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"Effect of Incorporating Sigmoid Selection on
Optimum Mesh Size Estimation for the
Samar Sea Multispecies Trawl Fishery"

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EFFECT OF INCORPORATING SIGMOID SELECTION ON OPTIMUM MESH SIZE ESTIMATION FOR THE SAMAR SEA MULTISPECIES TRAWL FISHERY

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ABSTRACT

The evaluation of optimum mesh size for multispecies trawl fisheries relies primarily on the aggregation of individual yield-per-recruit response surfaces. The analytic model expression incorporated in these procedures assumes knife-edge selection - an assumption recently demonstrated to generate considerable bias in single species assessment of short-lived tropical fish species. The present study examines the effect of replacing the usual knife-edge selection assumption with empirically-based sigmoid selection in the evaluation of the optimum mesh size for the Samar Sea multispecies demersal trawl fishery. Relaxation of the knife-edge assumption in favor of sigmoid selection results in the increase of the optimum mesh size for the mix of 12 trawl-caught species considered in the study from 3.5 to 5.5 cm. In addition, sigmoid selection leads to other more conservative results or measures (e.g. lower optimum exploitation levels and catch rate expectations) than would otherwise have been obtained with knife-edge selection.

1. INTRODUCTION

The analytic or yield-per-recruit (YPR) model (Beverton and Holt, 1957; Ricker, 1958) represents one of the traditional approaches to the analysis of yield from exploited fish populations. Adopting the "additions and removals" theory of Baranov (1918), and incorporating the age structure of the population as an important element in determining harvestable yield, the model allows for the evaluation of the optimum levels of exploitation (e.g. fishing effort, f, fishing mortality, F, or exploitation rate, E) and age/size at first capture (tc/Lc) for a given fish stock. Conventionally applied to single species populations, the analytic model is commonly used in calculating yield on a per-recruit basis due to uncertainties in the determination of absolute recruitment (Gulland, 1979; 1983; Jones, 1979).

Several workers have proposed modifications to the original formulation presented by Beverton and Holt (1957) and Ricker (1958) (e.g. Jones, 1957; Paulik and Gales, 1964; Beverton and Holt, 1966; Andersen and Ursin, 1977). These works vary from attempts at more simplistic generalizations to complex incorporation of details in efforts at more properly depicting biological "reality" as it is in relation to harvestable yield. Of late, Pauly and Soriano (1986) demonstrated that the assumption of knife-edge selection conventionally made in YPR computations generates considerable bias, especially in the case of short-lived species. The bias generated not only affects the magnitude of the YPR, but more significantly, the location of the optimum in the exploitation level and age/size at capture response surface.

Most fisheries in the Southeast Asian region (for that matter, also other regions in both tropical and temperature areas) are multispecies in nature. Hence, what is generally of interest is the yield from the mix of species rather than that for a single component of the species mix. Several attempts at combining single species assessments are available in the literature for estimating the best mesh size (proportional to tc/Lc) and exploitation levels for multispecies stocks (e.g. Sainsbury, 1984; Silvestre, 1986a, Sinoda et al., 1979; Federizon et al., 1986). Majority of these works rely on the use of the yield-per-recruit model with the usual assumption of knife-edge selection. For instance, Silvestre (1986a) computed the biologically optimum mesh size for the Samar Sea demersal trawl fishery to be about 3.5 cm assuming knife edge selection and equal catchabilities for the 12 species included in his analysis. The present contribution examines the effect of incorporating sigmoid size selection in determining the optimum mesh size for the said fishery.

2. MATERIALS AND METHODS

The basic data for this study were collected in the Samar Sea (Fig. 1) during the course of a trawling survey from March 1979 to May 1980 and selection experiments in May 1982 conducted by the UPV College of Fisheries in collaboration with the German Agency for Technical Cooperation (GTZ). Details with respect to the Samar Sea demersal fishery and survey methodology are given in Armada et al. (1983). The catch rate, selection and length frequency data generated during the

survey had been analyzed in previous works for the following: 1) growth parameters (Woo, Loo, and K) of the von Bertalanffy equation (Silvestre, 1986b); 2) mortality coefficients (Z and M) of the exponential decay model (Silvestre, 1986b); 3) size selection parameters (Silvestre et al., 1986), and 4) relative recruitment (Silvestre, 1986a). The parameters estimated in the above studies were primarily used for the 12 species included in the analysis below. These 12 species (Table 1) account for about 50% of the total catch of fish and invertebrates taken during the entire course of the Samar Sea trawl survey.

The approach used here to evaluate the optimum mesh size (incorporating size selection) for the Samar Sea demersal trawl fishery follows the procedure described by Silvestre (1986a) with one major modification - the yield-per-recruit equation used was replaced by that presented by Pauly and Soriano (1986). This procedure involves the aggregation of individual YPR response surfaces of the 12 species included in the analysis. The aggregation procedure involves standardization along the 3 axes of the YPR response surface, namely: 1) the fishing effort/mortality/exploitation rate axis; 2) the age/length at first capture axis, and 3) the YPR axis. For purposes of this study, the aggregation was done using the expression:

$$Y'(Ms,F) = \sum_{j=1}^{n} [Y'/R(Ms,F]j \times Rj \times Wooj \qquad (1)$$

where Y' (Ms,F) is the value of the aggrgate yield index at the lattice points Ms,F of the yield response surface (Ms being the mesh size and F the fishing mortality rate); [Y'/R(Ms,F)]j is the relative YPR for species j at the lattice points Ms,F; Rj is the relative recruitment index for species j and is a measure of the relative significance of species j to aggregate yield; W_{ooj} is the asymptotic weight of species j, and n the number of species included in the aggregation procedure. The relative yield-per-recruit at the lattice points Ms,F for each species was calculated using the expression of Pauly and Soriano (1986),

$$Y'/R = \sum_{i=L_{min}}^{L_{oo}} P_i \left((Y'/R)_i \cdot G_{i-1} \right) - \left((Y'/R)_{i+1} \cdot G_i \right) \qquad (2)$$

in which (Y'/R)i and (Y'/R)i+1 refer to relative YPR as computed from the lower limit of length class i and i+1, respectively; Pi the probability of capture between Li and Li+1, and Gi is defined by

$$G_i = \prod_{j=1}^{i} rj \qquad (3)$$

where ri is a factor expressing the proportion of recruits of length Li which survive and grow to length Li+1, and is computed (for 0<E<1) from

$$r_i = \frac{(1-c_i)^{(M/K)(E/(1-E))P_i}}{(1-c_{i-1})^{(M/K)(E/(1-E))P_i}} \qquad (4)$$

where rLmin-1 = 1 and rLoo = 0. The (Y'/R)i and (Y'/R)i+1 in equation 2 is computed using the expression given by Beverton and Holt (1964), i.e.

$$\frac{Y'}{R} = E(1-c)^{M/K} \cdot \left[1 - \frac{3(1-c)}{1 + \frac{(1-E)}{(M/K)}} + \frac{3(1-c)^2}{1 + \frac{2(1-E)}{(M/K)}} - \frac{(1-c)^3}{1 + \frac{3(1-E)}{(M/K)}} \right] \qquad (5)$$

where E is the exploitation rate (= F/Z = F/(F+M); F and M, respectively, being the instantaneous rate of fishing and natural mortality), c is the ratio Lc/Loo (Lc being the length at first capture and Loo the asymptotic length), and K the growth coefficient of the von Bertalanffy equation.

The use of the above equations involve standardization along the 3 axes of the conventional YPR response surface, and requires: 1) determination of the relative catchabilities of the mix of species being considered; 2) rescaling of the Lc/c axis to a common entity, in this case mesh size (Ms), and 3) a measure of relative (in the absence of absoluce)

recruitment. With respect to the first requirement, the catchability coefficients (q's) were taken as equal and constant through the range of f. This is due to the lack of information by which differential fishing pressure could be examined. The assumption holds if trawlers (on the average) catch the species under consideration in equal proportion relative to their respective population sizes.

The second requirement was met by converting c to Lc, and subsequently to Ms using selection factors, S.F. (see Gulland, 1969) computed for each species, i.e.

$$c = Lc/Loo \tag{6}$$

$$Ms = Lc/S.F. \tag{7}$$

The S.F. vlaues were obtained either from selection experiments in the Samar Sea (Silvestre et al., 1986) or from the average of S.F. values for the species from other areas in the South China Sea (see selection studies cited in Silvestre, 1986a). The probabilities of capture at length (Pi's) for each species included in the analysis at a given mesh size were obtained as follows: (1) the lengths corresponding to 25%, 50% and 75% probability of retention (i.e. L25, L50 & L75), at a mesh size of 4.0 cm were obtained for each species (e.g. from Silvestre et al., 1986 and other selection studies cited in Silvestre, 1986a); (2) these were plotted in the lc vs Ms coordinate and projected backward to the origin to obtain linear expressions for L25, L50, and L75 as a function of mesh size; and (3) the Pi's were then subsequently computed

from the logistic that best describes L25, L50 and L75 at that mesh size. Fig. 2 gives a representation of this procedure for the specific case of N. nematophorus where the Pi's are obtained for a mesh size of 3.0 cm (marked B in the figure).

The third requirement was met by using relative recruitment indices. Sainsbury (1984) presents alternative procedures by means of which such indices could be estimated. In this study, the index of relative recruitment was computed from an expression that stems from the formulation of Ricker (1975) and Munro (1974; 1979), viz.

$$R' = c/f \times Ze^{z(t_{r1} - t_{r2})} e^{M(t_{r2} - t_o)} \qquad (8)$$

where c/f is the mean catch per effort (number/hour) for the species during the Samar Sea trawl survey; t_{ri} the relative age at first capture to the survey gear (Ms = 4.0 cm); t_r2 the relative age at first capture to the 2.0 cm mesh size common among trawlers in the Samar Sea; and the rest as previously defined. Silvestre (1986a) used this expression to estimate R' for the species included in this analysis.

3. RESULTS

The parameter values utilized in the calculation of aggregate yield indices for this study are summarized in Table 1. The parameters of the von Bertalanffy equation (Woo, Loo and K) and natural mortality (M) of the exponential decay model are given in columns 2 to 5. It appears that the species herein considered are characterized by relatively high

growth rates and natural mortality indicating high turnover rates. The relative recruitment indices computed by Silvestre (1986a) for each of the 12 species are given in column 6. These indicate a trend of higher R' among smaller-sized species (e.g. L. bindus with R' = 3306) and vice versa (e.g. N. japonicus with R' = 1). The SF values given in the last column of Table 1 come primarily (i.e. 7 of the 12 estimates listed) from covered cod end selection experiments conducted in the Samar Sea (Silvestre et al., 1986). The rest were taken from the average of SF's for the species from other areas in the South China Sea (Jones, 1976; Saeger et al., 1976; SEAFDEC, 1978; Eiamsaard, 1979; Meemeskul, 1979; Sinoda et al., 1979). The S.F. values varied between 1.58 for L. bindus to 2.45 for S. leptolepis. Note that the lower the value of SF for a given species implies a shorter length at first capture (L50) for the species to a given mesh size of the trawl cod end.

The length-specific probabilities of capture at 4.0 cm mesh size for each of the 12 species are given in Appendix I. These were utilized in estimating the length-specific probabilities of capture for the species at other mesh sizes as explained in the previous section. The Pi's at Ms=4.0 cm for seven species (L. bindus, P. longimanus, S. undosquamis, V. sulphureus, N. nematophrous, N. japonicus and L. leuciscus) were obtained from the Samar Sea selection experiments (Silvestre et al, 1986). The rest were estimated as follows: (1) for L. splendens and L. equulus, a logistic curve drawn through L25, L50, and L75 estimated from the S.F. value for the species and the selection range of L. bindus were used to estimate Pi's at Ms = 4.0 cm; (2) for U. moluccensis, the same procedure as in (1) was followed except that the selection range of U.

sulphureus was used; and (3) for P. tayenus and S. leptolepis, the same procedure as in (1) was followed except that the selection ranges used stemmed from the resultant curves for the species given by Corpuz et al. (1985).

The aggregate yield response surface for the mix of 12 species considered in this study are given in Tables 2 and 3 for computations involving knife-edge selection and length-specific probabilities of capture, respectively. These are given through the range of F (0.25 to 5.00 at 0.25 invervals) versus Ms (1.5 cm to 6.0 cm at 0.5 cm intervals). Values giving maximum Y' at a given F are underlined while those giving maximum Y' at a given Ms are indicated by an asterisk for the range and step values of F and Ms considered. The response surfaces are illustrated graphically in Fig. 3 with mesh sizes ranging from 2.0 cm to the mesh size that gives maximum aggregate yield at very high exploitation levels (F = 4.0), at 0.5 cm mesh size increments. It is clear that the mesh size of 2.0 cm that is used by trawlers in the Samar Sea is inappropriate and counter-productive for the mix of species under consideration, whether the computations involve knife-edge selection or length-specific probabilities of capture. Aside from this generality, however, the incorporation of length-specific probabilities of capture leads to considerable changes in the results of the analysis - and consequent advise - toward more conservative figures. With the incorporation of probabilities of capture, the Y' values at given Ms become more "humped" and the F levels that maximize Y' at a given Ms are lower. The magnitude of the Y' values have also decreased together with the measure of overall "MSY" for the species mix (i.e. from about 5100

to 4200 or an 18% decrease). The biologically optimum mesh size for the species mix has also increased considerably from about 3.5 cm to about 5.5 cm, or approximately a 60% increase. Figure 4 illustrates the disparity in optimum mesh size results when selection ogives rather than knife-edge selection is incorporated in the computations. The disparity increases with increasing exploitation level. Moreover, the figure reflects the considerable upward shift in the eumetric fishing line B-B' for the multispecies mix.

4. DISCUSSION

The assumption of knife-edge selection has been demonstrated to result in considerable bias in the case of single species yield-per-recruit analysis (Pauly and Soriano, 1986). The bias generated by such assumption, hence, is expected to be far more serious (i.e. compounded) in studies involving combined/aggregate single species assessments. The present study illustrates the disparity in results generated in optimum mesh size analysis for multispecies trawl fisheries when knife-edge selection is assumed. The optimum mesh size for the Samar Sea demersal trawl fishery has been shown to increase from 3.5-5.5 cm when length-specific probabilities of capture are incorporated in the computations. Overall, doing away with the knife-edge assumption leads to more conservative figures/advise (e.g. higher optimum Ms, lower exploitation levels, lower catch rate expectations) than otherwise would have been obtained with such an assumption. It should also be noted that the 5.5 cm optimum mesh size thus obtained is more consistent with those recommended for other areas in the South China Sea involving

basically similar species assemblages (e.g. Jones, 1976; Meemeskul, 1979; Sinoda et al., 1979).

The aggregation/optimization procedure presented above involves solely the maximization of biological yield. A final evaluation of the optimum mesh size for the Samar Sea demersal trawl fisheries would have to incorporate: (1) the rest of the other species being exploited or vulnerable to the trawl gear, and; (2) measures of socioeconomic desirability (e.g. prices) of species comprising the catch. The standardizations employed along the three axes of the conventional YPR response surface need further empirical attention, especially the elaboration of differential fishing pressure exerted on the species mix by the trawl fishery. In addition, the limitations of the conventional analytic approach to tropical multispecies assessment are widely understood. Utilization of the results above must be made in the light of the assumptions and simplifications that the models and methods utilized entail.

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Table 1: Growth, mortality, recruitment and selection parameters utilized for the computation of the optimum multispecies mesh size for the Samar Sea.

Species	W_{oo} a) (g)	L_{oo} b) (cm)	K b) (yr)	M c) (yr)	R' d)	SF
Leiognathus bindus	44	12.1	0.98	2.21	3306	1.58 e)
Pentaprion longimanus	72	14.0	0.70	1.69	180	2.08 e)
Saurida undosquamis	323	33.3	0.30	0.77	6	2.40 e)
Upeneus sulphureus	146	18.8	0.55	1.33	148	2.34 e)
Nemipterus nematophorus	295	25.5	0.55	1.05	7	1.99 e)
Leiognathus splendens	63	13.1	0.90	2.02	128	1.68 f)
Leiognathus equulus	380	24.0	0.56	1.26	2	1.59 f)
Priacanthus tayenus	293	29.0	0.65	1.34	4	1.94 f)
Selaroides leptolepis	158	19.9	0.53	1.29	14	2.45 f)
Nemipterus japonicus	340	26.6	0.45	1.08	1	2.26 e)
Upeneus moluccencis	276	24.1	0.65	1.43	14	2.37 f)
Leiognathus leuciscus	39	13.7	0.93	2.12	93	1.70 e)

a) from Silvestre (1986a) using the length-weight relationship given by Villoso (1981).

b) from Silvestre (1986b) estimated using ELEFAN I.

c) from Silvestre (1986b) using the empirical equation of Pauly (1980).

d) from Silvestre (1986a) using the expression $R' = c/f \times z \times e^{z(tr1-tr2)} \times e^{M(tr2-t_o)}$

e) from Silvestre et al.,(1986) estimated via selection experiments in the Samar Sea.

f) average of selection factor values for the species from other areas in the South China Sea (Jones,1976; Saeger et al., 1976; SEAFDEC, 1978; Eiamsaard, 1979; Meemeskul, 1979, Sinoda et al., 1979).

Table 2. Aggregate yield index, Y'(X10), response surface for 12 trawl-caught species from the Samar Sea assuming knife-edge selection. (values underlined: maximum Y' at given F. Values with asterisk : Maximum Y' at given mesh size)

Fishing Mortality (Y^{-1})	Mesh Size (cm)									
	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
0.25	160	160	159	154	144	131	114	94	72	50
0.50	250	255	257	253	241	221	194	161	124	86
0.75	300	313	320	319	308	286	253	211	163	114
1.00	328	348	361	365	356	334	297	249	193	135
1.25	342	368	388	397	392	370	332	280	218	153
1.50	347*	380	406	420	418	398	360	304	239	167
2.00	343	387*	424	448	454	438	400	342	268	189
2.50	330	384	430*	462	475	464	428	368	291	205
3.00	315	375	429	469	488	482	448	388	308	218
3.50	299	365	426	472	497	494	462	402	321	228
4.00	284	354	420	472*	502	503	474	414	331	236
4.50	270	344	414	471	505	510	482	424	340	242
5.00	258	335	409	469	507*	515	490	431	347	248

Table 3. Aggregate Yield Index, Y'(X10), Response Surface for 12 trawl-caught species from the Samar Sea incorporating sigmoid size selection (values underlined: maximum Y' at given F. Values with asterisk : maximum Y' at given mesh sizes).

Fishing Mortality (Y^{-1})	Mesh Size (cm) 1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
0.25	140	142	142	143	142	141	138	135	130	123
0.50	223	227	231	234	235	236	233	229	222	212
0.75	267	276	283	290	294	297	296	293	285	275
1.00	289	301	312	323	330	336	338	336	329	319
1.25	297*	313	327	341	352	360	365	365	360	349
1.50	296	315*	333*	350	364	375	382	384	380	371
2.00	282	306	329	352*	371*	387*	399	405	404	396
2.50	261	289	315	343	366	387	402*	411*	413	407
3.00	240	270	299	330	356	381	398*	411	414*	410*
3.50	219	251	283	316	345	372	392	406	412	409
4.00	201	234	267	302	333	362	384	400	407	406
4.50	184	218	253	289	321	352	375	393	401	401
5.00	170	205	239	277	310	342	366	385	394	395

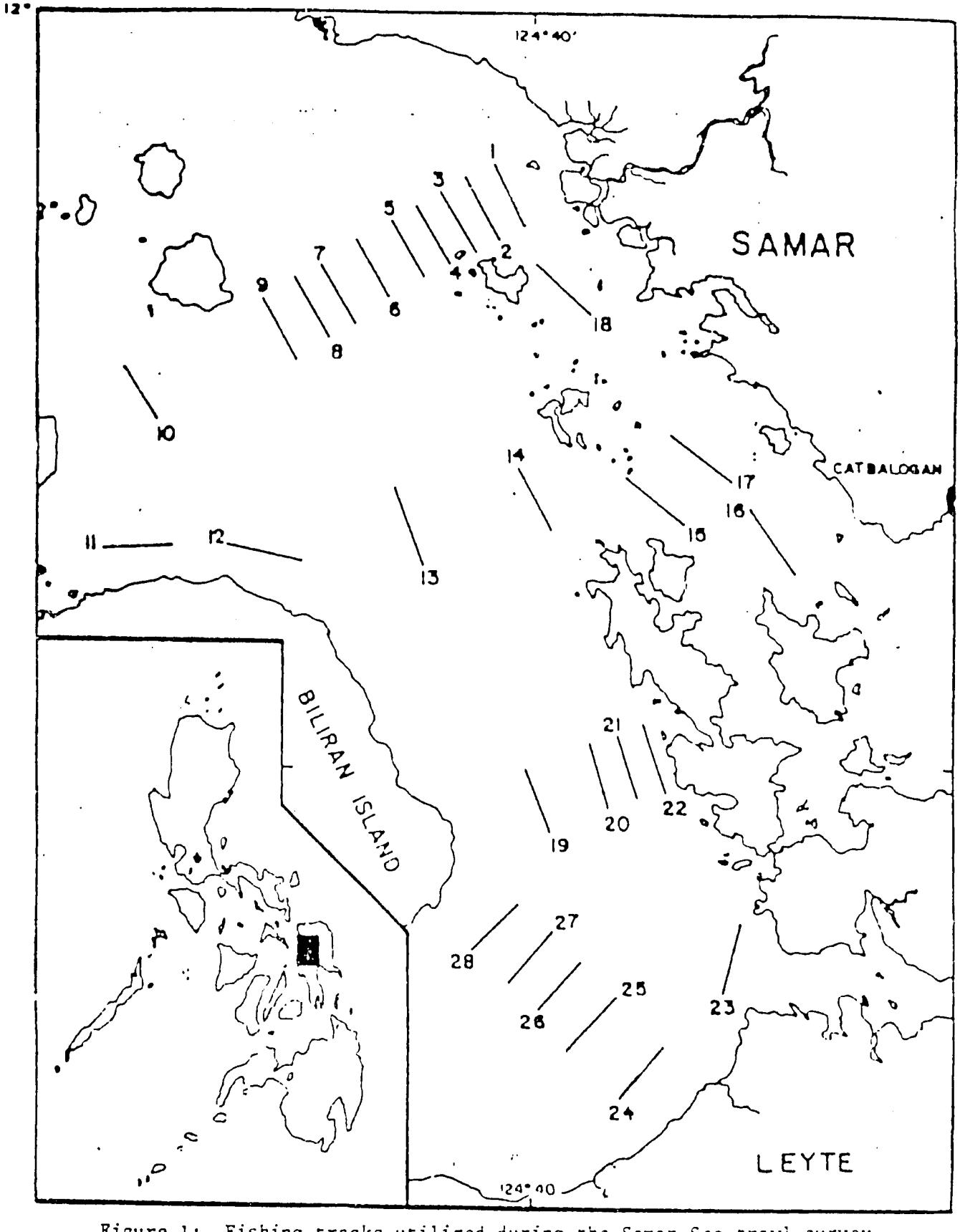

Figure 1: Fishing tracks utilized during the Samar Sea trawl survey. Parameters used in this study stem from data collected in the area from March 1979 to May 1980, as well as in May 1982.

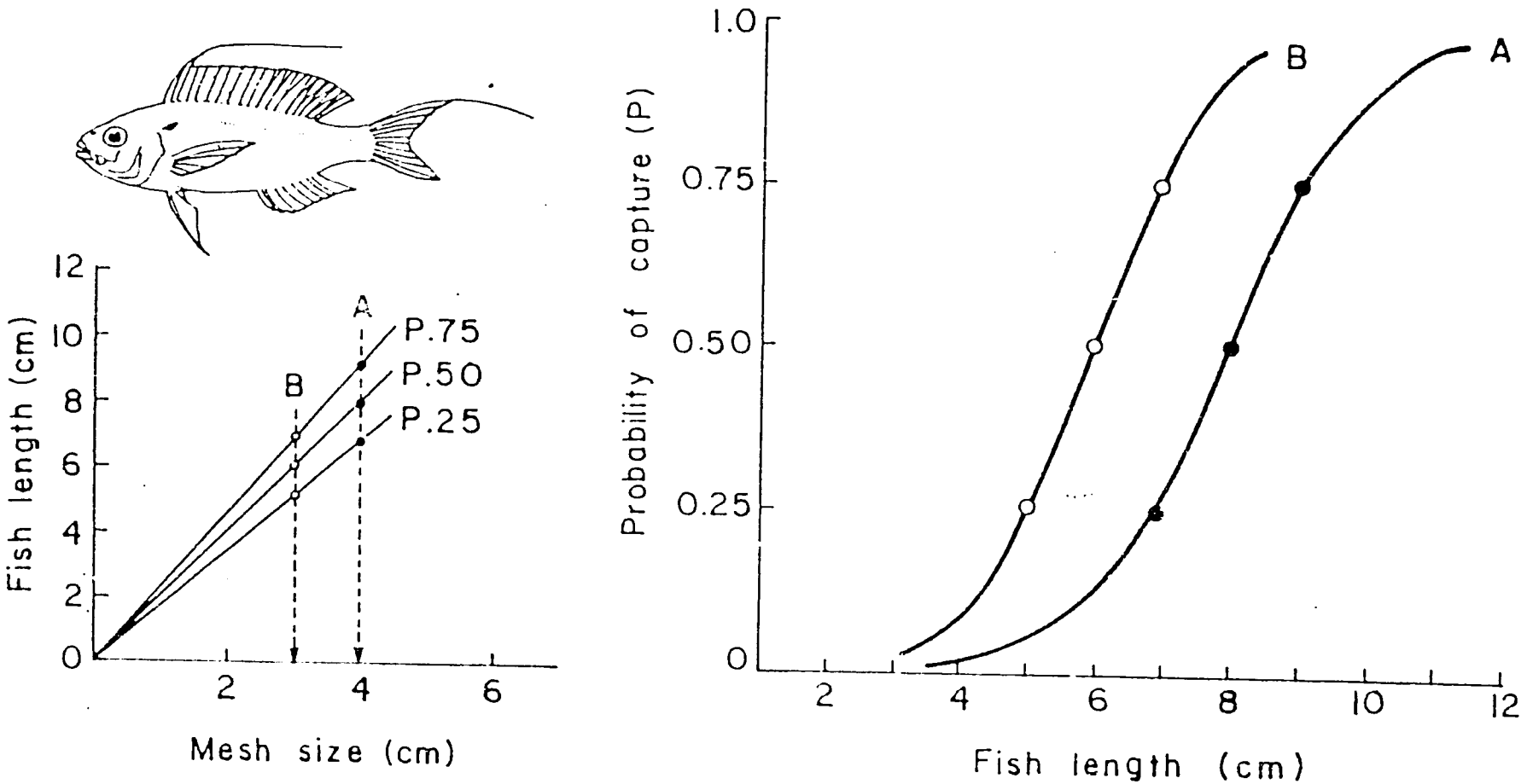

Figure 2. Representation of the method utilized for estimating probabilities of capture as a function of any mesh size (e.g. mesh size in left panel) based on an empirical selection ogive (A in right panel) and constant slopes (i.e. probabilities) to link fish length and mesh size (left panel). Based on selection data for *Nemipterus nematophorus* from Silvestre *et.al.* (1986).

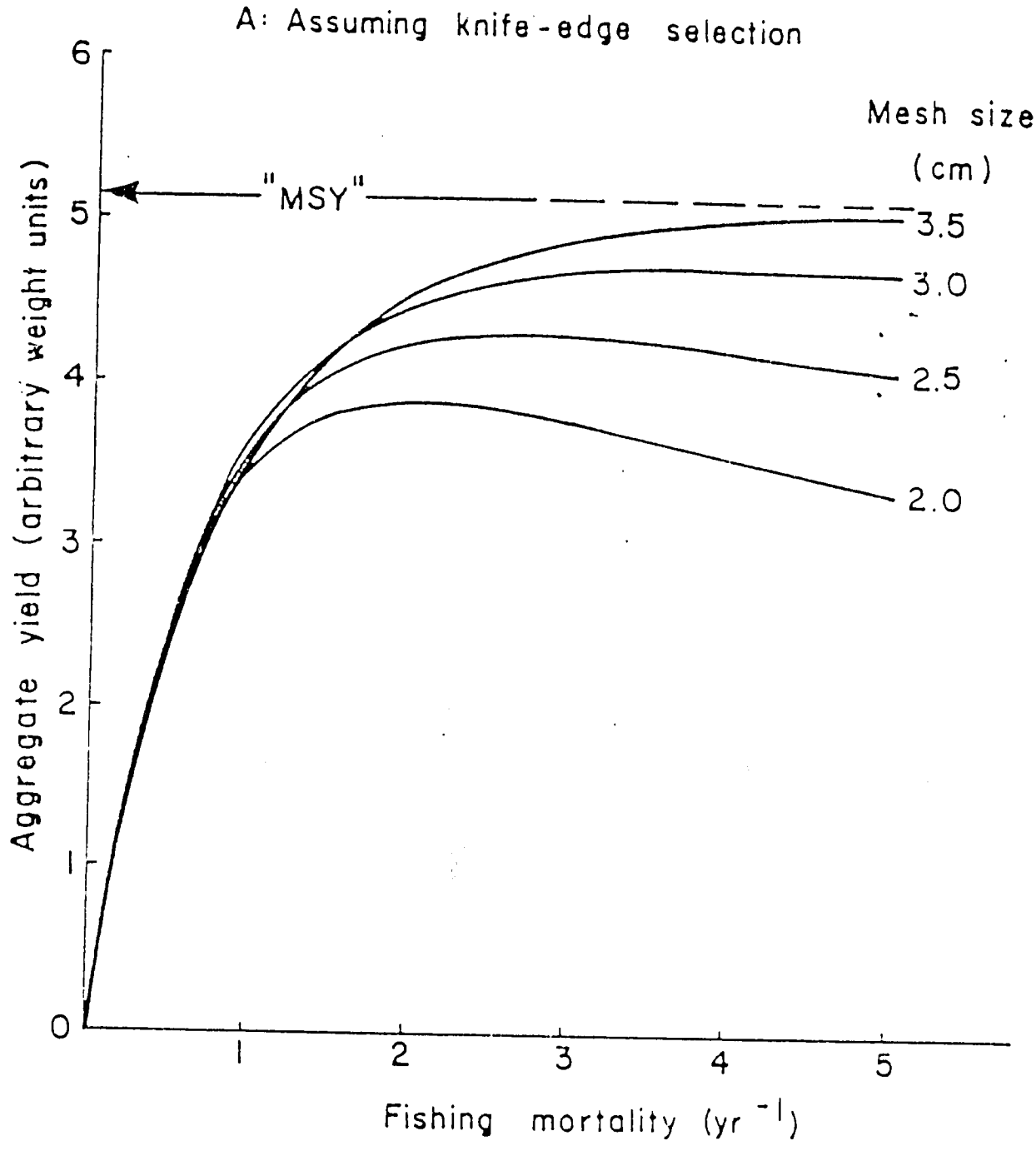

Figure 3. Aggregate yield index (Y') versus fishing mortality (F) for the 12 trawl-caught species from the Samar Sea with computations involving knife-edge selection (A) and sigmoid selection (B). Mesh sizes range from 2.0 cm (common among trawlers in the Samar Sea) to the size that gives maximum Y' at high exploitation levels (e.g. F about 4.0) at 0.5 mesh size intervals.

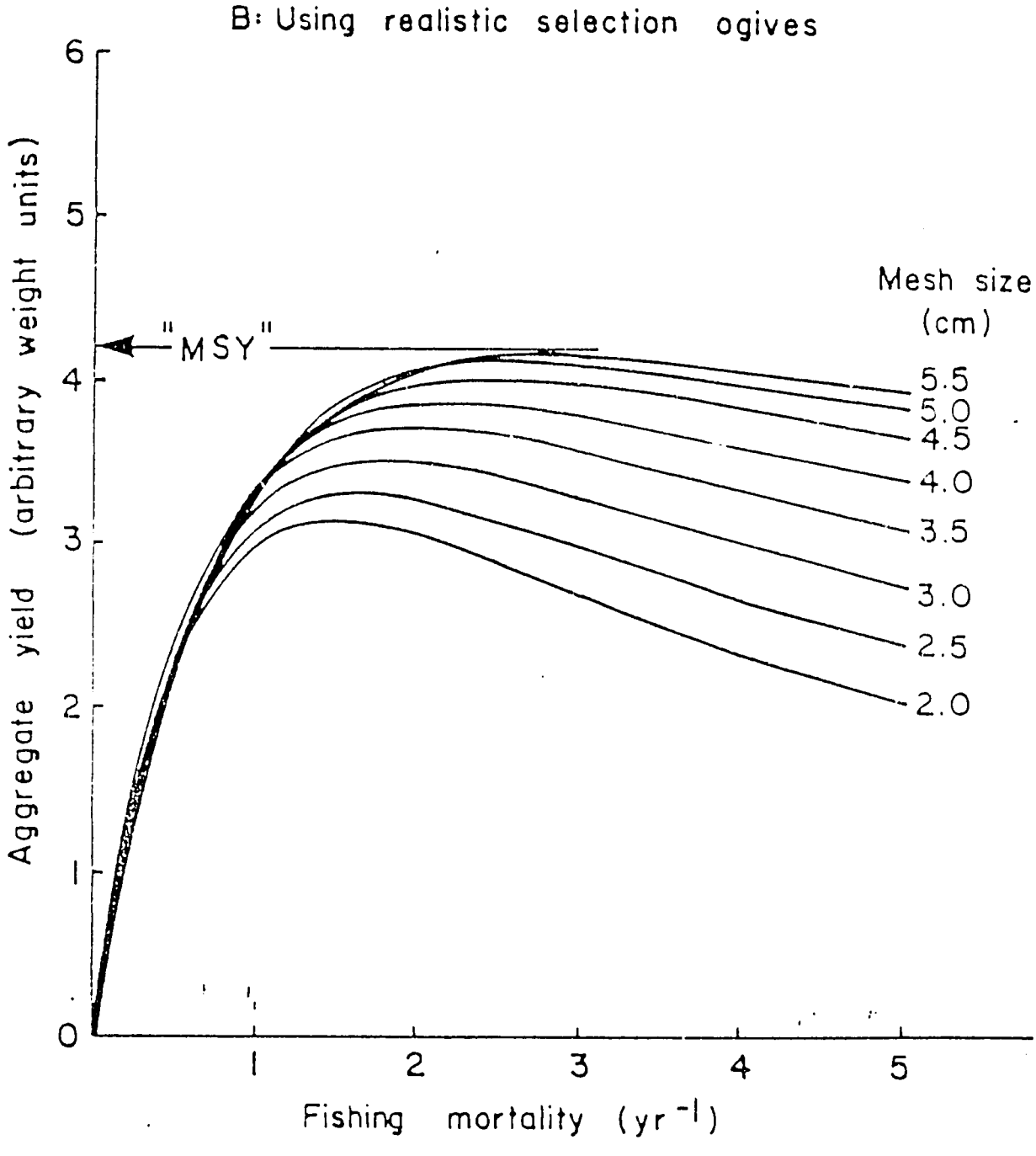

Figure 3. Cont'd.

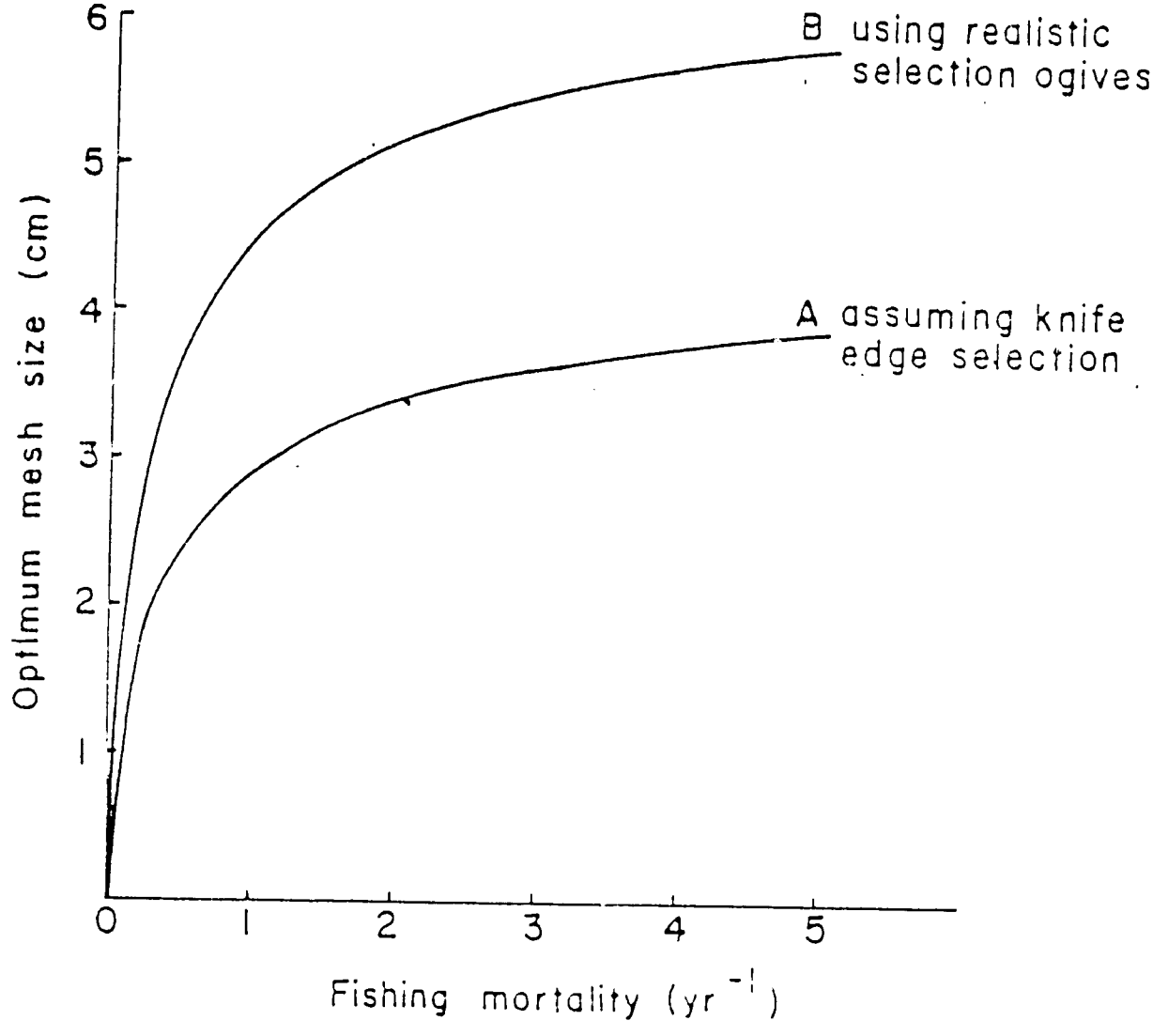

Figure 4. Optimum mesh size (Ms giving maximum Y' at given F) through the range of F for the mix of 12 trawl-caught species from the Samar Sea assuming knife-edge selection (curve A) and incorporating sigmoid selection (curve B).

APPENDIX I: Probabilities of capture for 12 species at M_s =

Species	Length (cm)	Probability
L. bindus	0 - 4.4	0
	4.5 - 4.9	0.01
	5.0 - 5.4	0.05
	5.5 - 5.9	0.17
	6.0 - 6.4	0.45
	6.5 - 6.9	0.77
	7.0 - 7.4	0.93
	7.5 - 7.9	0.98
	8.0 - 12.1	1.0
P. longimanus	0 - 5.9	0
	6 - 6.9	0.02
	7 - 7.9	0.13
	8 - 8.9	0.71
	9 - 9.9	0.97
	10 - 10.9	1.0
	11 - 14.0	1.0
S. undosquamis	0 - 4.9	0
	5 - 5.9	0.01
	6 - 6.9	0.03
	7 - 7.9	0.09
	8 - 8.9	0.23
	9 - 9.9	0.47
	10 - 10.9	0.73
	11 - 11.9	0.89
	12 - 12.9	0.96
	13 - 13.9	0.99
	14 - 33.3	1.0
U. sulphureus	0 - 4.9	0
	5 - 5.9	0.01
	6 - 6.9	0.03
	7 - 7.9	0.10
	8 - 8.9	0.27
	9 - 9.9	0.54
	10 - 10.9	0.79
	11 - 11.9	0.93
	12 - 12.9	0.98
	13 - 13.9	0.99
	14 - 18.8	1.0

N. nematophorus	0 - 2.9	0
	3 - 3.9	0.01
	4 - 4.9	0.03
	5 - 5.9	0.08
	6 - 6.9	0.19
	7 - 7.9	0.39
	8 - 8.9	0.63
	9 - 9.9	0.82
	10 - 10.9	0.93
	11 - 11.9	0.97
	12 - 12.9	0.99
	13 - 25.5	1.0
L. splendens	0 - 4.9	0
	5 - 5.4	0.02
	5.5 - 5.9	0.07
	6.0 - 6.4	0.22
	6.5 - 6.9	0.54
	7.0 - 7.4	0.82
	7.5 - 7.9	0.95
	8.0 - 8.4	0.99
	8.5 - 13.1	1.0
L. equulus	0 - 4.4	0
	4.5 - 4.9	0.01
	5.0 - 5.4	0.04
	5.5 - 5.9	0.14
	6.0 - 6.4	0.40
	6.5 - 6.9	0.72
	7.0 - 7.4	0.91
	7.5 - 7.9	0.98
	8.0 - 8.4	0.99
	8.5 - 24.0	1.00
P. tayenus	0 - 1.9	0
	2.0 - 2.9	0.01
	3.0 - 3.9	0.02
	4.0 - 4.9	0.05
	5.0 - 5.9	0.11
	6.0 - 6.9	0.23
	7.0 - 7.9	0.43
	8.0 - 8.9	0.66
	9.0 - 9.9	0.83
	10.0 - 10.9	0.92
	11.0 - 11.9	0.97
	12.0 - 12.9	0.99
	13.0 - 29.0	1.00

S. leptolepis	0 - 7.9	0
	8 - 8.9	0.05
	9 - 9.9	0.34
	10 - 10.9	0.82
	11 - 11.9	0.98
	12 - 12.9	1.0
	13 - 19.9	1.0
N. japonicus	0 - 4.9	0
	5 - 5.9	0.01
	6 - 6.9	0.04
	7 - 7.9	0.13
	8 - 8.9	0.34
	9 - 9.9	0.63
	10 - 10.9	0.85
	11 - 11.9	0.95
	12 - 12.9	0.98
	13 - 26.6	1.0
U. moluccensis	0 - 6.9	0
	7 - 7.9	0.01
	8 - 8.9	0.02
	9 - 9.9	0.07
	10 - 10.9	0.19
	11 - 11.9	0.42
	12 - 12.9	0.70
	13 - 13.9	0.88
	14 - 14.9	0.96
	15 - 15.9	0.99
	16 - 24.1	1.0
L. leuciscus	0 - 3.4	0
	3.5 - 3.9	0.01
	4.0 - 4.4	0.02
	4.5 - 4.9	0.04
	5.0 - 5.4	0.09
	5.5 - 5.9	0.17
	6.0 - 6.4	0.30
	6.5 - 6.9	0.48
	7.0 - 7.4	0.67
	7.5 - 7.9	0.81
	8.0 - 8.4	0.90
	8.5 - 8.9	0.95
	9.0 - 9.4	0.98
	9.5 - 9.9	0.99
	10.0 - 13.7	1.0