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Length/Weight relationships for Greenland halibut, *Reinhardtius hippoglossoides*, from Northwest Atlantic (NAFO Regulatory Area: Divisions 3L, 3M and 3NO)

by

E. Román and X. Paz
Instituto Español de Oceanografía P.O Box 1552, 36280 Vigo, Spain

ABSTRACT

Sampling length and weight data collected during Flemish Cap survey (1995 and 1996) and fishing activity monitoring (1993 and 1994) were used to produce relationships and plots for length-weight and gutted weight/total weight for Greenland halibut in the NAFO Regulatory Area (Divisions 3L, 3M and 3NO). The parameter values were obtained by sex, division and by semester.

INTRODUCTION

The relationship between length and weight is a necessary parameter in performing proper analytical assessments of fish stocks which is also required for intra- and inter-specific comparisons. Measurements of both length and weight (mass) of individual fish are commonly made in situ (on board, if the catches are processed) as part of routine monitoring programs (Gutreuter and Krzoska, 1994), as occurs in Spanish fisheries targeting Greenland halibut in the NAFO Regulatory Area (Junquera et al., 1992).

The problem of proportionality of fish weight increment in relation to growth in length is usually analysed from two different viewpoints: ideal and empirical. The empirical length-weight relationship is used for the study of short term variations, either individual or collective, within population (Dulčić and Kraljević, 1996).

There are publications regarding the Greeanland halibut length-weight relationships, but these do not cover all NAFO divisions and use data from some years ago (Bowering and Stansbury, 1984). The NAFO Scientific Council has no updated parameters of length-weight relationships for this specie.In this paper, we present the length-weight of Greenland halibut in Divisions 3L, 3M y 3NO by semester and sex. We, also analyse the relationship between total and gutted weights.

MATERIAL AND METHODS

Information has been obtained from two separate sources: the Spanish sampling program

developed in deep fisheries which provides a substantial amount of biological data, and the EU Surveys in the Flemish Cap. Data from the years 1993 and 1994, and 1995 and 1996 respectively were considered. In two cases, length and weight data were taken on board. The ungutted weight of each fish was recorded in grammes. In the sampling in the commercial vessels and in the Flemish Cap surveys, the weight was measured to the nearest 5g on a mechanical scale. In some cases, the gutted weight was also taken.

Length measurements were taken as total length to the nearest centimeter below.

Length (L), total weight (TW) and gutted weight (GW) were recorded, relationships and plots have been produced for length /total weight, length /gutted weight and gutted weight/total weight. In the case of there being no gutted weight data, only a lenght/total weight relationships was calculated. For relationships between length and weight (total or gutted) a function of the form:

$$W = aL^b$$

was fitted to the data, where W = weight (g) and L = length (cm).

The estimation of value parameters was obtained by the log log transformed expression:

$$\log W = \log a + b (\log L)$$

and the results were retransformed.

For relationships between total weight and gutted weight a function of the form:

$$TW = b\ GW$$

was fitted to the data, where TW = total weight and GW = gutted weight.

The weight at length of many species is known to vary seasonally and, wherever possible, as in the case of Greenland halibut, the length/weight relationships have been prepared by sex, semester and division in each year and their coefficient of determination was estimated. The S.E. for each parameter was also estimated.

The application of all length-weight relationships obtained should be limited to the observed length ranges. It is not the purpose of this report to compare length-weight relationships by areas or seasons, but rather to present the information available in a concise form.

RESULTS

The data for 1993 and 1994, shown in Table 1, summarizes the characteristics of the samples taken on board commercial vessels, the sample size, the minimum, maximum and mean lengths (±SE) and weights (±SE) used in analysis for each case, as well as the value parameters

of the relationships: a and b combined, and the coefficient of determination r^2 and their SE by semester and division are presented in Table 3.

The values corresponding to the characteristics and parameters for length-weight, length-gutted weight and gutted weight-total weight by sex, semester, division and year are shown in Tables 5 and 6.

Plots fitted for Greenland halibut relationships of length/total weight, length/gutted weight and gutted weight/total weight by sex, Division, semester and year are shown in Figures 1 to 8.

Tables 2 and 4 show the samples characteristics and value parameters of length-weight relationships from Flemish Cap (Division 3M) Greenland halibut populations are shown for each year: 1995 and 1996. The values of length-weight, length-gutted weight and gutted weight-total weight by sex and year are shown in Tables 7 and 8.

The corresponding plots fitted from Flemish Cap Greenland halibut relationships for length/total weight, length/gutted weight and gutted weight/total weight by sex and year are shown in Figures 9 and 10.

REFERENCES

Bowering, W.R. and D.E: Stansbury. 1984. Regressions of Weight on Length for Witch Flounder (*Glyptocepahalus cynoglossus*) of the eastern Newfoundland Area. J. North A. Fish. Sci. 5:105-106.

Bowering, W.R. and D.E: Stansbury. 1984. Regressions of Weight on Length for Greenland halibut (*Reinhardtius hippoglossoides*) of the eastern Newfoundland Area. J. North A. Fish. Sci. 5:107-108.

Dulčić, J. and M. Kraljević, 1996. Weight- length relationships for 40 fish species in the eastern Adriatic (Croatian waters). Fisheries Research, 28: 243-251.

Gutreuter, S. And D.J. Kroska, 1994. Quantifying Precision In Situ Length and Weight Measurements of fish. North American Journal of Fisheries Management 14: 318-322.

Junquera, S, S Iglesias, and E. De Cárdenas. MS 1992. Spanish fishery of Greenland Halibut (*Reinhardtius hippoglossoides*) in 1990-1991. NAFO Sci Counc. Res Doc. N° 28, Serial N 2072: 14p.

Savvatimsky, P.I. and D.B.Atkinson. 1993. Length-weight Relationships of Roundnose Grenadier (*Coryphaenoides rupestris* Gunn.) in Different Areas of the Northwest Atlantic. NAFO Sci. Counc Studies 19: 71-98.

Table 1.- Total length and weight characteristics (mean, range and standard error) for Greenland halibut sampled in NAFO Regulatory Area by Division and semester 1993 and 1994. (SE* standard error)

Division	Individuals	Length characteristics			Weight characteristics		
		Mean	SE*	Range (cm)	Mean	SE*	Range (g)
January - June 1993							
3L	1001	50,68	0,3925	(27-91)	1500,68	45,68	(175-8100)
3M	996	55,772	0,3378	(33-93)	1818,03	42,63	(300-9300)
3NO	664	55,687	0,404	(33-95)	1736,45	50,54	(250-10000)
July - December 1993							
3L	1063	40,28	0,1757	(25-60)	601,697	8,268	(140-1954)
3M	370	54,75	0,67	(32-98)	1925,26	88,04	(280-11350)
3NO	1066	45,93	0,289	(25-81)	978,09	20,24	(115-5250)
January - June 1994							
3L	1055	40,96	0,2256	(24-65)	653,223	10,957	(110-2455)
3M	1115	49,346	0,3455	(26-95)	1348,23	36,14	(166-8568)
3NO	693	46,52	0,4094	(21-76)	1132,17	29,88	(85-4770)
July - December 1994							
3L	1022	42,054	0,3244	(22-88)	788,366	22,098	(80-6000)
3M	989	53,684	0,2647	(30-78)	1418,18	23,28	(210-5300)
3NO	995	38,88	0,29	(21-80)	604,37	20,27	(70-6350)

Table 2.- Total length and weight characteristics (mean, range and standard error) for Greenland halibut in Flemish Cap (Division 3M) during July 1995 and July 1996. (SE* standard error)

Division	Individuals	Length characteristics			Weight characteristics		
		Mean	SE*	Range (cm)	Mean	SE*	Range (g)
July 1995							
3M	726	38,6	0,471	(13-70)	648,7	20,435	(15-3460)
July 1996							
3M	905	37,8	0,413	(10-82)	617	19,515	(10-7900)

Table 3.- Parameters of the relationships ($W=aL^b$) between total weight (g) and total length (cm) for Greenland halibut, sampled in NAFO Regulatory Area by Division and semester 1993 and 1994. (SE* standard error)

Division	Parameters of the relationship					
	a	SE (a)*	b	SE (b)*	r^2	SE (e)*
January - June 1993						
3L	0.0033	0,0278	3,2584	0,0164	0,9753	0,05254
3M	0,0009	0,0284	3,5756	0,0162	0,9798	0,0427
3NO	0,003	0,0329	3,2699	0,0189	0,9782	0,0381
July - December 1993						
3L	0,0095	0,031	2,9731	0,0194	0,9567	0,03916
3M	0,0024	0,0404	3,338	0,0233	0,9822	0,0455
3NO	0,0038	0,0239	3,2134	0,0144	0,9789	0,0427
January - June 1994						
3L	0,0078	0,0254	3,0273	0,0158	0,972	0,0403
3M	0,0048	0,0209	3,1658	0,0124	0,9833	0,0409
3NO	0,0088	0,0215	3,0231	0,013	0,9874	0,0305
July - December 1994						
3L	0,0047	0,0198	3,1697	0,0123	0,9848	0,041
3M	0,0035	0,0295	3,219	0,0171	0,9729	0,0364
3NO	0,0045	0,0228	3,1687	0,0144	0,9798	0,0403

Table 4.- Parameters of the relationships ($W=aL^b$) between total weight (g) and total length (cm) for Greenland halibut in Flemish Cap (Division 3M) during July 1995 and July 1996 (SE* standard error)

Division	Parameters of the relationship					
	a	SE (a)*	b	SE (b)*	r^2	SE (e)*
July 95						
3M	0,0062	0,0144	3,0828	0,0092	0,9936	0,0412
July 1996						
3M	0,0072	0,0163	3,0419	0,0104	0,9895	0,0527

Table 5.- Length and weight characteristics and parameters of the relationships by sex, semester and Division for *Reinhardtius hippoglossoides* sampled in NAFO Regulatory Area during 1993. Total Length/Total Weight (L/TW); Total Length/Gutted Weight (L/GW); Gutted Weight/Total Weight (GW/TW).

Division	Relationship	Individuals	a	b	r^2	Length range	Weight range
January - June 1993							
3L	L/TW (m)	349	0,0071	3,052	0,9523	(27-69)	(175-3200)
3L	L/TW (f)	651	0,003	3,284	0,9768	(30-91)	(225-8100)
3L	L/GW	799	0,0025	3,299	0,976	(27-89)	(150-6275)
3L	GW/TW	799	-	1,097	0,9968	-	(150-6800)
3L	GW/TW (m)	279	-	1,121	0,9939	-	(150-2500)
3L	GW/TW (f)	519	-	1,095	0,9967	-	(175-6800)
3M	L/TW (m)	337	0,0011	3,587	0,9673	(33-77)	(320-5600)
3M	L/TW (f)	659	0,0009	3,562	0,9802	(34-93)	(300-9300)
3M	L/GW	497	0,0008	3,565	0,9796	(33-80)	(290-6200)
3M	GW/TW	497	-	1,088	0,9927	-	(270-6490)
3M	GW/TW (m)	174	-	1,09	0,9977	-	(290-3350)
3M	GW/TW (f)	323	-	1,088	0,991	-	(270-6490)
3NO	L/TW (m)	189	0,0042	3,18	0,9612	(33-69)	(250-3250)
3NO	L/TW (f)	475	0,0029	3,272	0,9796	(33-95)	(250-10000)
July - December 1993							
3L	L/TW (m)	519	0,0117	2,921	0,9569	(27-60)	(170-1954)
3L	L/TW (f)	544	0,0082	3,013	0,9581	(25-58)	(140-1684)
3L	L/GW	1060	0,0082	2,999	0,965	(25-60)	(130-1832)
3L	GW/TW	1060	-	1,076	0,994	-	(130-1954)
3L	GW/TW (m)	517	-	1,074	0,9957	-	(158-1954)
3L	GW/TW (f)	543	-	1,079	0,9924	-	(130-1684)
3M	L/TW (m)	89	0,0049	3,149	0,9688	(33-70)	(295-3505)
3M	L/TW (f)	281	0,0024	3,34	0,9829	(32-98)	(280-11350)
3M	L/GW	287	0,0032	3,25	0,9867	(32-98)	(260-9985)
3M	GW/TW	287	-	1,103	0,9937	-	(260-11350)
3M	GW/TW(m)	63	-	1,061	0,9978	-	(275-3505)
3M	GW/TW (f)	224	-	1,105	0,9929	-	(260-11350)
3NO	L/TW (m)	363	0,0048	3,15	0,9722	(26-65)	(130-2580)
3NO	L/TW (f)	701	0,0036	3,238	0,9811	(25-81)	(115-5250)
3NO	L/GW	1062	0,0037	3,205	0,9771	(25-81)	(100-4485)
3NO	GW/TW	1062	-	1,074	0,9961	-	(100-5250)
3NO	GW/TW (m)	363	-	1,064	0,9972	-	(115-2580)
3NO	GW/TW (f)	697	-	1,078	0,9957	-	(100-5250)

Table 6.- Length and weight characteristics and parameters of the relationships by sex, semester and Division for *Reinhardtius hippoglossoides* sampled in NAFO Regulatory Area during 1994. Total Length/Total Weight (L/TW); Total Length/Gutted Weight (L/GW); Gutted Weight/Total Weight (GW/TW).

Division	Relationship	Individuals	a	b	r^2	Length range	Weight range
January - June 1994							
3L	L/TW (m)	442	0,008	3,018	0,9727	(24-62)	(110-1990)
3L	L/TW (f)	613	0,0078	3,04	0,9718	(25-65)	(120-2455)
3L	L/GW	1055	0,0081	2,995	0,9772	(24-65)	(105-2280)
3L	GW/TW	1055	-	1,092	0,9925	-	(105-2455)
3L	GW/TW (m)	442	-	1,093	0,9919	-	(105-1990)
3L	GW/TW (f)	613	-	1,091	0,9928	-	(110-2455)
3M	L/TW (m)	359	0,0072	3,054	0,9771	(26-71)	(166-4036)
3M	L/TW (f)	752	0,0045	3,185	0,9837	(29-95)	(222-8568)
3M	L/GW	1111	0,005	3,138	0,9842	(26-90)	(156-7850)
3M	GW/TW	1111	-	1,086	0,9974	-	(156-8568)
3M	GW/TW (m)	359	-	1,073	0,9971	-	(156-4036)
3M	GW/TW (f)	752	-	1,088	0,9972	-	(208-8568)
3NO	L/TW (m)	236	0,0083	3,036	0,9886	(21-65)	(85-2550)
3NO	L/TW (f)	457	0,0091	3,014	0,9866	(26-76)	(150-4770)
3NO	L/GW	687	0,0083	3,014	0,9895	(21-76)	(80-3895)
3NO	GW/TW	687	-	1,094	0,9943	-	(80-4770)
3NO	GW/TW (m)	235	-	1,087	0,9954	-	(80-2550)
3NO	GW/TW (f)	452	-	1,096	0,9939	-	(130-4770)
July - December 1994							
3L	L/TW (m)	436	0,0053	3,125	0,9841	(22-69)	(80-3000)
3L	L/TW (f)	586	0,0044	3,181	0,9851	(24-88)	(100-6000)
3L	L/GW	1022	0,0045	3,129	0,9864	(22-88)	(75-5500)
3L	GW/TW	1022	-	1,099	0,9956	-	(75-6000)
3L	GW/TW (m)	436	-	1,087	0,9968	-	(75-3000)
3L	GW/TW (f)	586	-	1,103	0,9952	-	(90-6000)
3M	L/TW (m)	365	0,0038	3,196	0,9644	(34-71)	(295-3130)
3M	L/TW (f)	624	0,0036	3,215	0,9727	(30-78)	(210-5300)
3M	L/GW	988	0,0037	3,19	0,9755	(30-78)	(200-4815)
3M	GW/TW	988	-	1,069	0,9968	-	(200-5300)
3M	GW/TW (m)	365	-	1,06	0,9968	-	(280-3130)
3M	GW/TW (f)	623	-	1,072	0,9965	-	(200-5300)
3NO	L/TW (m)	375	0,0045	3,163	0,9716	(24-60)	(94-2090)
3NO	L/TW (f)	620	0,0047	3,16	0,9829	(21-80)	(70-6350)
3NO	L/GW	995	0,0039	3,185	0,9831	(21-80)	(64-6000)
3NO	GW/TW	995	-	1,08	0,9982	-	(64-6350)
3NO	GW/TW (m)	375	-	1,065	0,9969	-	(90-2090)
3NO	GW/TW (f)	620	-	1,082	0,9984	-	(64-6350)

Table 7.- Length and weight characteristics and parameters of the relationships by sex for *Reinhardtius hippoglossoides* sampled in Flemish Cap (Division 3M) during July 1995. Total Length/Total Weight (L/TW); Total Length/Gutted Weight (L/GW); Gutted Weight /Total Weight (GW/TW).

Division	Relationship	Individuals	a	b	r^2	Length range	Weight range
3M	L/TW (m)	292	0,0063	3,071	0,994	(15-66)	(23-2820)
3M	L/TW (f)	403	0,0053	3,1267	0,993	(14-70)	(22-3460)
3M	L/GW	606	0,0043	3,159	0,9939	(14-70)	(15-2960)
3M	GW/TW	606	-	1,079	0,9973	-	(15-3460)
3M	GW/TW (m)	253	-	1,066	0,9985	-	(22-2820)
3M	GW/TW (f)	343	-	1,086	0,9969	-	(15-3460)

Table 8.- Length and weight characteristics and parameters of the relationships by sex for *Reinhardtius hippoglossoides* sampled in Flemish Cap (Division 3M) during July 1996. Total Length/Total Weight (L/TW);Total Length/Gutted Weight (L/GW); Gutted Weight /Total Weight (GW/TW).

Division	Relationship	Individuals	a	b	r^2	Length range	Weight range
3M	L/TW (m)	361	0,007	3,0484	0,9889	(14-64)	(40-2600)
3M	L/TW (f)	511	0,0069	3,052	0,9888	(10-82)	(10-7900)
3M	L/GW	841	0,0037	3,198	0,9933	(12-82)	(8-6300)
3M	GW/TW	841	-	1,099	0,994	-	(8-7900)
3M	GW/TW (m)	340	-	1,08	0,9969	-	(18-2600)
3M	GW/TW (f)	477	-	1,107	0,993	-	(20-7900)

1993 (January-June)

1993 (July-December)

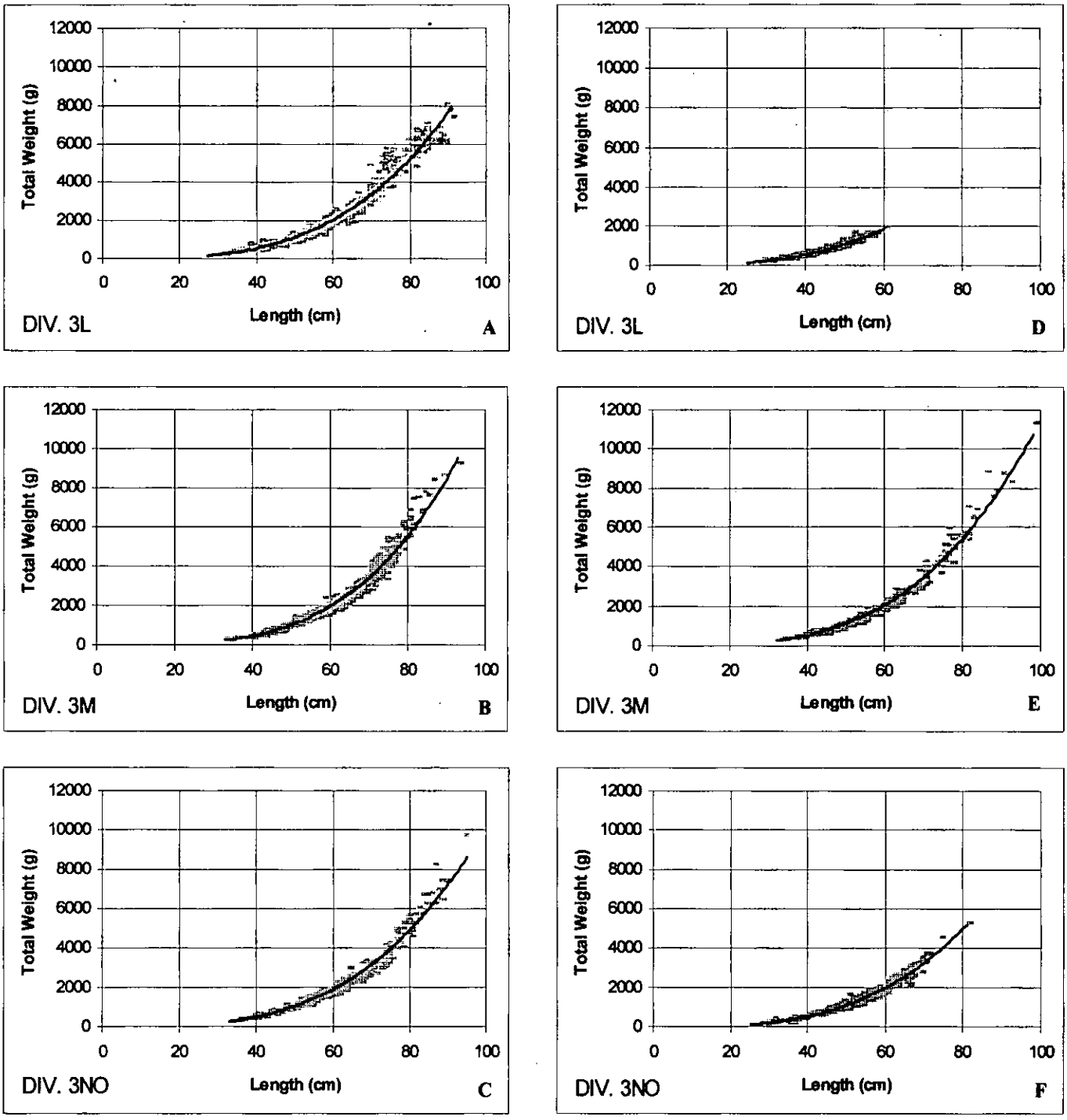


Figure 1.- Length/Weight relationships for *Reinhardtius hippoglossoides* during January-June 1993 (A, B, C) and July-December 1993 (D, E, F) by semester and division: A,D: Length/Total Weight for division 3L B,E: Length /Total Weight for division 3M C,F: Length/Total Weight for division 3NO

1994 (January-June)

1994 (July-December)

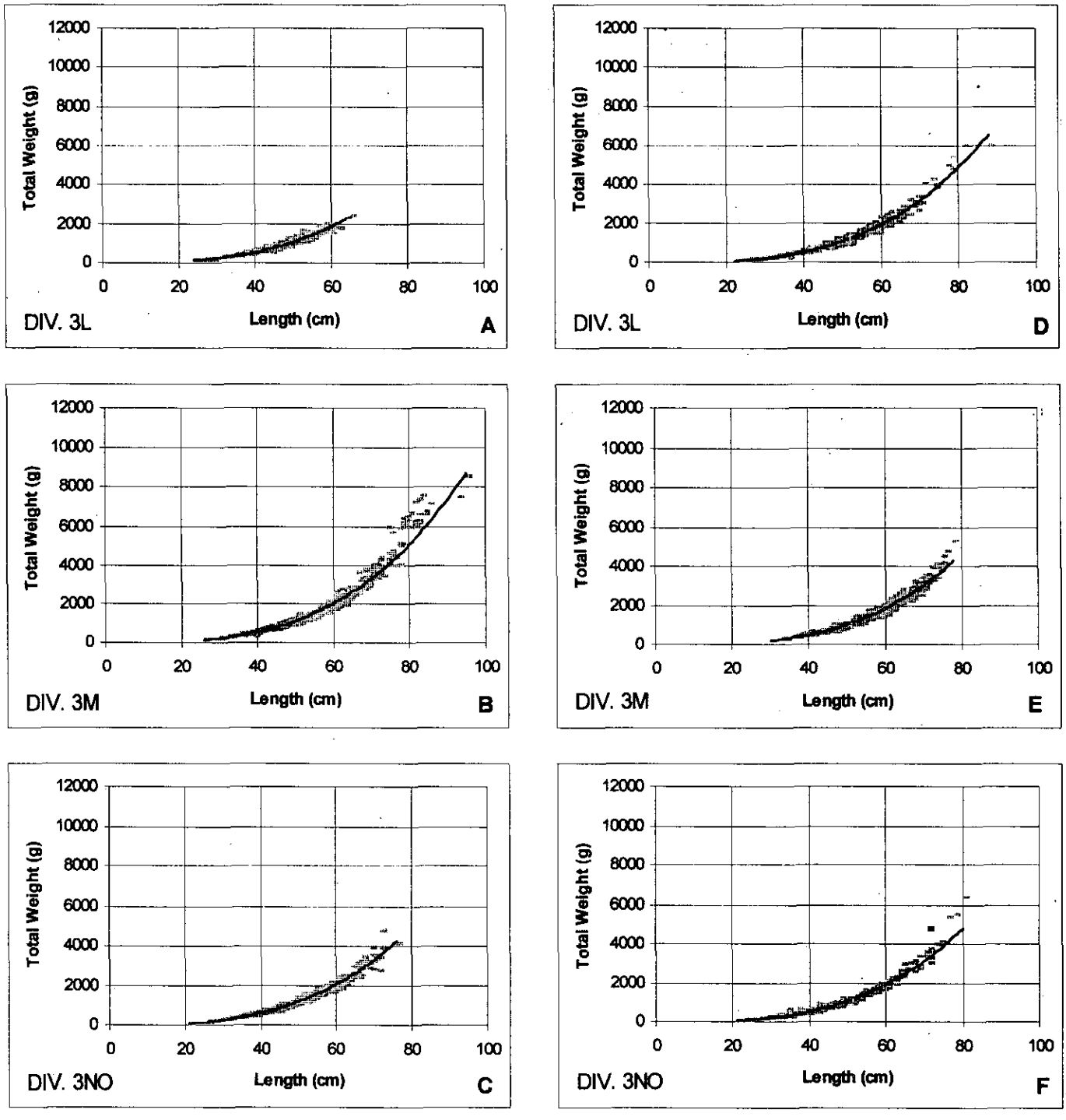
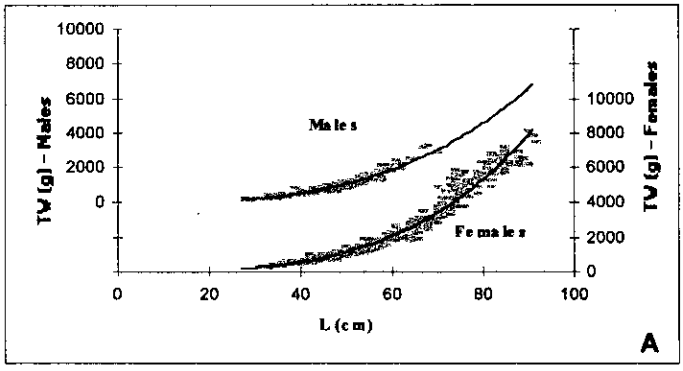
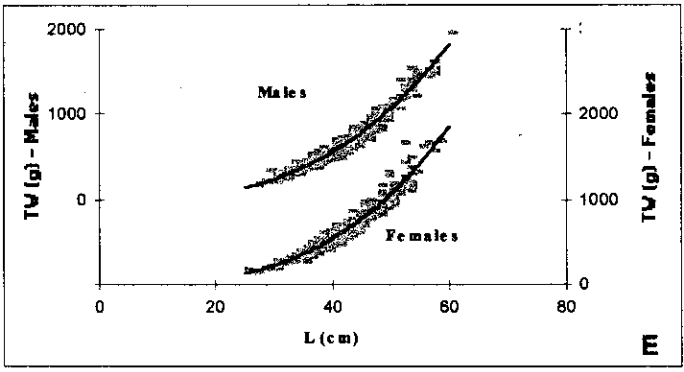


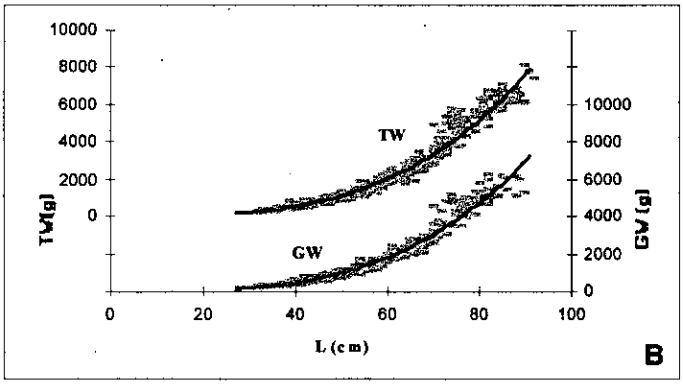
Figure 2.- Length/Weight relationships for *Reinhardtius hippoglossoides* during January-June 1994 (A, B, C) and July-December 1994 (D, E, F) by semester and division: A,D: Length/Total Weight for division 3L B,E: Length /Total Weight for division 3M C,F: Length/Total Weight for division 3NO

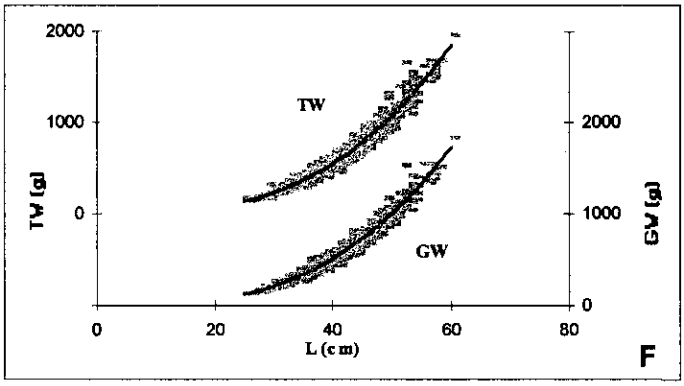
1993 (January-June)

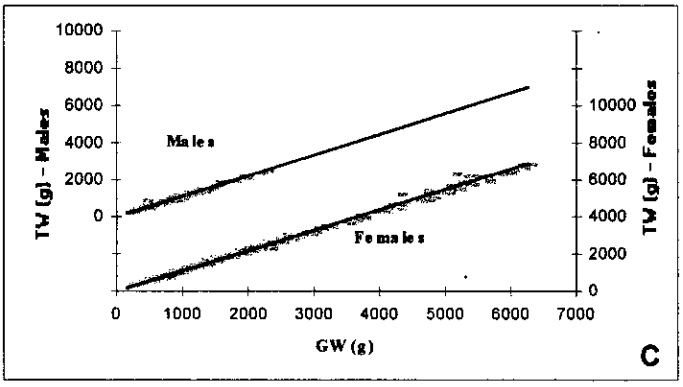
1993 (July-December)

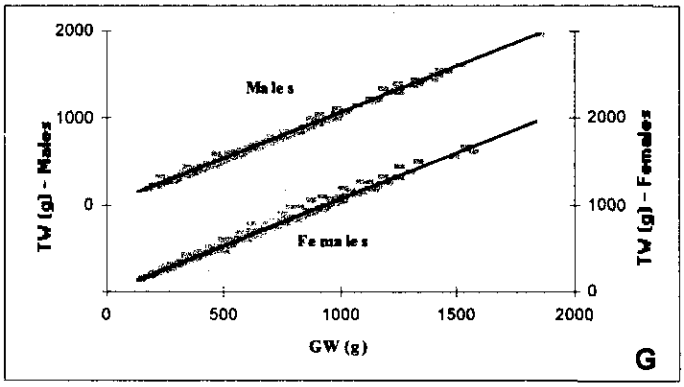


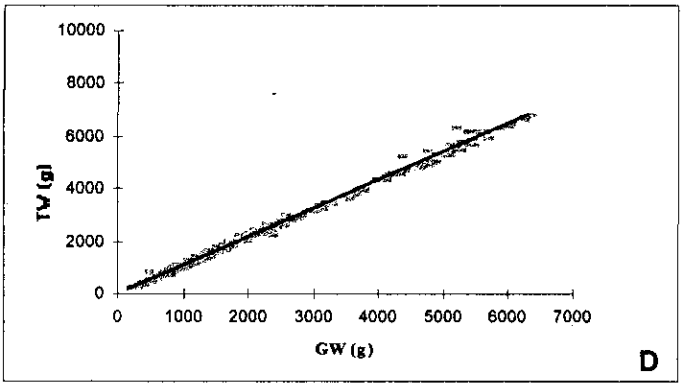












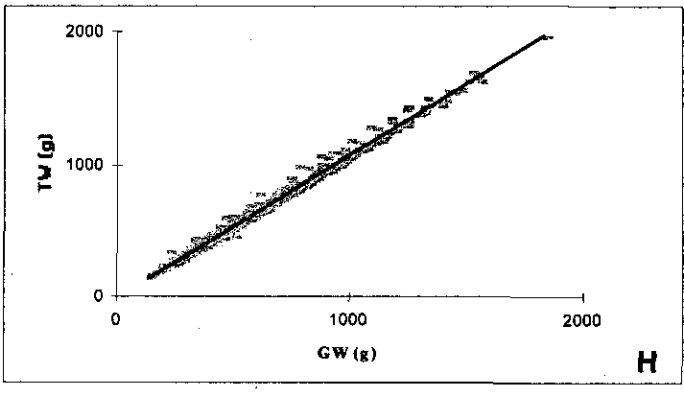


Figure 3.- Length/Weight and Gutted Weight/Total Weight relationships by sex and combined for *Reinhardtius hippoglossoides* in **division 3L** during January - June 1993 (A, B, C, D) and July - December 1993 (E, F, G, H): A,E: Length/Total Weight by sex. B,F: Length /Total Weight and Length /Gutted Weight. C,G: Gutted Weight/Total Weight by sex. D,H: Gutted Weight/Total Weight.

1993 (January-June)

1993 (July-December)

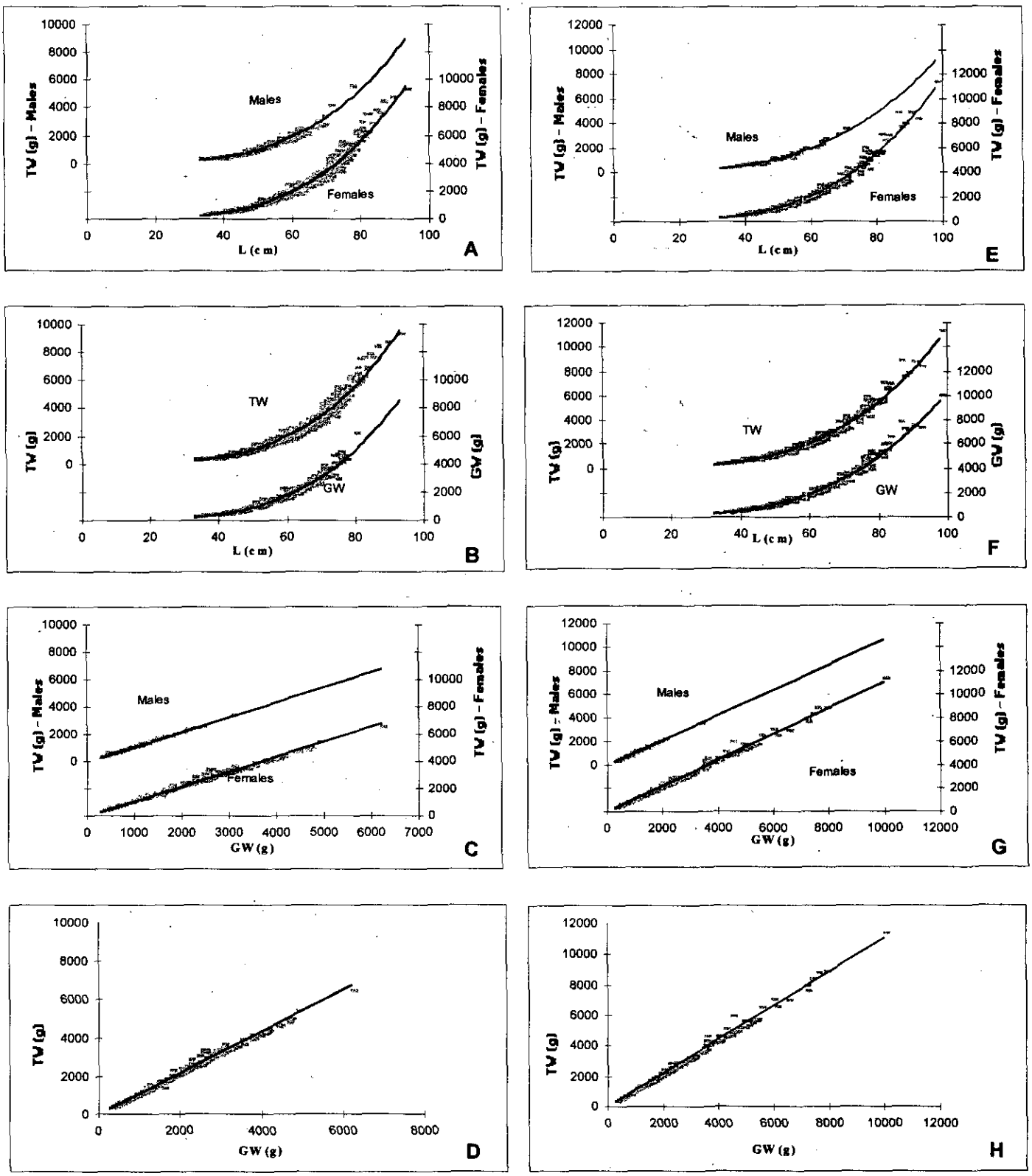
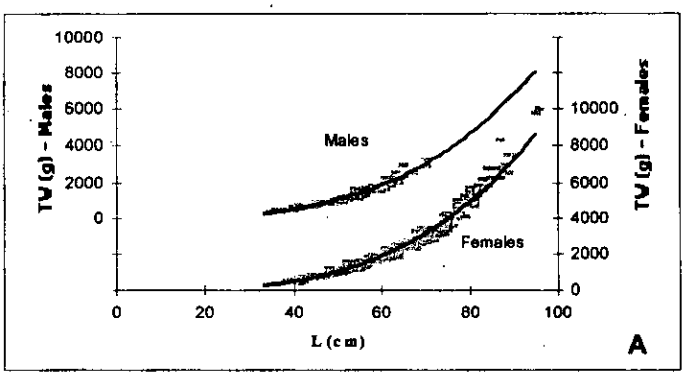
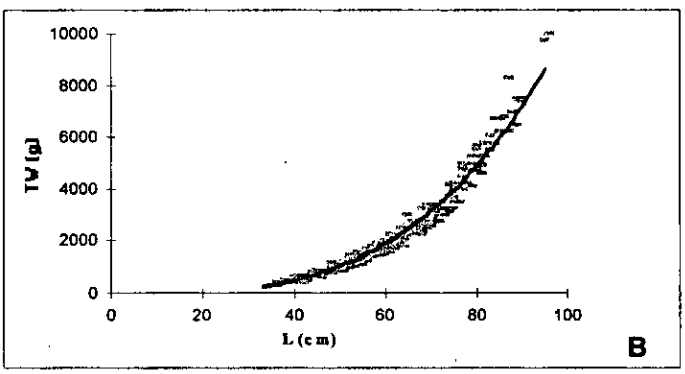


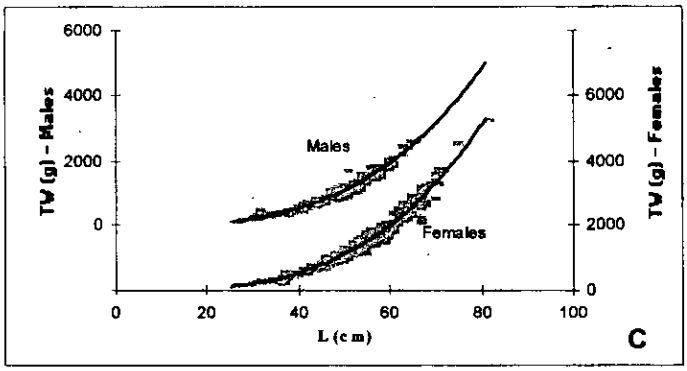
Figure 4.- Length/Weight and Gutted Weight/Total Weight relationships by sex and combined for *Reinhardtius hippoglossoides* in **division 3M** during January - June 1993 (A, B, C, D) and July - December 1993 (E, F, G, H): A,E: Length/Total Weight by sex. B,F: Length /Total Weight and Length /Gutted Weight. C,G: Gutted Weight/Total Weight by sex. D,H: Gutted Weight/Total Weight.

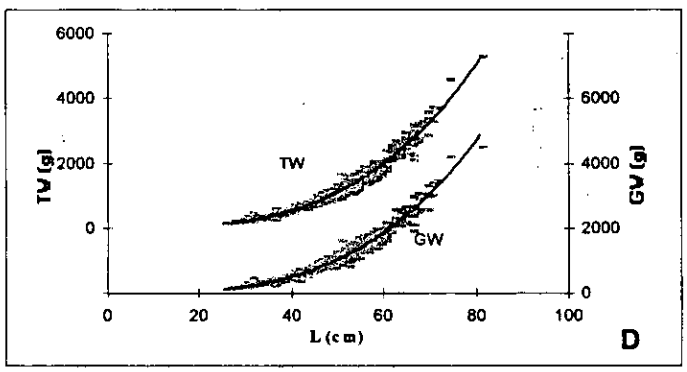
1993 (January-June)

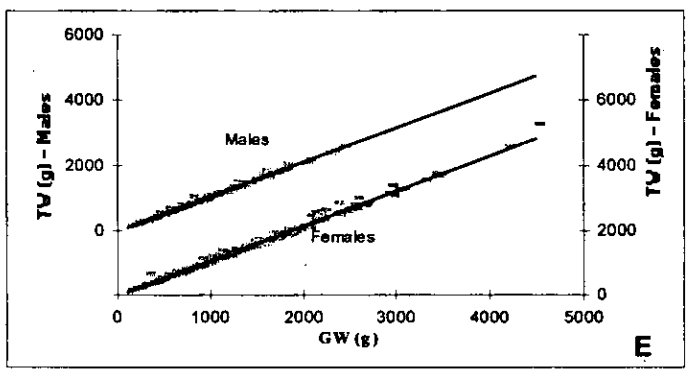




1993 (July-December)







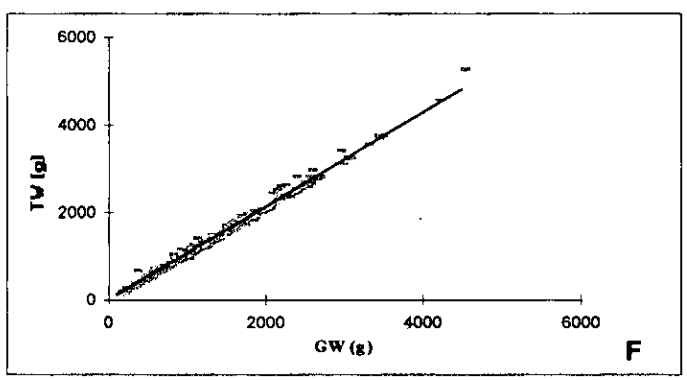


Figure 5.- Length/Weight and Gutted Weight/Total Weight relationships by sex and combined for *Reinhardtius hippoglossoides* in **division 3NO** during January - June 1993 (A, B) and July - December 1993 (C, D, E, F): A,C: Length/Total Weight by sex. B: Length /Total Weight . D: Length /Total Weight and Length/Gutted Weight. E: Gutted Weight/Total Weight by sex. F: Gutted Weight/Total Weight.

1994 (January-June)

1994 (July-December)

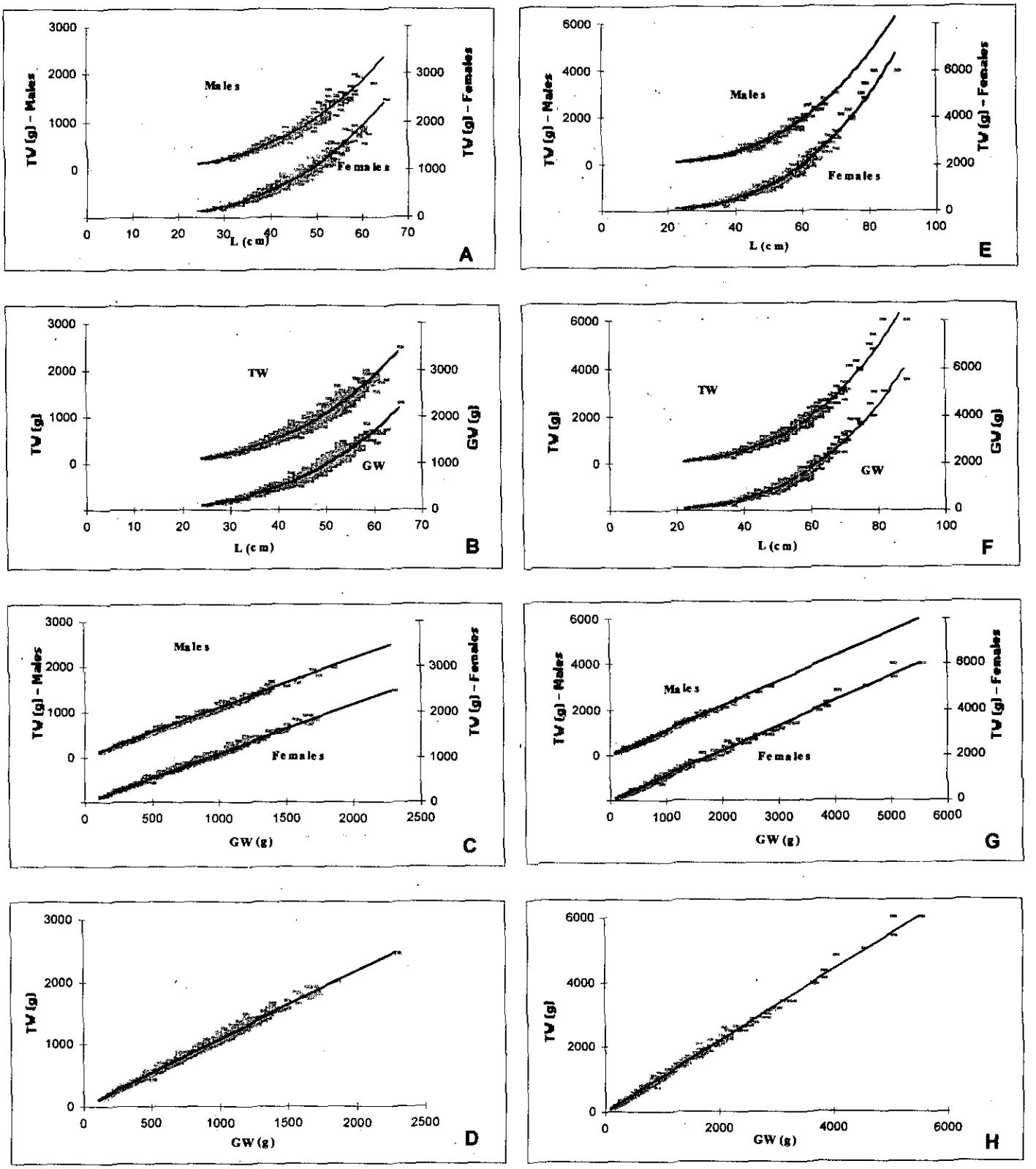


Figure 6.- Length/Weight and Gutted Weight/Total Weight relationships by sex and combined for *Reinhardtius hippoglossoides* in **division 3L** during January - June 1994 (A, B, C, D) and July - December 1994 (E, F, G, H): A,E: Length/Total Weight by sex. B,F: Length /Total Weight and Length /Gutted Weight. C,G: Gutted Weight/Total Weight by sex. D,H: Gutted Weight/Total Weight.

1994 (January-June)

1994 (July-December)

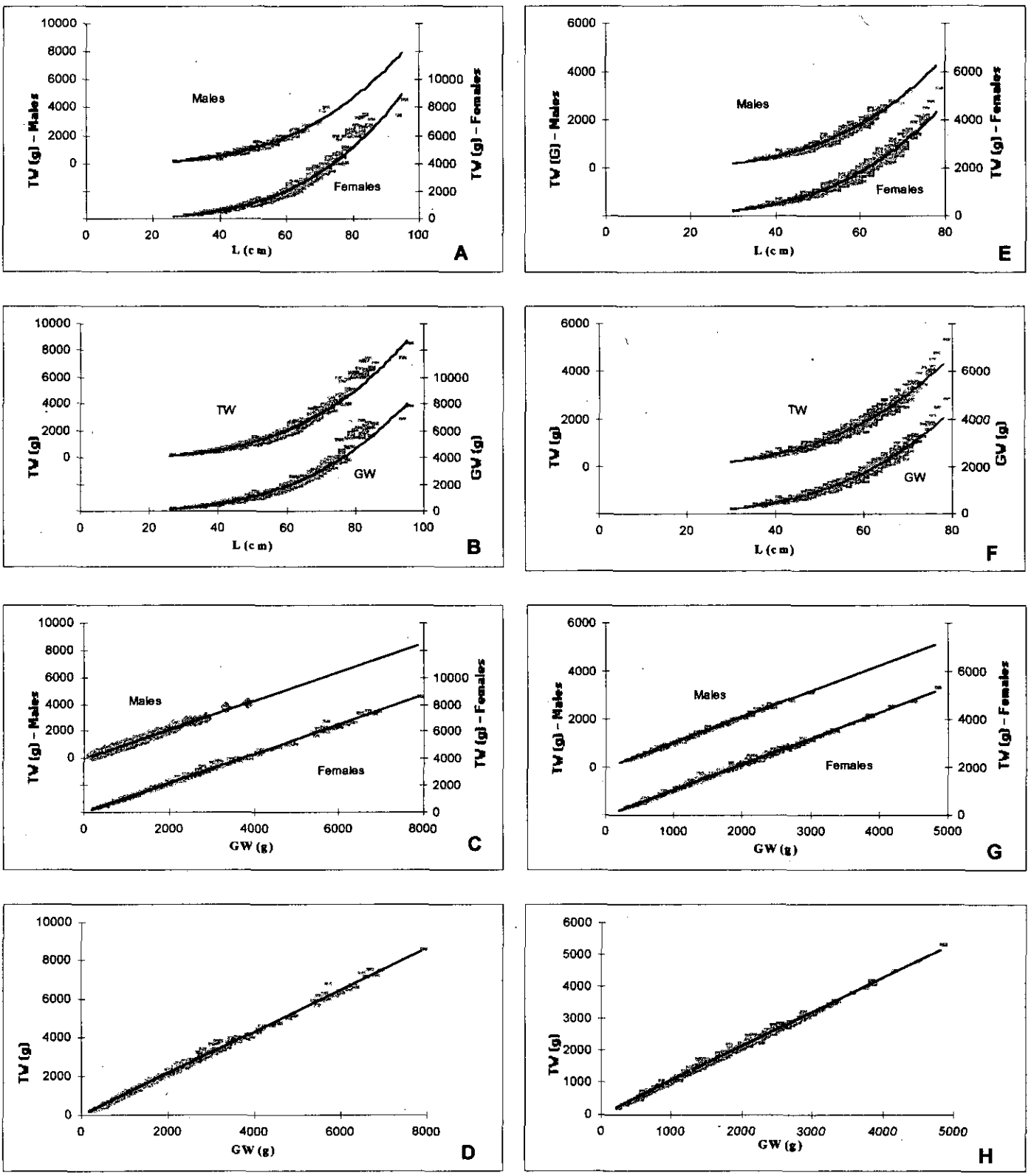


Figure 7.- Length/Weight and Gutted Weight/Total Weight relationships by sex and combined for *Reinhardtius hippoglossoides* in **division 3M** during January - June 1994 (A, B, C, D) and July - December 1994 (E, F, G, H): A,E: Length/Total Weight by sex. B,F: Length /Total Weight and Length /Gutted Weight. C,G: Gutted Weight/Total Weight by sex. D,H: Gutted Weight/Total Weight.

1994 (January-June)

1994 (July-December)

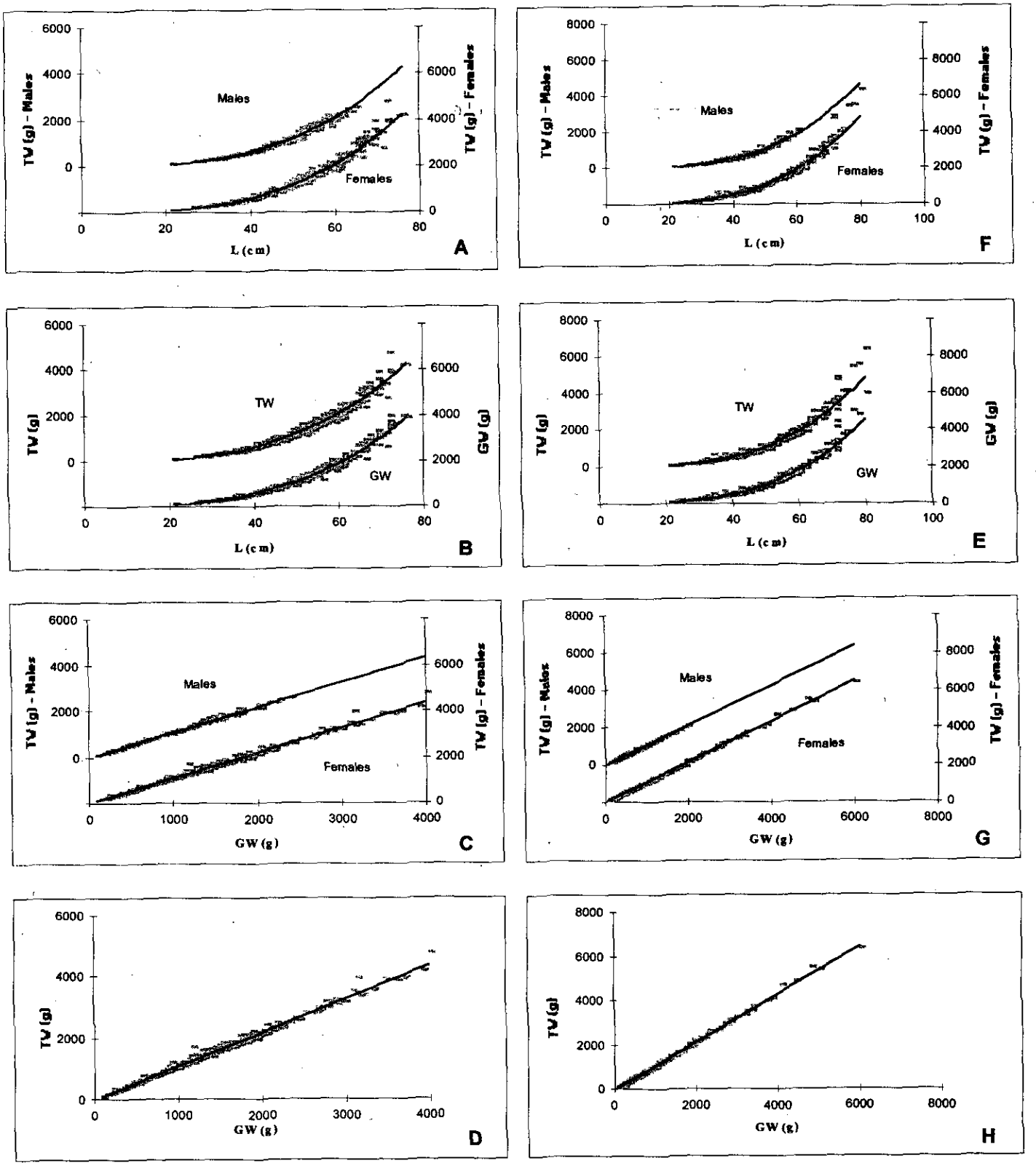
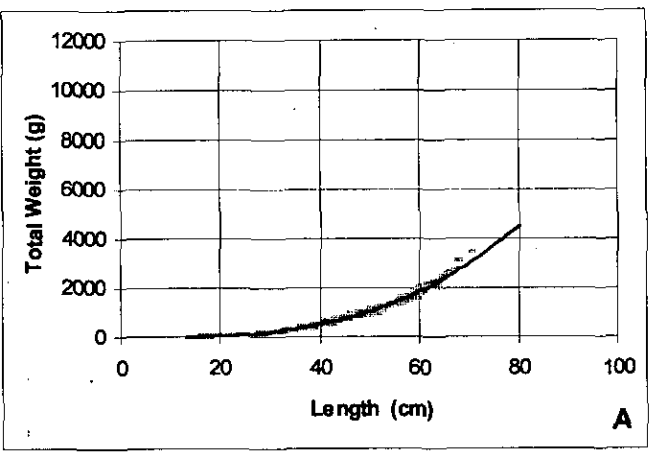
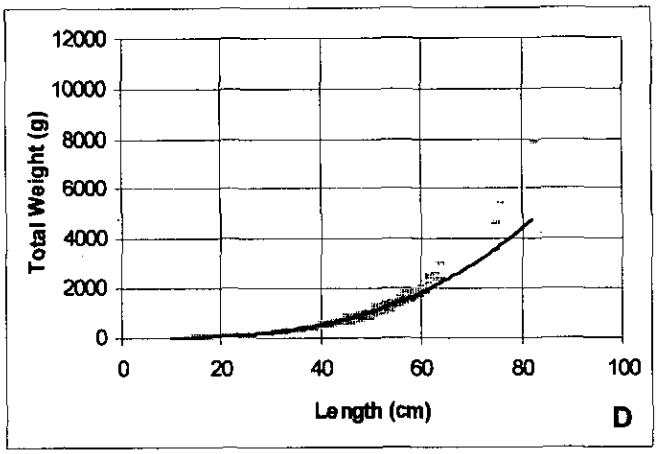


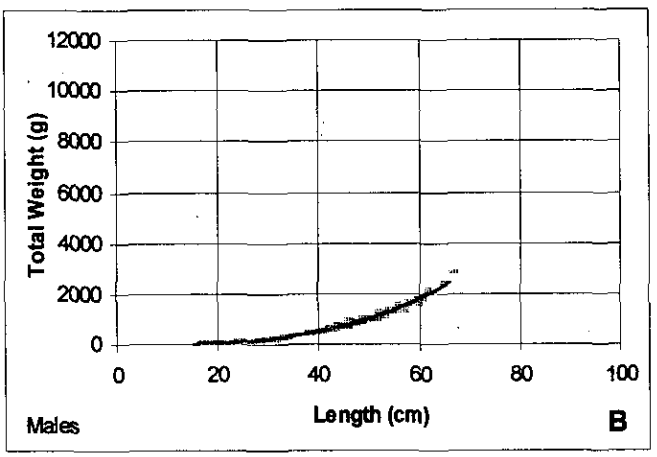
Figure 8.- Length/Weight and Gutted Weight/Total Weight relationships by sex and combined for *Reinhardtius hippoglossoides* in **division 3NO** during January - June 1994 (A, B, C, D) and July - December 1994 (E, F, G, H): A,E: Length/Total Weight by sex. B,F: Length /Total Weight and Length /Gutted Weight. C,G: Gutted Weight/Total Weight by sex. D,H: Gutted Weight/Total Weight.

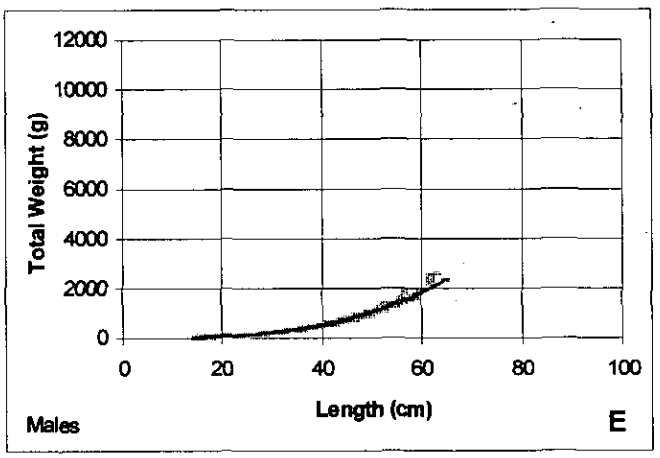
1995 (July)

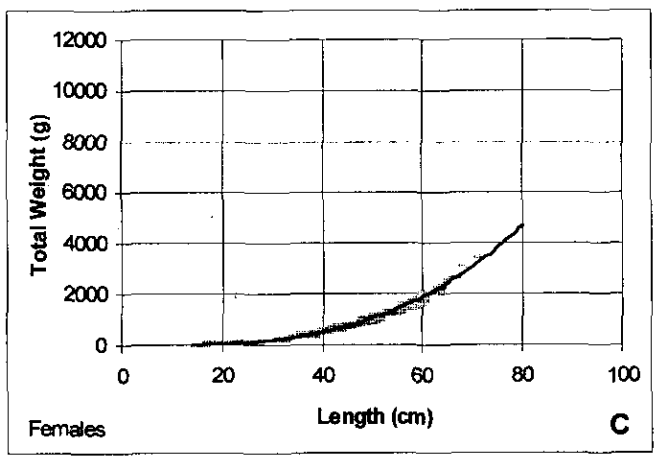
1996 (July)











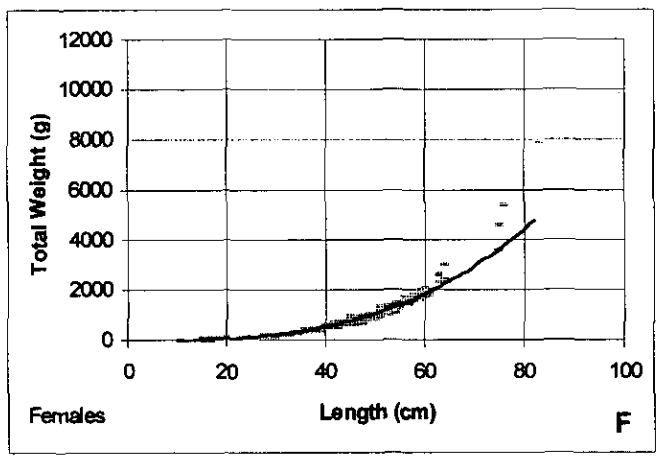


Figure 9.- Length/Weight relationships for *Reinhardtius hippoglossoides* in Flemish Cap (Div. 3M) during July 1995 (A, B, C) and July 1996 (D, E, F): A,D: Length/Total Weight B,E: Length /Total Weight by males C,F: Length/Total Weight by females.

1995 (July) 1996 (July)

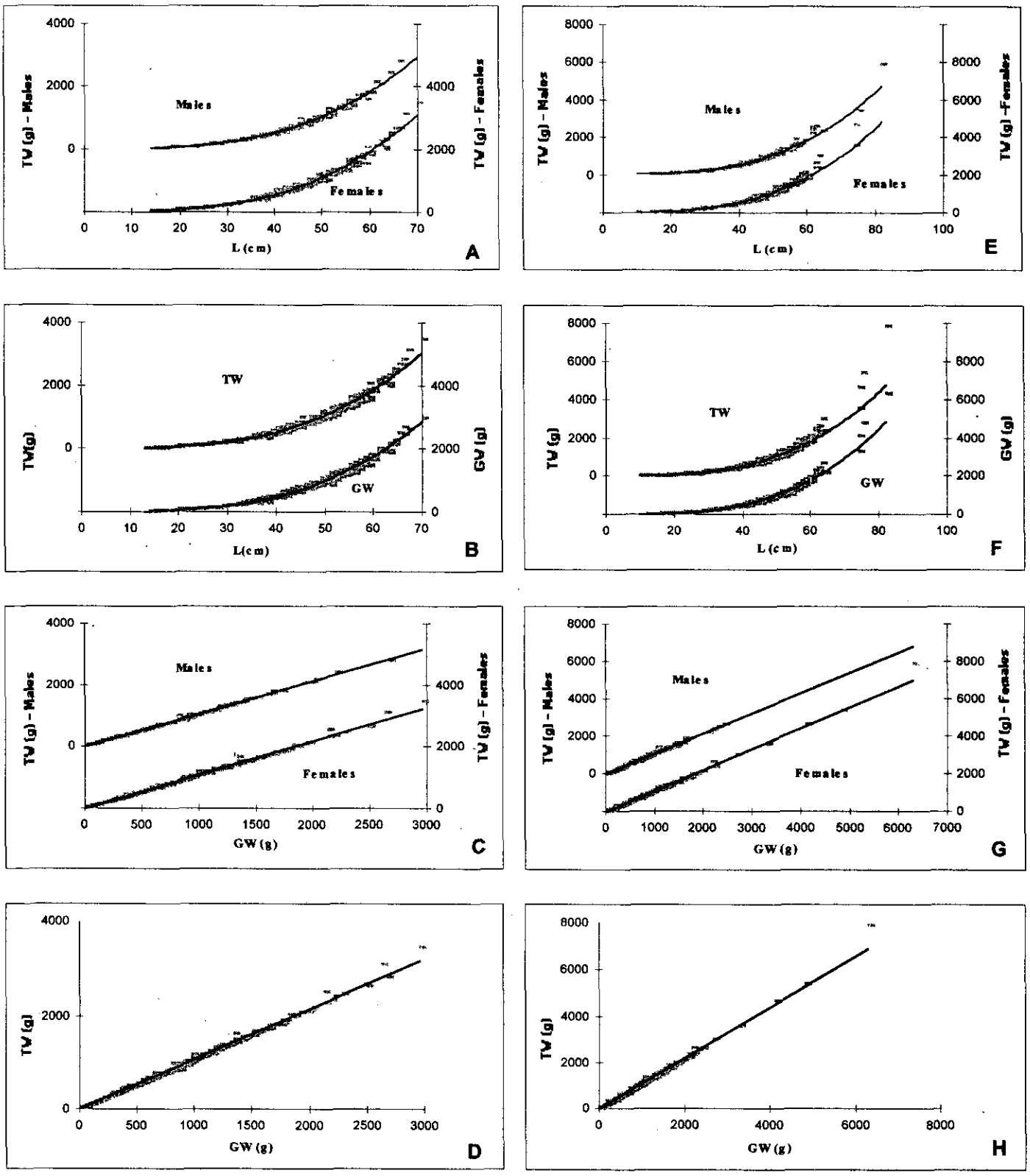


Figure 10.- Length/Weight and Gutted Weight/Total Weight relationships by sex and combined for *Reinhardtius hippoglossoides* in **Flemish Cap** (Division 3M), during July 1995 (A, B, C, D) and July 1996 (E, F, G, H): A,E: Length/Total Weight by sex. B,F: Length /Total Weight and Length /Gutted Weight. C,G: Gutted Weight/Total Weight by sex. D,H: Gutted Weight/Total Weight.