.279	2.839	3.218	.911
29 06 76	log S = -3.316 + 2.372 log L	-3.694	-2.938	2.148	2.596	.818
09 07 76	log S = -3.890 + 2.723 log L	-4.422	-3.358	2.403	3.044	.744
16 07 76	log S = -4.844 + 3.275 log L	-5.121	-4.567	3.110	3.440	.941
21 07 76	log S = -4.548 + 3.128 log L	-4.943	-4.152	2.887	3.368	.872
06 08 76	log S = -2.840 + 2.040 log L	-3.456	-2.224	1.675	2.405	.557
11 08 76	log S = -3.556 + 2.504 log L	-4.001	-3.110	2.254	2.754	.803
20 08 76	log S = -3.944 + 2.691 log L	-4.269	-3.620	2.507	2.875	.898
27 08 76	log S = -4.148 + 2.822 log L	-4.391	-3.904	2.681	2.963	.941
02 09 76	log S = -3.425 + 2.381 log L	-4.093	-2.758	1.995	2.767	.604
14 09 76	log S = -3.527 + 2.447 log L	-3.989	-3.065	2.180	2.714	.772
07 10 76	log S = -4.179 + 2.822 log L	-4.547	-3.812	2.606	3.037	.873
29 10 76	log S = -3.730 + 2.553 log L	-4.131	-3.328	2.295	2.810	.798
All Samples (1976)	log S = -4.119 + 2.809 log L	-4.207	-4.030	2.756	2.861	.870

Table A4.5. Log-log regression shell weight (g) over shell length (mm), Souris River, 1977.

Date	log (shell weight) = log α + β log (shell length) log S = log α + β log L	95% confidence limits				r^2
		y-intercept		slope		
31 05 77	log S = -4.796 + 3.209 log L	-5.088	-4.505	3.043	3.375	.938
14 06 77	log S = -4.950 + 3.261 log L	-5.327	-4.573	3.038	3.483	.896
29 06 77	log S = -5.086 + 3.343 log L	-5.447	-4.724	3.133	3.554	.910
12 07 77	log S = -4.932 + 3.274 log L	-5.237	-4.626	3.099	3.449	.933
27 07 77	log S = -4.143 + 2.801 log L	-4.601	-3.686	2.534	3.069	.815
11 08 77	log S = -5.162 + 3.418 log L	-5.459	-4.865	3.250	3.587	.943
25 08 77	log S = -5.202 + 3.439 log L	-5.718	-4.686	3.144	3.733	.846
12 09 77	log S = -4.383 + 2.969 log L	-4.778	-3.988	2.740	3.198	.871
23 09 77	log S = -5.224 + 3.442 log L	-5.524	-4.924	3.268	3.616	.940
12 10 77	log S = -4.650 + 3.124 log L	-4.999	-4.300	2.922	3.325	.906
26 10 77	log S = -4.178 + 2.861 log L	-4.549	-3.808	2.646	3.076	.877
09 11 77	log S = -4.449 + 3.023 log L	-4.905	-3.992	2.758	3.288	.840
All Samples (1977)	log S = -4.940 + 3.284 log L	-5.049	-4.832	3.221	3.347	.898

APPENDIX 5

Allometric relationships between shell length and dried meat weight of soft-shell clams, Prince Edward Island, 1976 and 1977.

Table A5.1. Log-log regression dried meat weight (g) over shell length (mm), Fortune Bay, 1977.

$$\log(\text{meat weight}) = \log\alpha + \beta\log(\text{shell length})$$

Date	$\log M = \log\alpha + \beta\log L$	95% confidence limits				r^2
		y-intercept		slope		
19 05 77	log M = -6.530 + 3.814 log L	-7.546	-5.513	3.203	4.425	.610
31 05 77	log M = -5.479 + 3.159 log L	-6.158	-4.800	2.754	3.563	.710
15 06 77	log M = -5.453 + 3.141 log L	-6.247	-4.659	2.661	3.621	.632
29 06 77	log M = -6.064 + 3.514 log L	-6.601	-5.527	3.195	3.834	.829
12 07 77	log M = -6.139 + 3.527 log L	-6.756	-5.522	3.169	3.885	.796
27 07 77	log M = -6.130 + 3.511 log L	-6.840	-5.421	3.087	3.936	.733
11 08 77	log M = -5.479 + 3.095 log L	-6.090	-4.866	2.734	3.457	.747
25 08 77	log M = -5.488 + 3.131 log L	-6.099	-4.877	2.776	3.486	.758
12 09 77	log M = -4.851 + 2.785 log L	-5.443	-4.259	2.445	3.125	.729
23 09 77	log M = -5.580 + 3.166 log L	-6.484	-4.677	2.643	3.680	.596
12 10 77	log M = -5.756 + 3.243 log L	-6.406	-5.106	2.864	3.621	.747
26 10 77	log M = -5.942 + 3.360 log L	-6.793	-5.091	2.864	3.857	.648
09 11 77	log M = -5.995 + 3.384 log L	-6.789	-5.202	2.926	3.841	.689
All Samples (1977)	log M = -4.946 + 2.814 log L	-5.133	-4.759	2.705	2.924	.661

Table A5.2. Log-log regression dried meat weight (g) over shell length (mm), Foxley River, 1976.

$$\log(\text{meat weight}) = \log \alpha + \beta \log(\text{shell length})$$

Date	$\log M = \log \alpha + \beta \log L$	95% confidence limits				r^2
		y-intercept		slope		
03 06 76	log M = -5.443 + 3.062 log L	-6.525	-4.362	2.472	3.652	.718
10 06 76	log M = -4.915 + 2.745 log L	-5.749	-4.082	2.285	3.206	.604
18 06 76	log M = -5.735 + 3.177 log L	-6.258	-5.211	2.880	3.473	.827
25 06 76	log M = -4.561 + 2.551 log L	-5.319	-3.803	2.129	2.973	.595
02 07 76	log M = -3.444 + 2.013 log L	-4.006	-2.881	1.704	2.321	.639
09 07 76	log M = -5.686 + 3.193 log L	-6.475	-4.897	2.747	3.638	.676
16 07 76	log M = -5.778 + 3.222 log L	-6.725	-4.830	2.694	3.750	.600
21 07 76	log M = -5.097 + 2.806 log L	-5.541	-4.653	2.555	3.056	.839
25 08 76	log M = -4.778 + 2.660 log L	-5.116	-4.440	2.470	2.851	.906
28 09 76	log M = -4.667 + 2.619 log L	-5.452	-3.882	2.187	3.051	.596
19 10 76	log M = -6.767 + 3.735 log L	-7.426	-6.108	3.370	4.100	.899
June	log M = -5.488 + 3.060 log L	-5.854	-5.122	2.856	3.264	.723
July	log M = -4.918 + 2.758 log L	-5.259	-4.577	2.567	2.948	.674
All Samples (1976)	log M = -5.029 + 2.812 log L	-5.443	-5.156	2.886	3.049	.836

Table A5.3. Log-log regression dried meat weight (g) over shell length (mm), Mill River, 1976.

Date	log (meat weight) = log α + β log (shell length) log M = log α + β log L	95% confidence limits y-intercept		slope		r^2
17 06 76	log M = -4.626 + 2.524 log L	-5.336	-3.915	2.124	2.925	.641
25 06 76	log M = -4.566 + 2.537 log L	-5.183	-3.948	2.194	2.880	.687
02 07 76	log M = -4.002 + 2.219 log L	-4.781	-3.222	1.782	2.655	.532
09 07 76	log M = -5.665 + 3.194 log L	-6.283	-5.048	2.855	3.534	.795
15 07 76	log M = -6.625 + 3.709 log L	-7.145	-6.105	3.412	4.006	.878
21 07 76	log M = -5.301 + 3.007 log L	-5.881	-4.721	2.661	3.352	.753
03 08 76	log M = -5.382 + 3.029 log L	-5.850	-4.914	2.763	3.296	.859
12 08 76	log M = -4.959 + 2.799 log L	-5.601	-4.317	2.447	3.151	.717
18 08 76	log M = -6.030 + 3.377 log L	-6.355	-5.705	3.197	3.557	.941
03 09 76	log M = -5.828 + 3.292 log L	-6.117	-5.538	3.121	3.462	.938
28 09 76	log M = -5.273 + 2.957 log L	-5.589	-4.956	2.772	3.143	.937
19 10 76	log M = -4.995 + 2.778 log L	-5.446	-4.544	2.526	3.030	.919
June	log M = -4.851 + 2.675 log L	-5.332	-4.370	2.406	2.944	.672
July	log M = -5.309 + 2.980 log L	-5.578	-5.039	2.826	3.133	.798
August	log M = -5.631 + 3.165 log L	-5.863	-5.398	3.035	3.294	.895
September	log M = -5.469 + 3.077 log L	-5.682	-5.257	2.953	3.202	.934
All Samples (1976)	log M = -5.300 + 2.967 log L	-5.443	-5.156	2.886	3.049	.836

Table A5.4. Log-log regression dried meat weight (g) over shell length (mm), Rollo Bay, 1976.

$\log(\text{meat weight}) = \log \alpha + \beta \log(\text{shell length})$

Date	$\log M = \log \alpha + \beta \log L$	95% confidence limits				r^2
		y-intercept		slope		
04 06 76	$\log M = -4.952 + 2.677 \log L$	-5.930	-3.974	2.100	3.254	.590
10 06 76	$\log M = -5.443 + 2.995 \log L$	-6.076	-4.811	2.621	3.369	.721
18 06 76	$\log M = -5.925 + 3.319 \log L$	-6.304	-5.547	3.086	3.552	.891
24 06 76	$\log M = -6.848 + 3.896 \log L$	-7.362	-6.334	3.582	4.210	.861
29 06 76	$\log M = -7.730 + 4.367 \log L$	-8.367	-7.094	3.990	4.744	.844
09 07 76	$\log M = -4.761 + 2.566 \log L$	-5.424	-4.098	2.167	2.966	.624
16 07 76	$\log M = -5.950 + 3.238 \log L$	-6.446	-5.454	2.943	3.533	.829
21 07 76	$\log M = -5.030 + 2.657 \log L$	-5.612	-4.447	2.303	3.012	.693
06 08 76	$\log M = -4.732 + 2.555 \log L$	-5.595	-3.868	2.043	3.067	.500
11 08 76	$\log M = -5.052 + 2.850 \log L$	-5.566	-4.537	2.561	3.139	.798
20 08 76	$\log M = -5.686 + 3.173 \log L$	-6.117	-5.255	2.928	3.417	.874
27 08 76	$\log M = -7.045 + 3.923 \log L$	-7.473	-6.617	3.674	4.172	.909
02 09 76	$\log M = -4.840 + 2.658 \log L$	-5.343	-4.337	2.367	2.949	.770
14 09 76	$\log M = -4.723 + 2.649 \log L$	-5.328	-4.118	2.299	2.998	.698
07 10 76	$\log M = -5.833 + 3.252 \log L$	-6.307	-5.359	2.973	3.530	.846
29 10 76	$\log M = -6.123 + 3.338 \log L$	-7.040	-5.205	2.749	3.926	.564
All samples (1976)	$\log M = -6.470 + 3.606 \log L$	-6.594	-6.346	3.532	3.680	0.847

Table A5.5. Log-log regression dried meat weight (g) over shell length (mm), Souris River, 1977.

Date	log (meat weight) = log α + β log (shell length) log M = log α + β log L	95% confidence limits				r^2
		y-intercept		slope		
31 05 77	log M = -4.477 + 2.498 log L	-5.032	-3.923	2.182	2.815	.715
14 06 77	log M = -5.191 + 2.882 log L	-5.876	-4.506	2.478	3.287	.671
29 06 77	log M = -4.782 + 2.709 log L	-5.332	-4.232	2.388	3.030	.741
12 07 77	log M = -4.324 + 2.407 log L	-4.923	-3.726	2.063	2.751	.663
27 07 77	log M = -5.881 + 3.314 log L	-6.557	-5.205	2.918	3.710	.738
11 08 77	log M = -4.186 + 2.688 log L	-5.412	-4.220	2.350	3.027	.717
25 08 77	log M = -4.100 + 2.310 log L	-4.701	-3.499	1.968	2.652	.647
12 09 77	log M = -5.047 + 2.828 log L	-5.993	-4.101	2.279	3.376	.516
23 09 77	log M = -5.299 + 2.961 log L	-5.763	-4.834	2.693	3.230	.830
12 10 77	log M = -5.468 + 3.067 log L	-6.046	-4.890	2.734	3.401	.773
26 10 77	log M = -5.032 + 2.846 log L	-5.651	-4.413	2.487	3.205	.716
09 11 77	log M = -5.779 + 3.244 log L	-6.572	-4.987	2.784	3.704	.666
All Samples (1977)	log M = -5.011 + 2.808 log L	-5.188	-4.834	2.706	2.910	.708

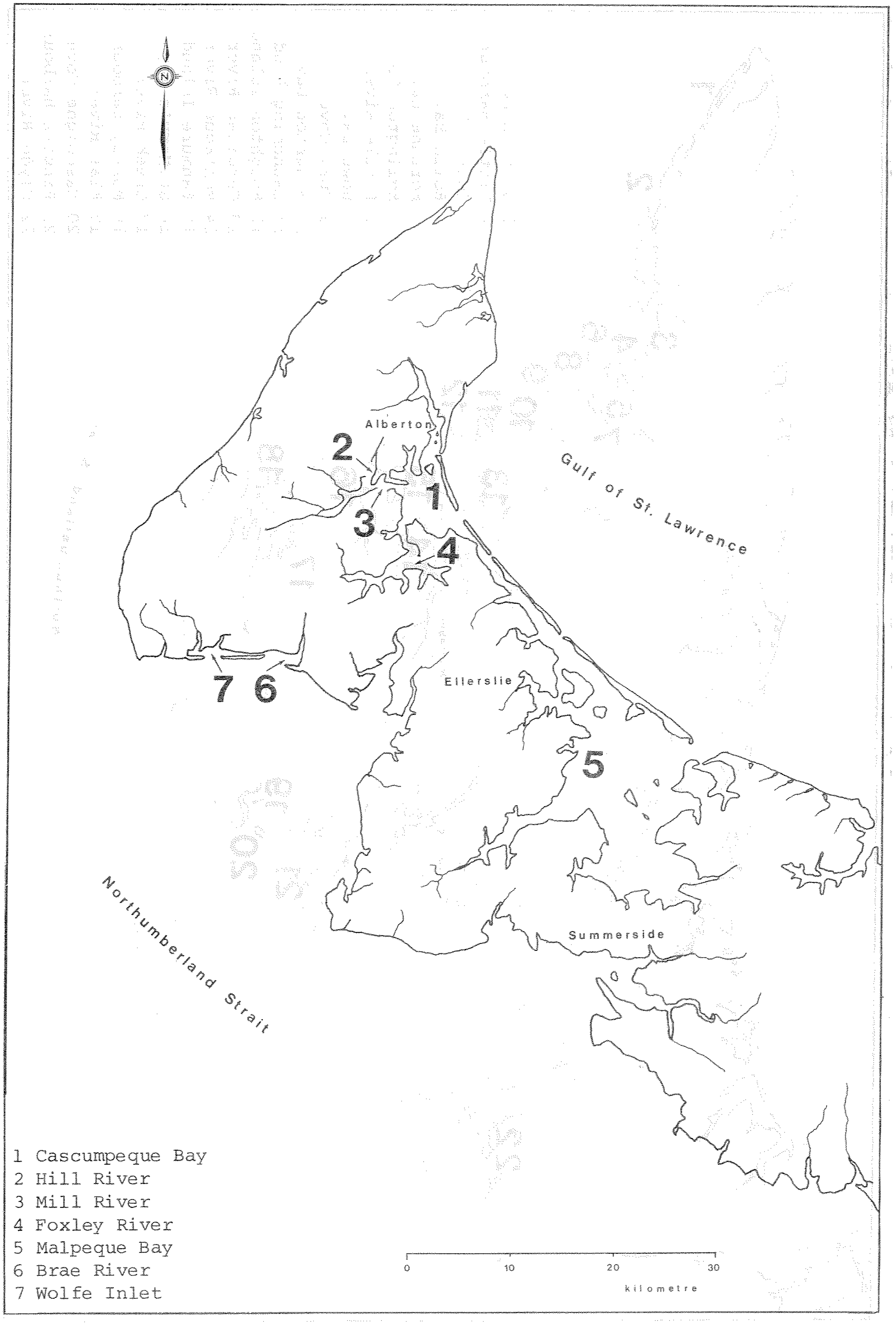


Figure 1. Locations surveyed for soft-shell clams in western Prince Edward Island.

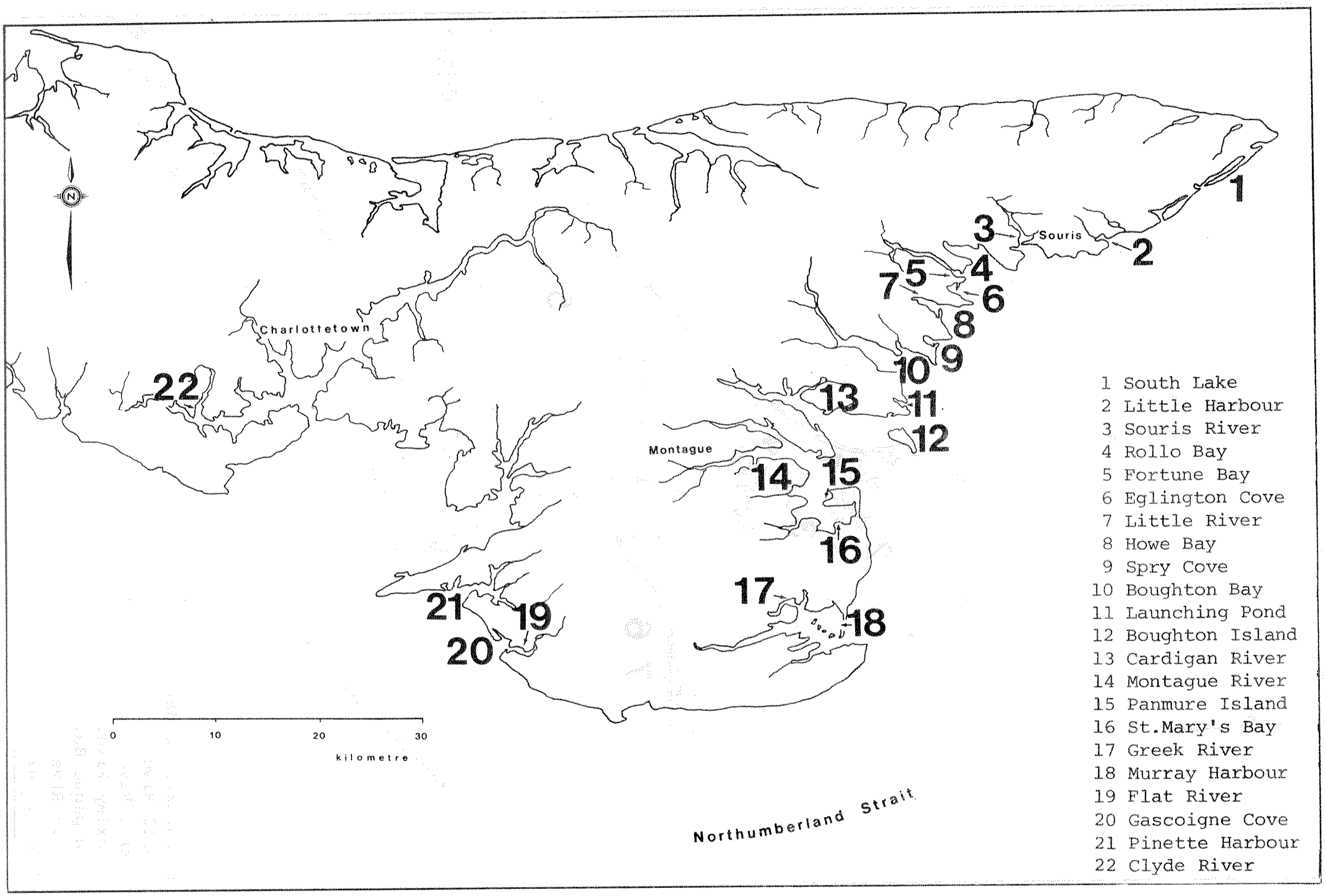


Figure 2. Locations surveyed for soft-shell clams in eastern Prince Edward Island.

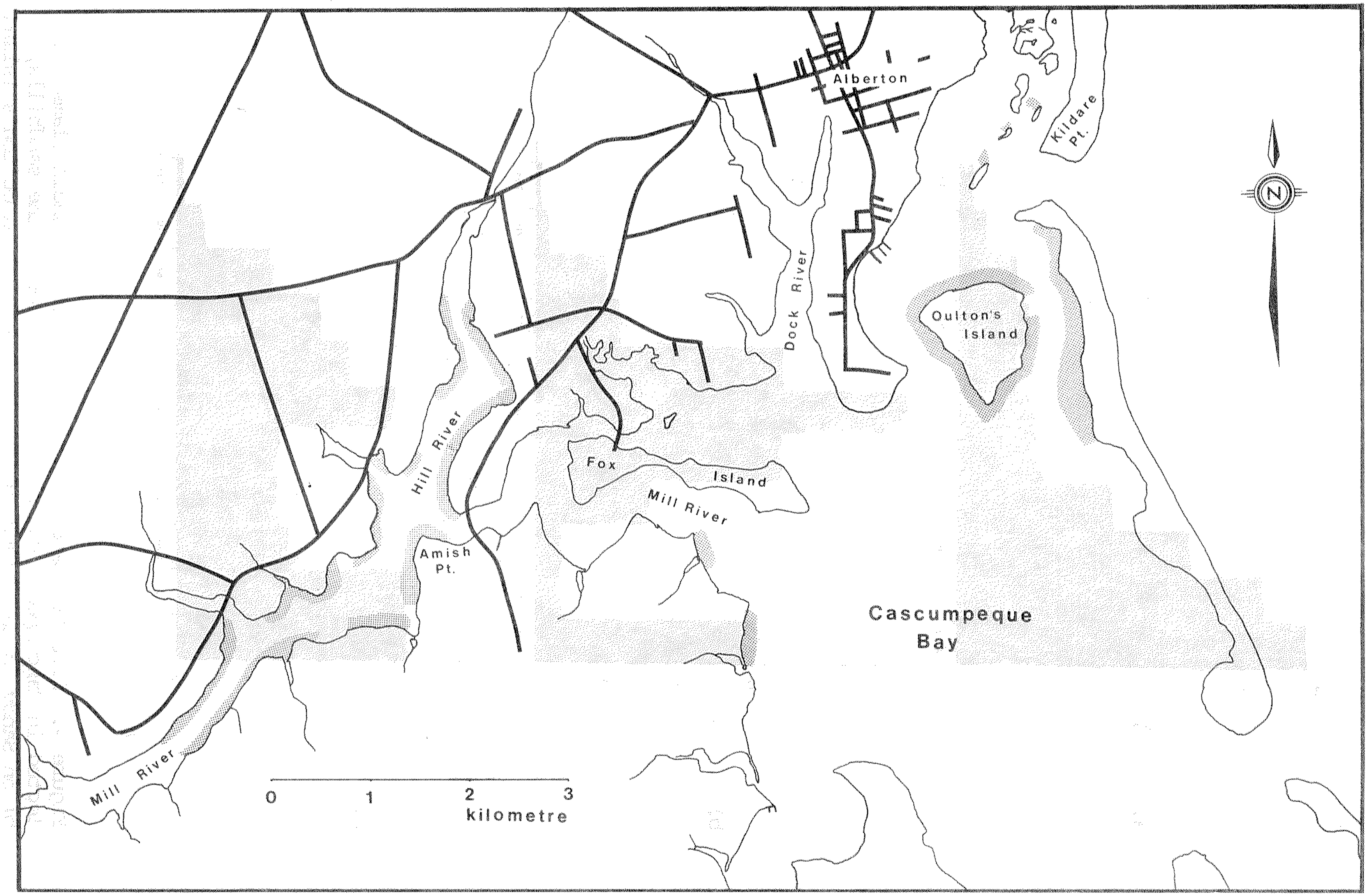


Figure 3. Soft-shell clam flats (stippled) sampled in Cascumpeque Bay. For location reference see Fig. 1.

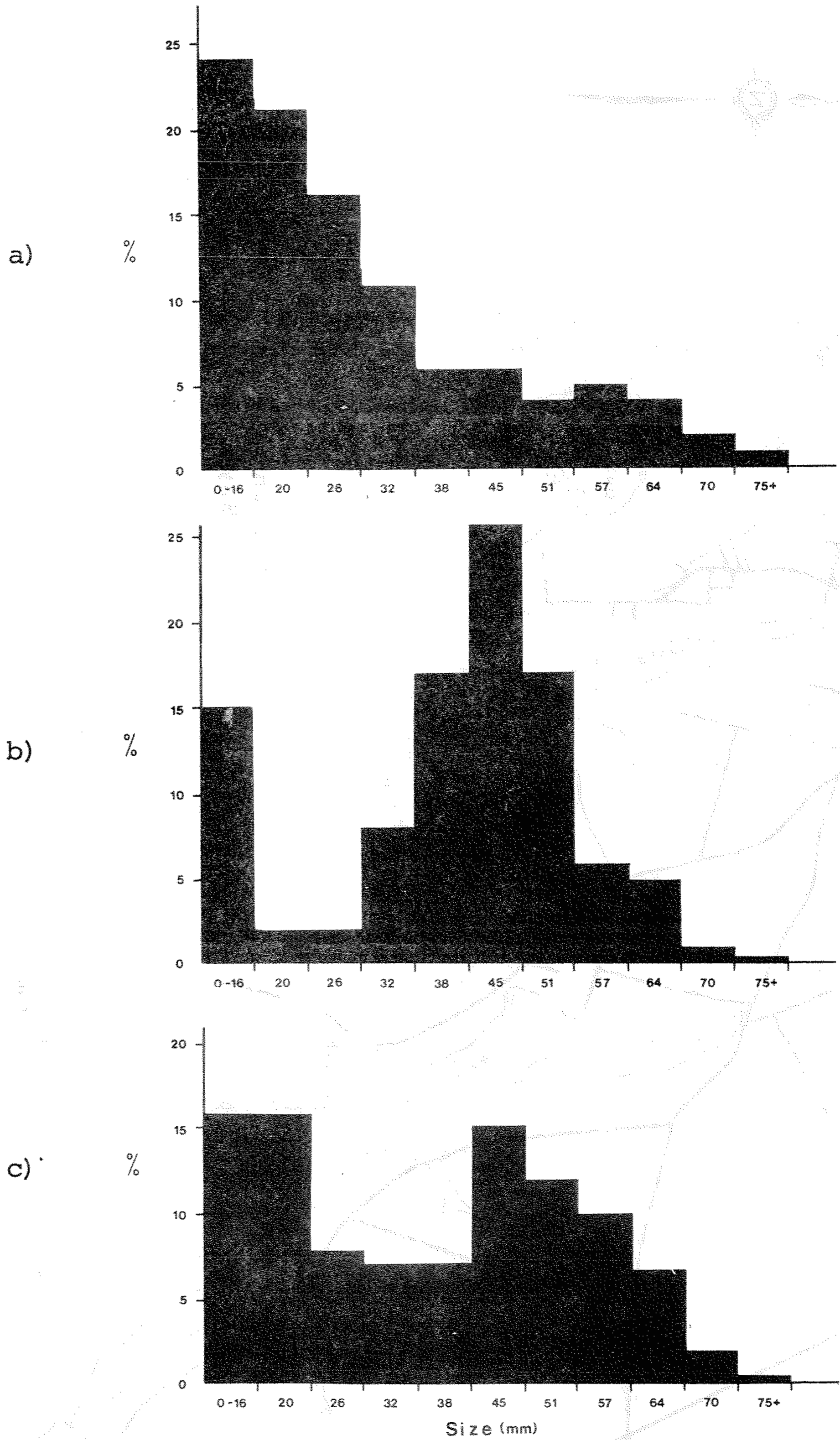


Figure 4. Size-frequency distribution for soft-shell clams collected in Cascumpeque Bay a) on the lee side of the sandhills, b) on Sandy Islands, west of Kildare Point, c) on Oulton's Island.

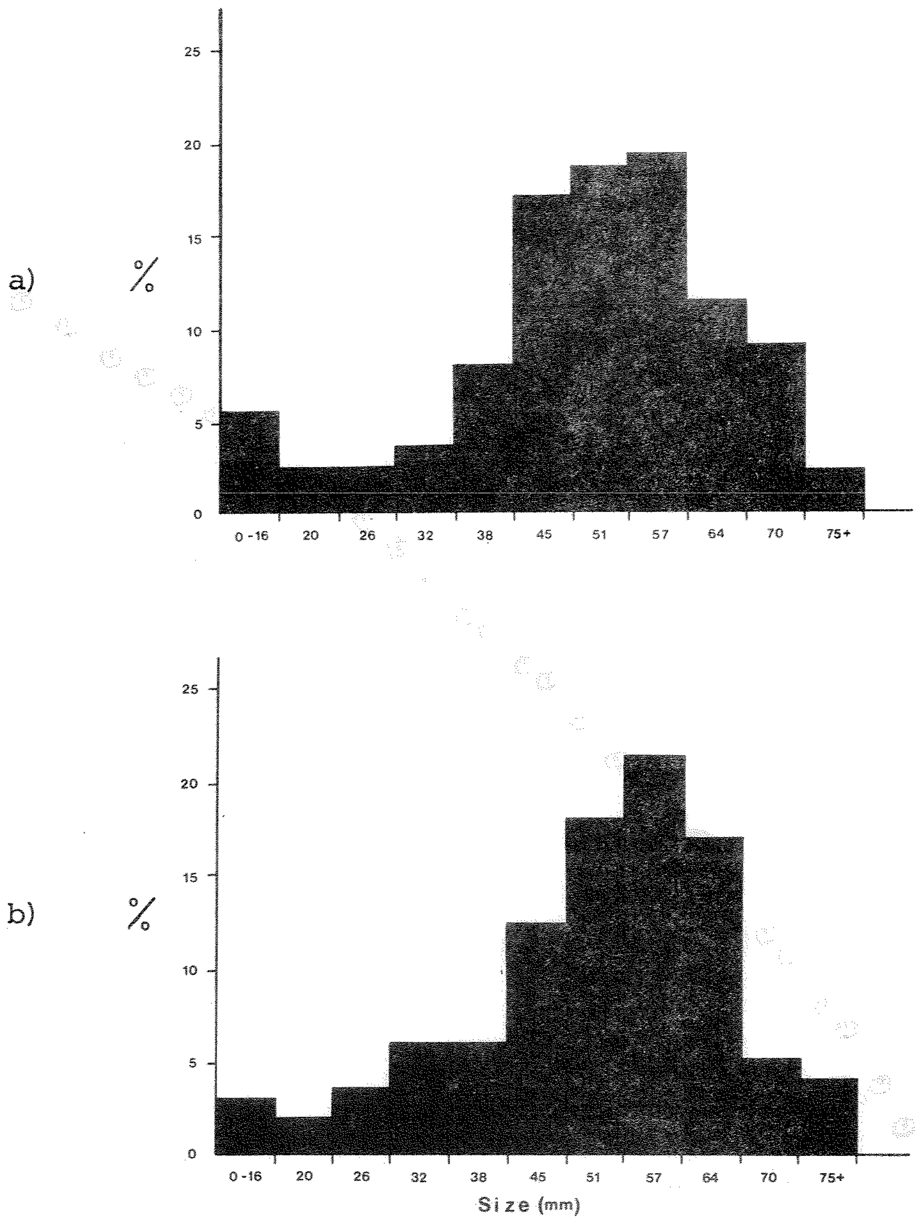


Figure 5. Size-frequency distribution for soft-shell clams collected on a) the east shore of Hill River, b) the west shore.

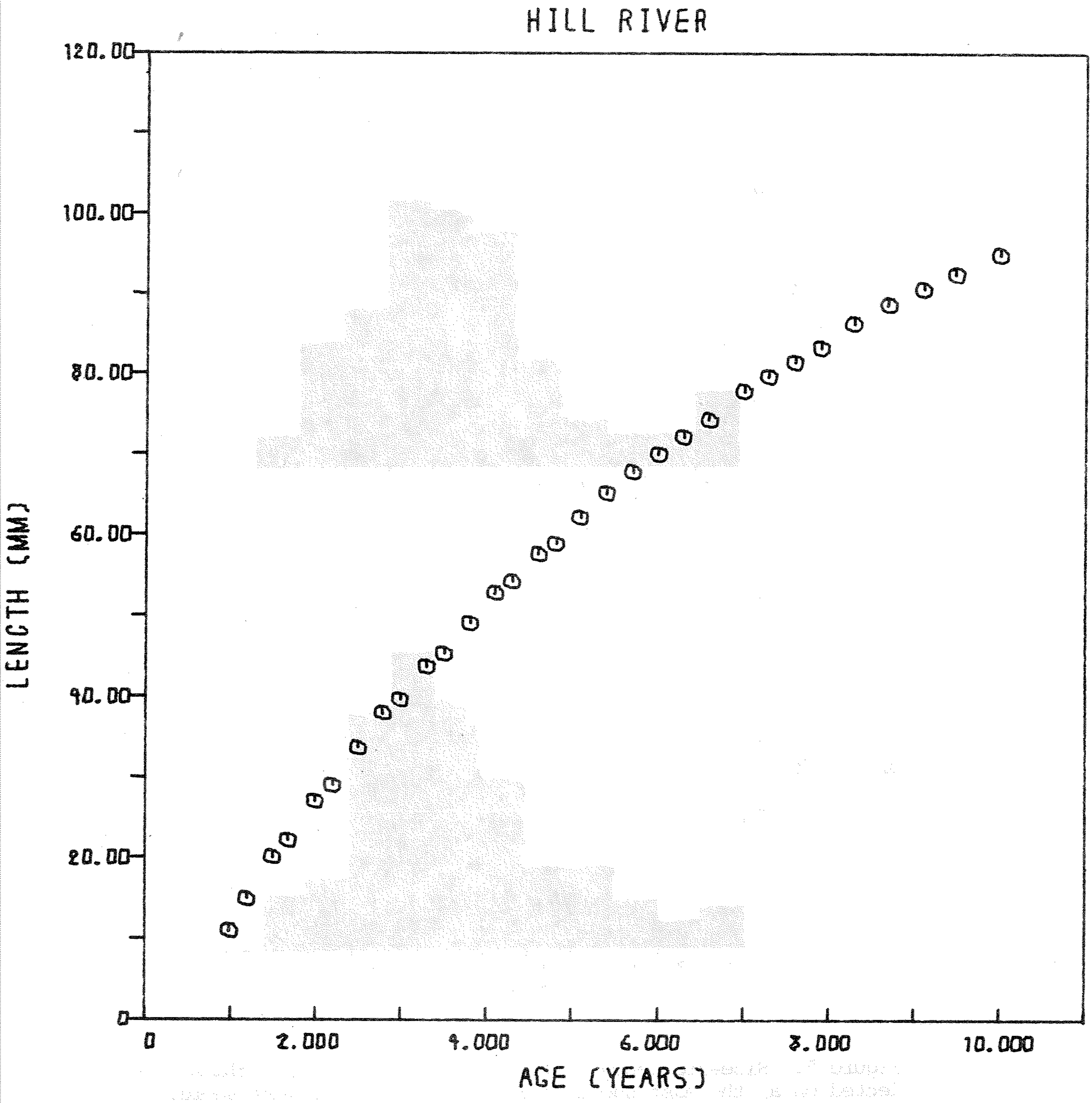
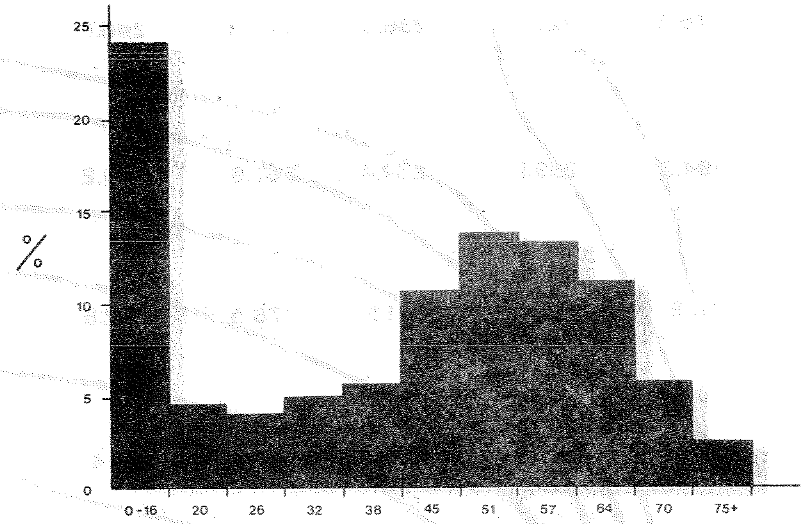


Figure 6. Von Bertalanffy growth curve for soft-shell clams in Hill and Mill Rivers.

a)



b)

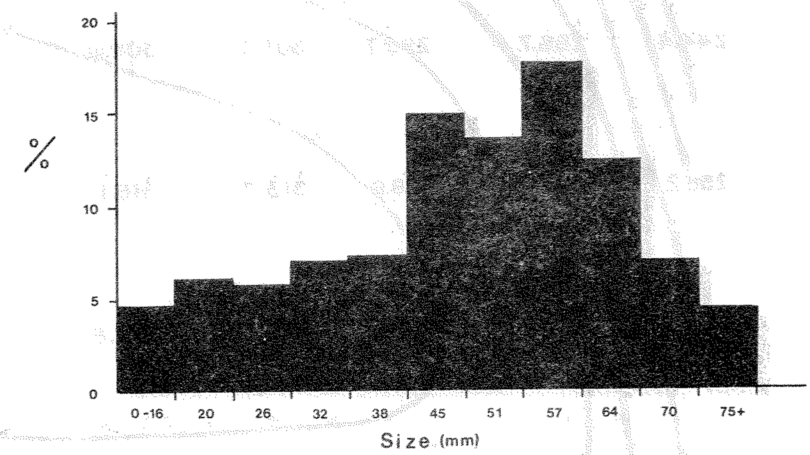


Figure 7. Size-frequency distribution for soft-shell clams from a) the east shore, b) the west shore of Mill River.

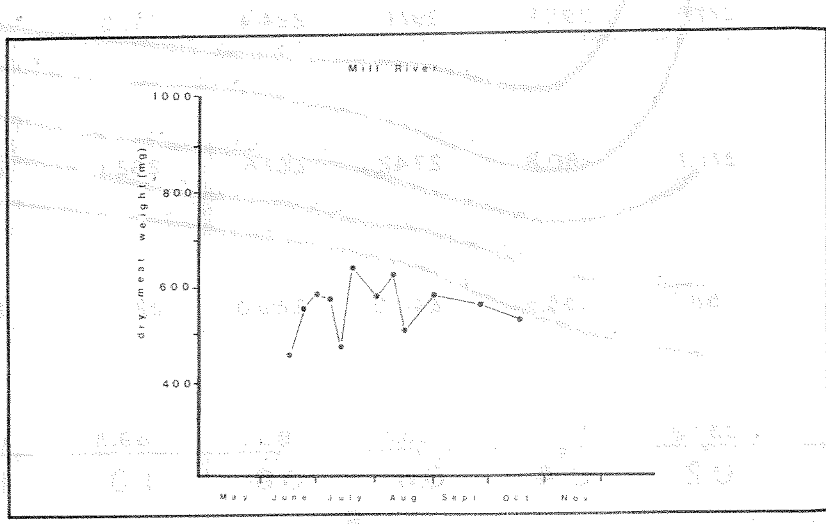


Figure 8. Fluctuations in dried meat weight of a 50-mm clam from Mill River, May to November, 1976. Calculated from the equations presented in Appendix 5.

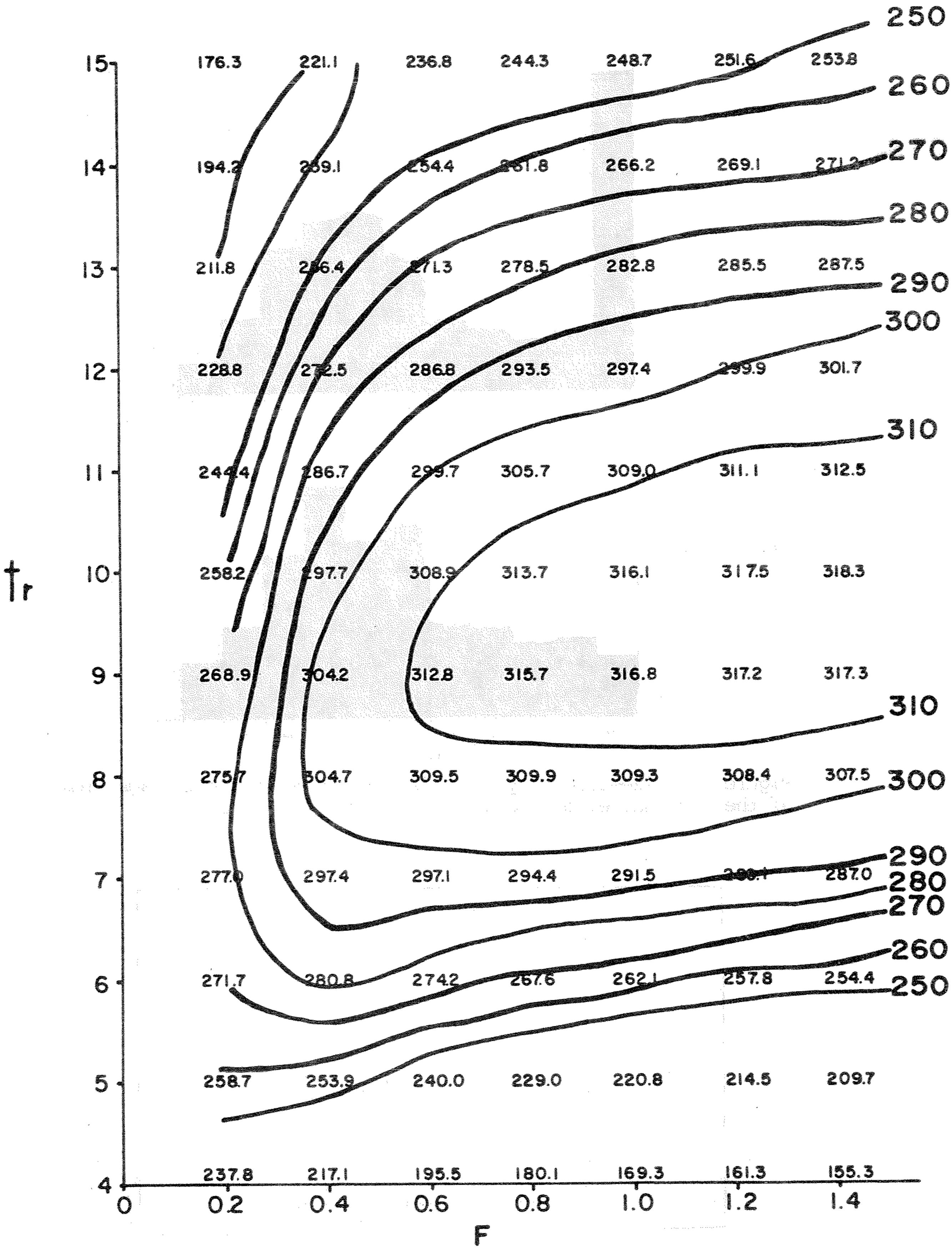


Figure 9. Yields and yield isopleths (kg per 10^5 recruits) for soft-shell clams collected in Mill River. t_r: age (years) of first capture, F: fishing mortality.

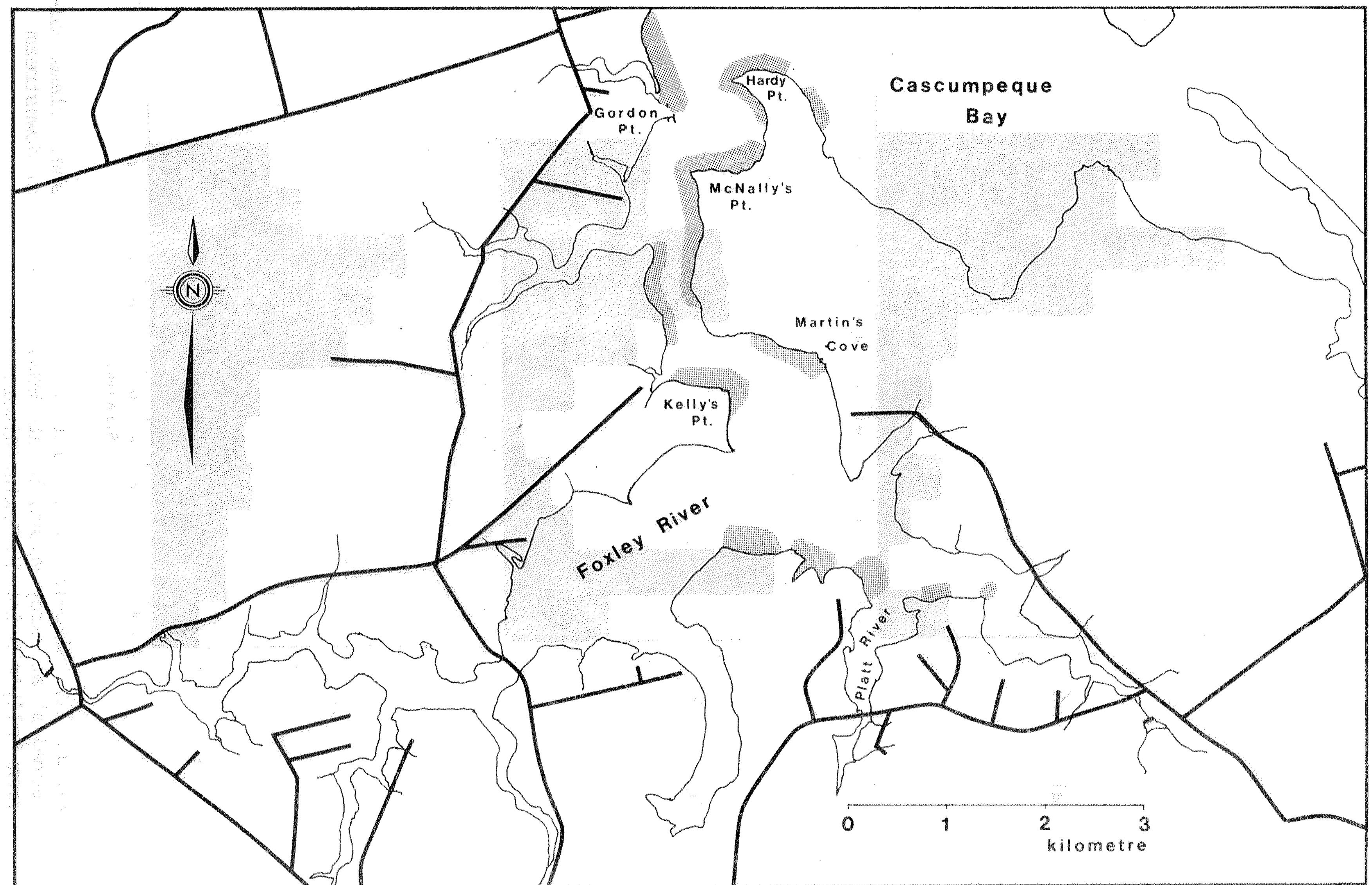


Figure 10. Soft-shell clam flats (stippled) surveyed in Foxley River. For location reference, see Fig. 1.

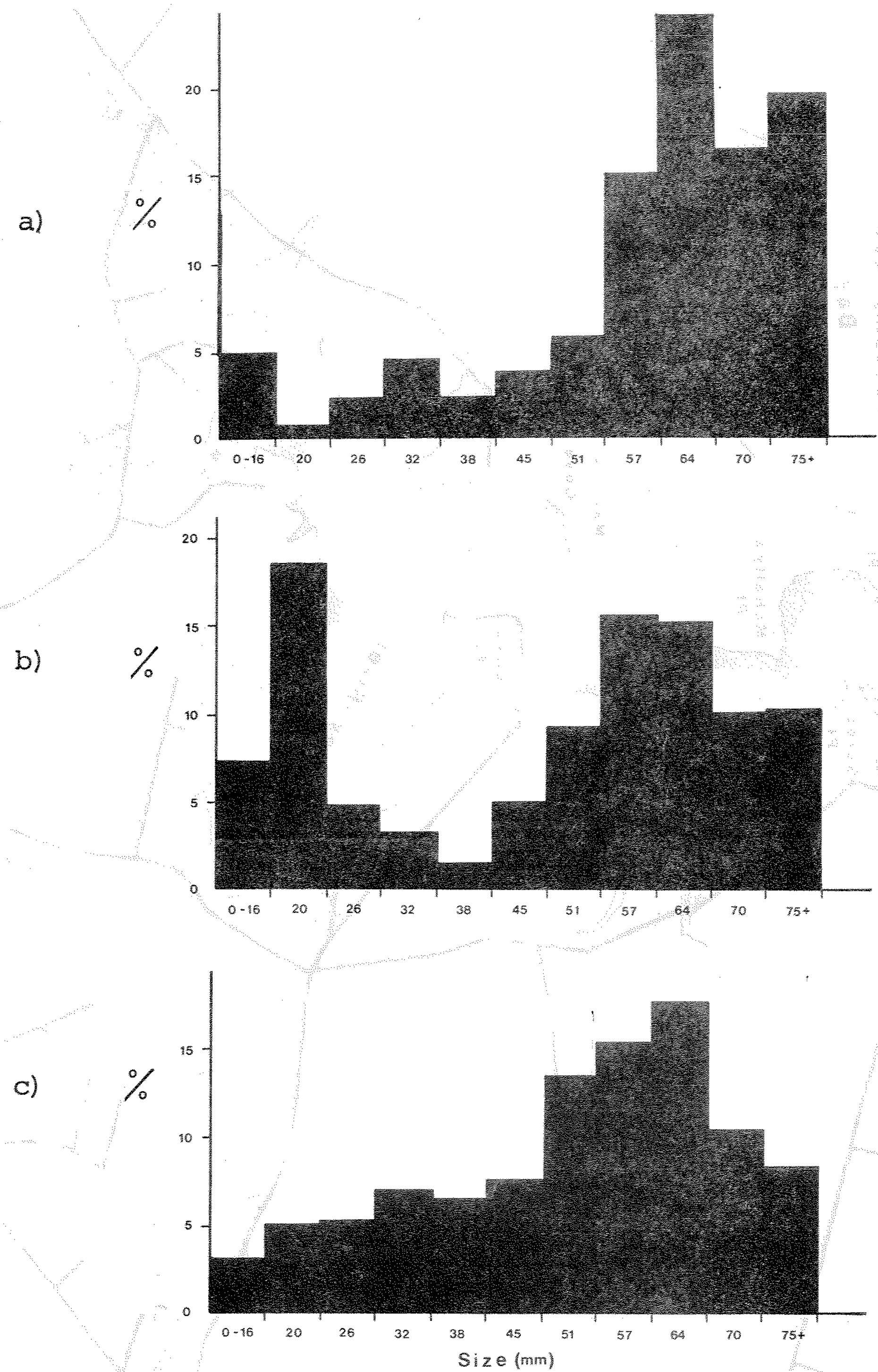


Figure 11. Size-frequency distribution for soft-shell clams collected a) at Hardy Point, b) at McNally's Point, c) downstream from Kelly's Point in Foxley River.

d)

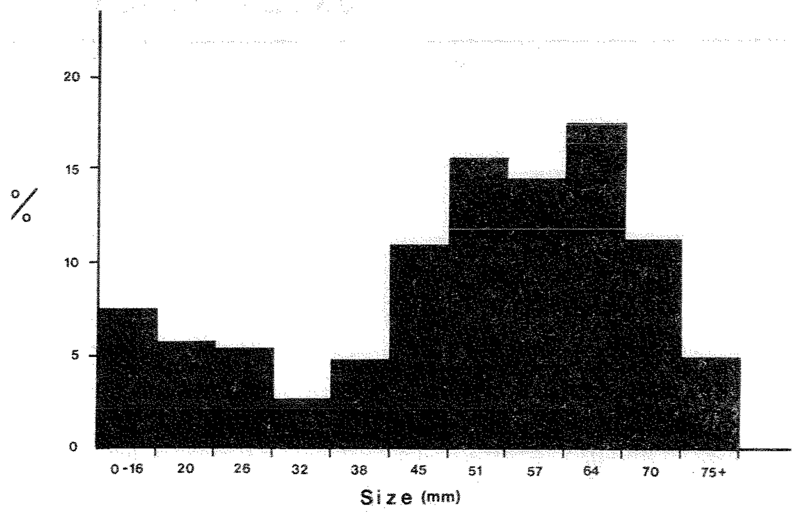


Figure 11. Size-frequency distribution for soft-shell clams from Foxley River near Platt River.

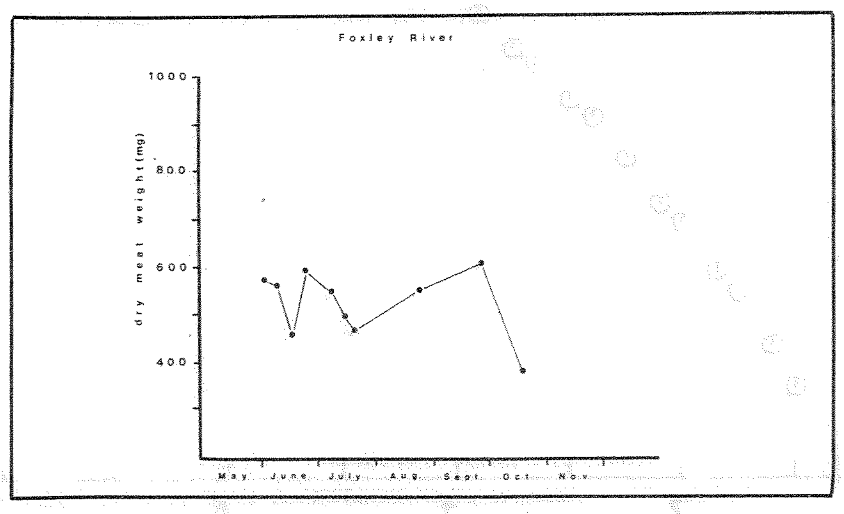


Figure 13. Fluctuations in dried meat weight of a 50-mm clam from Foxley River, May to November, 1976. Calculated from the equations presented in Appendix 5.

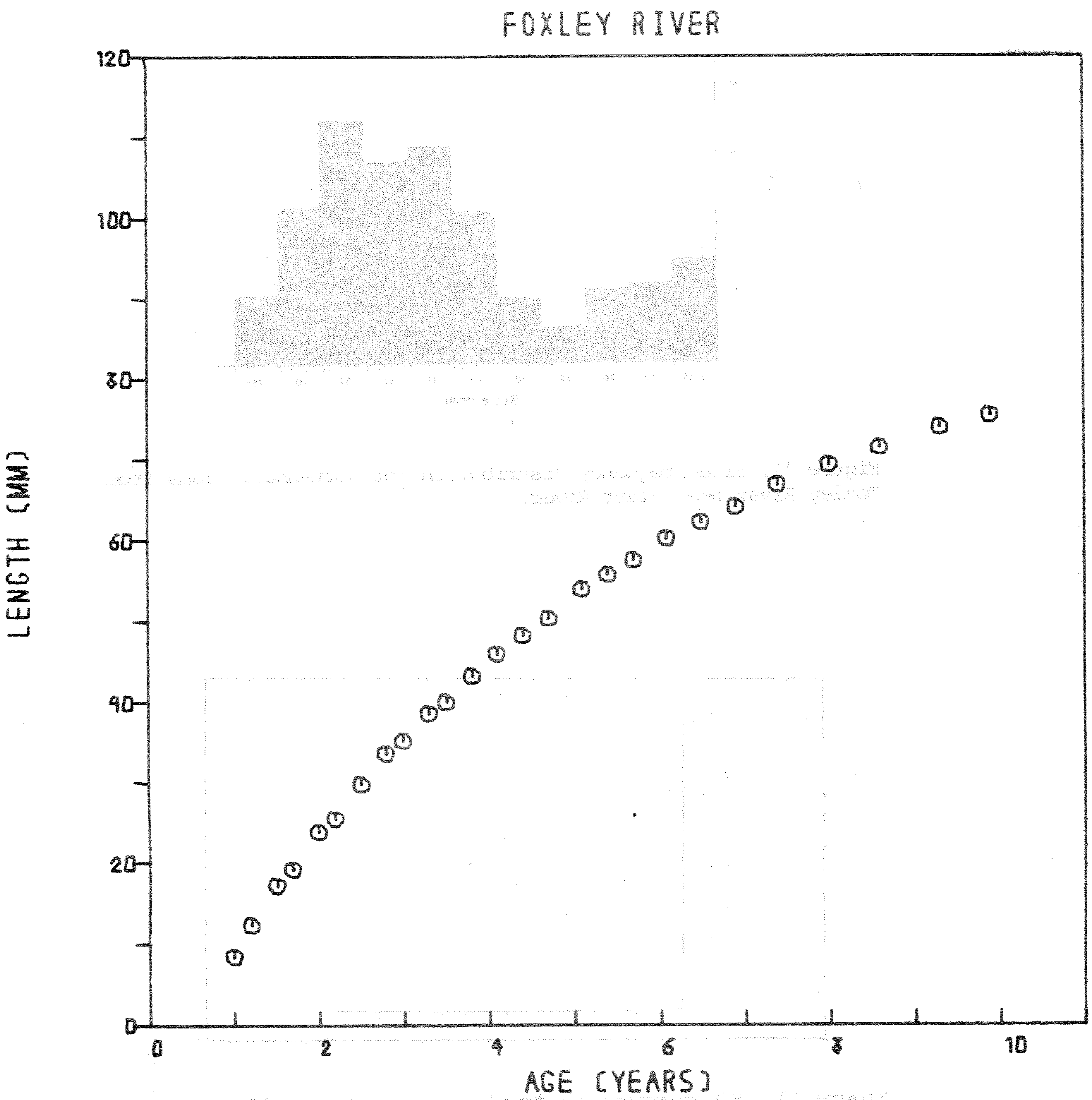


Figure 12. Von Bertalanffy growth curve for soft-shell clams from Foxley River.

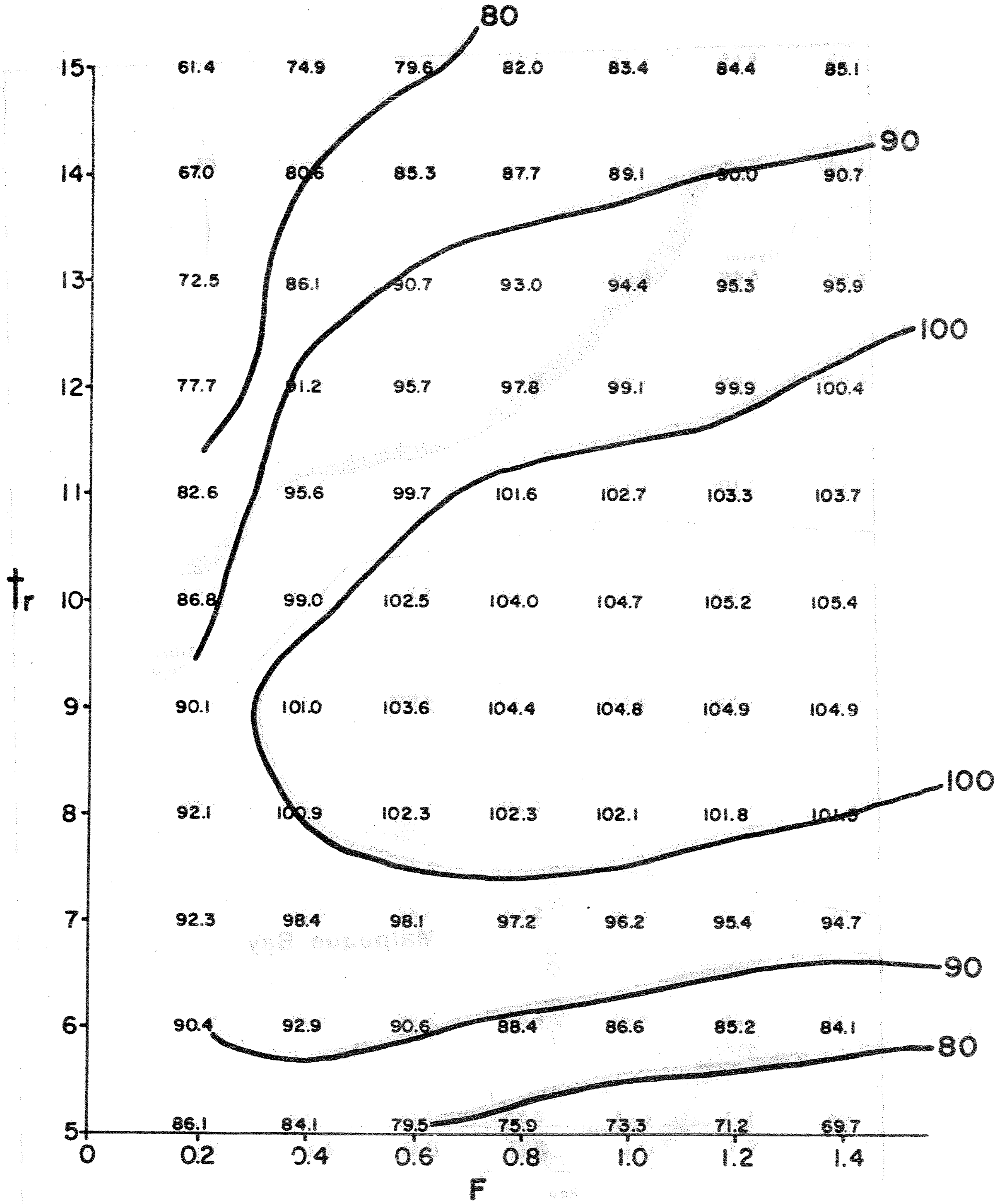


Figure 14. Yields and yield isopleths (kg per 10^5 recruits) for soft-shell clams collected in Foxley River. t_r: age (years) of first capture, F: fishing mortality.

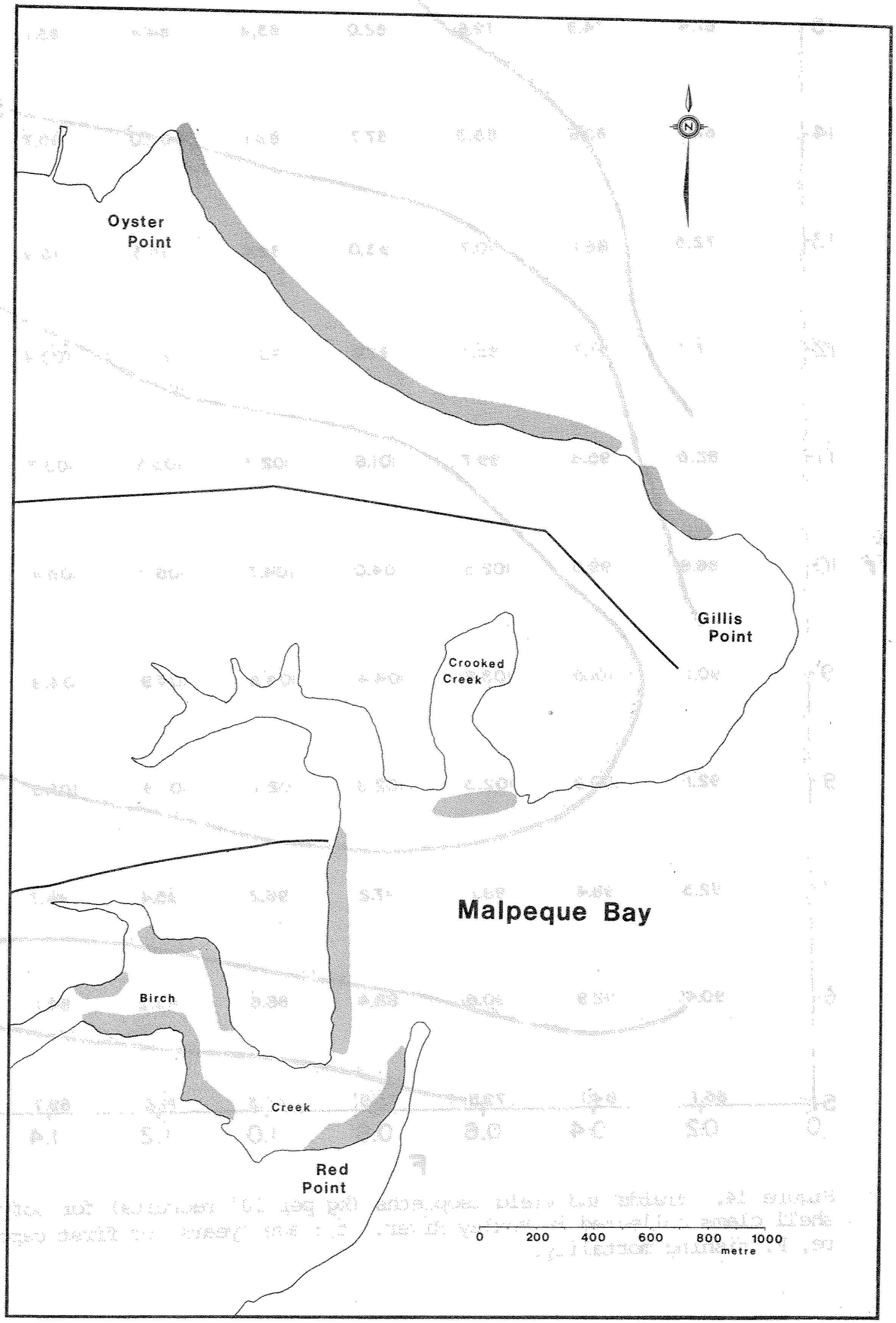
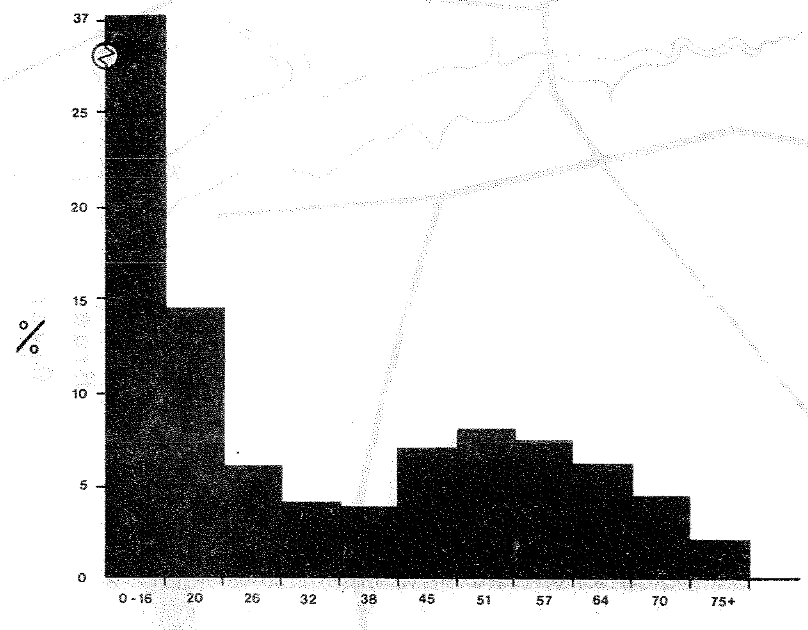


Figure 15. Soft-shell clam flats (stippled) surveyed in Malpeque Bay. For location reference, see Fig. 1.

a)



b)

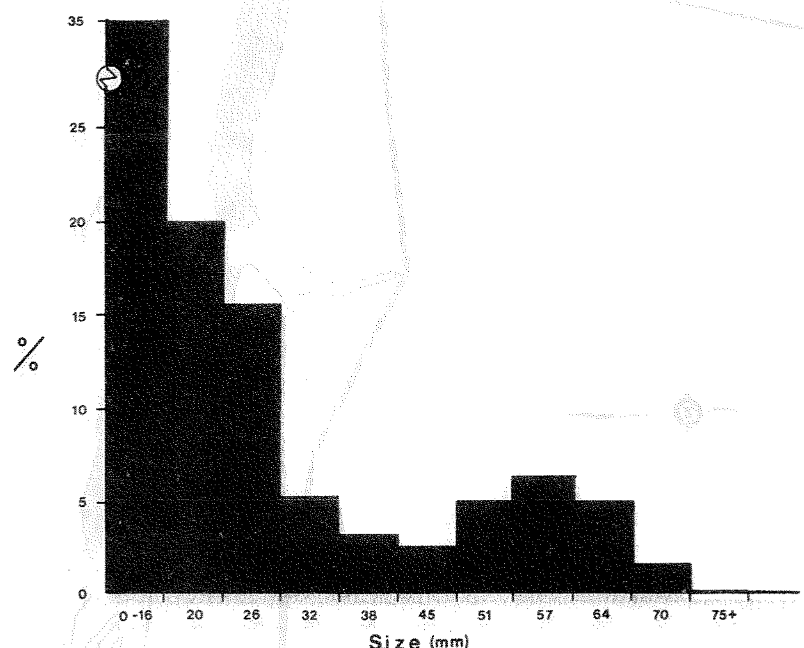


Figure 16. Size-frequency distribution for soft-shell clams from a) Malpeque Bay, b) Lennox Island.

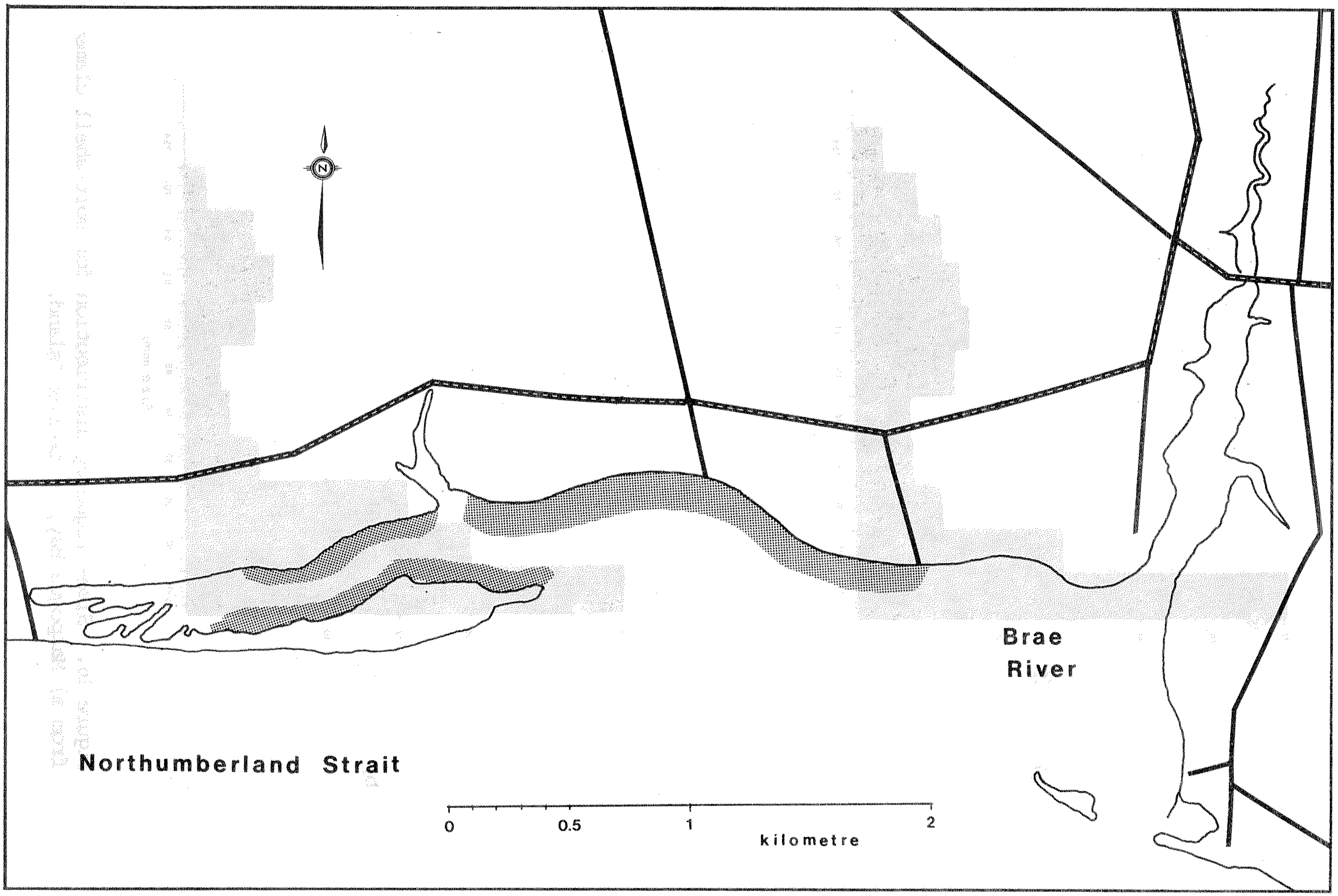
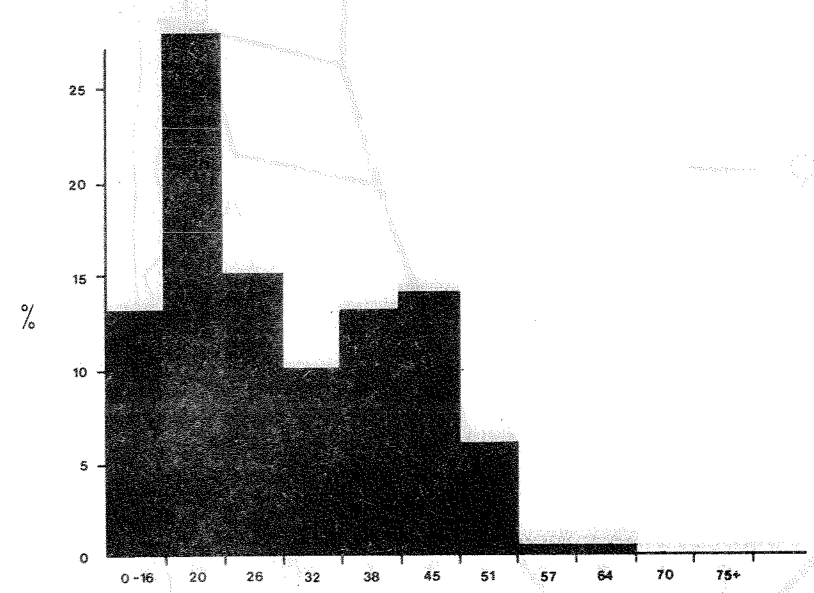


Figure 17. Soft-shell clam flats (stippled) surveyed near Brae River. For location reference, see Fig. 1.

a)



b)

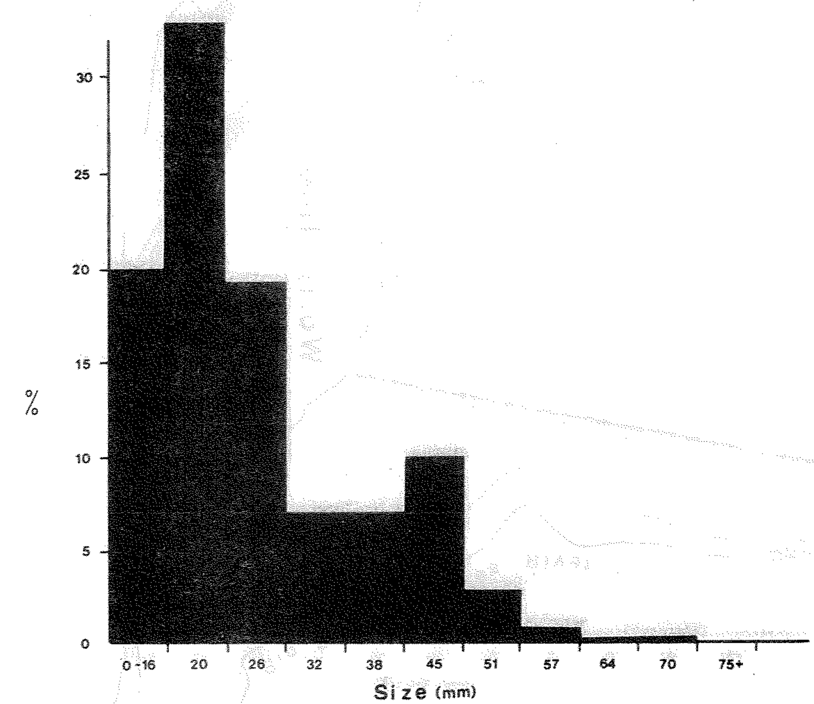


Figure 18. Size-frequency distribution for soft-shell clams collected on a) mainland flats, b) on sand barrier flats near Brae River.

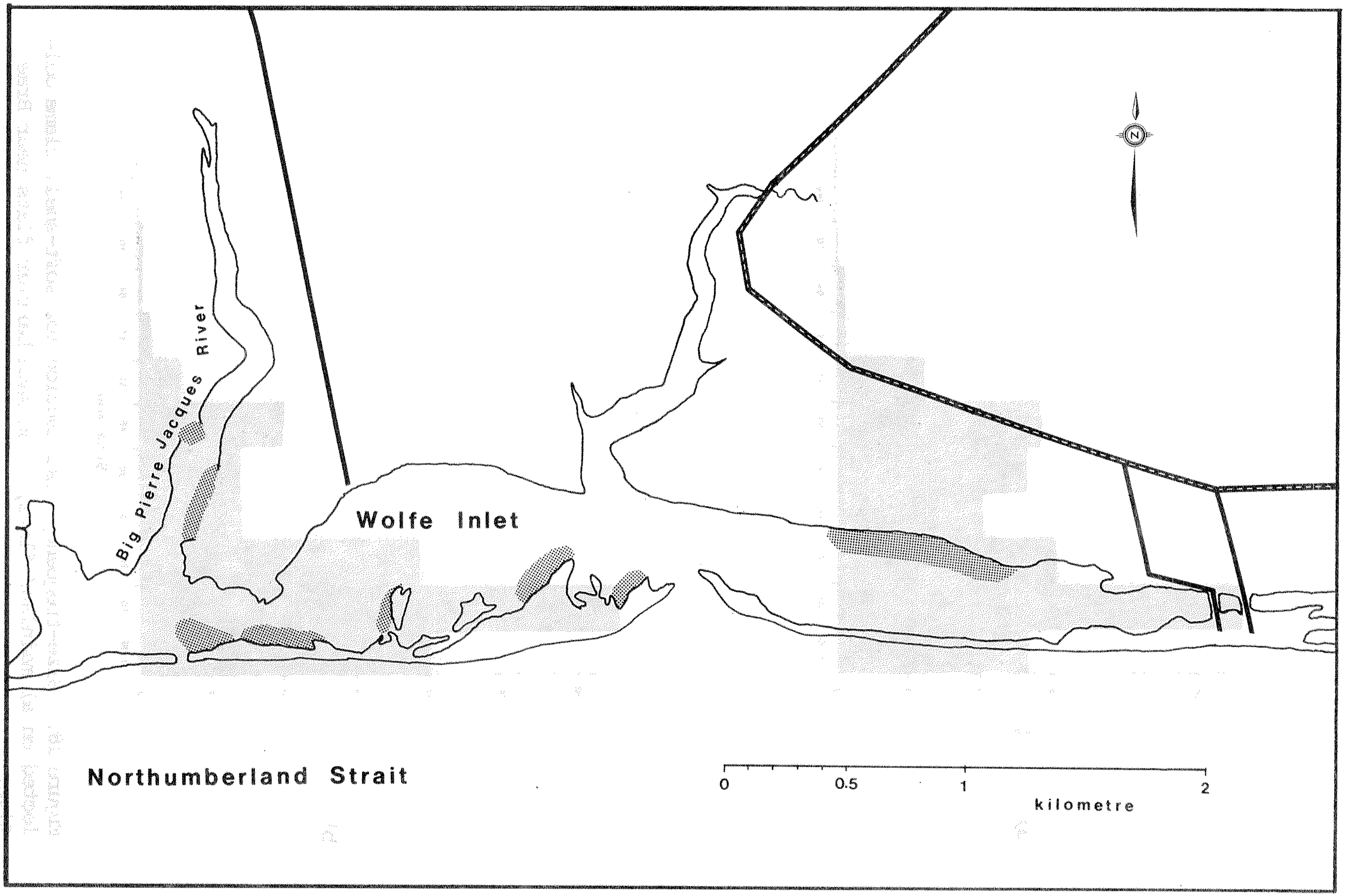


Figure 19. Soft-shell clam flats (stippled) surveyed in Wolfe Inlet. For location reference, see Fig. 1.

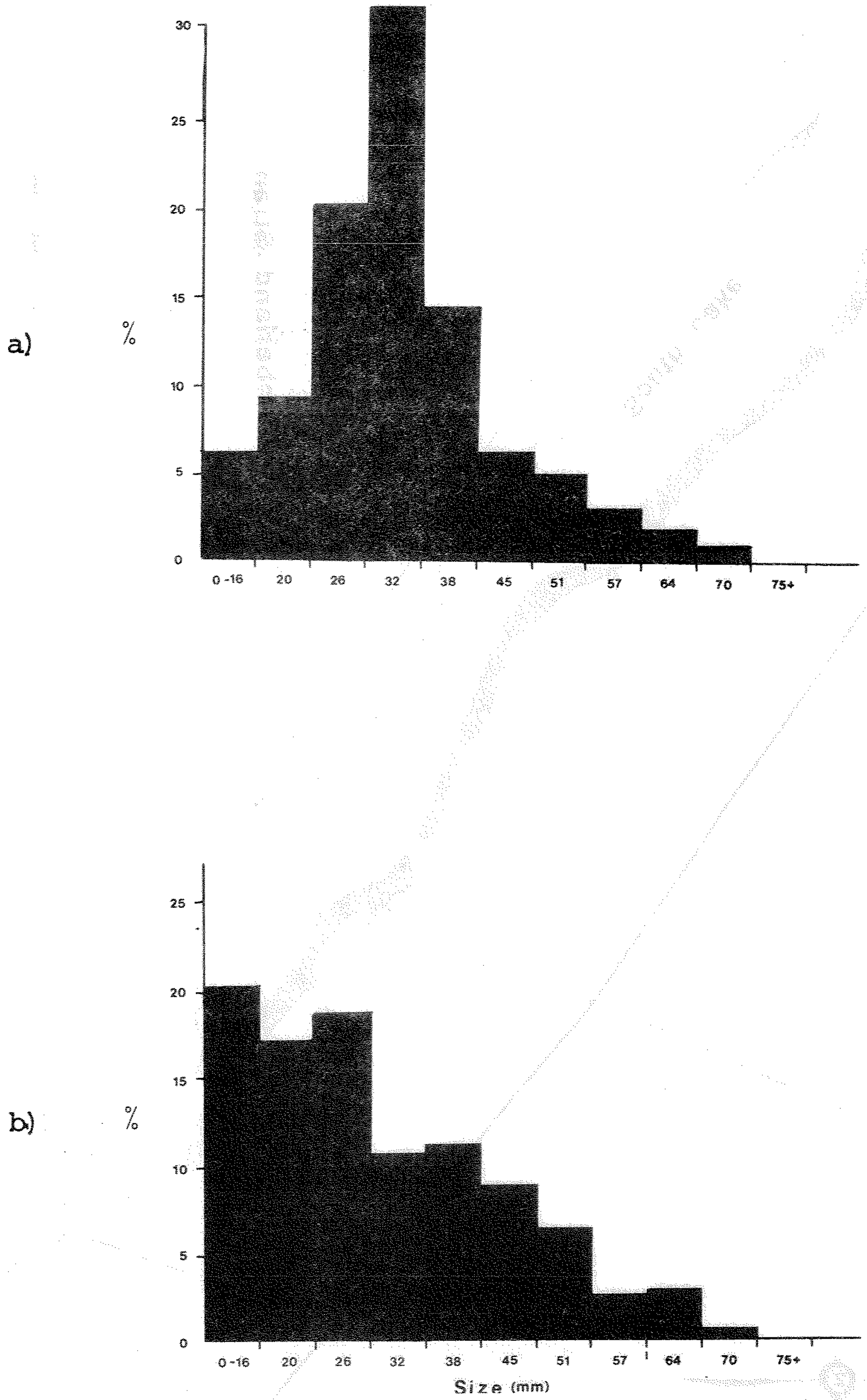


Figure 20. Size-frequency distribution for soft-shell clams collected on a) the mainland shore, b) the barrier island shore of Wolfe Inlet.

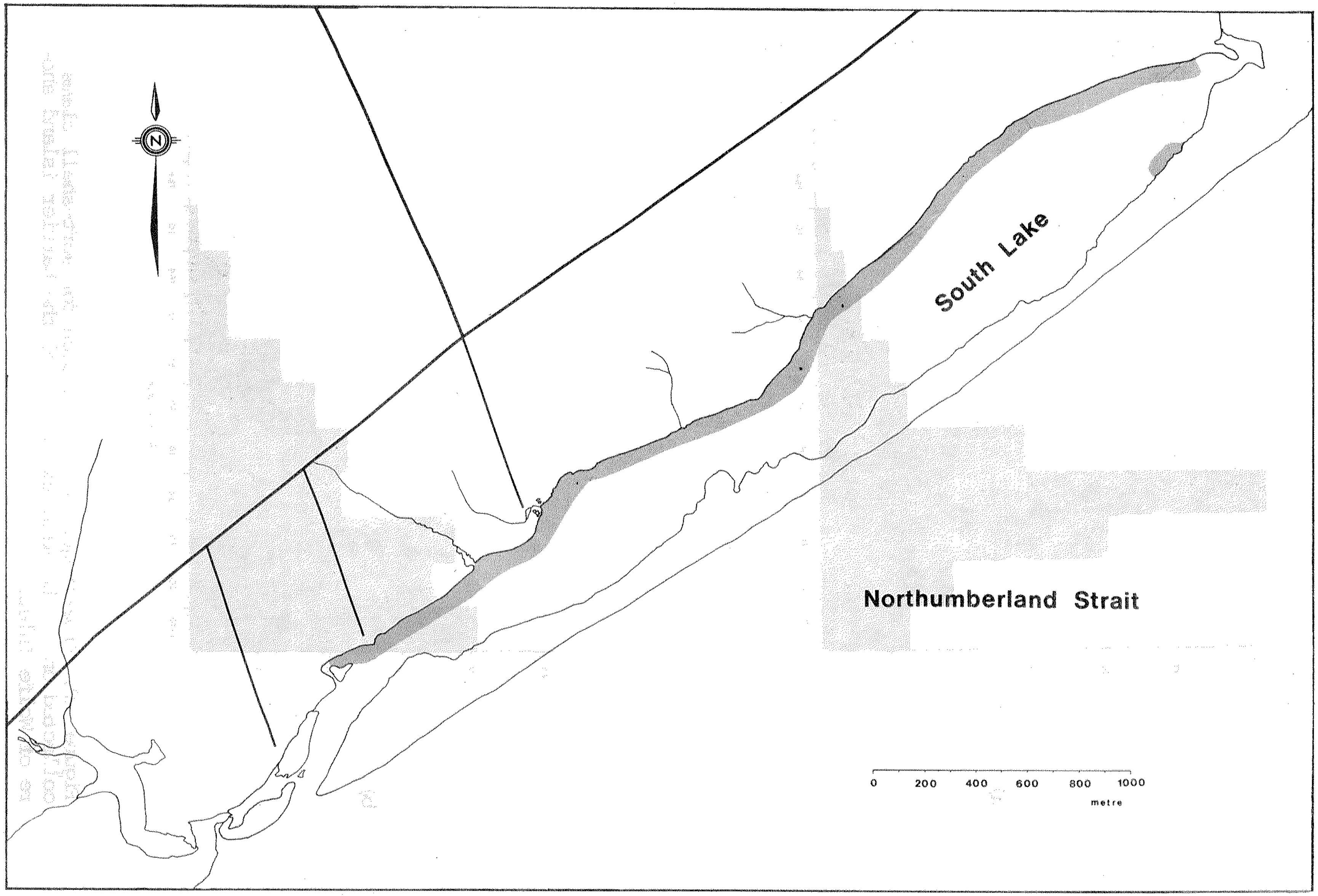


Figure 21. Soft-shell clam flats (stippled) surveyed in South Lake. For location reference, see Fig. 2.

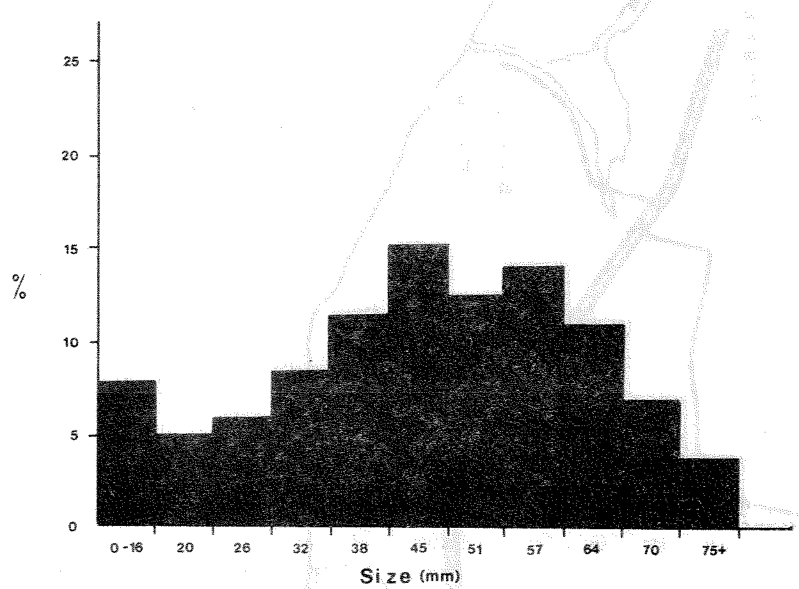


Figure 22. Size-frequency distribution for soft-shell clams in South Lake, mainland shore.

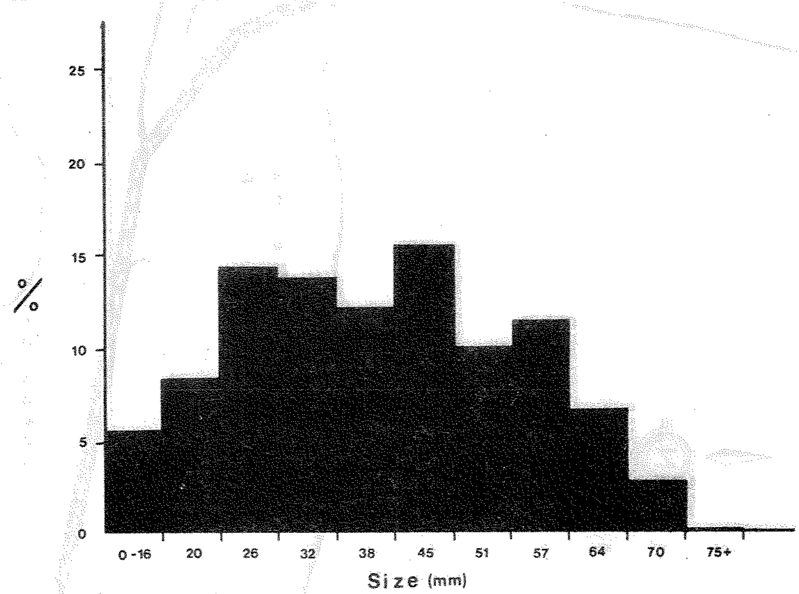


Figure 24. Size-frequency distribution for soft-shell clams from Little Harbour Pond.

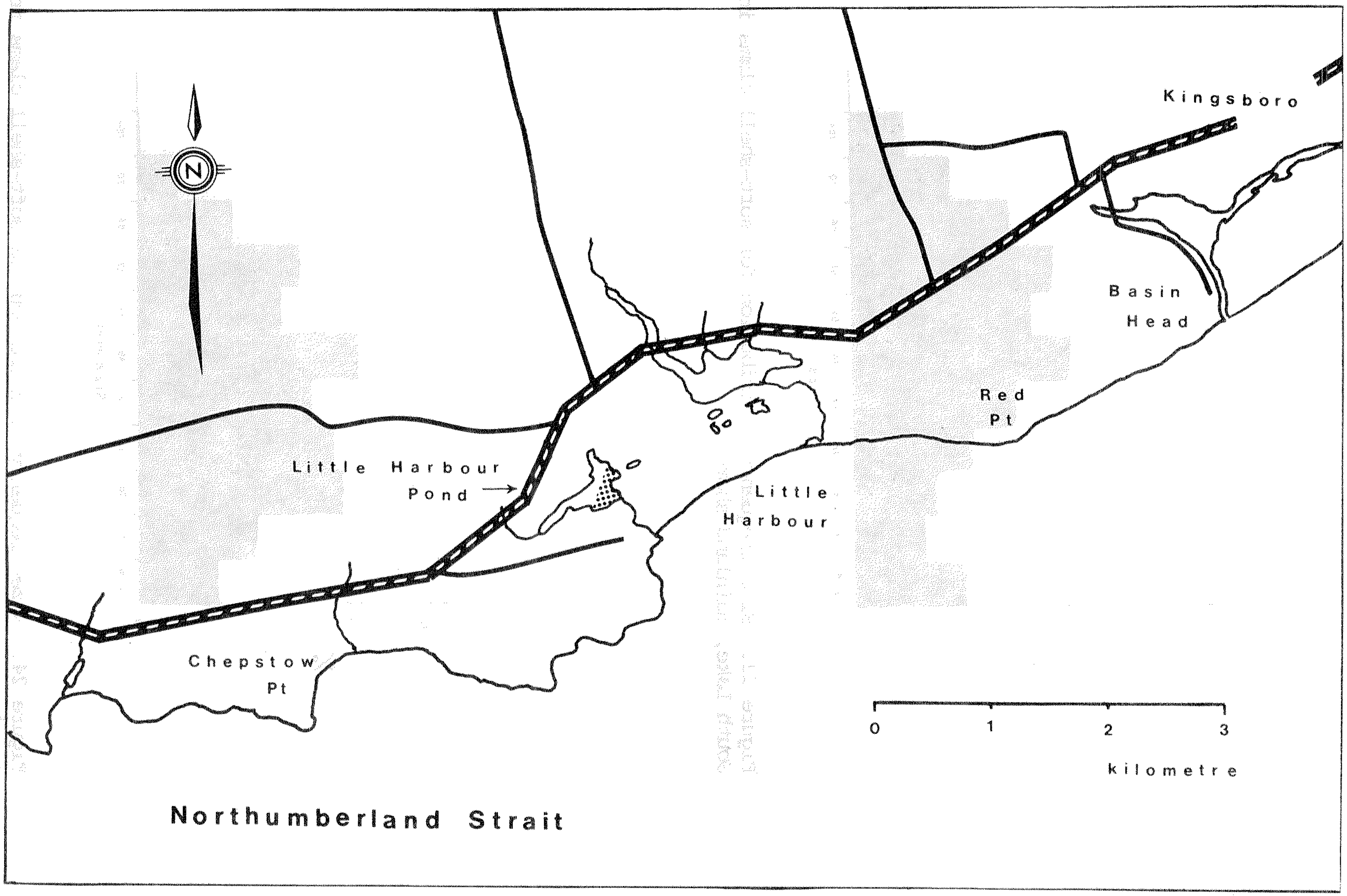


Figure 23. Soft-shell clam flats (stippled) surveyed in Little Harbour Pond. For location reference, see Fig. 2.

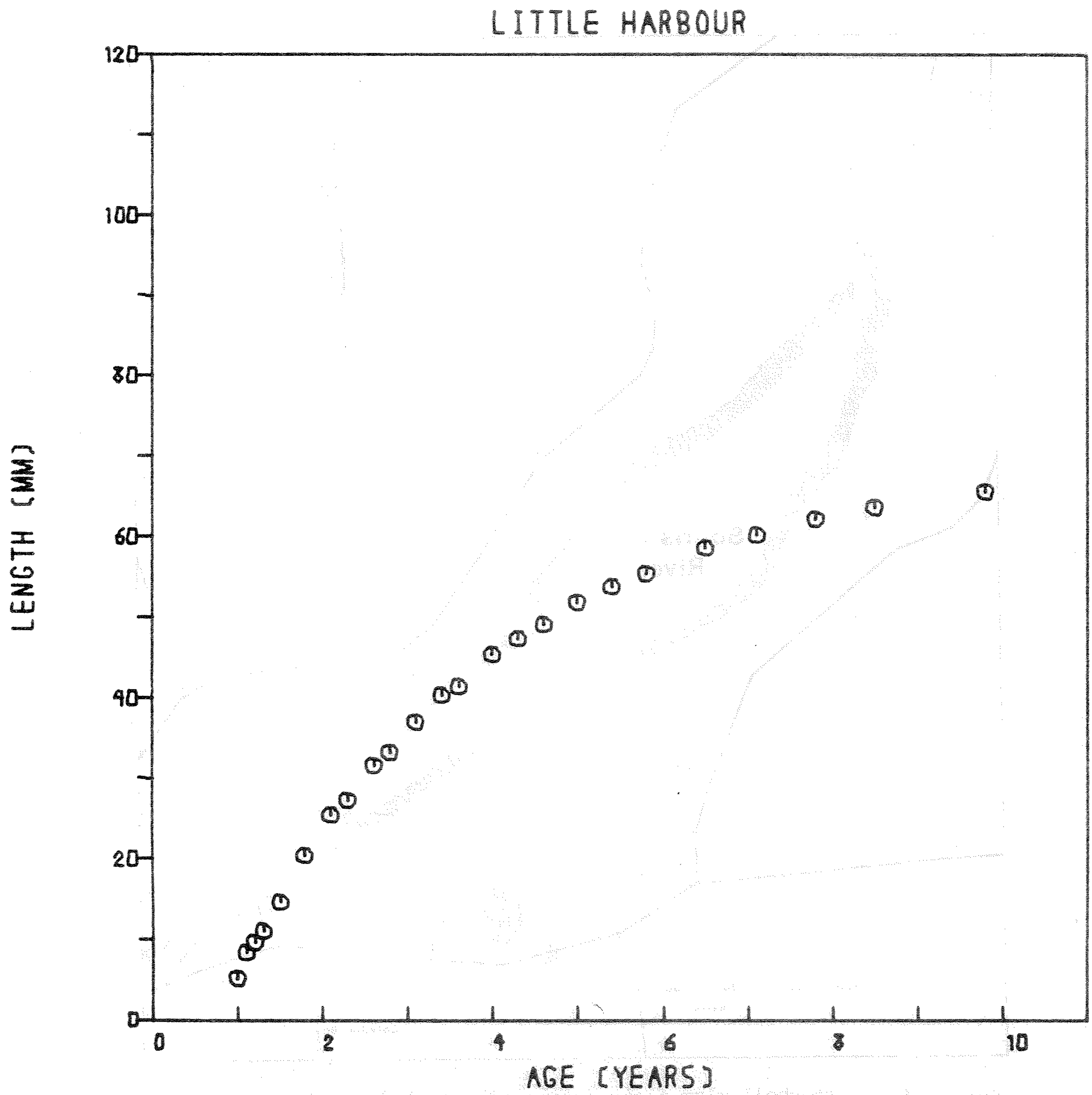


Figure 25. Representative Von Bertalanffy growth curve for soft-shell clams collected on flats in northeastern Prince Edward Island.

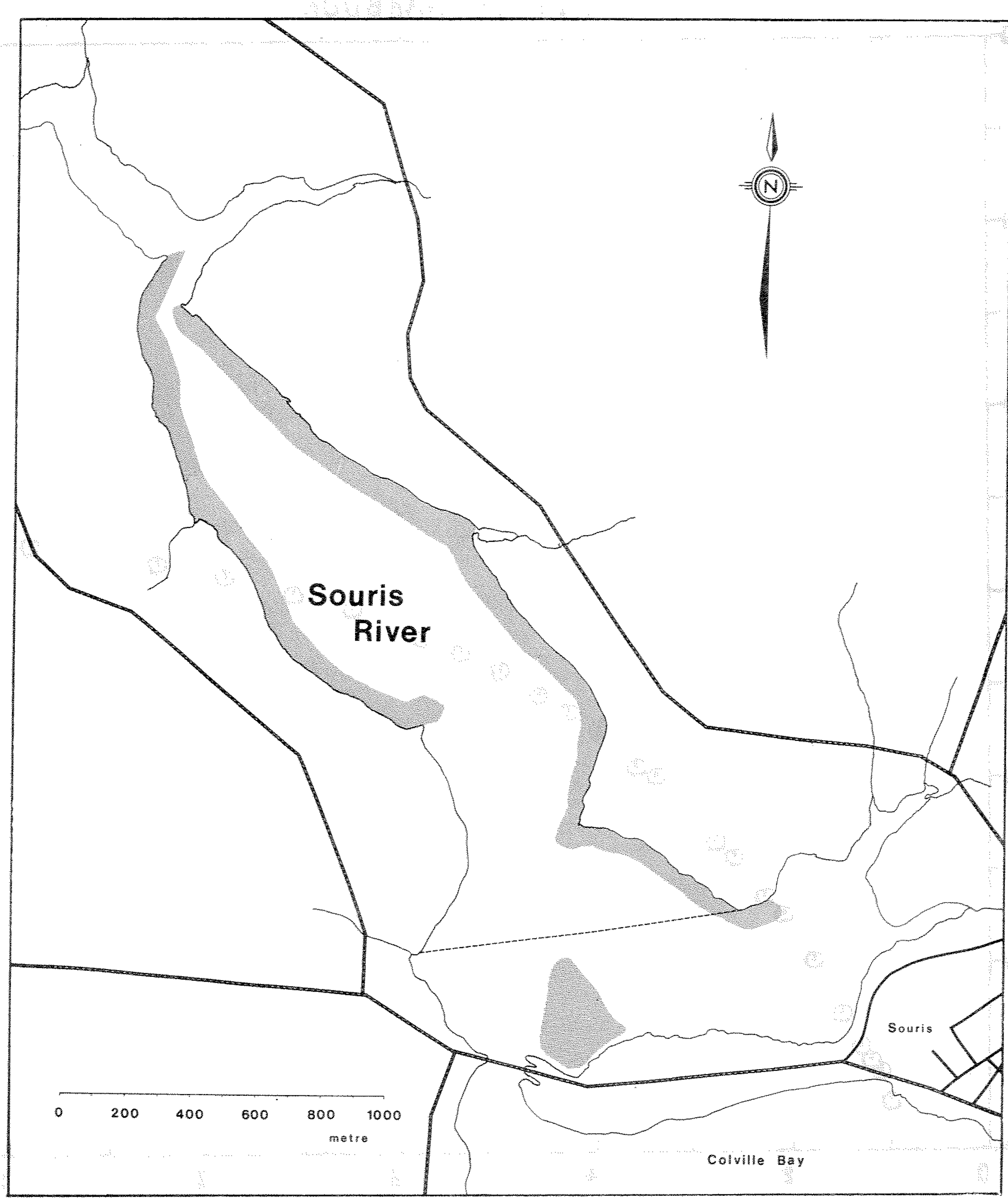


Figure 26. Soft-shell clam flats (stippled) sampled at the mouth of the Souris River. The dotted line represents a 'closure line'. For location reference, see Fig. 2.

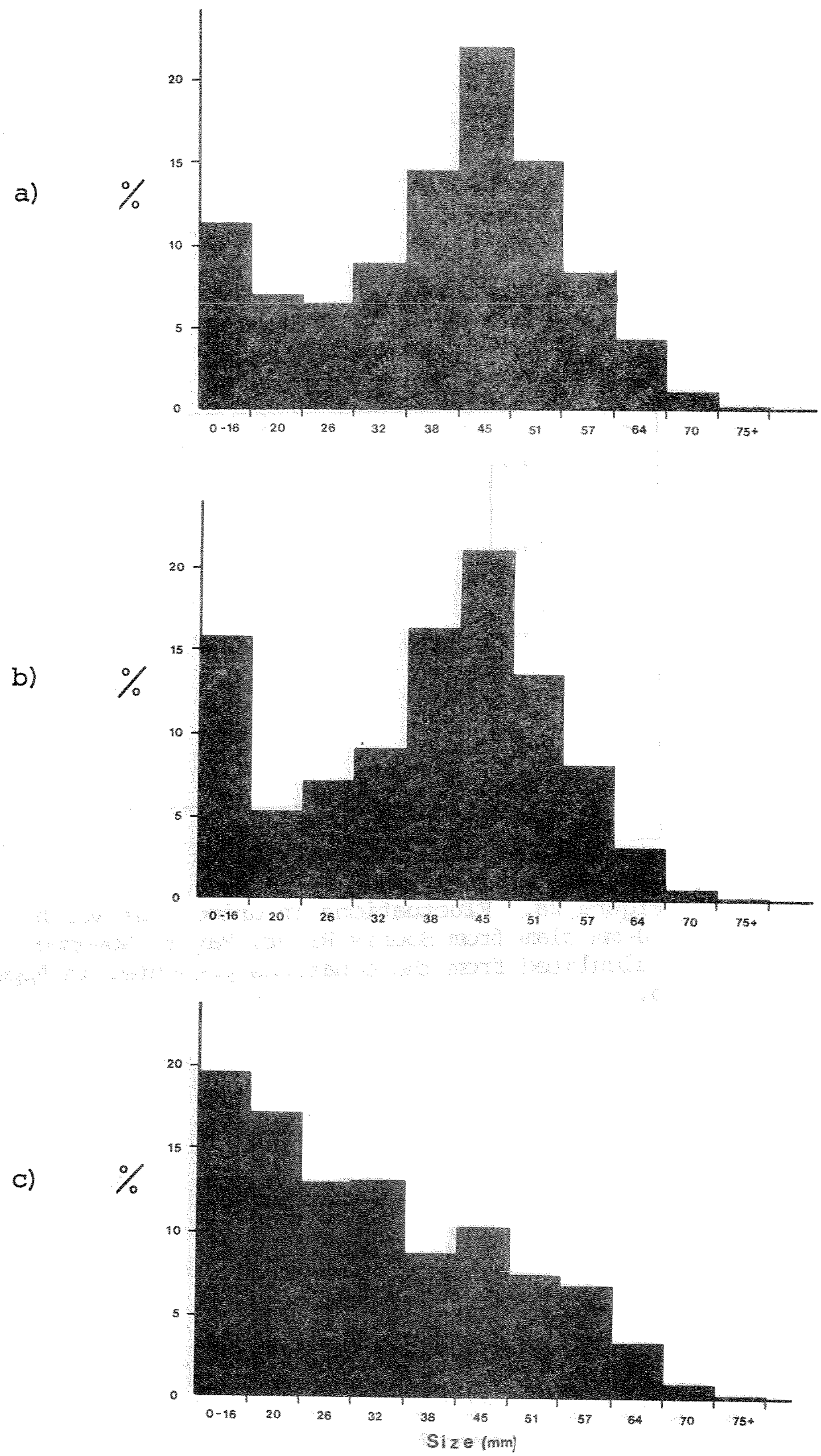


Figure 27. Size-frequency distribution for soft-shell clams collected on a) the east shore, b) the west shore, c) the shoal at the mouth of the Souris River.

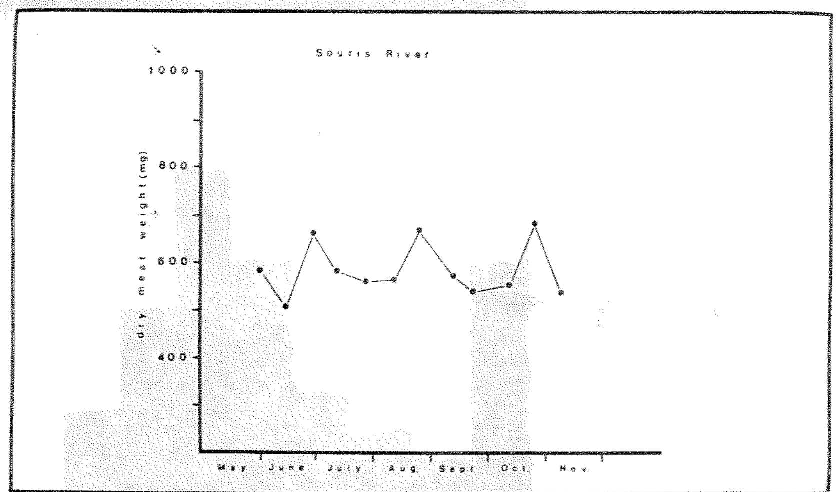


Figure 28. Fluctuations in dried meat weight of a 50-mm clam from Souris River, May to November, 1977. Calculated from the equations presented in Appendix 5.

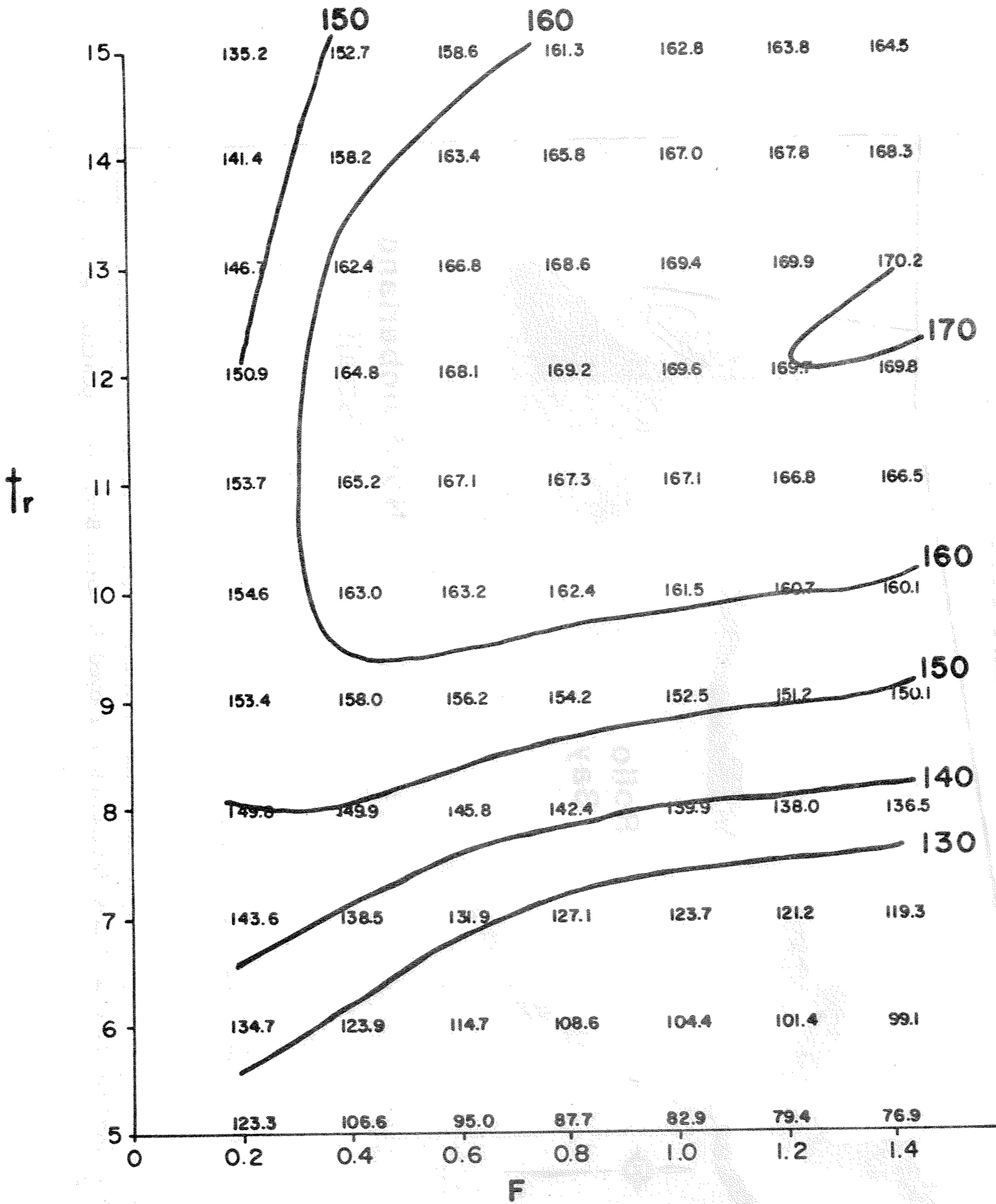


Figure 29. Yields and yield isopleths (kg per 10^5 recruits) for soft-shell clams collected in the Souris River area. t_r: age (years) of first capture, F: fishing mortality.

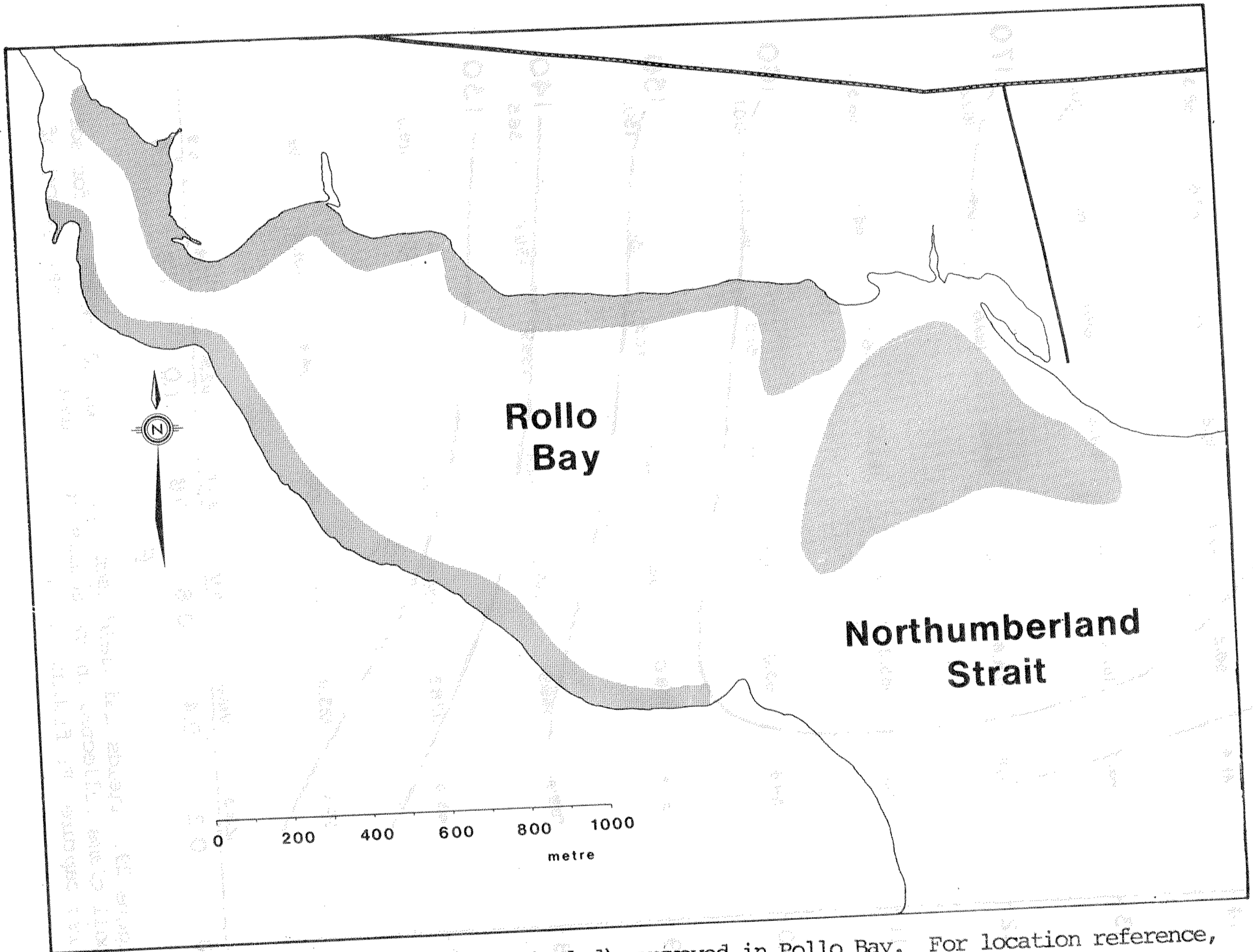


Figure 30. Soft-shell clam flats (stippled) surveyed in Rollo Bay. For location reference, see Fig. 2.

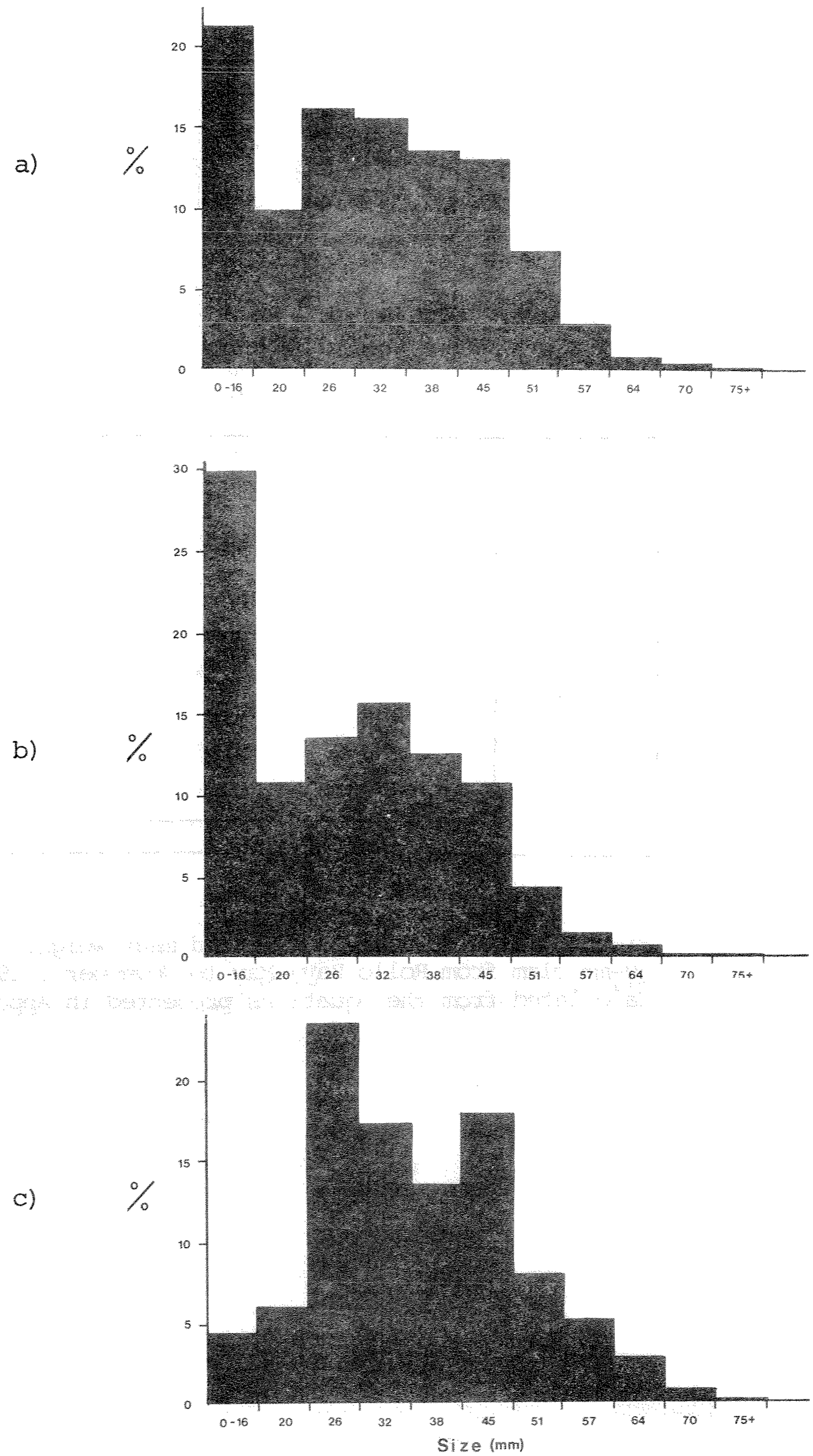


Figure 31. Size-frequency distribution for soft-shell clams collected on a) the north shore, b) the south shore, c) the shoal in Rollo Bay.

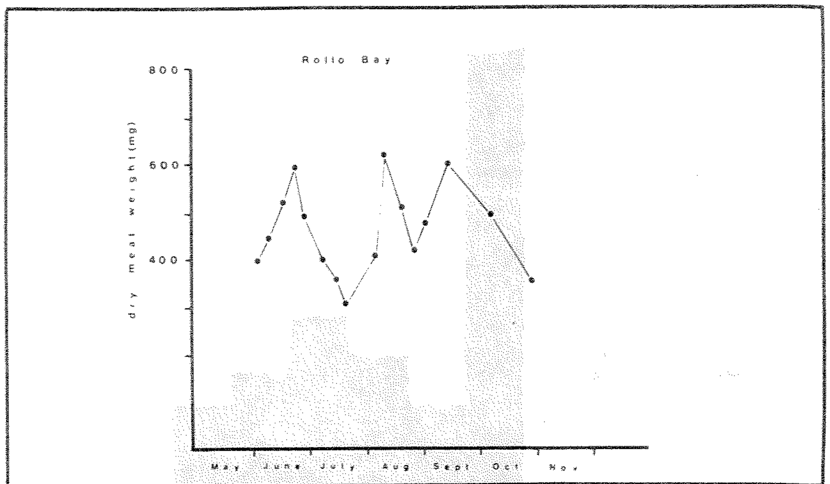


Figure 32. Fluctuations in dried meat weight of a 50-mm clam from Rollo Bay, May to November , 1976. Calculated from the equations presented in Appendix 5.

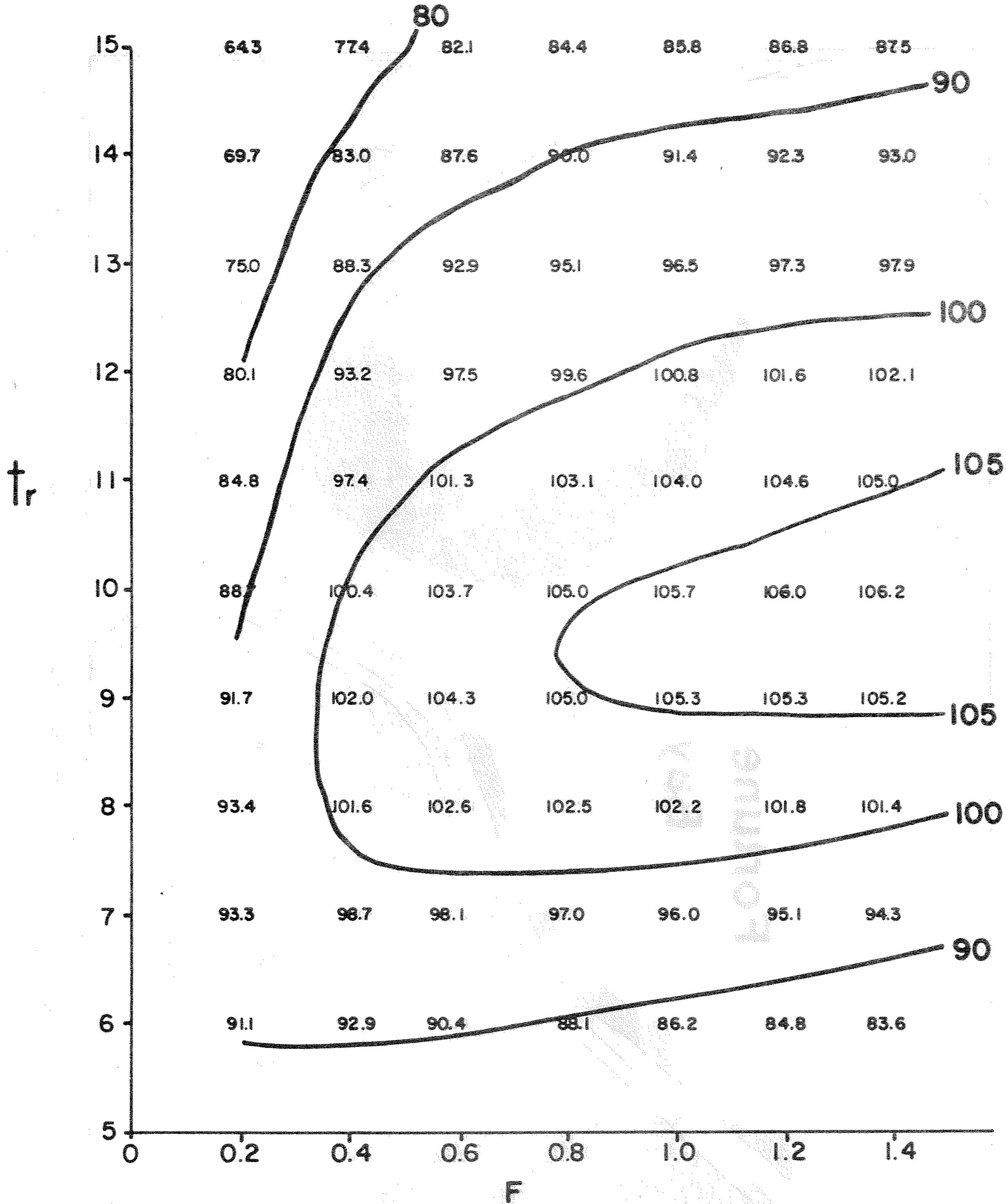


Figure 33. Yields and yield isopleths (kg per 10^5 recruits) for soft-shell clams collected on Rollo Bay flats. t_r: age (years) of first capture, F: fishing mortality.

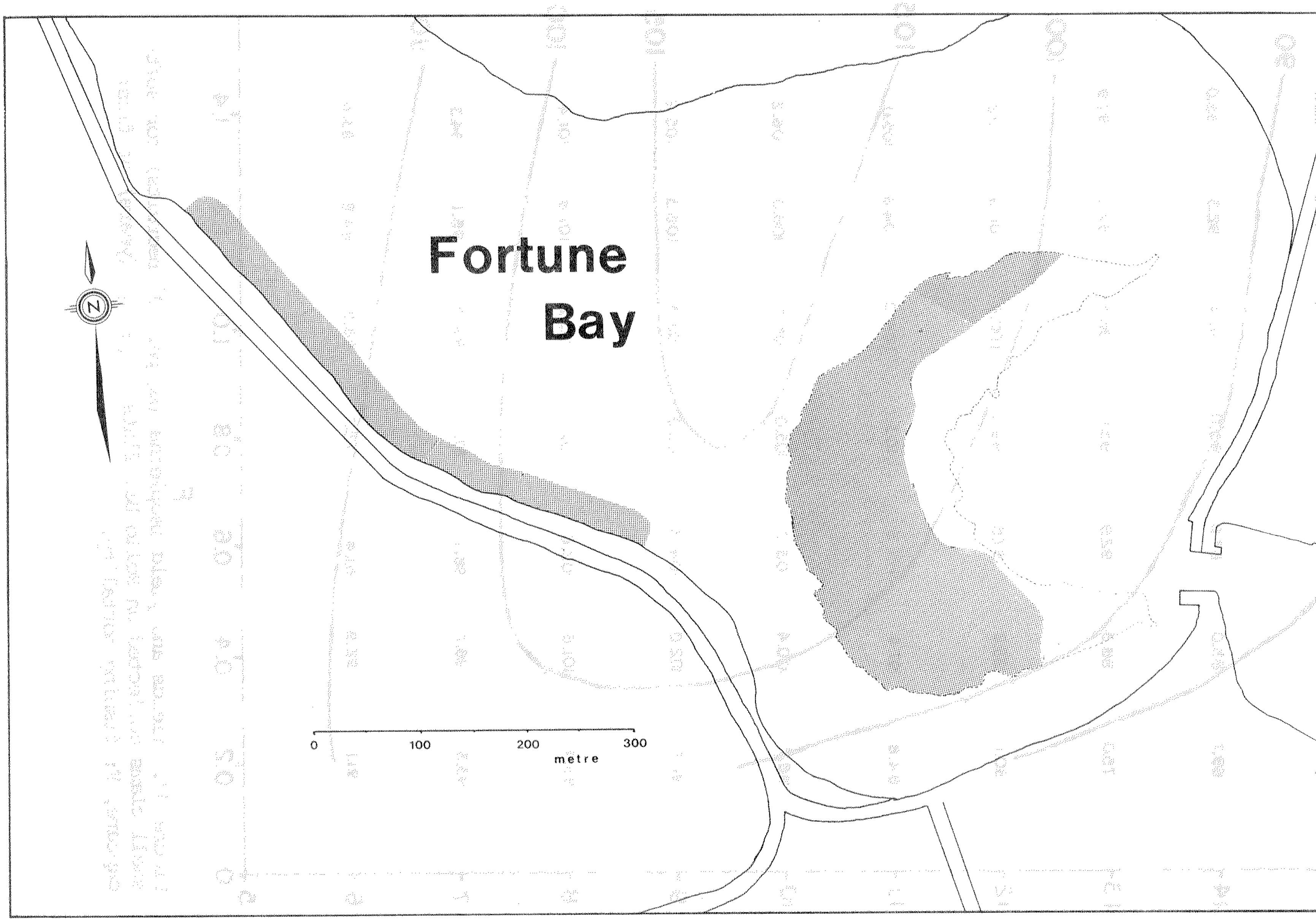


Figure 34. Tidal flats (stippled) surveyed in Fortune Bay. For location reference, see Fig. 2.

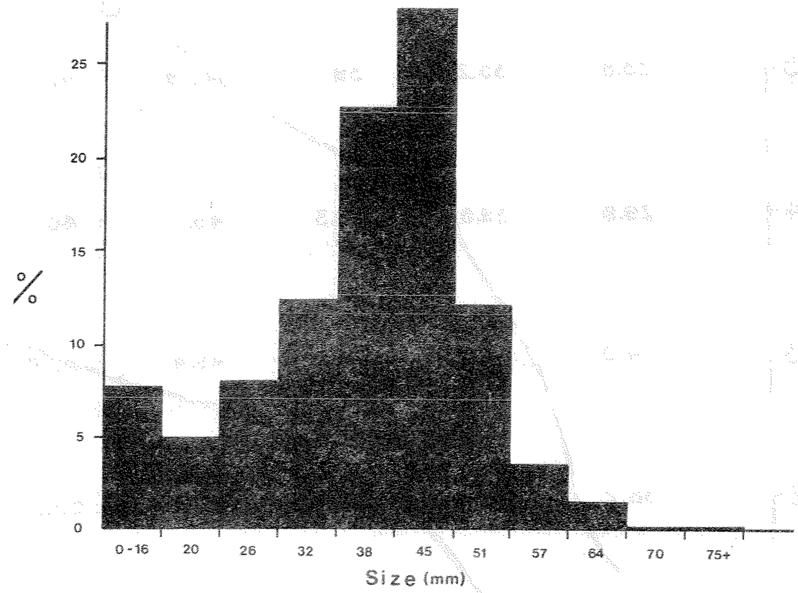


Figure 35. Size-frequency distribution for soft-shell clams from the shoal in Fortune Bay.

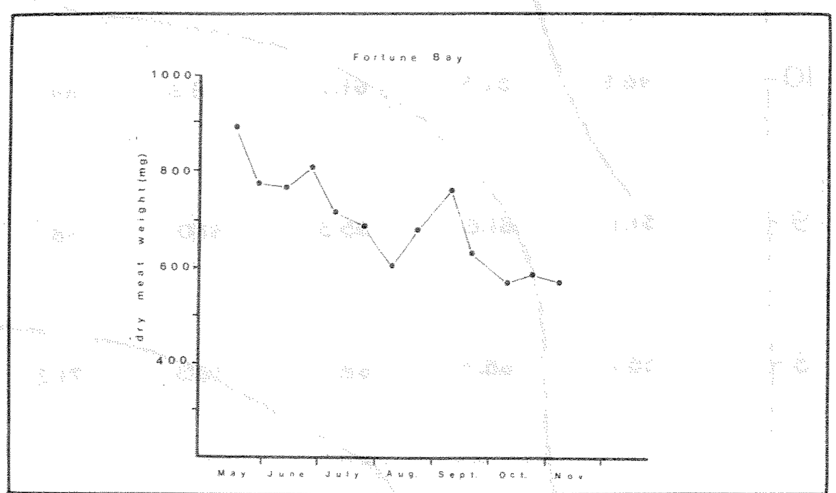


Figure 36. Fluctuations in dried meat weight of a 50-mm clam from Fortune Bay, May to November, 1977. Calculated from the equations presented in Appendix 5.

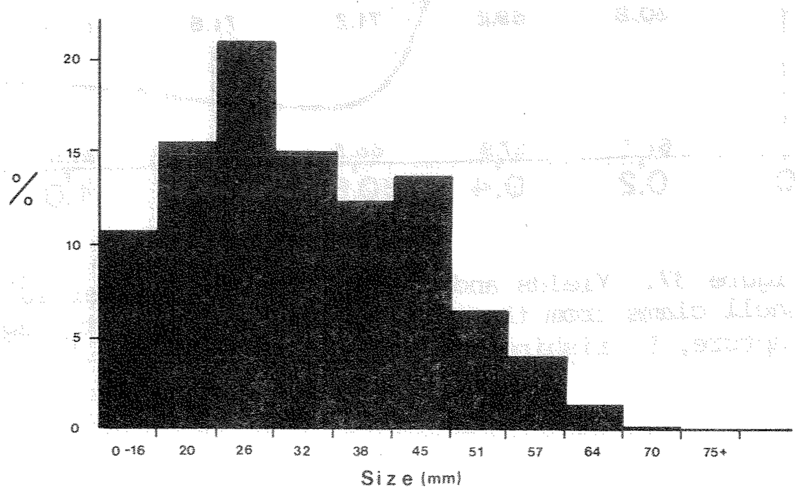


Figure 39. Size-frequency distribution for soft-shell clams from Eglington Cove.

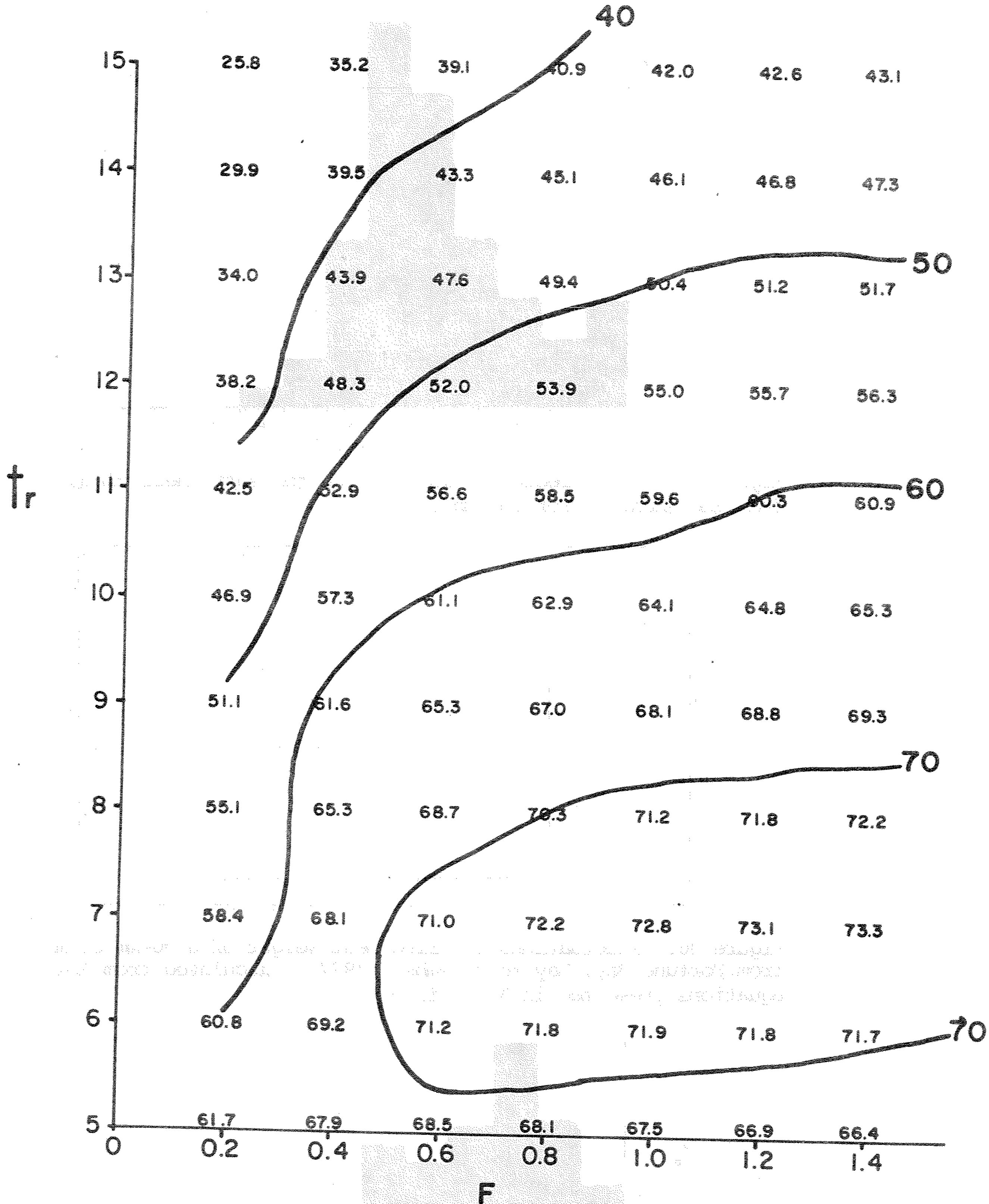


Figure 37. Yields and yield isopleths (kg per 10^5 recruits) for soft-shell clams from the shoal in Fortune Bay. t_r: age (years) of first capture, F: fishing mortality.

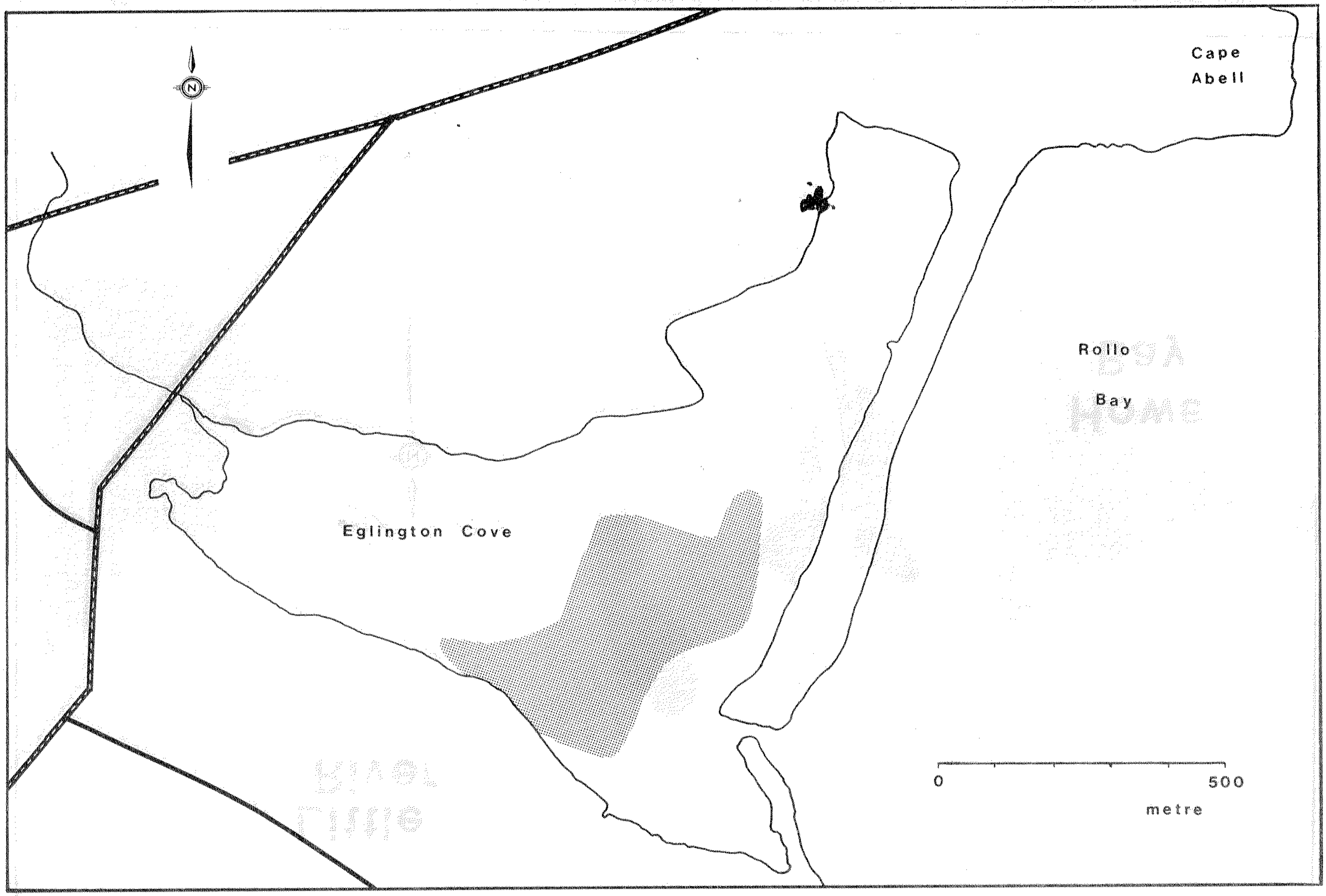


Figure 38. Soft-shell clam flats (stippled) surveyed in Eglington Cove. For location reference, see Fig. 2.

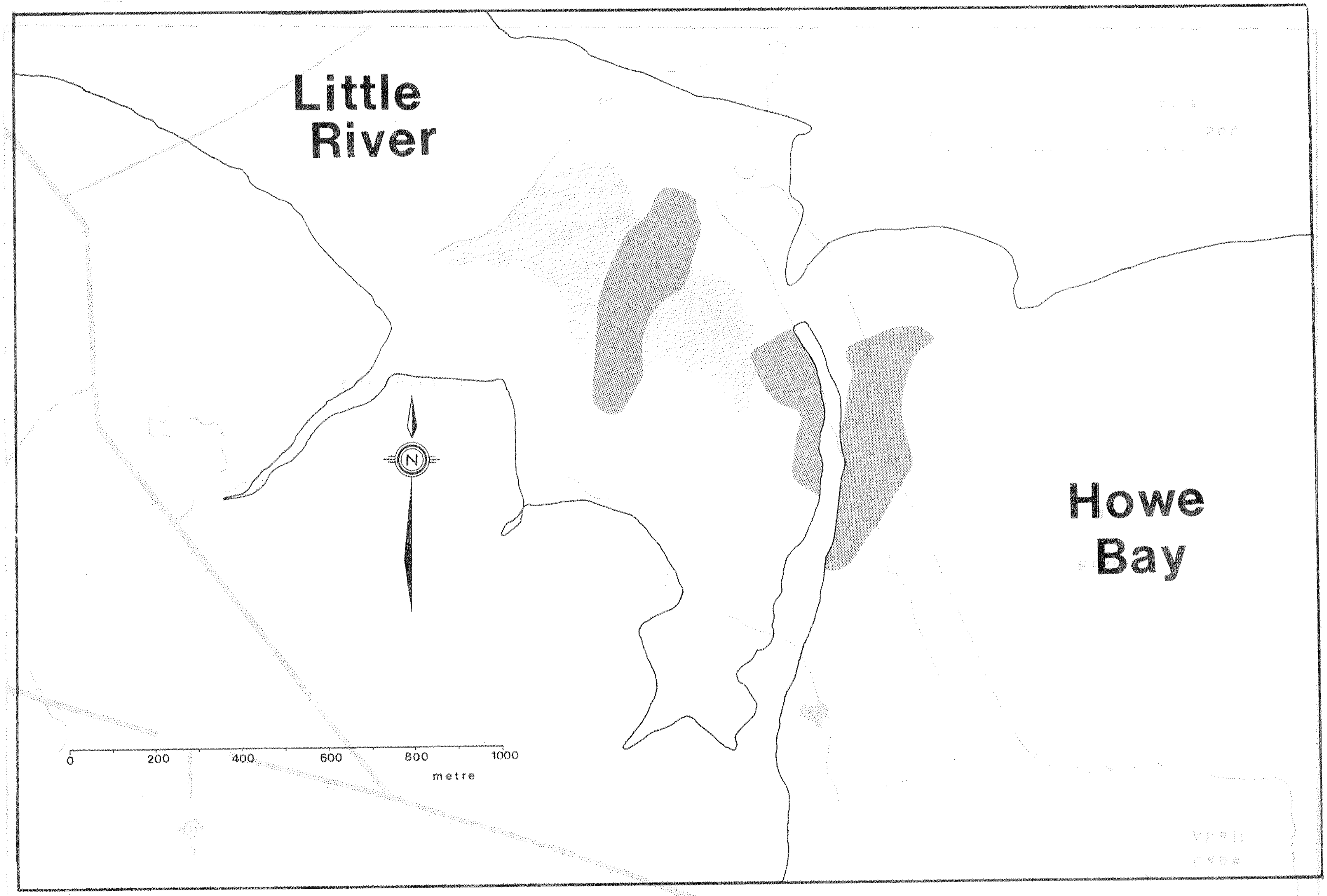


Figure 40. Soft-shell clam flats (stippled) inventoried at the mouth of Little River and in Howe Bay. For location reference, see Fig. 2.

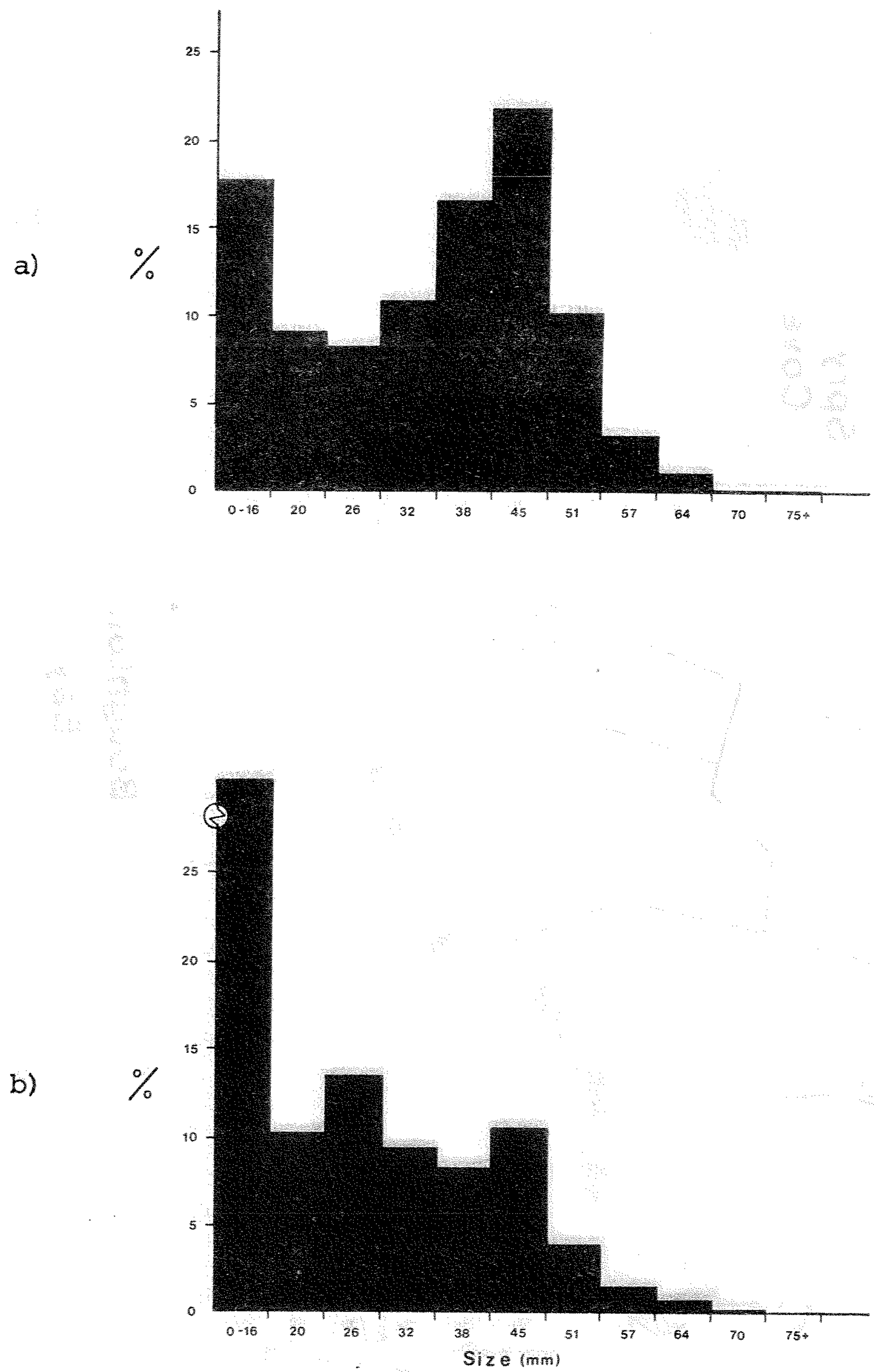


Figure 41. Size-frequency distribution for soft-shell clams from a) Howe Bay, b) Little River.

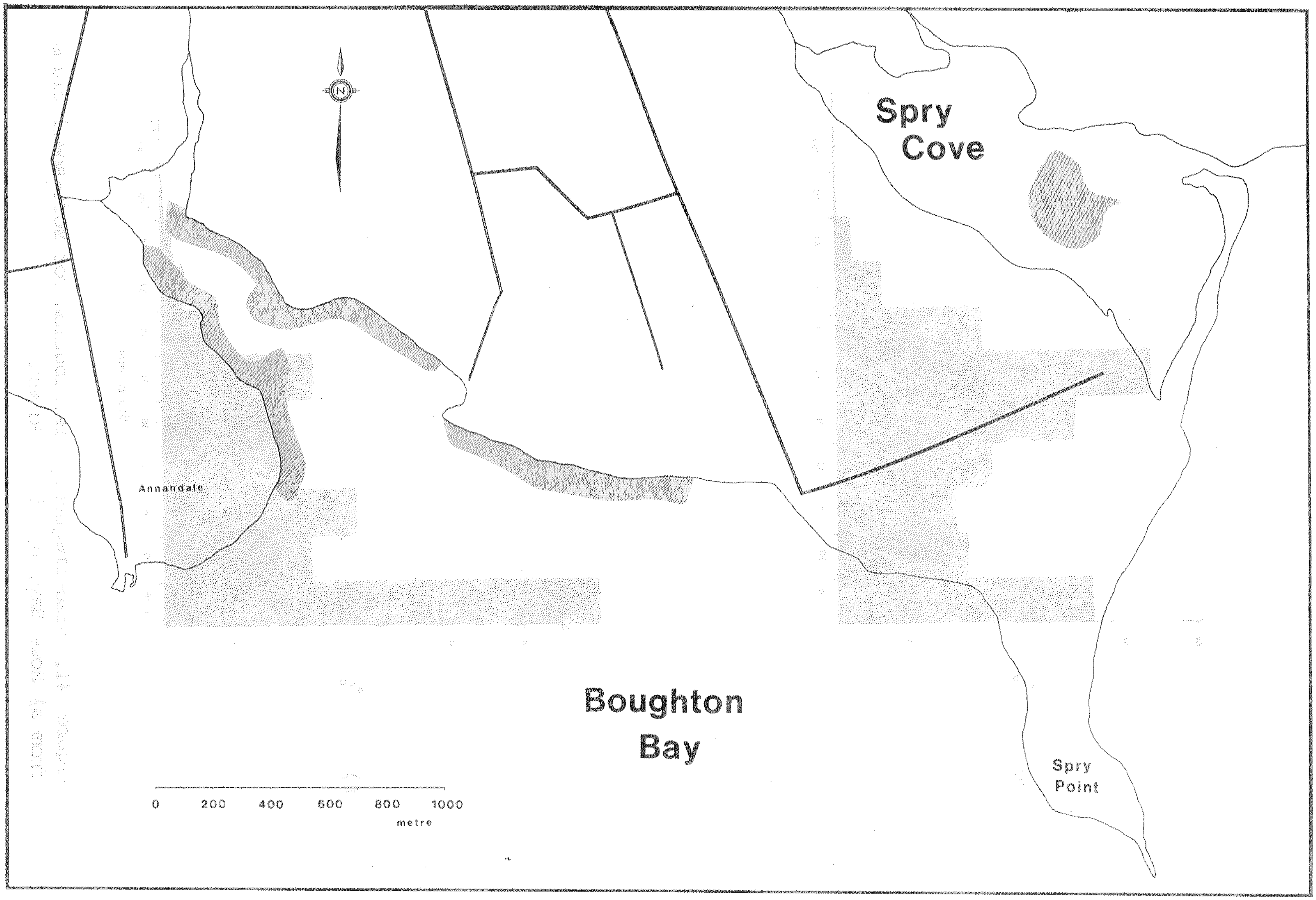


Figure 42. Soft-shell clam flats (stippled) surveyed in Spry Cove and Boughton Bay. For location reference, see Fig. 2.

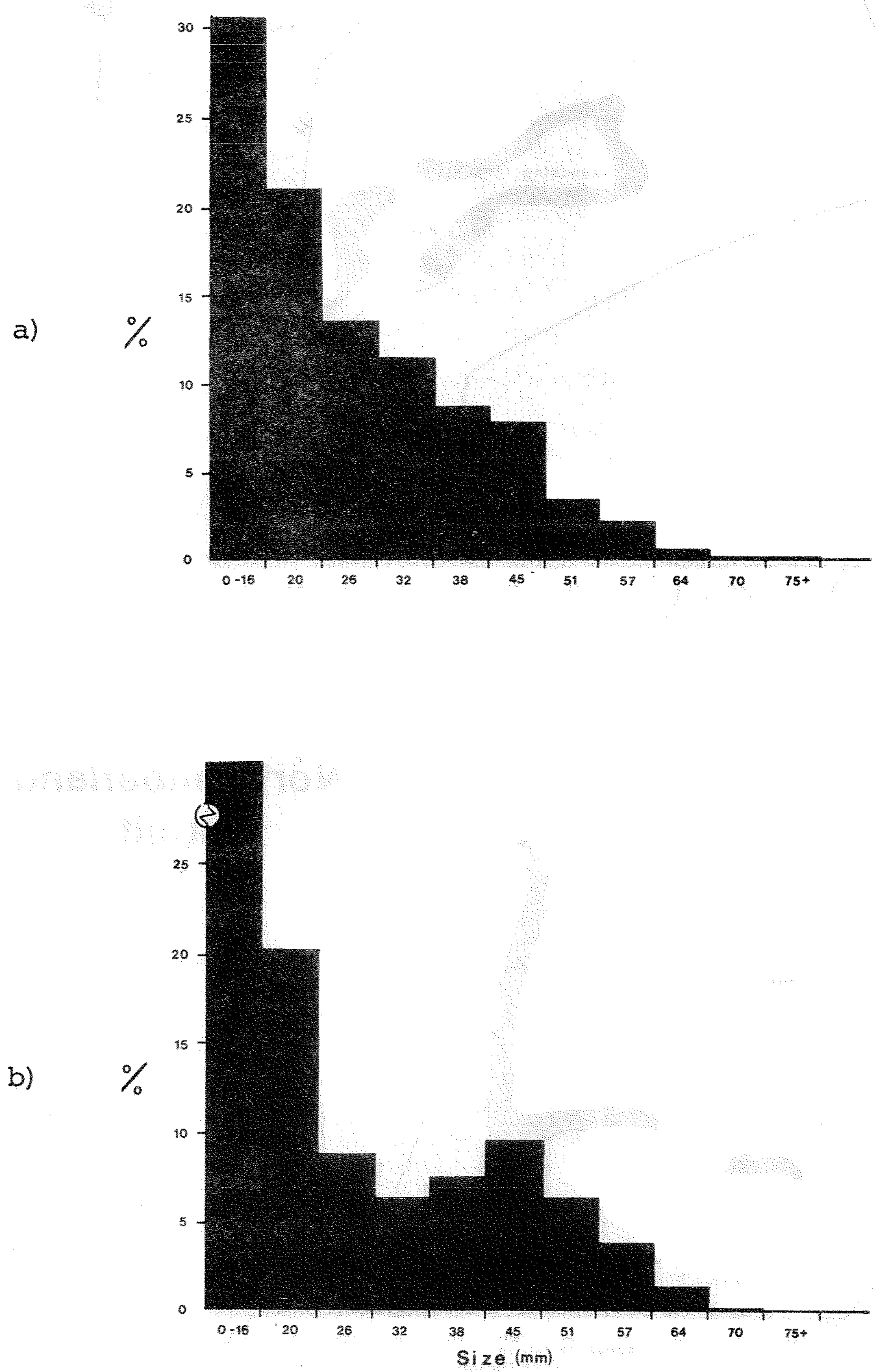


Figure 43. Size-frequency distribution for soft-shell clams collected a) in Spry Cove, b) in Boughton Bay.

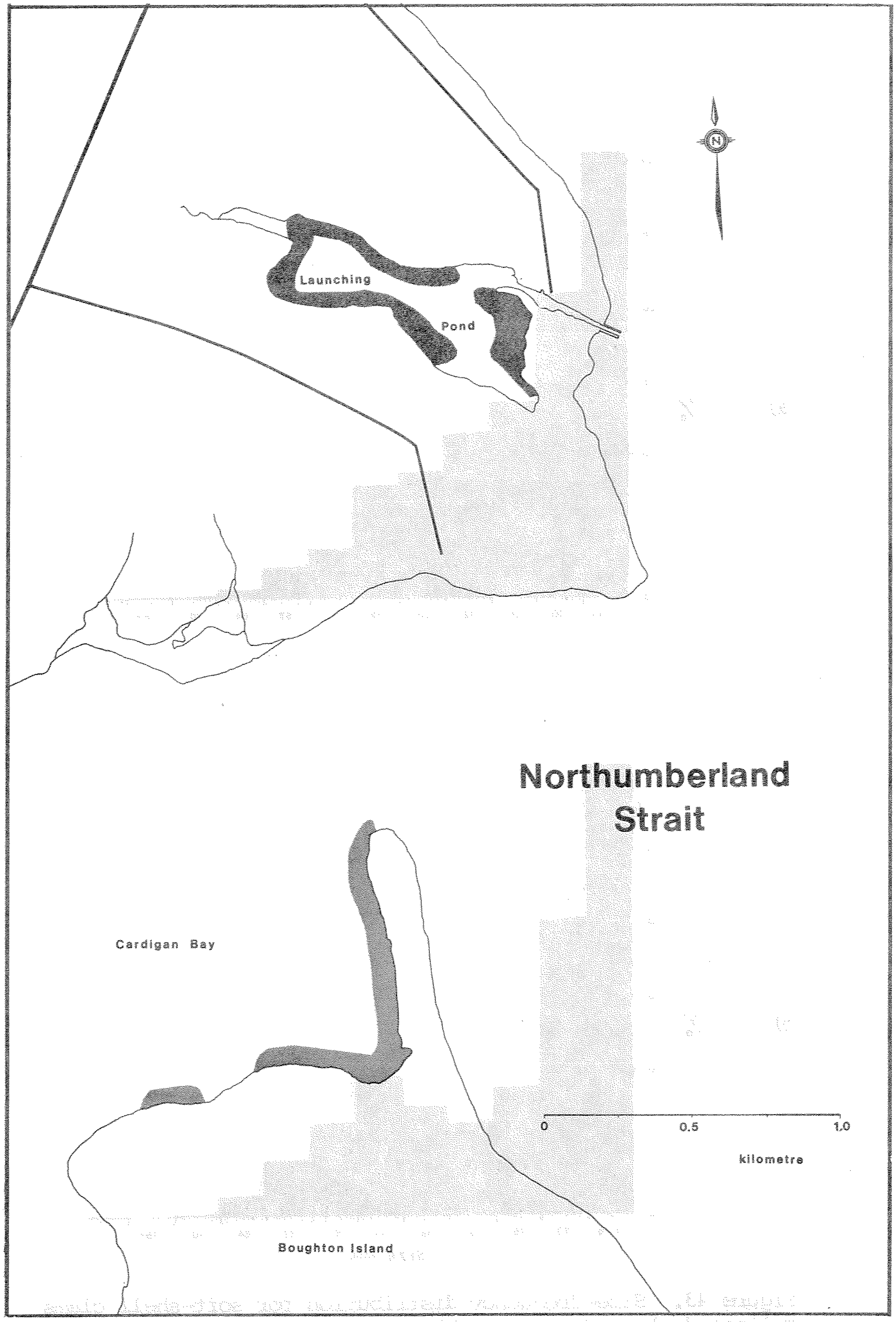


Figure 44. Soft-shell clam flats (stippled) sampled in Launching Pond and on Boughton Island. For location reference, see Fig. 2.

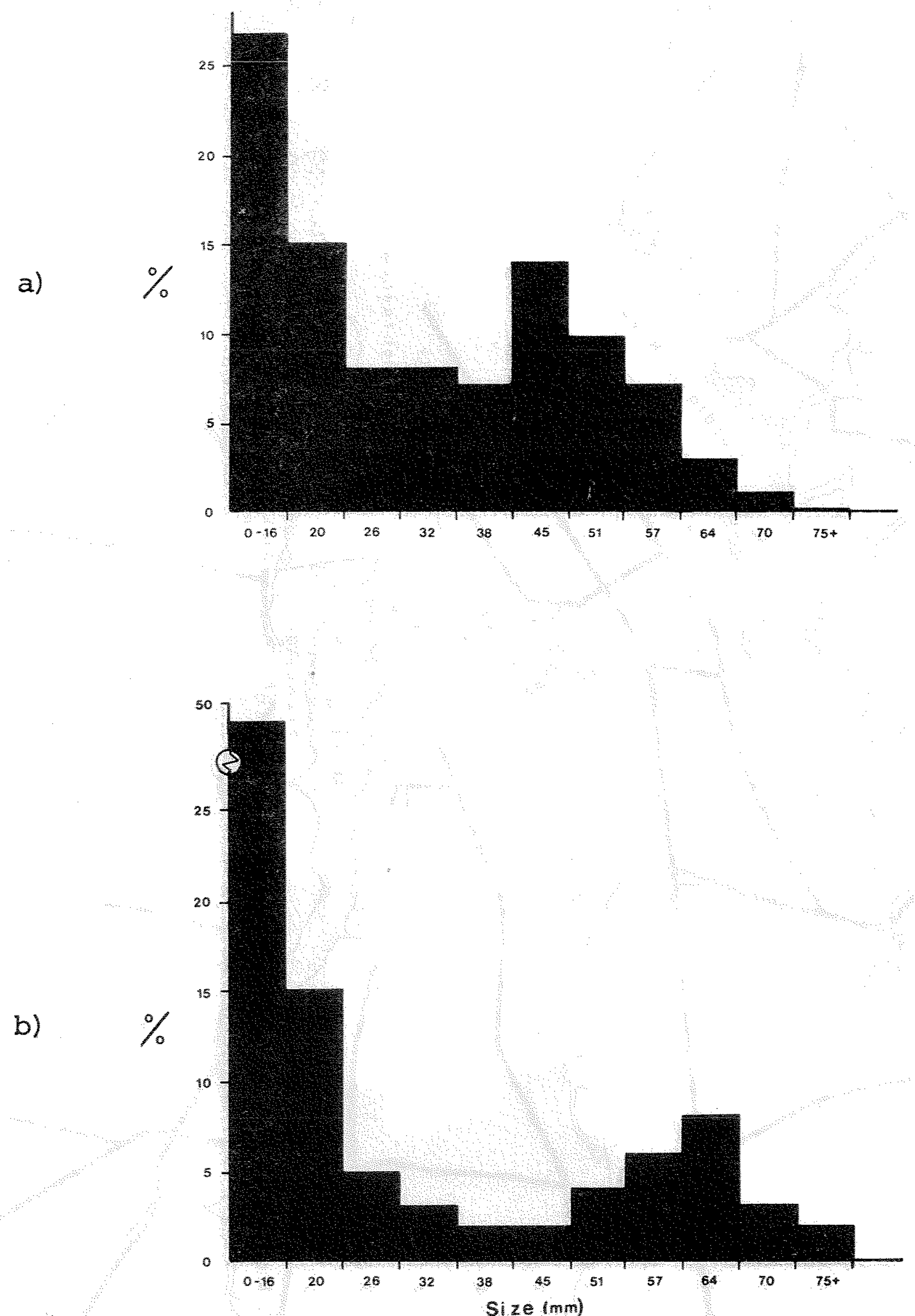


Figure 45. Size-frequency distribution for soft-shell clams from a) Launching Pond, b) Boughton Island.

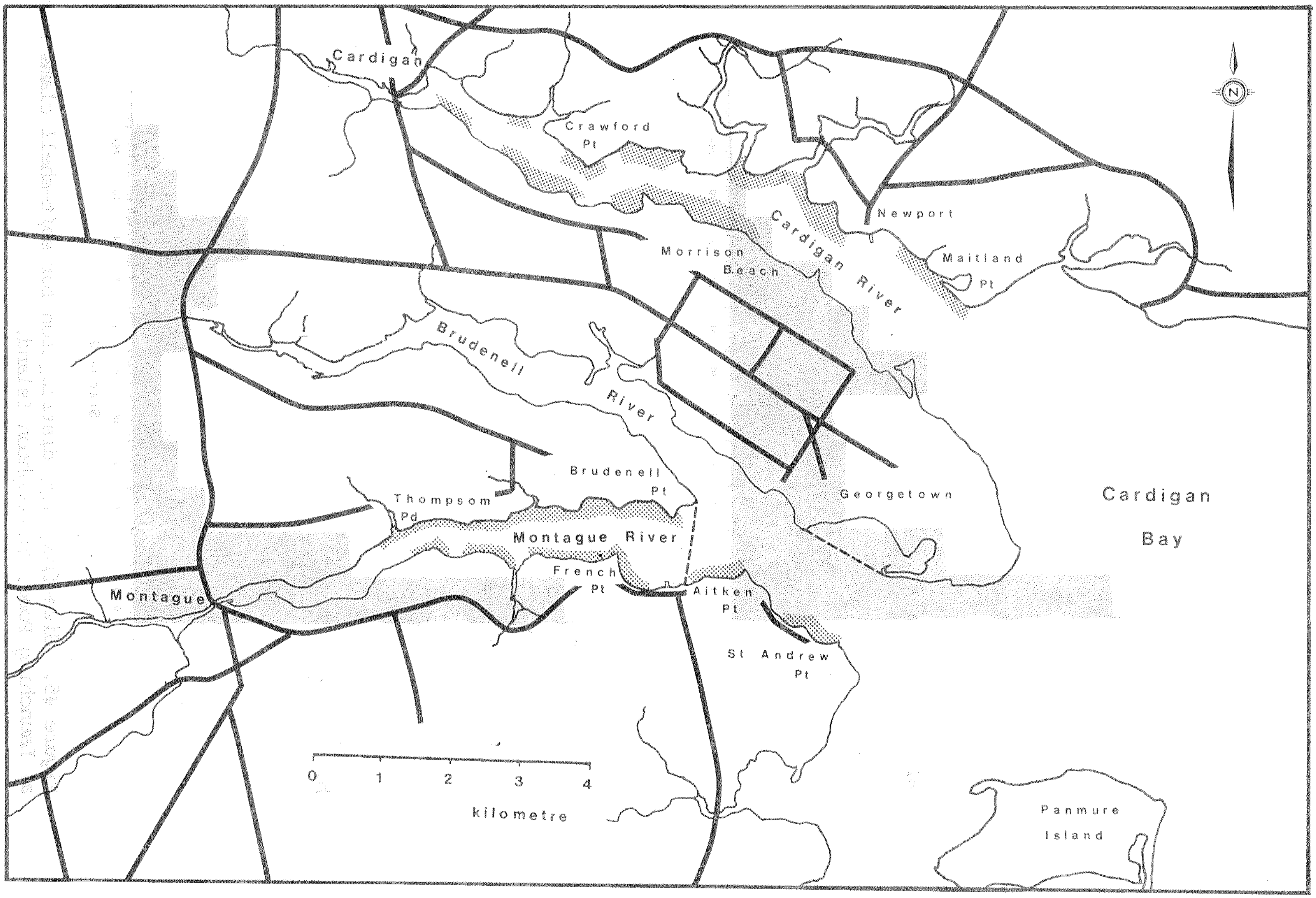
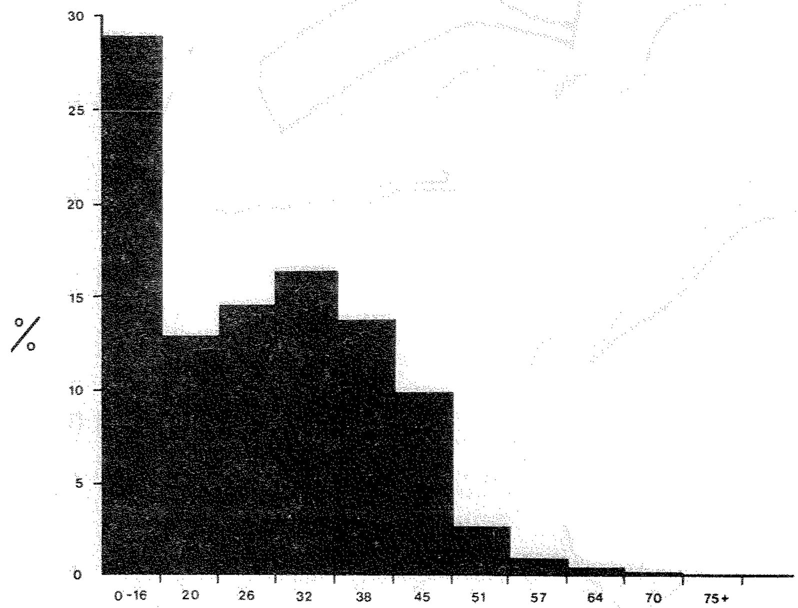


Figure 46. Soft-shell clam flats (stippled) investigated in Cardigan and Montague Rivers. For location reference, see Fig. 2.

a)



b)

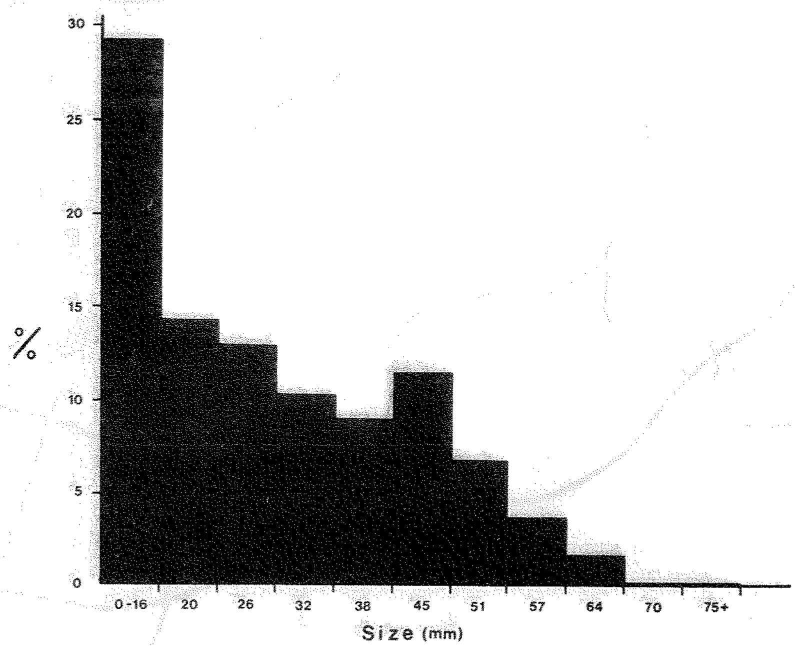


Figure 47. Size-frequency distribution for soft-shell clams collected a) along the south shore of Cardigan River, b) on the south shore of Montague River.

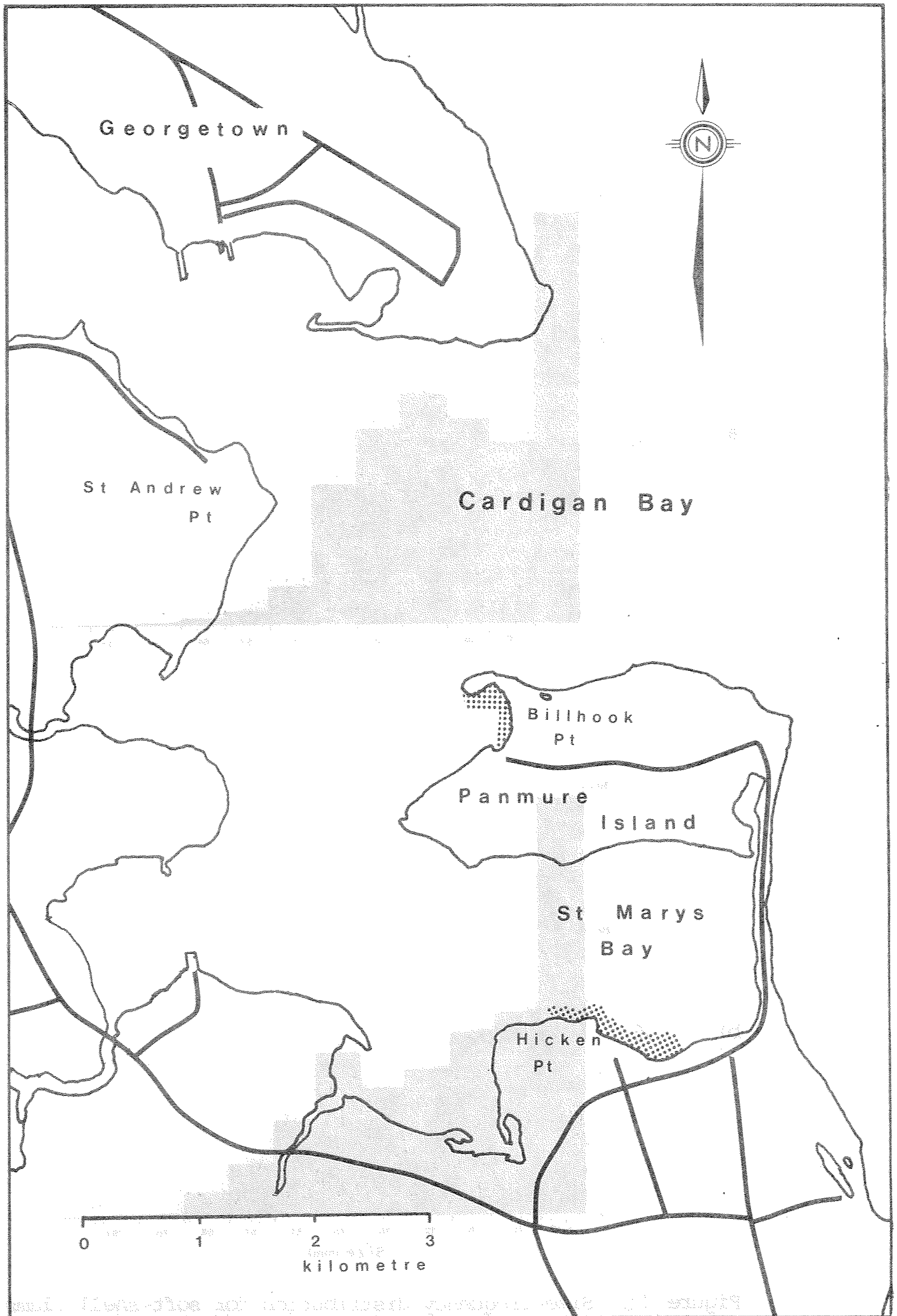


Figure 48. Soft-shell clam flats (stippled) surveyed on Panmure Island and in St. Mary's Bay. For location reference, see Fig. 2.

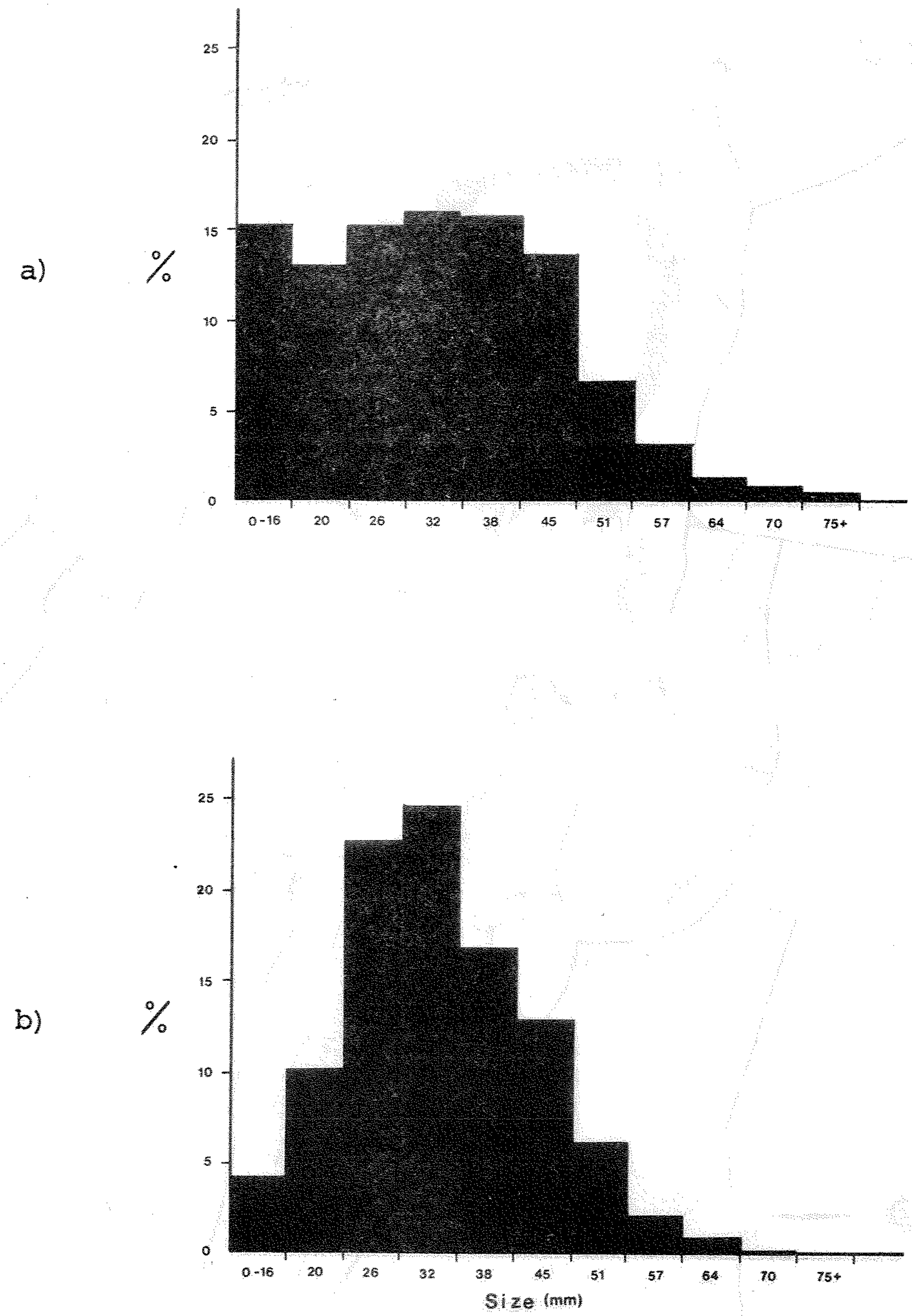


Figure 49. Size-frequency distribution for soft-shell clams from a) Panmure Island, b) St.Mary's Bay.

Figure 50. Soft-shell clam flats (stippled) investigated in the vicinity of Murray Harbour. For location reference, see Fig. 2.

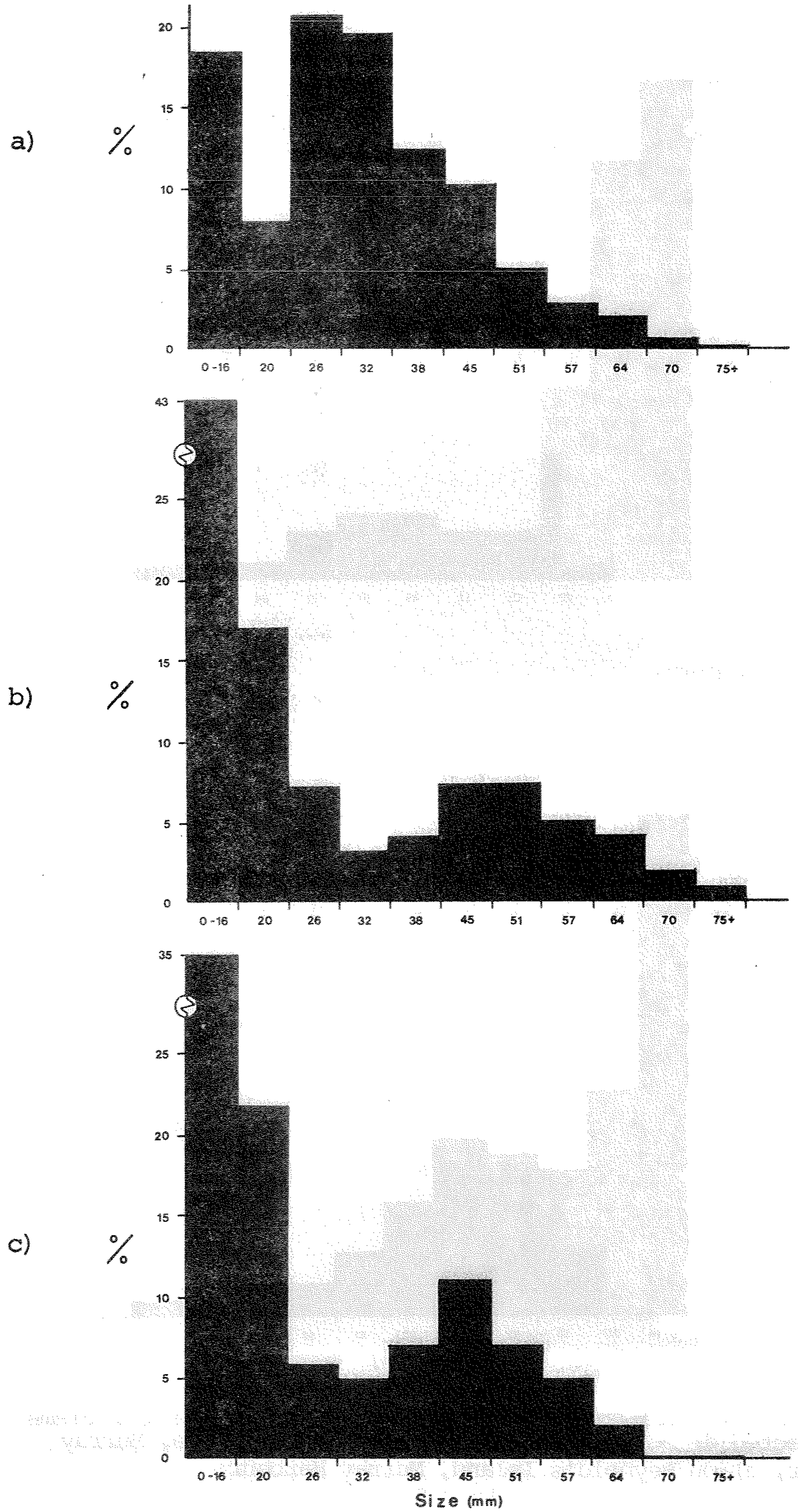


Figure 51. Size-frequency distribution for soft-shell clams from a) Greek River, b) along Poverty Beach, c) between Poverty Beach and Indian Point, Murray Harbour.

d)

e)

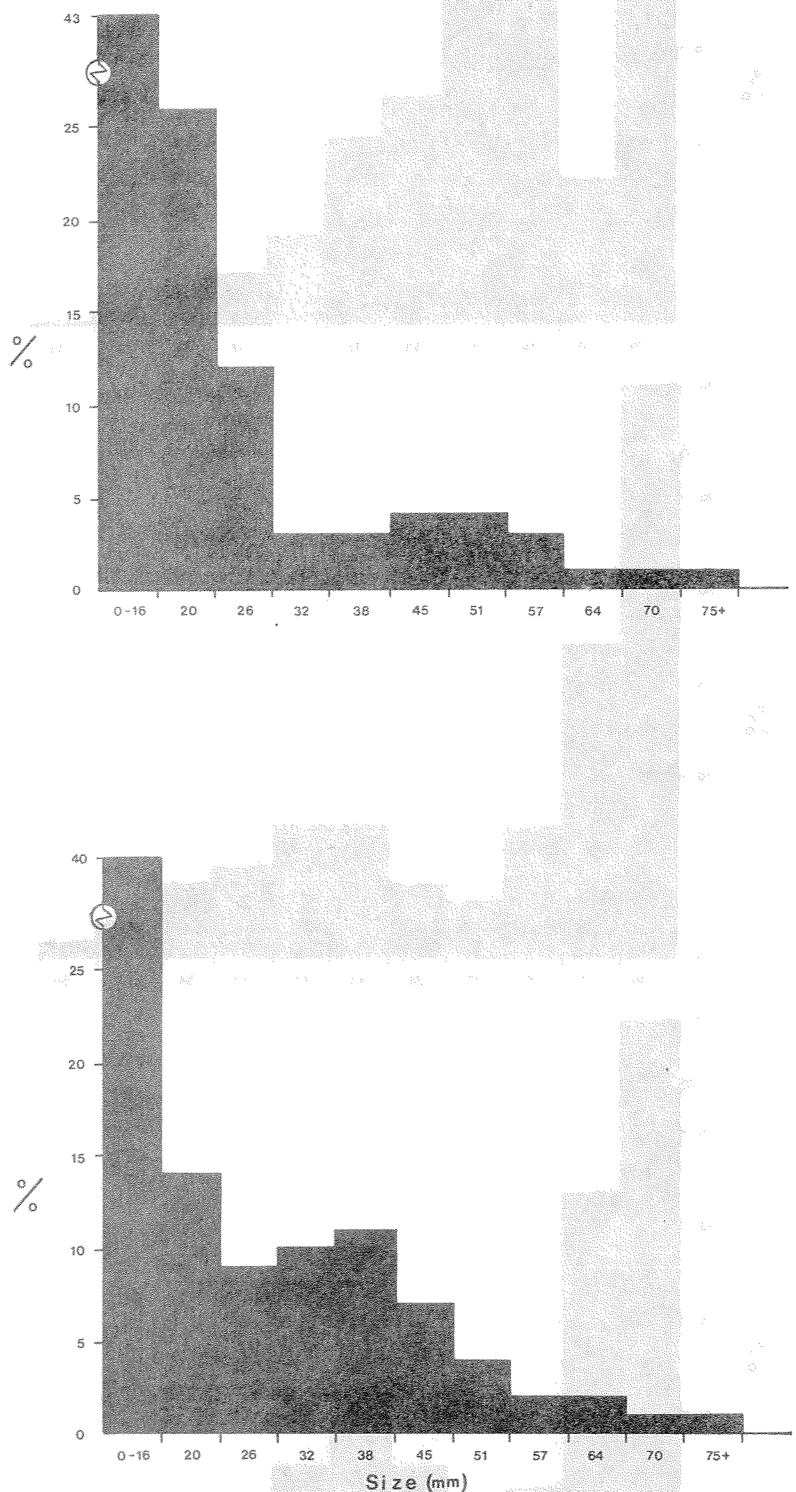


Figure 51. Size-frequency distribution for soft-shell clams collected d) between Fairchild Point and Log Cove, Murray River, e) on Reynold's Island, Murray Harbour.

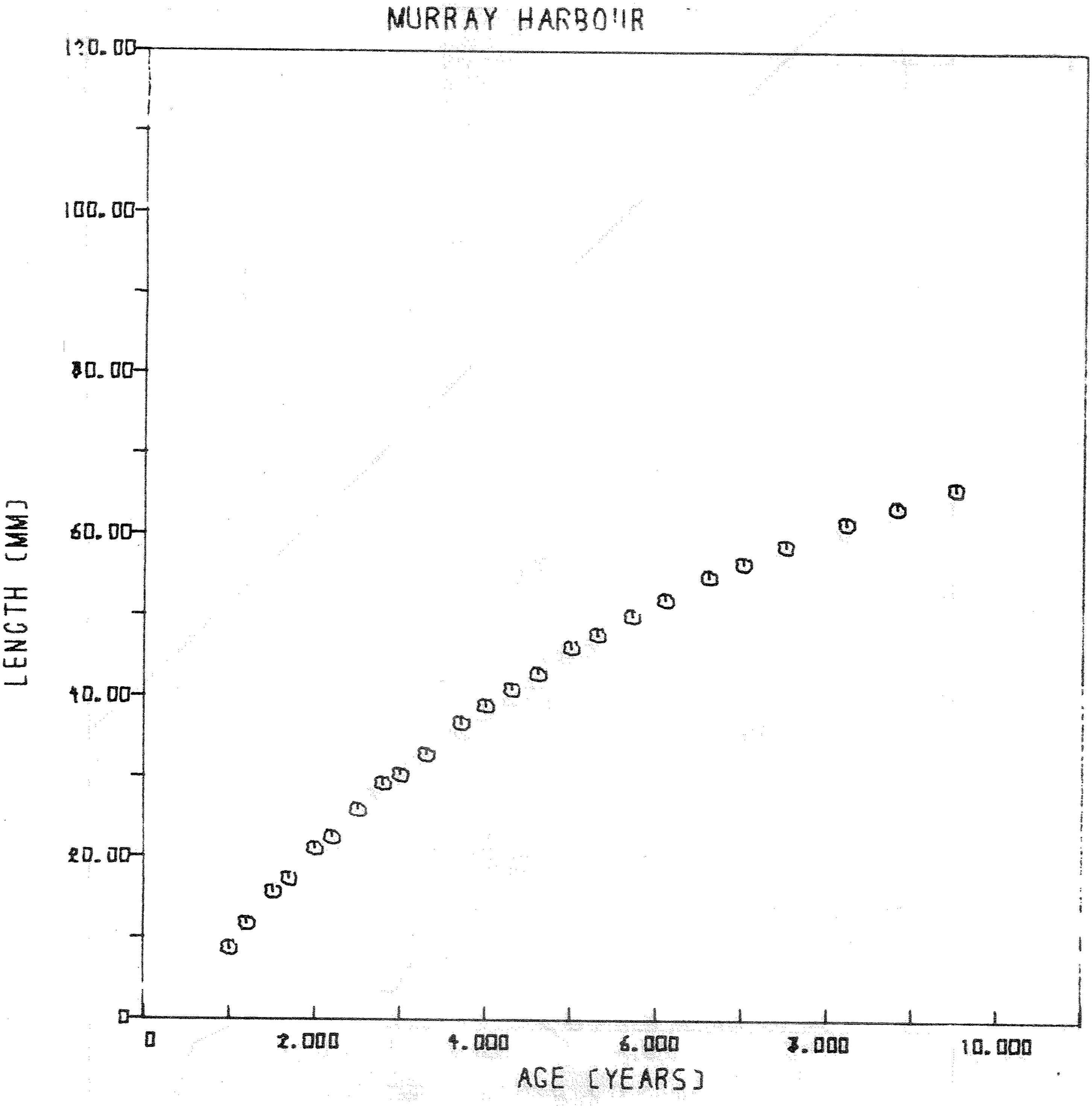


Figure 52. Von Bertalanffy growth curve for soft-shell clams sampled in the Murray Harbour area.

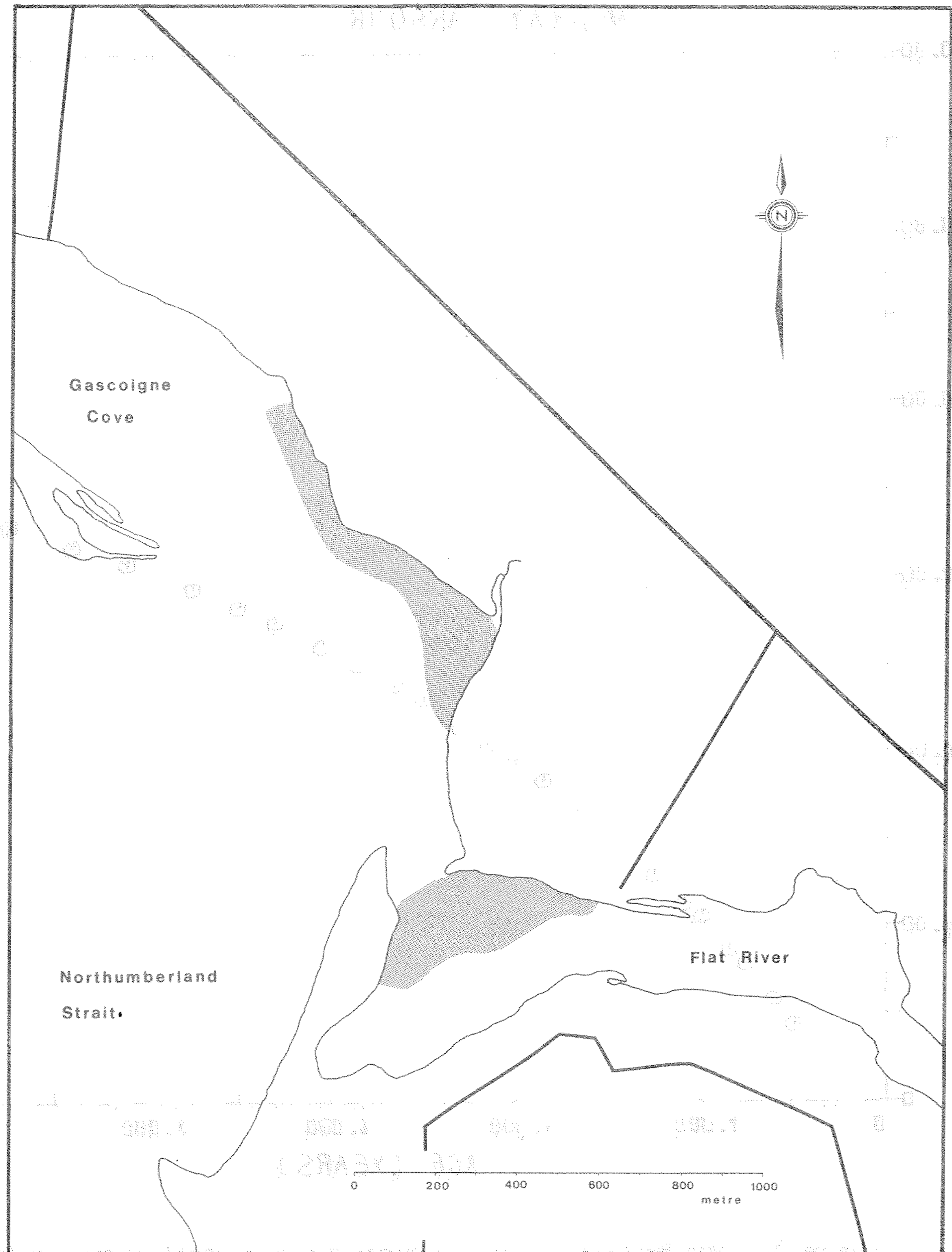


Figure 53. Soft-shell clam flats (stippled) at the mouth of Flat River and in Gascoigne Cove. For location reference, see Fig. 2.

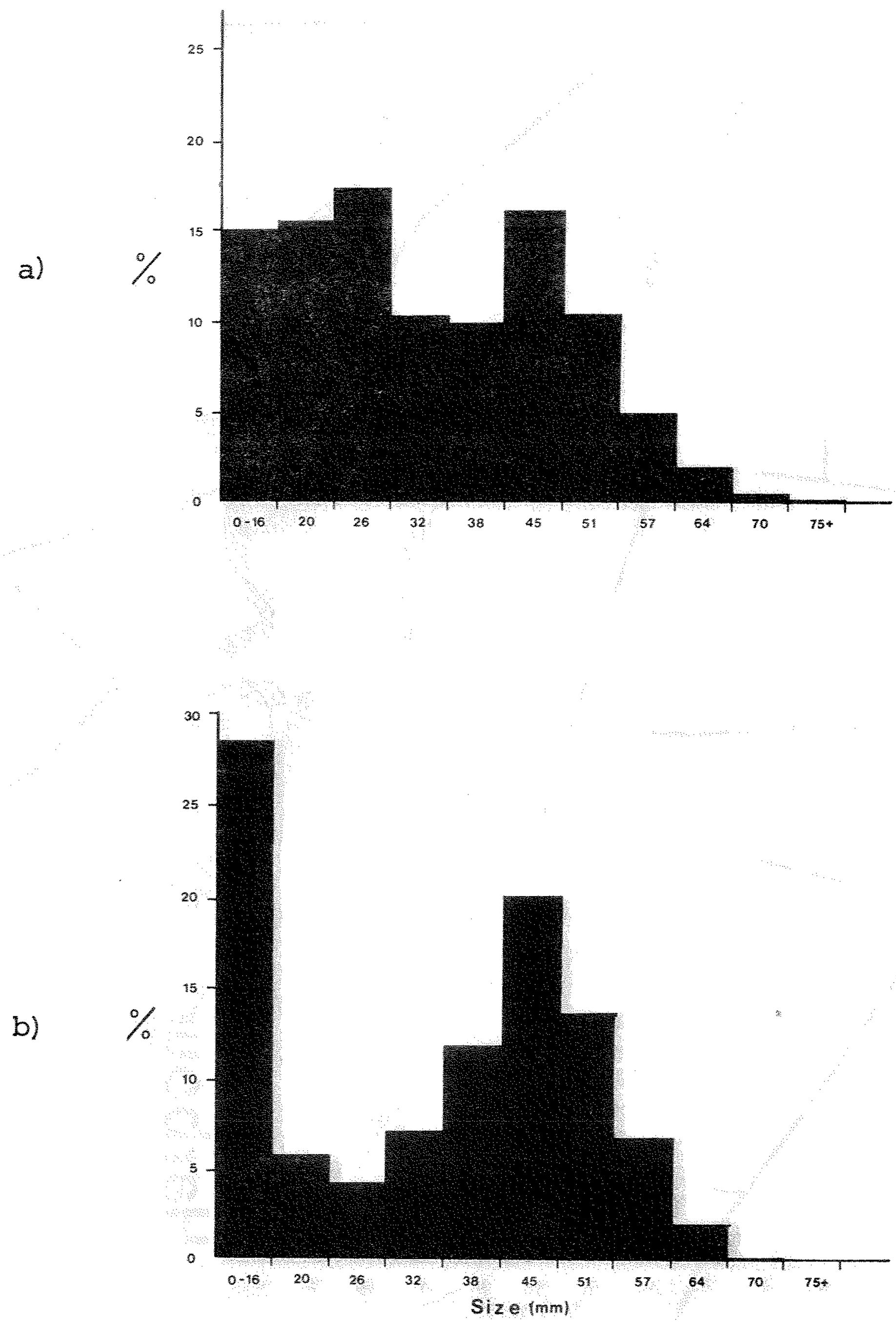


Figure 54. Size-frequency distribution for soft-shell clams collected a) at the mouth of Flat River, b) in Gascoigne Cove.

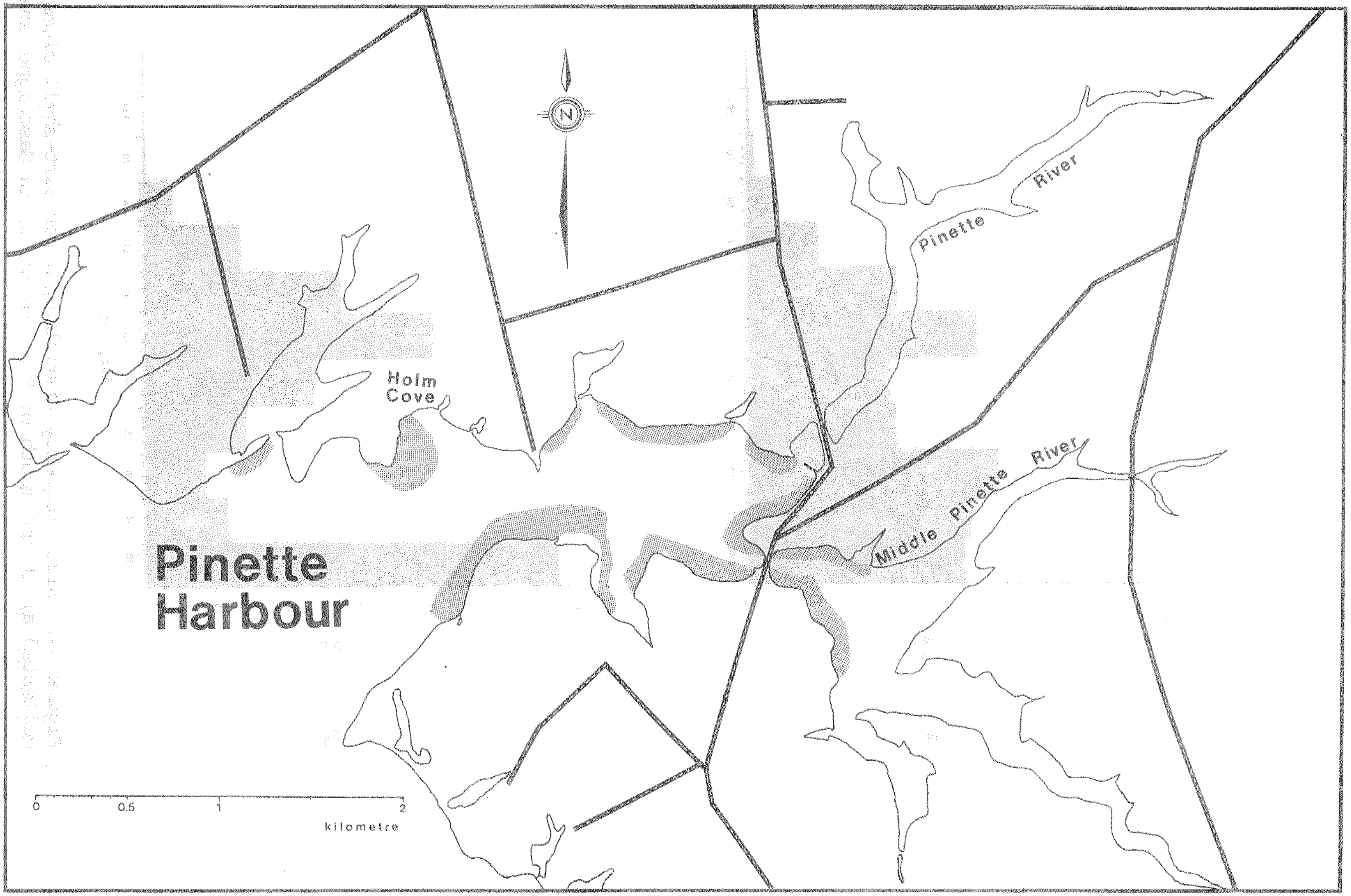


Figure 55. Soft-shell clam flats (stippled) surveyed in Pinette Harbour. For location reference, see Fig. 2.

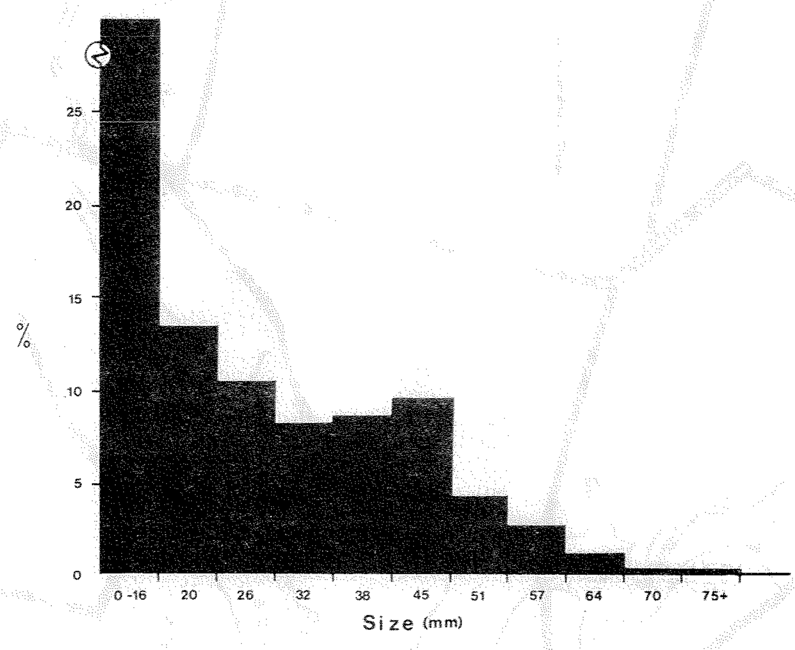


Figure 56. Size-frequency distribution for soft-shell clams from the Pinette Harbour area.

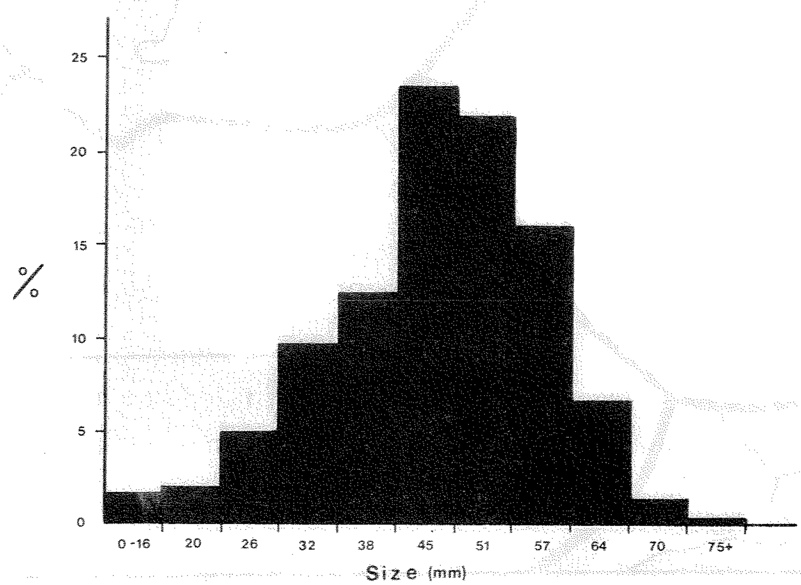


Figure 58. Size-frequency distribution for soft-shell clams from Clyde River.

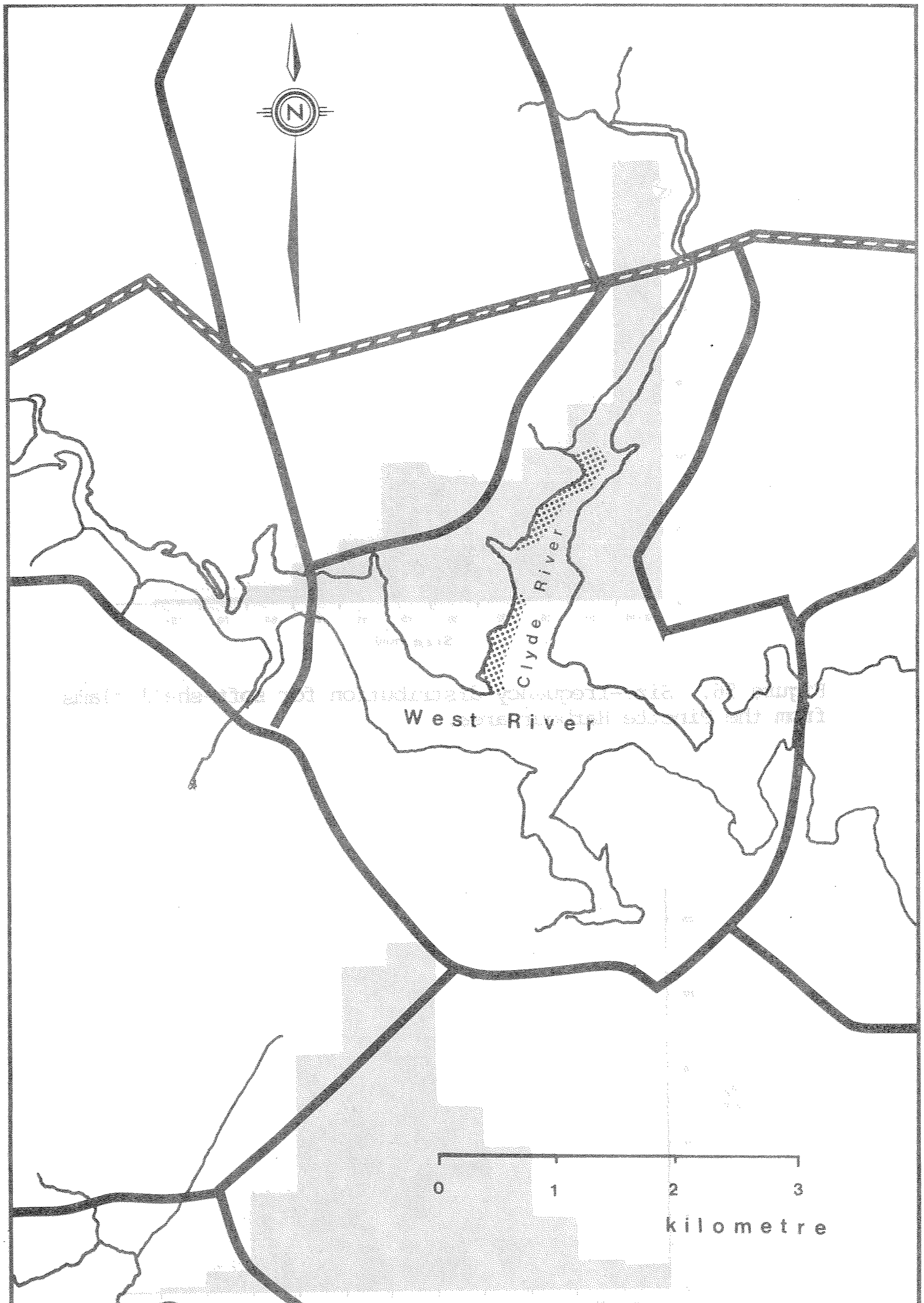


Figure 57. Soft-shell clam flats (stippled) surveyed in Clyde River. For location reference, see Fig. 2.