CENTRAL FILE

AN ANALYSIS OF MATURITY OBSERVATIONS OF 12 GROUNDFISH SPECIES COLLECTED FROM CAPE HATTERAS, NORTH CAROLINA TO NOVA SCOTIA IN 1977

by

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INTRODUCTION

The relationship between spawning stock and recruitment is part of classical fisheries biology and represents efforts to explain the natural fluctuations in stock size and year class strength. Though stock sizes have been estimated for various species for a number of years, the biological parameters to determine spawning stock size and reproduction potential have not been available. This report represents an initial attempt to make available size at maturity of groundfish species on a routine basis.

METHODS

Maturity information was collected during three National Marine Fisheries Service bottom-trawl surveys from Cape Hatteras, North Carolina to Nova Scotia in 1977. The surveys were conducted during the spring (March-May), summer (July-August) and fall (September-December) and approximately 930 stations were sampled. Approximately 22,000 maturity observations of 25 species were made as part of the routine biological sampling aboard the research vessel. Ovaries and testes were classified by macroscopic examination as immature (will not spawn during current spawning season), developing (will spawn during current spawning season), ripe (approaching or in a spawning condition), spent (have recently spawned) and resting (have spawned though gonads are in a quiescent state). For this analysis, all fish

classified as developing, ripe, spent or resting were classified as mature and were assumed to be part of the spawning stock.

The maturity data for 12 species (Table 1) were analyzed using probit analysis (Finney 1971). The percentage of mature fish by cm-length group was calculated for the interval 0-100%. The distribution of percentages plotted against length is in the general form of a cumulative normal frequency or sigmoid curve and on the normal scale is often markedly skewed with a long tail on the right caused by a few immature individuals. A logarithmic ($\log_{10}$) transformation of the length was made to normalize the curve.

The sigmoid curve was linearized by calculating the probit (Y) for the proportion (P) at each length where Y is defined for P as:

$$P = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{Y-5} \exp\left(-\frac{1}{2}\mu^2\right) d\mu$$

P is defined as the proportion mature from 0 to 1. Thus, the relationship between Y and log length (X) can be expressed by the linear equation:

$$Y = a + b\,X$$

The iterative method was used to calculate the above weighted linear regression equation by least squares. Chi square tests were used to indicate significant ($\chi^2 0.01$) heterogeneous deviations from regression. The regression coefficients were used to determine length at maturity (length at which 50% are mature = L_{50}) and is defined as the log length that gives P = 0.5. The variance of log L_{50} was estimated as:

$$V_{L_{50}} = \frac{1}{b^2}\left[\frac{1}{\Sigma nw} + \frac{\left[L_{50} - \frac{\Sigma nwx}{\Sigma nw}\right]^2}{\Sigma nw\left[x - \frac{\Sigma nwx}{\Sigma nw}\right]^2}\right]$$

where n is the number of observations at each cm-group, w is the weighting coefficient, Z^2/PQ (Finney 1971) for the probit (Y) and x is the log length. The standard error of log L_{50} (SE log L_{50}) was approximated as $\sqrt{V_{L_{50}}}$. The approximate 95% fiducial limits of log L_{50} is ±1.96·SE log L_{50}. The estimated standard error of L_{50} on the normal scale is:

$$SE_{L_{50}} = L_{50} \ (2.303\sqrt{V_{L_{50}}})$$

where $\pm 1.96 \cdot SE_{L_{50}}$ is the 95% confidence interval for L_{50}.

RESULTS

The observed and calculated percentage mature and the results of the probit analysis are shown in Tables 2-13. The calculated percentages were determined for each cm-group from the predictive probit equation. L_{50} and standard error (SE) of log L_{50} and L_{50} are presented by sex for each specie. The chi square value and degrees of freedom (df) are given to indicate the goodness of fit of the probit line.

DISCUSSION

The length at maturity, shown in Tables 2-13, for the 12 species represent the average L_{50} in 1977 for the entire area surveyed. Two important factors affecting the L_{50} are growth and possible areal or population differences in maturation rates. The L_{50} is, in fact, a weighted average for the entire survey interval (March-December) and the effects of growth were weighted according to sampling intensity for each seasonal survey. In an effort to detect the effects of growth, silver hake was analyzed by season. These results are shown

in Table 14. The seasonal increase in L_{50} was not evident and may indicate silver hake maturity is length dependent rather than age dependent. It is interesting to note, however, that the range in size from 0-100% mature was considerably shorter in summer than either spring or fall. It is unclear why this occurred though it may be related to sampling which was primarily inshore (<60 fm) during the summer survey.

The second factor, areal or population differences in L_{50}, was analyzed using silver hake collected during the spring survey. Two areas were designated and analyzed separately. They are 1) Middle Atlantic and southern New England and 2) Georges Bank, Gulf of Maine and Scotian Shelf (Table 15). A significant difference was found for L_{50} of males though not for females. The length range from 0-100% mature was quite different between the areas. The Middle Atlantic and southern New England sample indicate the onset of maturity was at a greater length than the more northern sample. The smallest mature male and female was 25 cm in the southern sample and for the northern sample males began maturing at 20 cm and females at 23 cm though L_{50} was greater for females in the northern samples.

The prudent application for these data (e.g. for comparison with other observations, for determining spawning stock length frequencies, etc.) must account for the possibility of temporal and/or areal differences in L_{50} and length ranges from 0-100% mature. Perhaps a more useful interval would be 10-90% mature (calculated percent) because, at least for some species (e.g. red hake, silver hake,

yellowtail flounder), a few observations of immature fish at the upper end of the size range will produce a skewed distribution of percent mature though this has little affect on L_{50}.

LITERATURE CITED

Finney, D. J. 1971. Probit Analysis. 3rd ed., Cambridge University Press. 333 p.

Table 1. Number of maturity observations by species from Cape Hatteras, North Carolina to Nova Scotia, 1977.

Species	Number of Observations
Silver hake *Merluccius bilinearis*	4521
Atlantic cod *Gadus morhua*	1638
Haddock *Melanogrammus aeglefinus*	2316
Red hake *Urophycis chuss*	2786
White hake *Urophycis tenuis*	1557
Butterfish *Peprilus triacanthus*	796
Redfish *Sebestes marinus*	1763
Summer flounder *Paralichthys dentatus*	579
Witch flounder *Glyptocephalus cynoglossus*	889
American plaice *Hippoglossoides platessoides*	1858
Yellowtail flounder *Limanda ferruginea*	1251
Winter flounder *Pseudopleuronectes americanus*	1077

Table 2. Summary of maturity observations for silver hake collected from Cape Hatteras, North Carolina to Nova Scotia, 1977.

Length (cm)	Males		Females	
	% Observed	% Calculated	% Observed	% Calculated
19	0.0	3.9	0.0	0.7
20	2.9	7.6	2.9	1.7
21	23.5	13.2	5.9	3.8
22	20.0	20.6	9.5	7.3
23	24.1	29.6	21.4	12.7
24	26.0	39.6	14.3	19.9
25	40.0	50.0	26.0	28.8
26	64.9	59.9	38.2	38.7
27	69.6	68.9	50.0	49.1
28	72.4	76.6	44.2	59.1
29	90.5	82.8	67.2	68.3
30	89.3	87.8	77.1	76.2
31	91.0	91.6	83.3	82.7
32	96.0	94.3	93.3	87.7
33	93.4	96.2	93.3	91.6
34	96.5	97.5	93.2	94.3
35	95.5	98.4	98.1	96.3
36	100.0	99.0	98.3	97.6
37			97.5	98.5
38			98.5	99.1
39			98.7	99.5
40			98.8	99.7
41			100.0	99.8
L_{50}	25.0		27.1	
SE ($\log L_{50}$)	0.00288		0.00249	
SE (L_{50})	0.1657		0.1552	
χ^2	23.96		24.31	
df	16		21	

Table 3. Summary of maturity observations for Atlantic cod collected from Cape Hatteras, North Carolina to Nova Scotia, 1977.

Length (cm)	Males		Females	
	% Observed	% Calculated	% Observed	% Calculated
37			0.0	11.9
38			14.3	14.1
39			7.1	16.6
40	0.0	10.9	20.0	19.3
41	22.2	13.0	26.7	22.1
42	7.1	15.2	26.9	25.1
43	24.0	17.7	18.5	28.2
44	30.4	20.3	41.4	31.4
45	44.4	23.0	48.3	34.7
46	33.3	25.9	36.0	38.0
47	23.8	28.9	43.6	41.4
48	32.0	32.0	50.0	44.7
49	34.5	35.1	41.4	48.0
50	39.3	38.3	55.3	51.2
51	39.1	41.5	41.9	54.4
52	47.1	44.6	59.5	57.5
53	47.1	47.8	45.5	60.4
54	50.0	50.9	68.0	63.3
55	48.0	53.9	50.0	66.1
56	53.8	56.9	57.9	68.7
57	43.8	59.8	78.6	71.2
58	42.9	62.7	75.0	73.5
59	61.1	65.2	77.8	75.7
60	80.0	67.8	77.3	77.8
61	87.5	70.2	60.0	79.7
62	81.8	72.6	85.7	81.5
63	71.4	74.7	75.0	83.2
64	81.3	76.8	83.3	84.7
65	80.0	78.7	83.3	86.2
66	100.0	80.6	100.0	97.5

L_{50}	53.7	49.6
SE ($\log L_{50}$)	0.00617	0.00576
SE (L_{50})	0.7621	0.6574
χ^2	15.64	24.76
df	25	28

Table 4. Summary of maturity observations for haddock collected from Cape Hatteras, North Carolina to Nova Scotia, 1977.

Length (cm)	Males		Females	
	% Observed	% Calculated	% Observed	% Calculated
31	0.0	7.5	0.0	7.7
32	8.3	10.0	6.7	9.9
33	13.8	12.9	17.4	12.5
34	6.3	16.3	16.7	15.4
35	34.6	20.1	25.0	18.6
36	13.6	24.1	31.6	22.1
37	46.4	28.5	17.2	25.8
38	44.7	33.1	44.0	29.7
39	46.4	37.9	37.7	33.8
40	46.5	42.7	52.5	37.9
41	33.3	47.5	41.7	42.1
42	50.0	52.2	31.7	46.3
43	39.3	56.8	39.6	50.4
44	63.6	61.2	45.9	54.4
45	53.1	65.3	50.0	58.3
46	60.0	69.2	58.5	62.0
47	62.5	72.8	69.0	65.6
48	59.1	76.2	70.4	68.9
49	77.8	79.2	64.7	72.0
50	87.5	81.9	73.1	74.0
51	86.7	84.2	79.4	77.6
52	93.9	86.5	80.0	80.1
53	93.9	88.5	87.1	82.3
54	100.0	90.2	80.0	84.4
55			93.5	86.2
56			100.0	87.9
L_{50}	41.5		42.9	
SE (log L_{50})	0.00493		0.00479	
SE (L_{50})	0.4709		0.4726	
χ^2	33.89		24.20	
df	22		24	

Table 5. Summary of maturity observations for red hake collected from Cape Hatteras, North Carolina to Nova Scotia, 1977.

Length (cm)	Males		Females	
	% Observed	% Calculated	% Observed	% Calculated
21	0.0	15.7	0.0	4.4
22	16.7	23.5	6.7	7.8
23	18.2	32.6	18.8	12.6
24	55.0	42.4	28.6	18.7
25	58.3	52.4	18.2	26.2
26	62.1	61.7	9.1	34.5
27	66.7	70.2	50.0	43.3
28	88.2	77.4	45.2	52.1
29	79.4	83.3	65.2	60.6
30	93.5	88.0	64.7	68.3
31	95.4	91.5	63.9	75.1
32	91.0	94.1	78.0	80.8
33	93.3	96.0	85.0	85.5
34	97.8	97.4	91.3	89.2
35	98.6	98.3	97.3	92.2
36	98.5	98.9	95.6	94.4
37	98.1	99.3	96.7	96.0
38	100.0	99.5	98.4	97.2
39			98.2	98.1
40			97.2	98.7
41			97.9	99.1
42			98.6	99.4
43			98.2	99.6
44			100.0	99.8
L_{50}	24.8		27.8	
SE (log L_{50})	0.00466		0.00373	
SE (L_{50})	0.2657		0.2383	
χ^2	17.30		22.67	
df	16		22	

Table 6. Summary of maturity observations for white hake collected from Cape Hatteras, North Carolina to Nova Scotia, 1977.

Length (cm)	Males		Females	
	% Observed	% Calculated	% Observed	% Calculated
34			0.0	7.5
35	0.0	14.6	15.4	9.4
36	16.7	18.2	14.3	11.6
37	25.0	22.1	21.4	14.1
38	25.0	26.4	28.6	16.7
39	60.0	31.0	12.5	19.7
40	23.1	35.7	33.3	22.8
41	45.8	40.5	33.3	26.1
42	64.0	45.4	38.5	29.6
43	46.2	50.3	22.2	33.2
44	47.8	55.0	47.1	36.8
45	60.7	59.5	40.0	40.5
46	68.4	63.8	20.0	44.2
47	65.0	67.9	52.9	47.8
48	86.5	71.7	31.3	51.4
49	62.5	75.2	58.8	54.9
50	75.0	78.3	46.2	57.9
51	75.0	81.2	61.1	61.6
52	68.4	83.8	52.2	64.7
53	92.3	86.1	46.7	67.7
54	100.0	88.1	58.3	70.5
55			66.7	73.2
56			64.3	75.7
57			70.6	78.0
58			95.2	80.1
59			96.0	82.1
60			100.0	83.9
L_{50}	43.0		47.6	
SE (log L_{50})	0.00592		0.00645	
SE (L_{50})	0.5850		0.7066	
χ^2	22.82		34.59	
df	18		25	

Table 7. Summary of maturity observations for butterfish collected from Cape Hatteras, North Carolina to Nova Scotia, 1977.

Length (cm)	Males		Females	
	% Observed	% Calculated	% Observed	% Calculated
10	0.0	13.4		
11	33.3	28.9		
12	55.6	47.9	0.0	49.5
13	55.0	65.8	63.6	66.0
14	85.7	79.8	90.9	78.9
15	90.2	89.1	88.4	87.8
16	93.7	94.6	93.4	93.4
17	97.8	97.5	91.8	96.6
18	98.1	99.0	100.0	98.4
19	100.0	99.5		
L_{50}	12.1		12.0	
SE ($\log L_{50}$)	0.00824		0.00913	
SE (L_{50})	0.2293		0.2519	
χ^2	2.87		12.41	
df	8		5	

Table 8. Summary of maturity observations for redfish collected from Cape Hatteras, North Carolina to Nova Scotia, 1977.

Length (cm)	Males		Females	
	% Observed	% Calculated	% Observed	% Calculated
16	0.0	8.2		
17	11.1	13.4	0.0	4.6
18	28.6	20.1	12.5	8.2
19	32.7	28.0	25.0	13.2
20	42.9	36.5	42.9	19.7
21	43.2	45.6	22.7	27.3
22	55.8	54.3	29.6	35.7
23	57.8	62.5	33.3	44.5
24	61.5	69.8	44.6	53.2
25	63.3	76.2	58.7	61.4
26	91.3	81.5	71.8	68.8
27	89.5	85.9	70.6	75.3
28	93.1	89.4	96.0	80.8
29	91.1	92.1	87.5	85.3
30	95.9	94.2	100.0	88.9
31	94.6	95.8		
32	98.2	96.9		
33	100.0	97.8		
L_{50}	21.5		23.6	
SE ($\log L_{50}$)	0.00541		0.00609	
SE (L_{50})	0.2673		0.3304	
χ^2	13.62		19.26	
df	16		12	

Table 9. Summary of maturity observations for summer flounder collected from Cape Hatteras, North Carolina to Nova Scotia, 1977.

Length (cm)	Males		Females	
	% Observed	% Calculated	% Observed	% Calculated
22	0.0	22.5		
23	33.3	29.2		
24	25.0	43.1	0.0	4.2
25	66.7	53.9	20.0	9.6
26	75.0	64.0	20.0	18.5
27	81.3	72.9	33.3	30.7
28	82.4	80.3	30.0	44.9
29	84.6	86.1	75.0	59.3
30	84.6	90.5	75.0	72.1
31	87.5	93.7	88.9	82.3
32	100.0	95.9	66.7	89.5
33			100.0	94.2
L_{50}	24.6		28.4	
SE ($\log L_{50}$)	0.00777		0.00826	
SE (L_{50})	0.4395		0.5393	
x^2	5.48		4.36	
df	9		8	

Table 10. Summary of maturity observations for witch flounder collected from Cape Hatteras, North Carolina to Nova Scotia, 1977.

Length (cm)	Males		Females	
	% Observed	% Calculated	% Observed	% Calculated
25	0.0	5.9		
26	20.0	9.0		
27	12.5	12.9	0.0	19.2
28	12.5	17.7	25.0	22.7
29	25.0	23.3	12.5	26.4
30	42.9	29.5	33.3	30.3
31	16.7	36.1	20.0	34.3
32	60.0	42.9	66.7	38.4
33	54.5	49.7	66.7	42.4
34	70.0	56.4	44.4	46.4
35	61.5	62.6	50.0	50.3
36	58.3	68.4	83.3	54.1
37	53.8	73.7	62.5	57.8
38	84.6	78.3	55.6	61.3
39	75.0	82.3	70.0	64.6
40	100.0	86.2	44.4	67.8
41			73.7	70.7
42			66.7	73.4
43			69.2	75.9
44			71.4	78.3
45			68.8	80.5
46			90.0	82.5
47			100.0	84.3
L_{50}	33.0		34.9	
SE (log L_{50})	0.00865		0.01278	
SE (L_{50})	0.6566		1.0257	
x^2	10.46		13.67	
df	14		19	

Table 11. Summary of maturity observations for American plaice collected from Cape Hatteras, North Carolina to Nova Scotia, 1977.

Length (cm)	Males		Females	
	% Observed	% Calculated	% Observed	% Calculated
20	0.0	10.9		
21	5.9	14.5		
22	18.8	19.2		
23	31.8	24.5		
24	12.5	30.4	0.0	3.0
25	51.9	36.4	11.1	4.9
26	37.0	42.6	17.4	7.6
27	50.0	48.7	11.1	11.1
28	66.7	54.6	10.8	15.4
29	61.3	60.3	19.4	20.5
30	65.7	65.4	23.5	26.3
31	69.6	70.3	25.0	32.7
32	74.1	74.6	46.9	39.3
33	72.4	78.4	54.9	46.0
34	84.0	81.8	50.0	52.8
35	87.5	84.5	54.0	59.2
36	76.9	87.4	62.5	65.1
37	87.5	89.5	63.0	70.6
38	91.3	91.4	74.4	75.5
39	100.0	93.0	84.4	79.9
40			85.1	83.6
41			85.2	86.8
42			85.1	89.5
43			93.9	91.7
44			93.9	93.5
45			97.1	94.9
46			100.0	96.1
L_{50}	27.2		33.6	
SE ($\log L_{50}$)	0.00679		0.00381	
SE (L_{50})	0.4248		0.2943	
χ^2	14.50		15.96	
df	18		21	

Table 12. Summary of maturity observations for yellowtail flounder collected from Cape Hatteras, North Carolina to Nova Scotia, 1977.

Length (cm)	Males		Females	
	% Observed	% Calculated	% Observed	% Calculated
20	0.0	16.5		
21	18.2	23.3	0.0	9.6
22	20.0	31.0	38.5	14.0
23	50.0	39.2	30.8	19.3
24	50.0	47.5	25.0	25.4
25	55.6	55.6	42.9	32.1
26	59.3	63.2	39.1	39.1
27	76.9	70.0	40.0	46.2
28	81.0	76.0	61.1	53.3
29	76.2	81.1	38.1	59.9
30	84.2	85.3	43.3	66.1
31	91.3	88.7	57.1	71.6
32	90.6	91.5	80.0	76.6
33	95.2	93.6	74.1	80.9
34	95.5	95.3	87.5	84.6
35	97.4	96.5	96.6	87.6
36	93.9	97.5	92.5	90.2
37	96.4	98.2	100.0	92.3
38	100.0	98.7		
L_{50}	24.3		27.5	
SE ($\log L_{50}$)	0.00704		0.00645	
SE (L_{50})	0.3935		0.408	
x^2	6.20		31.40	
df	17		15	

Table 13. Summary of maturity observations for winter flounder collected from Cape Hatteras, North Carolina to Nova Scotia, 1977.

Length (cm)	Males		Females	
	% Observed	% Calculated	% Observed	% Calculated
18			0.0	5.9
19	0.0	12.7	28.6	9.0
20	14.3	17.9	22.2	12.9
21	12.5	23.8	27.3	17.6
22	46.2	30.5	27.8	23.0
23	55.6	37.4	35.3	28.9
24	41.7	44.5	24.0	35.2
25	54.5	51.4	24.0	41.6
26	54.5	58.1	55.6	48.0
27	61.5	64.2	54.3	54.2
28	72.7	69.9	58.5	60.0
29	75.0	74.9	57.1	65.5
30	81.8	79.3	74.4	70.5
31	77.3	83.1	65.0	74.9
32	75.0	86.3	71.4	78.9
33	88.2	89.0	83.3	82.4
34	92.9	91.2	85.7	85.4
35	100.0	93.0	92.3	87.9
36			90.0	90.1
37			94.3	92.0
38			96.0	93.5
39			100.0	94.7
L_{50}	24.8		26.3	
SE ($\log L_{50}$)	0.00901		0.00653	
SE (L_{50})	0.5139		0.3952	
x^2	8.35		15.92	
df	15		20	

Table 14. Summary of maturity observations for silver hake by season collected from Cape Hatteras, North Carolina to Nova Scotia, 1977.

Length (cm)	Spring				Summer				Fall			
	Males		Females		Males		Females		Males		Females	
	% Observed	% Calculated	% Observed	% Calculated	% Observed	% Calculated	% Observed	% Calculated	% Observed	% Calculated	% Observed	% Calculated
19	0.0	3.1										
20	14.3	6.5			0.0	2.9			0.0	8.1	0.0	3.6
21	22.2	12.2			28.6	7.5			22.2	12.9	9.5	6.4
22	41.7	17.4	0.0	2.4	7.7	17.5	0.0	2.3	15.0	19.2	0.5	10.5
23	28.6	29.9	11.1	5.7	42.9	31.4	15.3	5.3	15.4	26.6	28.0	15.9
24	38.2	41.0	9.5	11.5	50.0	47.7	14.3	10.8	48.0	34.8	17.9	22.6
25	33.3	52.4	12.8	20.2	75.0	63.8	16.7	19.0	42.3	43.5	40.6	30.4
26	58.3	63.1	36.6	31.3	54.5	77.3	50.0	29.7	66.7	52.1	36.4	38.6
27	76.2	72.6	50.0	43.9	88.9	87.0	60.0	42.0	47.4	60.3	53.3	47.1
28	72.0	80.4	47.3	56.8	92.9	93.2	44.4	54.6	58.3	67.9	29.4	55.4
29	96.9	86.5	74.0	68.6	100.0	96.7	50.0	66.4	82.1	74.5	50.0	63.3
30	91.0	91.0	83.9	78.4			54.5	76.5	82.5	80.1	53.6	70.3
31	94.3	94.2	85.9	86.9			90.5	84.3	86.4	84.8	69.0	76.6
32	97.1	96.4	90.4	91.3			92.9	90.1	93.8	88.6	95.7	81.8
33	97.0	97.8	94.6	94.9			100.0	94.0	86.0	91.5	87.5	86.1
34	97.2	98.6	96.8	97.1					94.4	93.8	96.3	89.6
35	100.0	99.2	98.8	98.4					78.6	95.5	96.5	92.3
36			100.0	99.2					100.0	96.8	96.0	94.4
37											94.8	96.0
38											94.7	97.1
39											95.7	98.0
40											95.2	98.6
41											100.0	99.0
L_{50}	24.8		27.5		24.1		27.6		25.8		27.3	
SE ($\log L_{50}$)	0.00394		0.00297		0.00743		0.00660		0.00484		0.00487	
SE (L_{50})	0.2247		0.1880		0.4121		0.4187		0.2872		0.3056	
χ^2	19.87		8.47		10.02		11.32		24.98		27.91	
df	15		15		8		10		15		20	

Table 15. Summary of maturity observations for silver hake by area collected in spring 1977 from Cape Hatteras, North Carolina to Nova Scotia.

Length (cm)	Mid Atlantic and Southern New England				Georges Bank, Gulf of Maine and Nova Scotia			
	Males		Females		Males		Females	
	% Observed	% Calculated	% Observed	% Calculated	% Observed	% Calculated	% Observed	% Calculated
19					0.0	2.2		
20					14.3	5.2		
21					16.7	10.6		
22					41.7	18.6	0.0	1.6
23					30.0	29.0	12.5	4.0
24	0.0	17.9	0.0	15.2	40.6	41.0	6.3	8.9
25	33.3	30.6	14.3	24.9	33.3	50.3	12.5	16.6
26	55.6	45.2	50.0	37.2	59.3	65.0	34.3	27.3
27	61.5	60.2	52.9	50.2	82.8	75.0	47.8	40.0
28	65.0	73.3	62.5	62.7	76.7	83.0	35.5	53.3
29	92.3	83.5	90.0	73.6	90.7	88.9	63.3	65.9
30	86.1	90.5	85.7	82.4	95.2	93.1	82.9	76.6
31	93.9	94.9	73.9	88.8	98.2	95.9	90.9	84.8
32	97.7	97.5	92.3	93.2	92.6	97.6	85.7	90.7
33	100.0	98.8	96.8	96.1	100.0	98.6	95.2	94.6
34			96.6	97.8			97.0	97.1
35			100.0	98.9			97.0	98.4
36							100.0	99.2
L_{50}	26.31		26.99		24.72		27.75	
SE (log L_{50})	0.00508		0.00544		0.00380		0.00355	
SE (L_{50})	0.3073		0.3377		0.2160		0.2266	
x^2	4.45		10.70		15.44		12.28	
df	8		10		13		13	