GEAR SELECTIVITY

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Most of the fishing gears are selective for certain length range of fish thus excluding very small and very big fish. This property of fishing gears is termed as gear selectivity. Thompson and Ben-Yami (1984) considered selectivity as the capacity of any method of gear type to capture certain fractions or sections of the fish population whether grouped by species, age, size or behaviour and to exclude others. Gear selectivity needs to be considered when we go for estimation of size composition of fish. The ultimate aim of studies on size selection is to suggest suitable mesh sizes to catch fish of either economically optimum size or an optimum size for the judicial exploitation of the stock. It is an important tool for fisheries managers for regulating the minimum mesh sizes of fishing fleet by determining the minimum sizes of the target species in certain fisheries. Mesh sizes are regulated to conserve the spawning stock and to increase the long term sustainable yield. Estimation of total mortality and prediction of future yield using prediction models etc. will be affected by selectivity of gears.

It is well known that the complete length/age ranges of fish and shell fish are not under full exploitation. Trawl gears are selective for larger sizes of length while gillnets are selective for an intermediate length range; the smaller ones escape through the mesh and very large ones are not gilled. This property of fishing gear is called gear selectivity with regard to size selection. According to Lagler (1968), the selectivity of a gear may be defined by a curve giving for each size of fish the proportion of the total population of that size which is caught and retained by a unit operation of the gear. This leads to the definition of selectivity as the proportionality constant s_{ij} in the equation for catch per unit operation of a gear for fish of length j by mesh size i given by

$$c_{ij} = s_{ij} N_j$$

Selectivity of trawl gears

The fine meshed end of the net where the catch is collected is known as codent. The mesh size of the codent determines the gear selectivity of trawl gear. By covering the codent with a larger bag with very fine meshes we can determine the amount and sizes of fish that escapes through the codent meshes. Selectivity of the gear can then be determined by comparing the sizes of the fish in the codent with those of the fish in the cover. This experimental method is known as "covered codent method".

Using data from such experiments on numbers in codent and numbers in cover for different length classes a logistic curve given in the following form is fitted after working out the fraction retained.

$$y_i = \frac{1}{1+\exp(a-bx_i)}$$

Here y_i is the proportion of fish retained in the codent for the i^{th} length class and x_i is the mid-length of the i^{th}class. The parameters a and b are obtained through a regression analysis using the expression

$$\ln\left(\frac{1}{y_i}-1\right) = a - b\,x_i$$

Lengths corresponding to 25%, 50% and 75% retention are then obtained using the estimated values of a and b as

$$L_{25\%} = \frac{a-\ln(3)}{b}$$

$$L_{50\%} = \frac{a}{b}$$

$$L_{75\%} = \frac{a+\ln(3)}{b}$$

The length range from $L_{25\%}$ to $L_{50\%}$ which is symmetrical about $L_{50\%}$ is called as the selection range. As the probability that a fish will escape through a mesh depends on its shape and in particular on its body depth compared to the mesh size it is assumed that the body depth at which 50% of the fish are retained is proportional to the mesh size. That is

$D_{50\%}$= *A (mesh size)*

where A is a constant. As body depth is proportional to body length it implies that similar expression holds for length of the fish also.

$L_{50\%}$= *SF (mesh size)*

The constant SF is known as the selection factor.

Example:

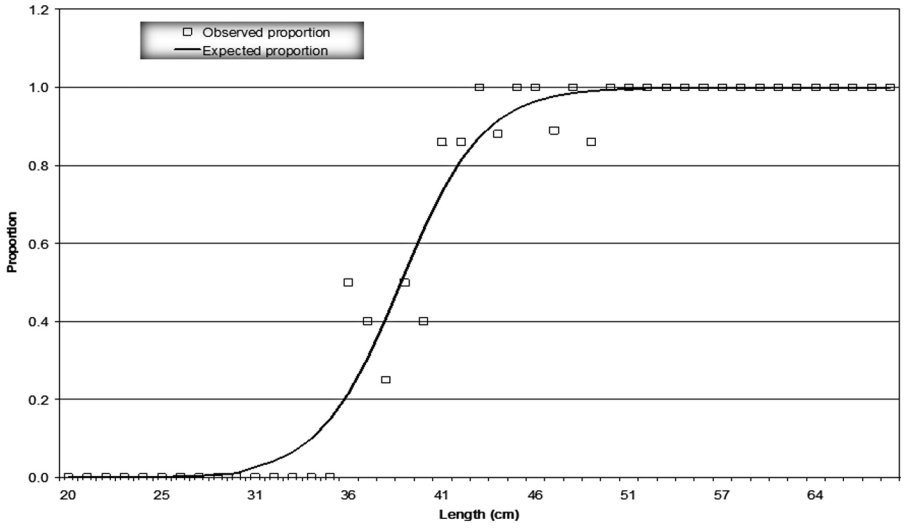
The following data is from an experiment that deals with threadfin breams (Nemipterus japonicus) that are caught with a trawl net with codent mesh size 4 cm and a cover of much small meshes.

Length Interval	Number in Codent	Number in Cover	Total Number	Sl-obs fraction retained	ln(1/Sl-1) (y)	Mid length (x)	Sl-est fraction retained
9-10	0	1	1	0.000			
10-11	1	6	7	0.143	1.792	10.5	0.129
11-12	2	7	9	0.222	1.253	11.5	0.232
12-13	2	4	6	0.333	0.693	12.5	0.383
13-14	7	5	12	0.583	-0.336	13.5	0.559
14-15	30	13	43	0.698	-0.836	14.5	0.722
15-16	61	8	69	0.884	-2.031	15.5	0.842
16-17	27	3	30	0.900	-2.197	16.5	0.916
17-18	7	0	7	1.000		17.5	0.957
18-19	4	1	5	0.800		18.5	0.979

Regression analysis done with x on y gave the following results

Summary Output					
Regression Statistics					
Multiple R	0.991298				
R Square	0.982672				
Adjusted R Square	0.979206				
Standard Error	0.225186				
Observations	7				
ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	14.37835	14.37835	283.5482	1.35E-05
Residual	5	0.253543	0.050709		
Total	6	14.63189			
	Coefficients	*Standard Errort Stat*		*P-value*	*Lower 95%*
Intercept	9.436398	0.580778	16.24786	1.61E-05	7.94346
X Variable 1	-0.7166	0.042556	-16.8389	1.35E-05	-0.82599

The gear selection ogive for trawl net with 4cm codent mesh size is given below.



Estimates of parameters of the logistic curve are a = 9.436398 and b = -0.7166. The lengths at which the fish are retained 25%, 50% and 75% are calculated as

L25%	11.6352
L50%	13.1683
L75%	14.7014

$L_{50\%}$ = *SF (mesh size)*

13.1683 = SF X 4

SF = 3.292

That is selection factor for the trawl net used with mesh size 4 is 3.292. These are useful for prediction of the effects of changes of mesh size using the Thompson and Bell method.