Advisory Committee on Fishery Management

ICES CM 1997/Assess:16

REPORT OF THE

MULTISPECIES ASSESSMENT WORKING GROUP

ICES Headquarters
11–19 August 1997

PART 2 OF 2

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK-1261 Copenhagen K Denmark

Table 3.2.2.2.3-1 Frequencies of occurrence of various magnitudes of differences in suitabilities between runs using only 1981 stomach data and only 1991 stomach data. Four replicated predators presented separately.

MAGNITUDE OF CHANGE IN SUITABILITY	COD	WHITING	SAITHE	HADDOCK
>-.4	1	2	11	15
-.2 to -.4	5	15	45	34
-.1 to -.2	25	32	40	28
-.05 to -.1	40	27	15	7
-.01 to -.05	85	64	36	10
-.005 to -.01	50	19	27	2
-.001 to -.005	72	20	8	1
0 to -.001	40	12	0	1
0 to +.001	20	4	0	7
+.001 to .005	31	13	10	6
+.005 to .01	50	33	10	9
+.01 to .05	108	81	29	6
+.05 to .1	57	46	19	14
+.1 to .2	27	19	16	26
+.2 to .4	9	7	3	9
>.4	0	2	8	2

Table 3.2.2.2.3-2 Frequencies of occurrence of various magnitudes of differences in m2 between runs using only 1981 stomach data and only 1991 stomach data. Four replicated predators presented separately.

MAGNITUDE OF CHANGE IN M2	COD	WHITING	SAITHE	HADDOCK
>-.2	0	6	0	0
-.1 to -.2	2	10	0	0
-.05 to -.1	9	15	3	4
-.01 to -.05	64	26	14	9
-.005 to -.01	45	26	14	9
-.001 to -.005	101	42	53	16
0 to -.001	201	170	97	65
0 to +.001	143	42	50	52
+.001 to .005	55	25	29	6
+.005 to .01	6	10	6	0
+.01 to .05	17	4	8	1
+.05 to .1	2	10	6	0
+.1 to .2	1	4	1	0
>+.2	1	0	0	0

Table 3.2.2.2.3-3 1981 run vs. 1991 run. Linear models fitting the change in suitability and M2 to the change in predator biomass. Models with both overall slope and with separate slopes for each predator are fit. Where significant fits were found, table entries are percent of variance explained, and, for separate slopes model, the species with significant parameter estimates. Changes are expressed as both absolute value (tonnes) and percent of mean biomass of the two runs.

Change in:	suit	M2
Predator biomass	**NO**	**.015 (+)**
Prey biomass	**NO**	**.013 (-)**
% Predator biomass	**NO**	**.014 (+)**
% Prey Biomass	**.012 (+)**	**.023 (-)**

Separate slopes:

Predator biomass	**NO**	**.072 (+ Whiting)**
Prey biomass	**.041 (+ Sandeel)**	**.038 (- Herring)**
% Predator biomass	**NO**	**.071 (+ Whiting)**
% Prey biomass	**.043 (+ Sandeel)**	**.058 (- Herring)**

Fixed effects model:	**.250**	**.176**
Quarter	**NO**	**.025 (+ Fourth quarter)**
Predator species	**.012 (- Whiting - Saithe)**	**.016 (+ Haddock)**
Prey species	**.020 (- Whiting - Norway Pout + Haddock)**	**NO**
Predator * Prey	**.137**	**NO**
Quarter * Predator	**.060**	**.0657 (-Whiting, 2nd quarter)**
Quarter * Prey	**NO**	**NO**

Table 3.2.3.1 Frequencies of occurrence of various magnitudes of differences in suitabilities and M2 between KEYRUN and run with only five traditional predators. Frequencies for all predators combined.

MAGNITUDE OF CHANGE IN SUITABILITY	FREQUENCY OF OCCURRENCE	MAGNITUDE OF CHANGE IN M2	FREQUENCY OF OCCURRENCE
> -.20	5	>-. 50	1
--.10 to -.20	10	-.20 to -.5-	0
-.05 to -.10	1	-.10 to -.20	4
-.01 to -.05	4	-.05 to -.10	16
-.005 to -.01	11	-.01 to -.05	58
-.001 to -.005	16	-.005 to -.01	40
0 to -.001	24	-.0001 to -.005	119
0. to .001	62	0 to -.0001	254
+.001 to .005	87	+0 to .0001	101
+.005 to .01	171	+.0001 to .005	411
+.01 to .05	473	+.005 to .001	67
+.05 to .1	242	+.001 to .05	118
+.1 to .2	143	+.05 to .1	33
+.2 to .5	90	+.1 to.2	18
>.5	13	>.2	14

Table 3.2.3.2 Keyrun vs. 5 predators run. Linear models fitting the change in suitability and M2 to the change in predator biomass. Models with both overall slope and with separate slopes for each predator are fit. Where significant fits were found, table entries are percent of variance explained, and, for separate slopes model, the species with significant parameter estimates. Changes are expressed as both absolute value (tonnes) and percent of mean biomass of the two runs.

Change in:	suit	M2
Predator biomass	**.007 (+)**	**.011 (+)**
Prey biomass	**NO**	**NO**
% Predator biomass	**.011 (+)**	**.010 (+)**
% Prey Biomass	**NO**	**NO**

Separate slopes:

Predator biomass	**.239 (- all predators)**	**.031 (+ Whiting + Haddock)**
Prey biomass	**.059 (- Haddock)**	**.028 (+ Herring)**
% Predator biomass	**.241 (- all predators)**	**NO**
% Prey biomass	**.071 (- Haddock)**	**.030 (+ Herring - Norway Pout)**

Fixed effects model:	**.053**	**.086**
Predator species	**.048**	**.077**
Prey species	**NO**	**NO**
Predator * Prey	**NO**	**.006**

Table 3.2.4.1 Frequencies of occurrence of various magnitudes of differences in suitabilities and M2 between KEYRUN and run with horse mackerel added. All predators combined.

MAGNITUDE OF CHANGE IN SUITABILITY	FREQUENCY OF OCCURRENCE	MAGNITUDE OF CHANGE IN M2	FREQUENCY OF OCCURRENCE
> -0.4	6	> -.4	1
-.2 to 0.4	5	-.2 to -.4	0
-.1 to -.2	6	-.1 to -.2	1
-.05 to -.1	18	-.05 to -.1	1
-.01 to -.05	70	-.01 to -.05	3
-.005 to -.01	46	-.005 to -.01	4
-.001 to -.005	119	-.001 to -.005	21
0 to -.001	621	0 to -.001	383
0 to +.001	389	0.0 to +.0001	585
+.001 to .005	50	+.0001 to .001	110
+.005 to .01	24	+.001 to .005	53
+.01 to .05	41	+.005 to .01	33
+.05 to .1	9	+.01 to .05	49
+.1 to .2	18	+.05 to .1	20
+.2 to .4	4	+.1 to .2	5
>+.4	5	>+.2	6

Table 3.2.4.2 Keyrun vs. Horse Mackerel run. Linear models fitting the change in suitability and M2 to the change in predator biomass. Models with both overall slope and with separate slopes for each predator are fit. Where significant fits were found, table entries are percent of variance explained, and, for separate slopes model, the species with significant parameter estimates. Changes are expressed as both absolute value (tonnes) and percent of mean biomass of the two runs.

Change in:	suit	M2
Predator biomass	**.058 (+)**	**.030 (+)**
Prey biomass	**.021 (-)**	**NO**
% Predator biomass	**.036 (+)**	**.015 (+)**
% Prey Biomass	**NO**	**NO**

Separate slopes:

Predator biomass	**.201 (Horse Mackerel)**	**.161 (Horse Mackerel)**
Prey biomass	**.067 (Herring)**	**NO**
% Predator biomass	**.206 (Horse Mackerel)**	**.167 (Horse Mackerel)**
% Prey biomass	**.063 (Herring)**	**NO**

Fixed effects model:	**NO**	**.065**
Predator species	**NO**	**.031**
Prey species	**NO**	**NO**
Predator * Prey	**NO**	**.006**

Table 3.2.5.1 Frequencies of occurrence of various magnitudes of differences in suitabilities and M2 between KEYRUN and run with old consumption rates. All predators combined.

MAGNITUDE OF CHANGE IN SUITABILITY	FREQUENCY OF OCCURRENCE	MAGNITUDE OF CHANGE IN M2	FREQUENCY OF OCCURRENCE
> -0.04	4	> -.1	3
-.02 to -.04	49	-.05 to -.1	8
-.01 to -.02	61	-.01to -.05	39
-.005 to -.01	86	-.005 to -.01	31
-.001 to -.005	192	-.001 to -.005	110
-.0005 to -.001	70	-.0005 to -.001	54
-.0001 to -.0005	109	-.0001 to -.0005	107
0 to -.0001	121	0.0 to -.0001	129
0 to +.0001	54	0.0 to +.0001	279
+.0001 to .0005	140	+.0001 to .0005	171
+.0005 to .001	154	+.0005 to .001	72
+.001 to .005	217	+.001 to .005	118
+.005 to .01	63	+.005 to .01	44
+.01 to .02	48	+.01 to .05	68
>.02	1	>.05	14

Table3.2.5.2 Keyrun vs. old consumption run. Linear models fitting the change in suitability and M2 to the change in predator biomass. Models with both overall slope and with separate slopes for each predator are fit. Where significant fits were found, table entries are percent of variance explained, and, for separate slopes model, the species with significant parameter estimates. Changes are expressed as both absolute value (tonnes) and percent of mean biomass of the two runs.

Change in:	suit	M2
Predator biomass	**.011 (+)**	**.172 (+)**
Prey biomass	**.014 (-)**	**NO**
% Predator biomass	**.011 (+)**	**.132 (+)**
% Prey Biomass	**.052 (-)**	**NO**

Separate slopes:

Predator biomass	**.021 (+ Whiting)**	**.381 (+ Whiting - Haddock)**
Prey biomass	**.209 (- Haddock - Norway Pout)**	**NO**
% Predator biomass	**.022 (+ Whiting)**	**.349 (+ Whiting - Haddock)**
% Prey biomass	**.212 (- Haddock - Whiting - Norway Pout)**	**NO**

Fixed effects model:	**.018**	**.034**
Predator species	**NO**	**.029**
Prey species	**.010**	**NO**
Predator * Prey	**NO**	**NO**

Table 4.2.2.1 Sample input data from 'cannibalism' scenario.

Bmax		70 Rmax	100				
M2 at age	maturity	partial	weight at	m1 +	z	numbers	SSB
1	0	0	0.05	0.5066	0.5066	100	0
0.5	0	0.1	0.1	0.3533	0.3733	60.25	0
0.2	0	0.5	0.2	0.2613	0.3613	41.46	0
0.1	0.5	0.8	0.4	0.2307	0.3907	28.90	5.781
0	1	1	0.6	0.2	0.4	19.56	11.734
0	1	1	0.8	0.2	0.4	13.11	10.487
0	1	1	1	0.2	0.4	8.79	8.787
0	1	1	1.2	0.2	0.4	5.89	7.068
0	1	1	1.4	0.2	0.4	3.95	5.528

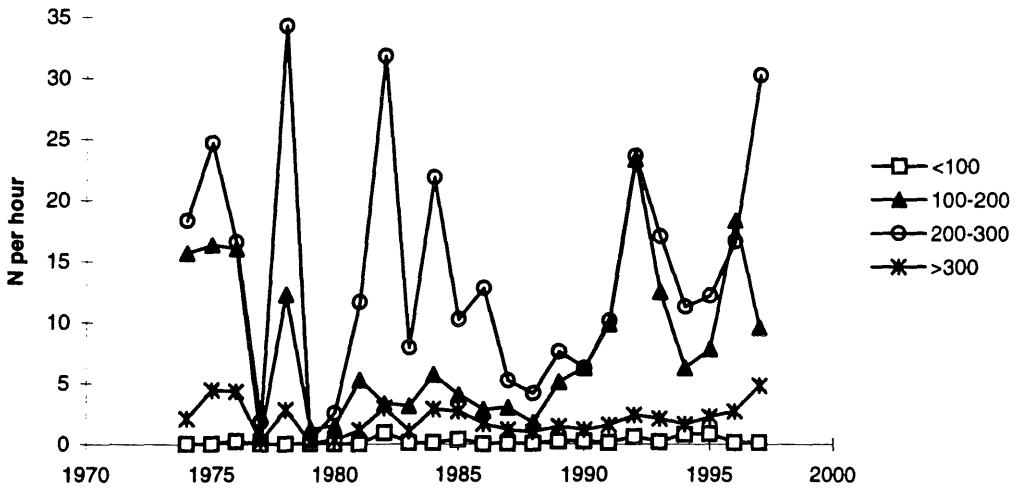
Table 4.2.2.2 Stock recruit parameters for the True and VPA estimated scenarios.

	Max Rec.	SSB at Max Rec.	a	b
True	100	70	3.88	.0143
All-age	54	40	3.67	.025
Sequential	40	61	1.81	.0165
Cannibalism	53	42	3.43	.0238

Figure 2.1.4.1.1

Survey indices of abundance of grey gurnard by size class (in mm) from the IBTS data

A. 1st quarter surveys by year



B. Means from quarterly surveys 1991-1995.

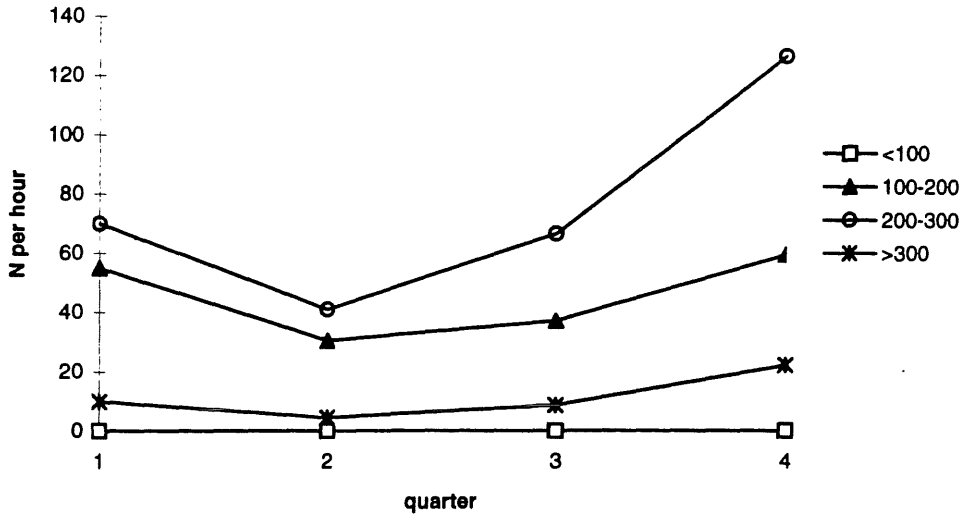


Figure 2.1.4.1.2

Estimated average biomass of grey gurnard by year corresponding to the quarterly input values of MSVPA (dots) based on IBTS data, compared to relative biomass estimates from EGFS (circles).

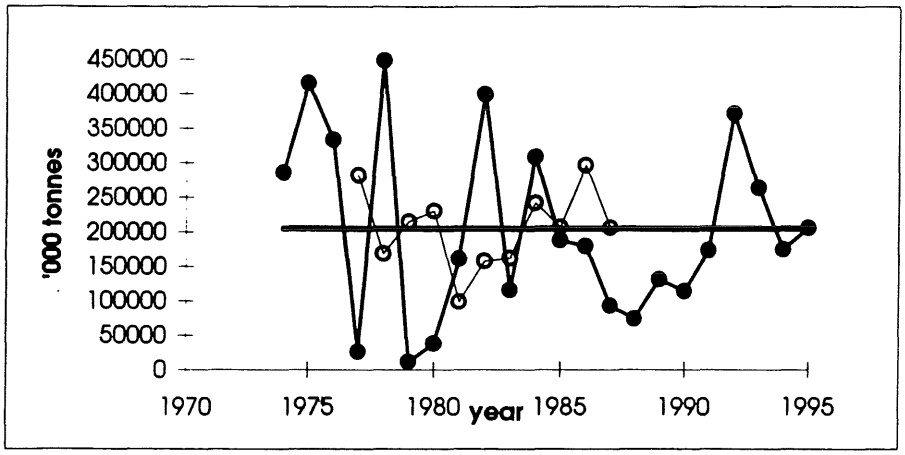
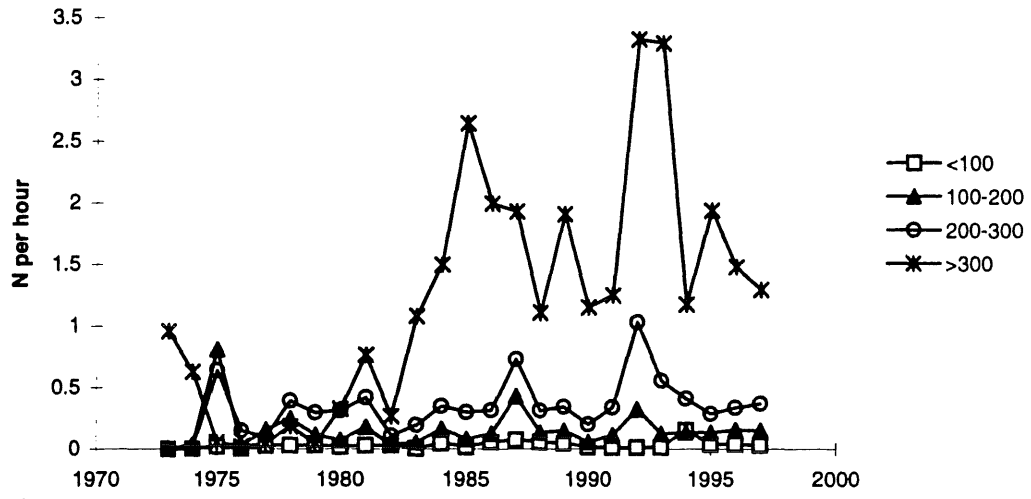


Figure 2.1.4.2.1 Survey indices of abundance of starry ray by size class (in mm) from the IBTS data.

A. 1st quarter surveys by year



B. Means from quarterly surveys 1991-1995.

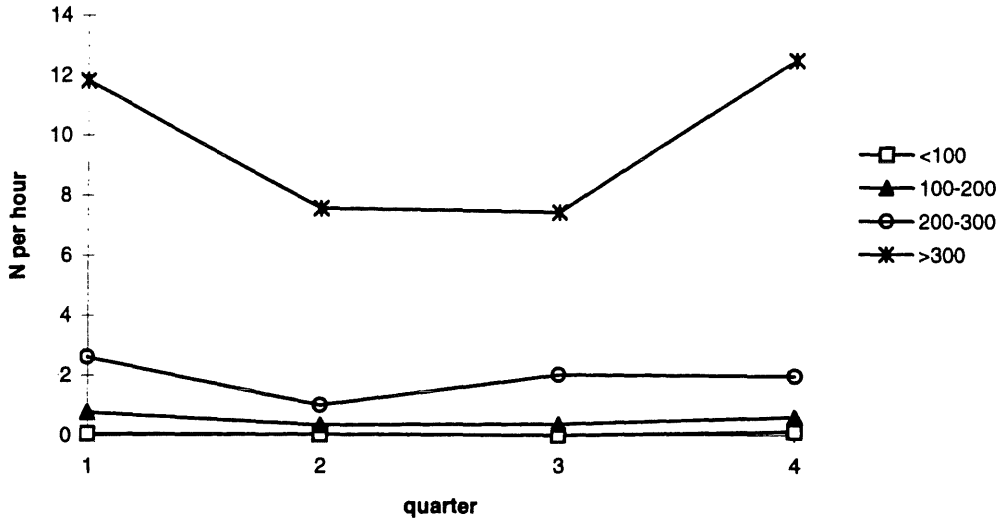


Figure 2.1.4.2.2

Estimated average biomass of starry ray by year corresponding to the quarterly input values of MSVPA (dots) based on IBTS data, compared to relative biomass estimates from EGFS (circles).

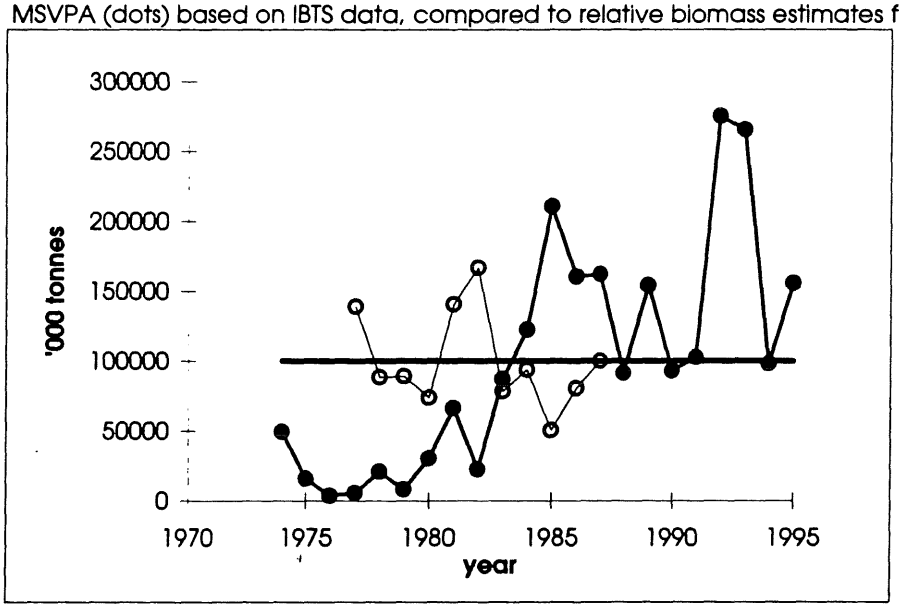


Figure 2.3.1

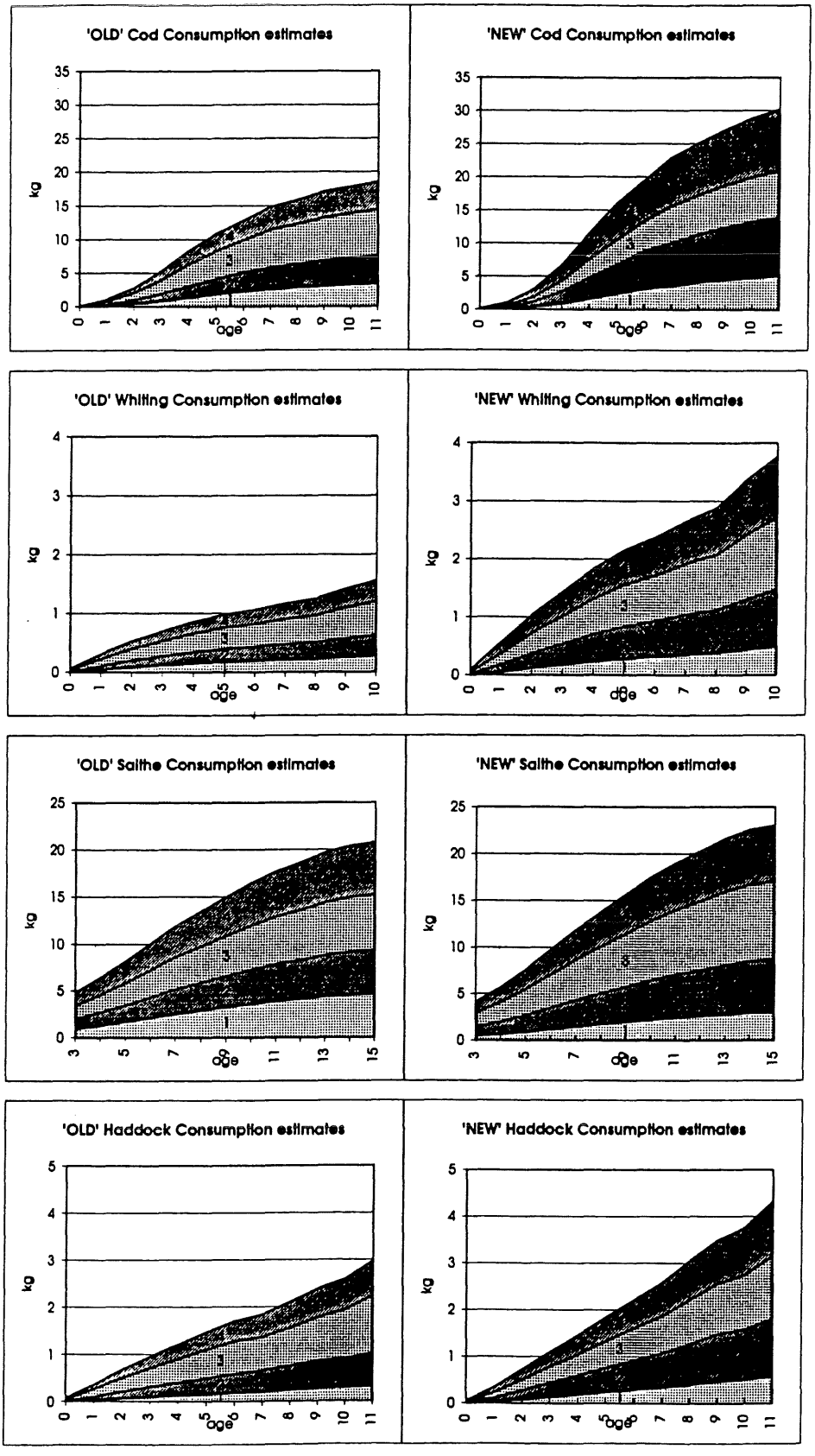

'OLD' Cod Consumption estimates
'NEW' Cod Consumption estimates
'OLD' Whiting Consumption estimates
'NEW' Whiting Consumption estimates
'OLD' Saithe Consumption estimates
'NEW' Saithe Consumption estimates
'OLD' Haddock Consumption estimates
'NEW' Haddock Consumption estimates
kg
age

Figure 2.4.1 Weight at age.

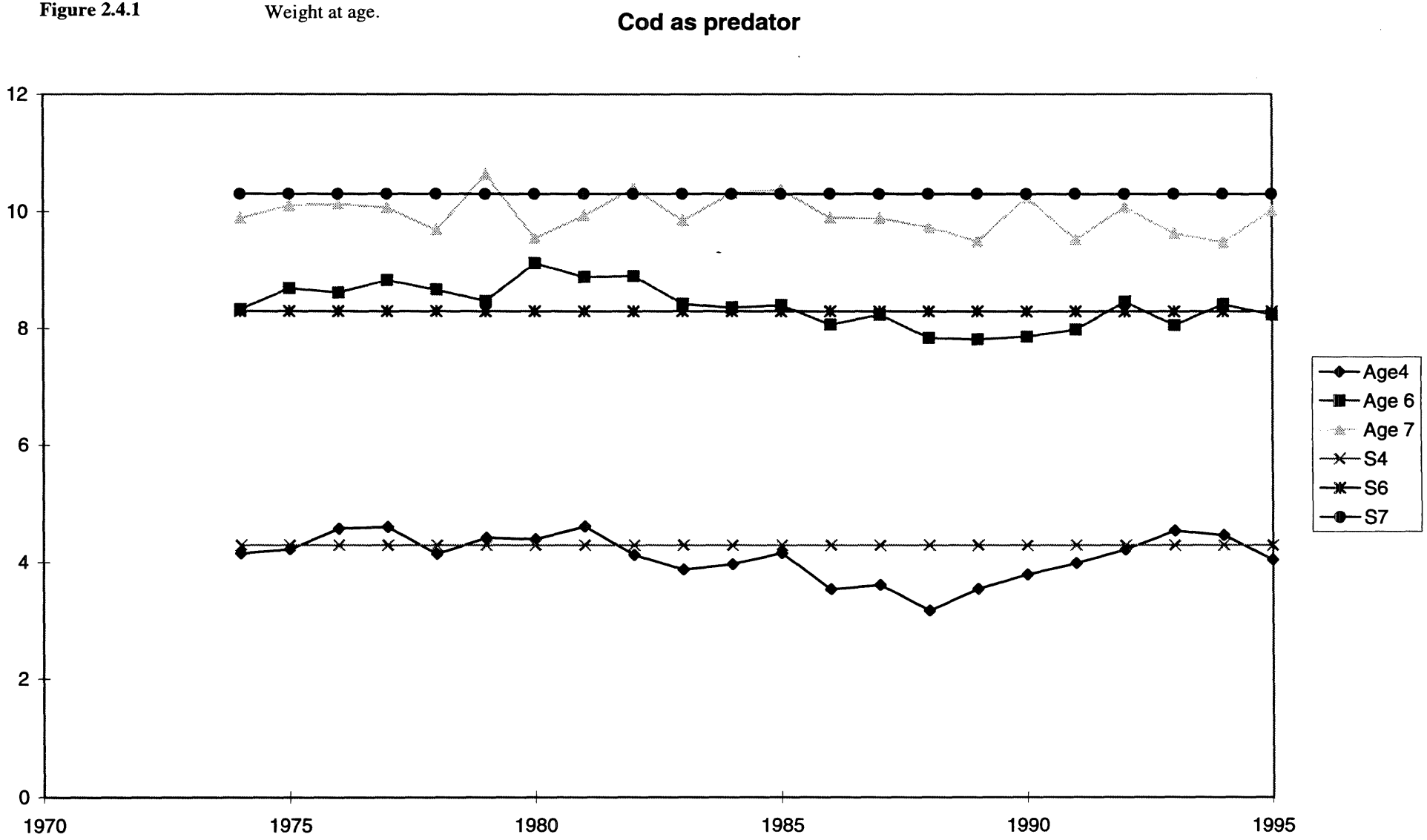


Figure 2.4.2 Weight at age.

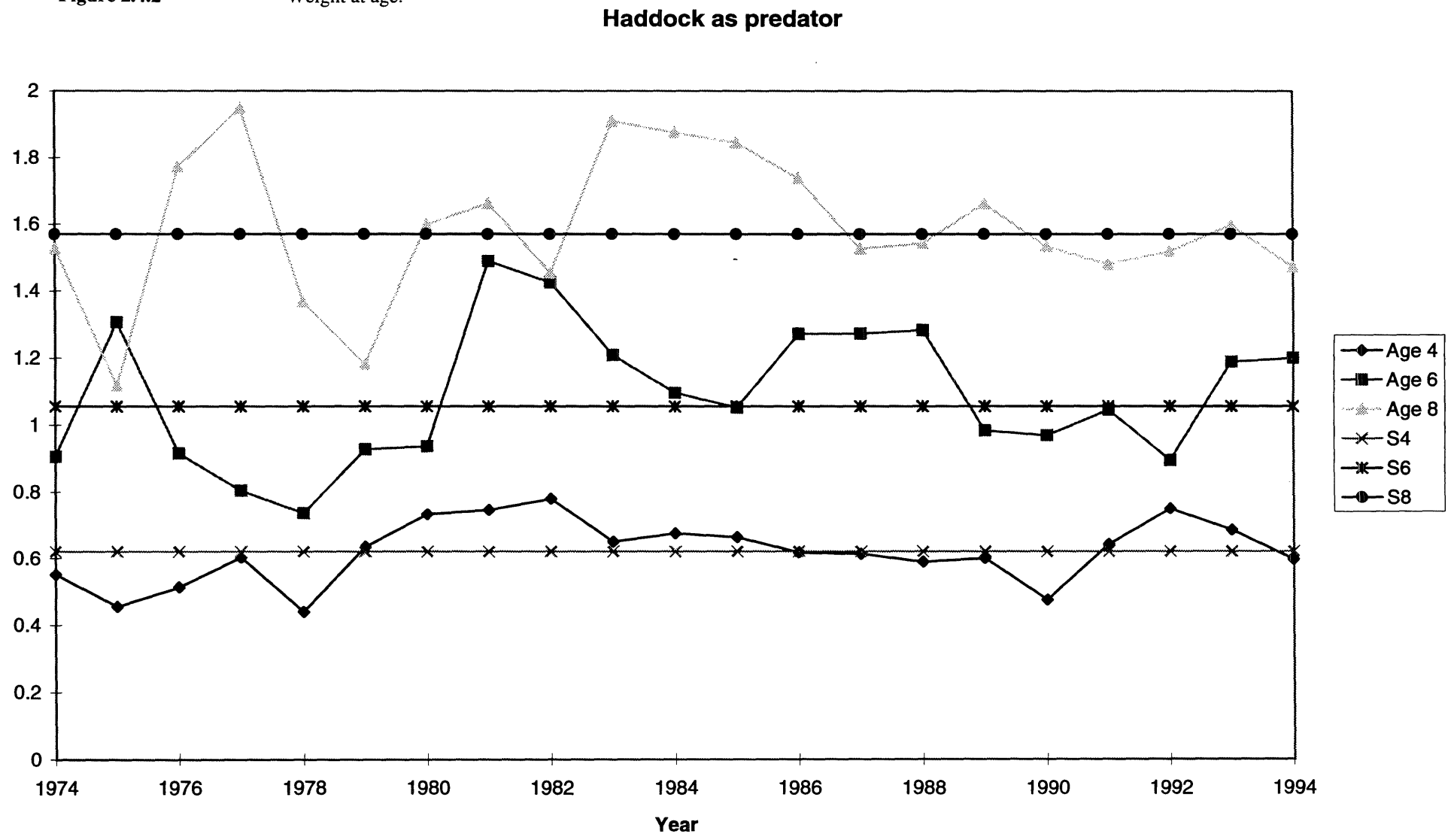


Figure 2.4.3 Weight at age.

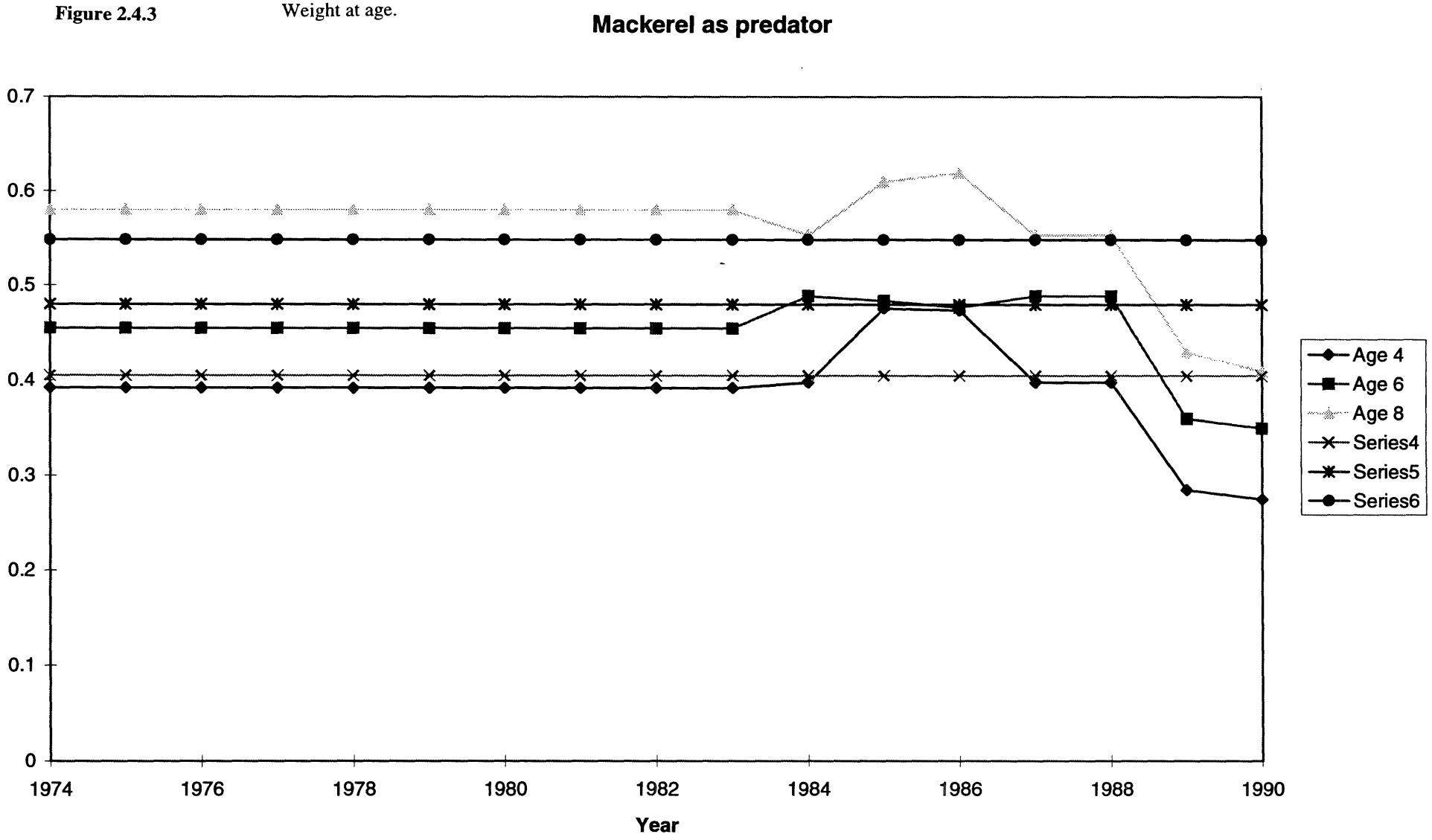


Figure 2.4.4 Weight at age.

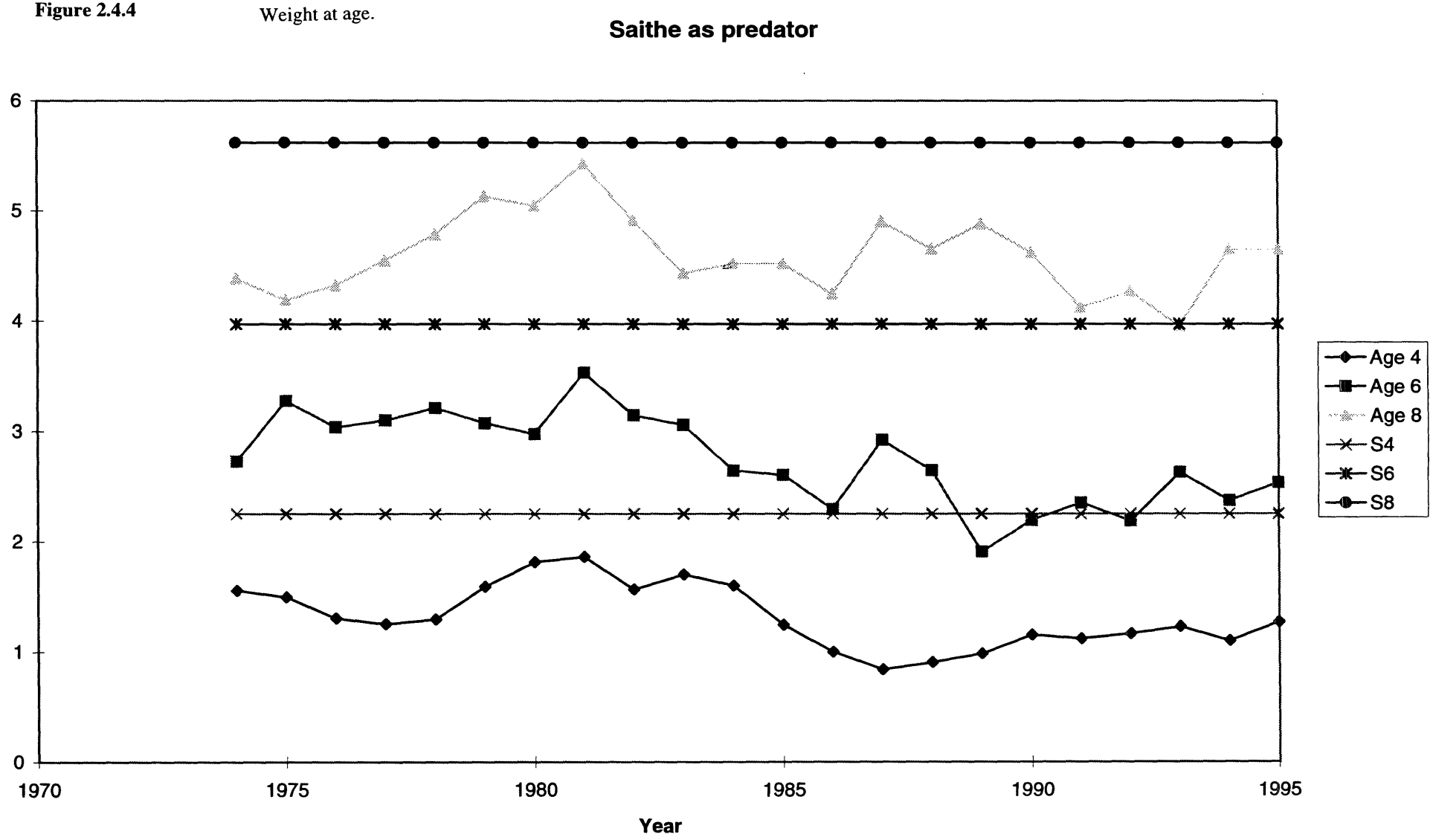


Figure 2.4.5 Weight at age.

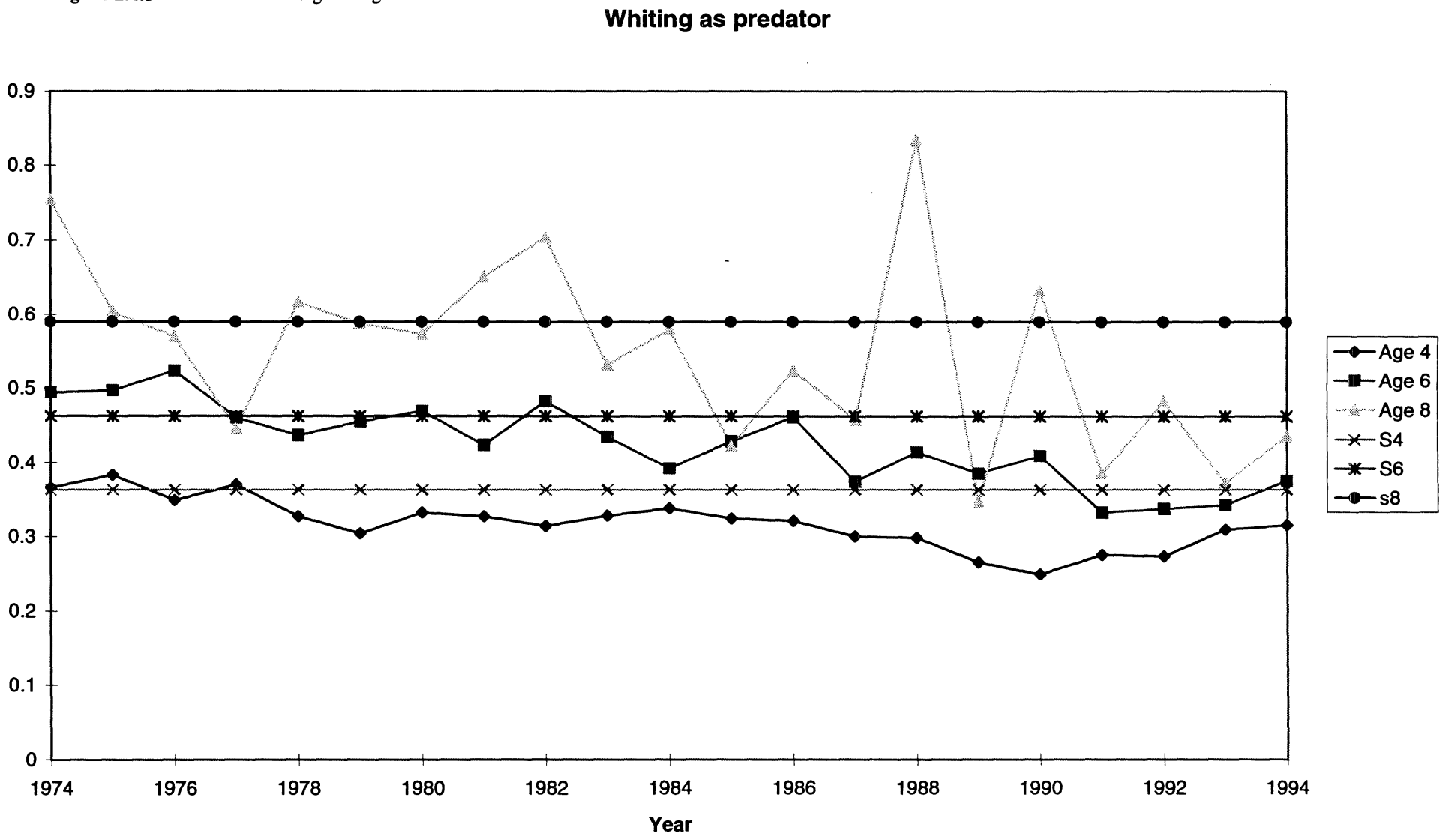


Figure 2.4.6 Weight at age.

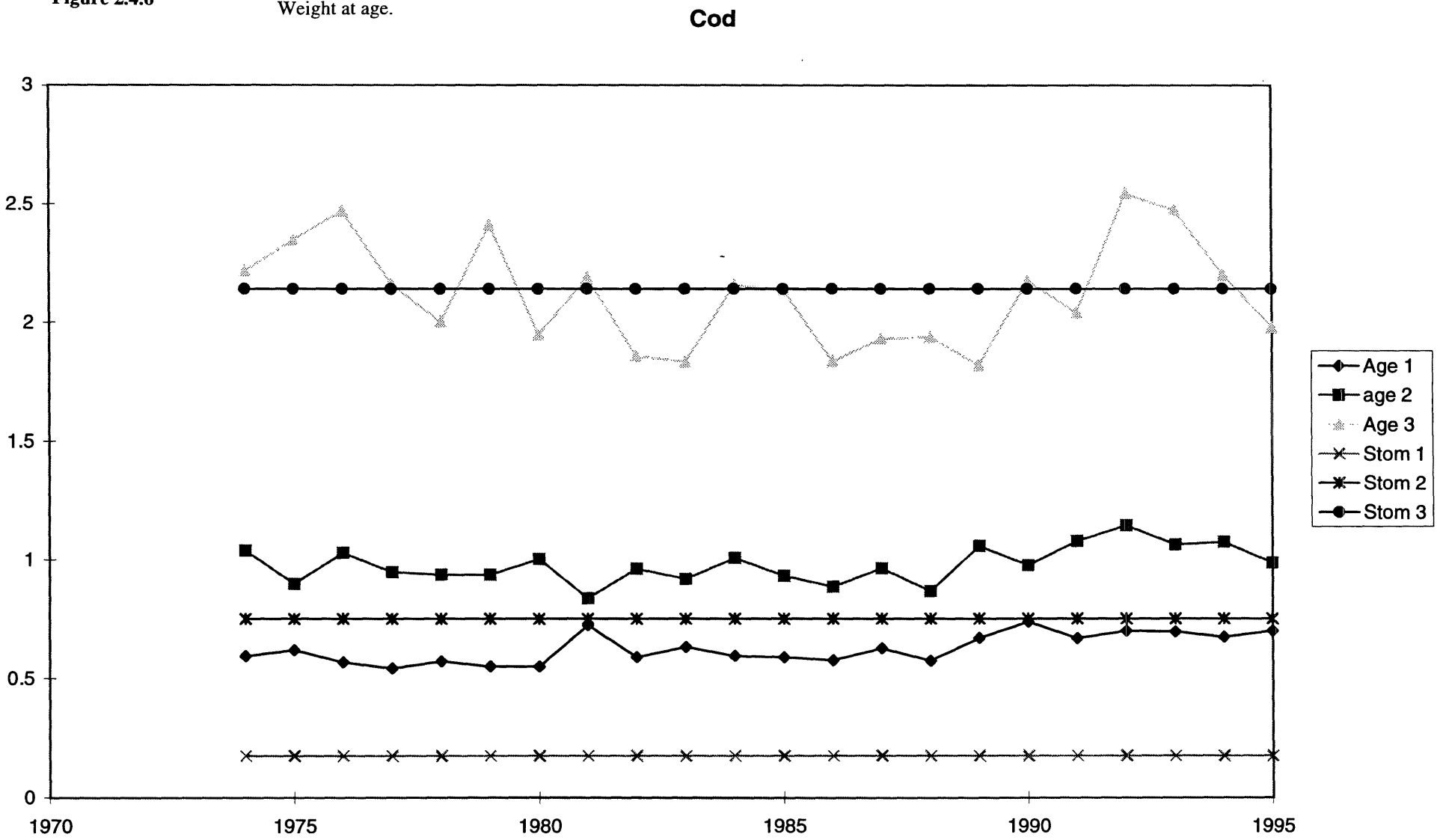


Figure 2.4.7 Weight at age.

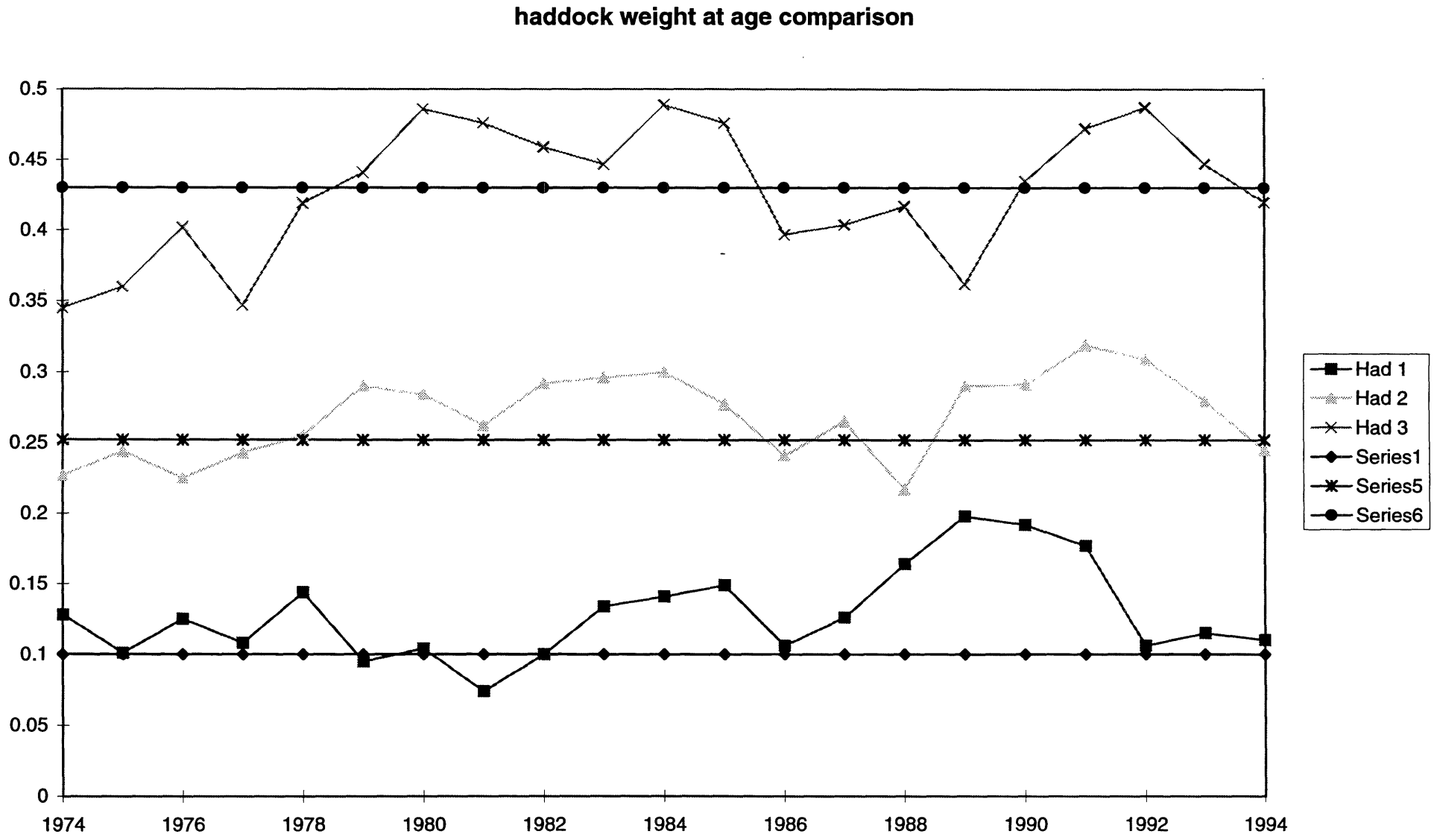


Figure 2.4.8 Weight at age.

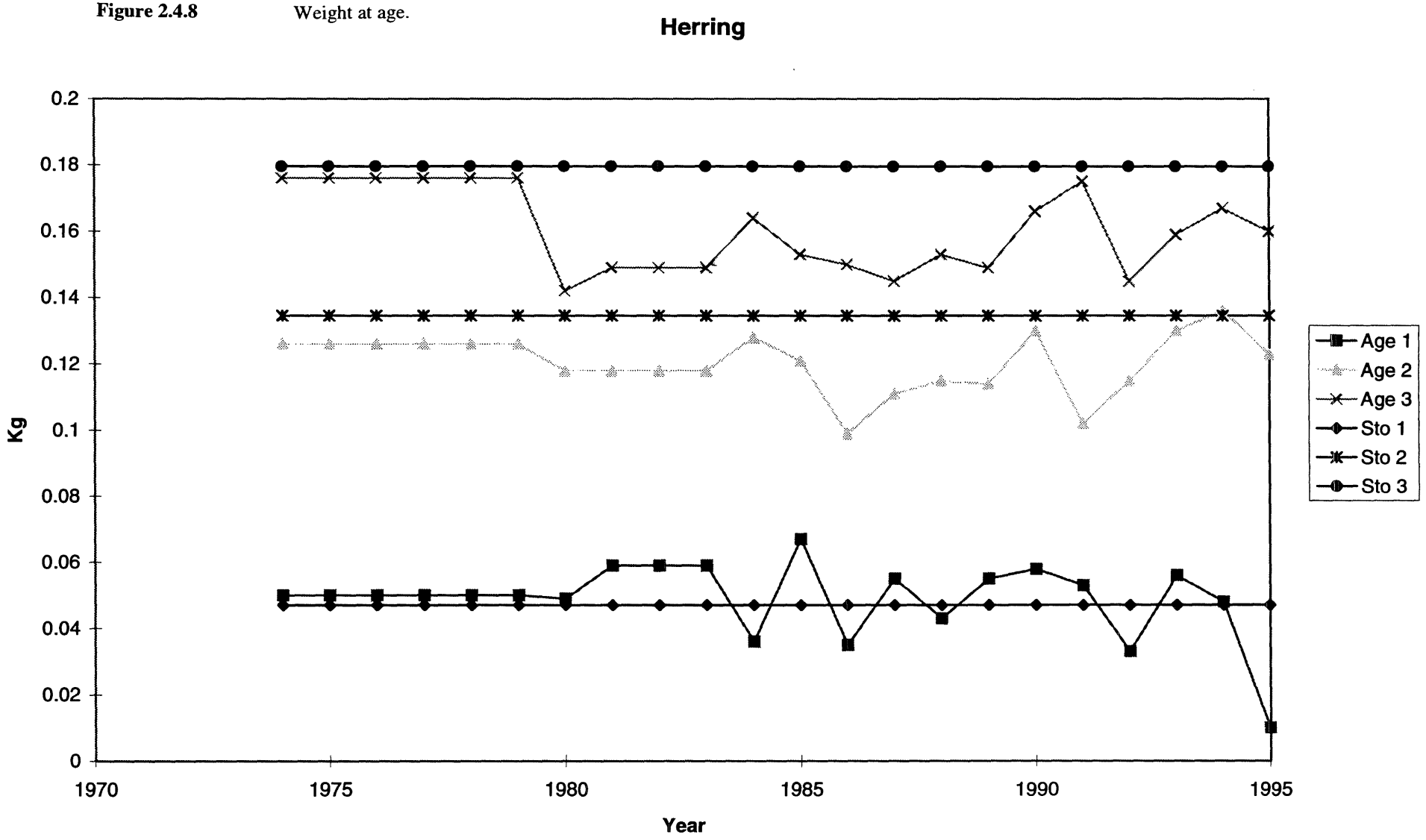


Figure 2.4.9 Weight at age.

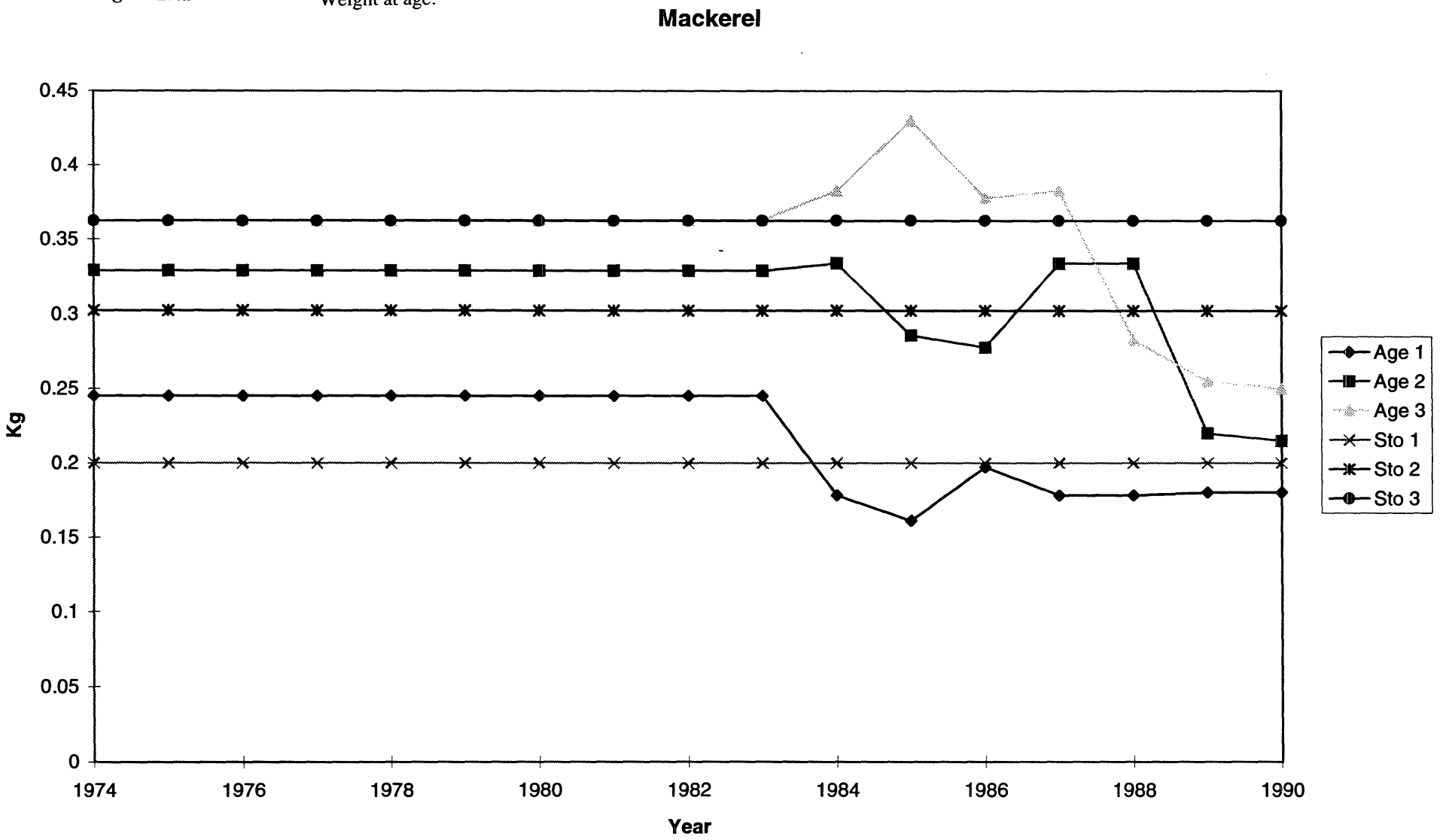


Figure 2.4.10 Weight at age.

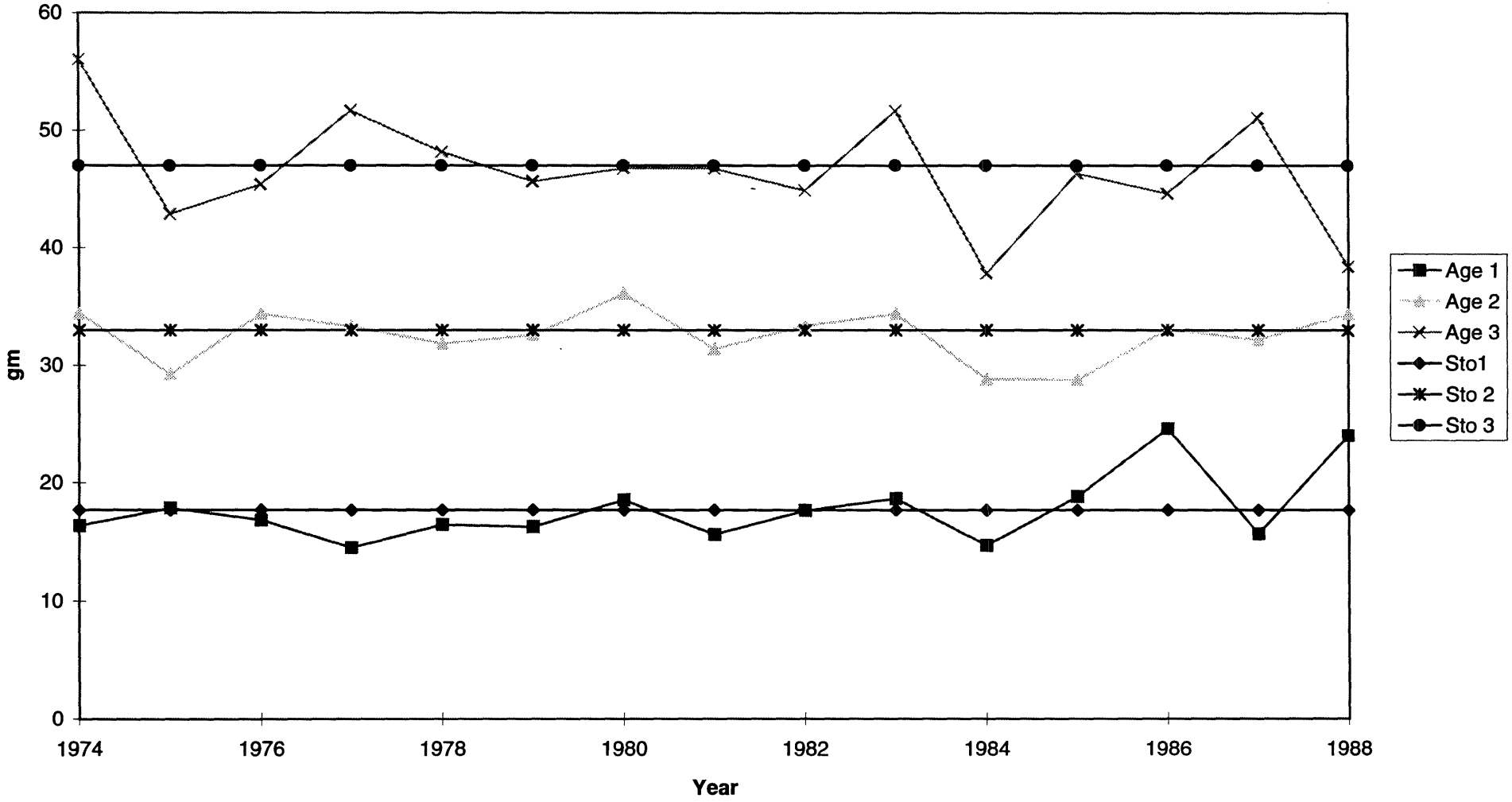


Figure 2.4.11 Weight at age.

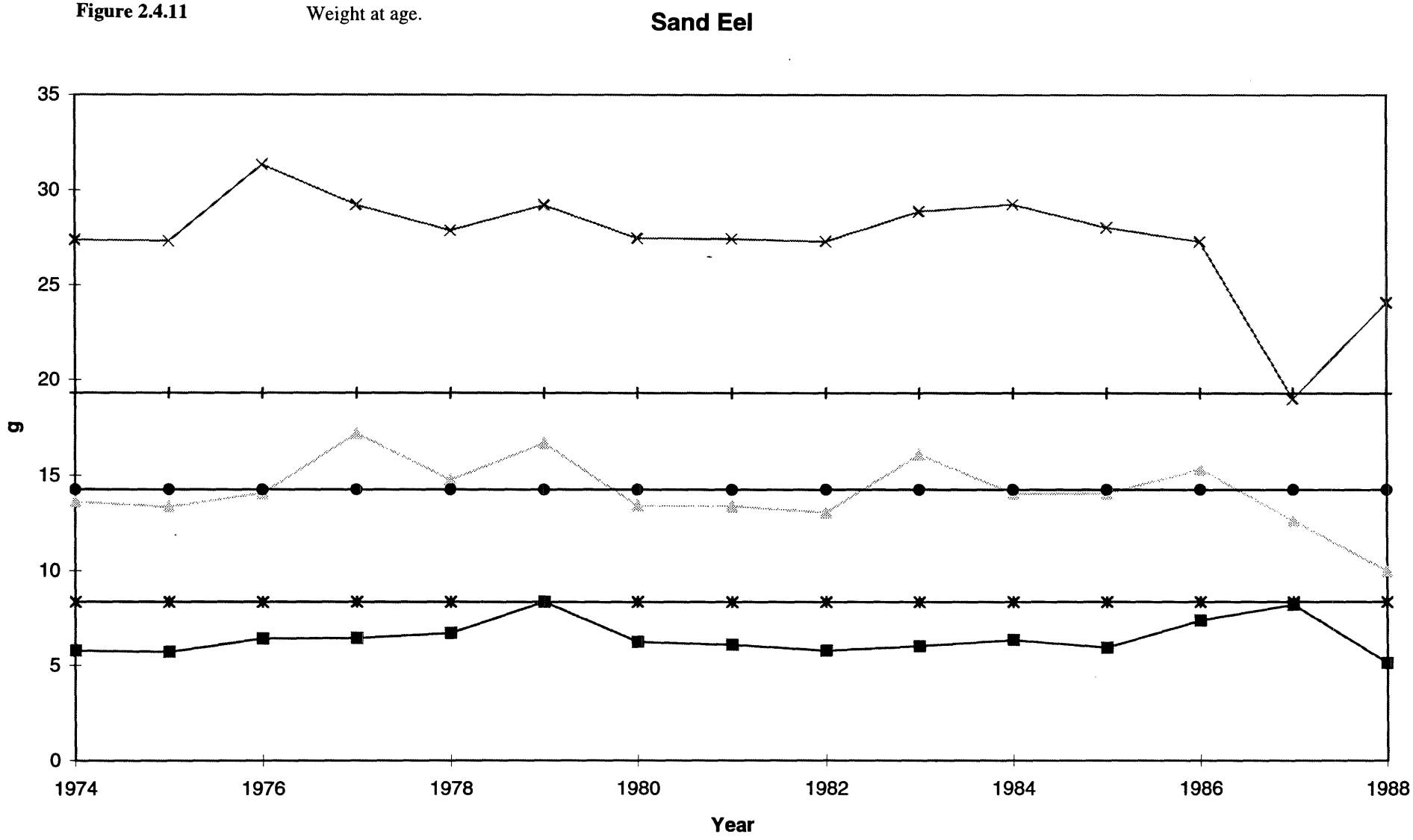


Figure 2.4.12 Weight at age.

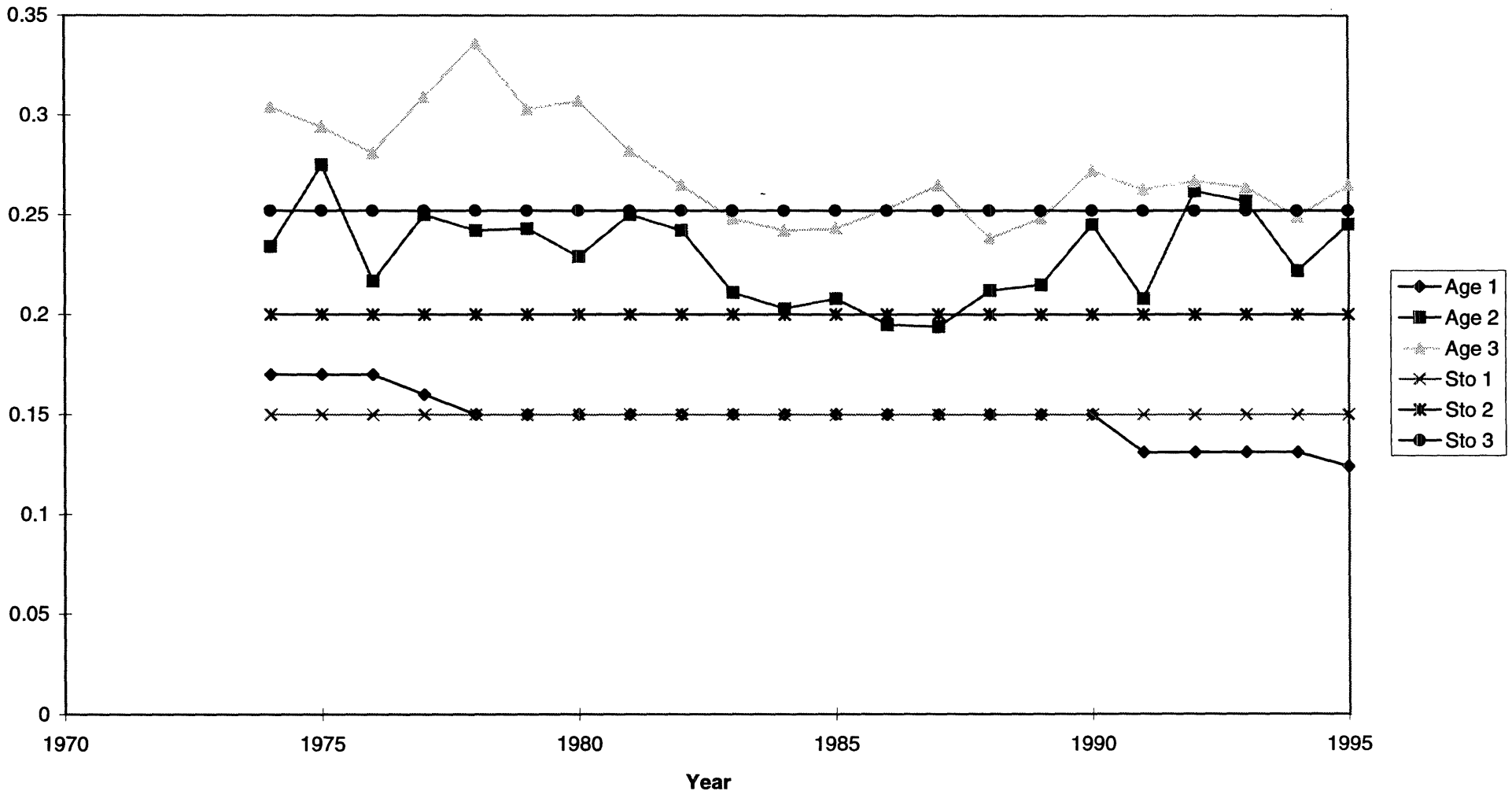


Figure 2.4.13 Weight at age.

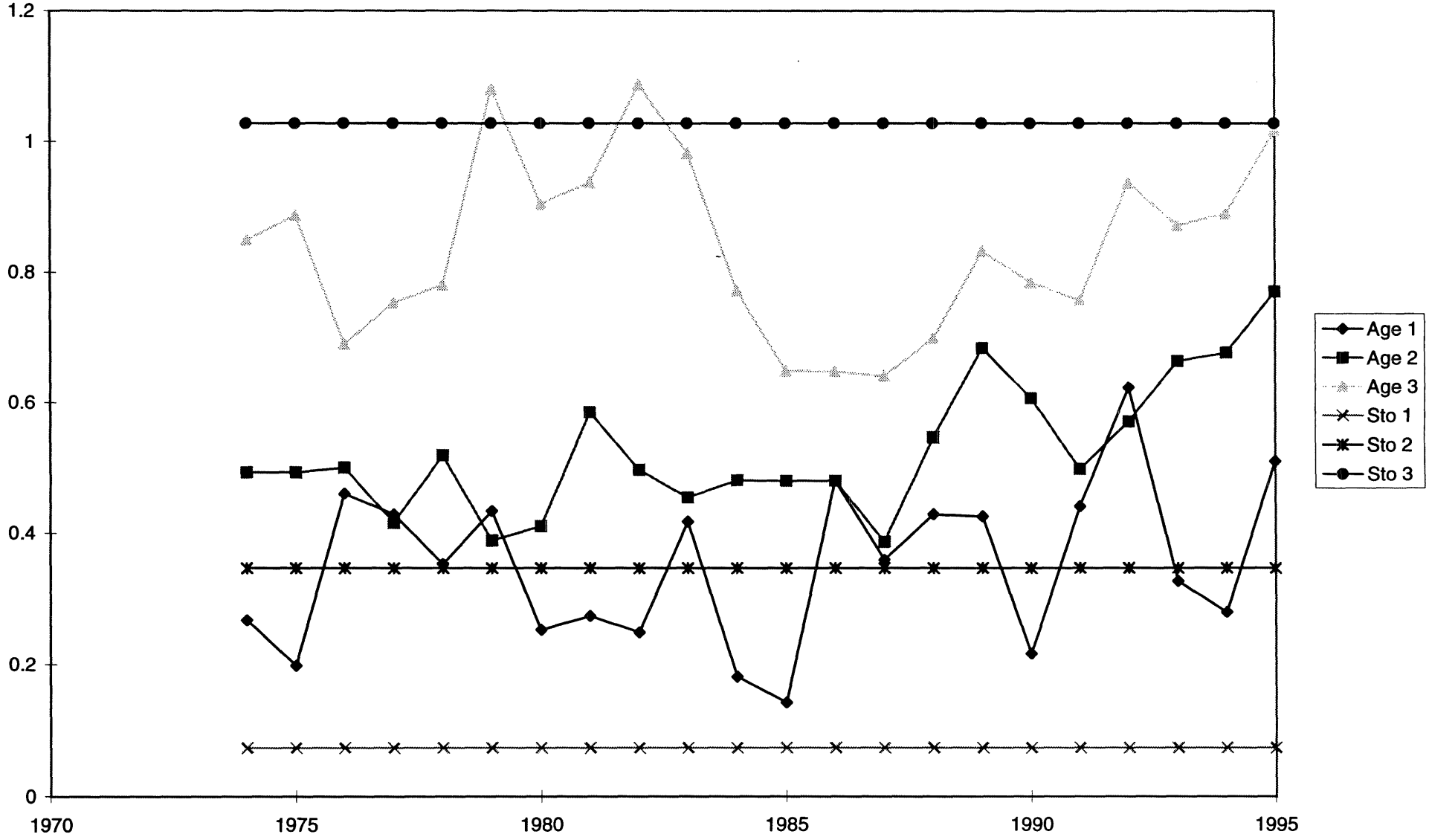


Figure 2.4.14 Weight at age.

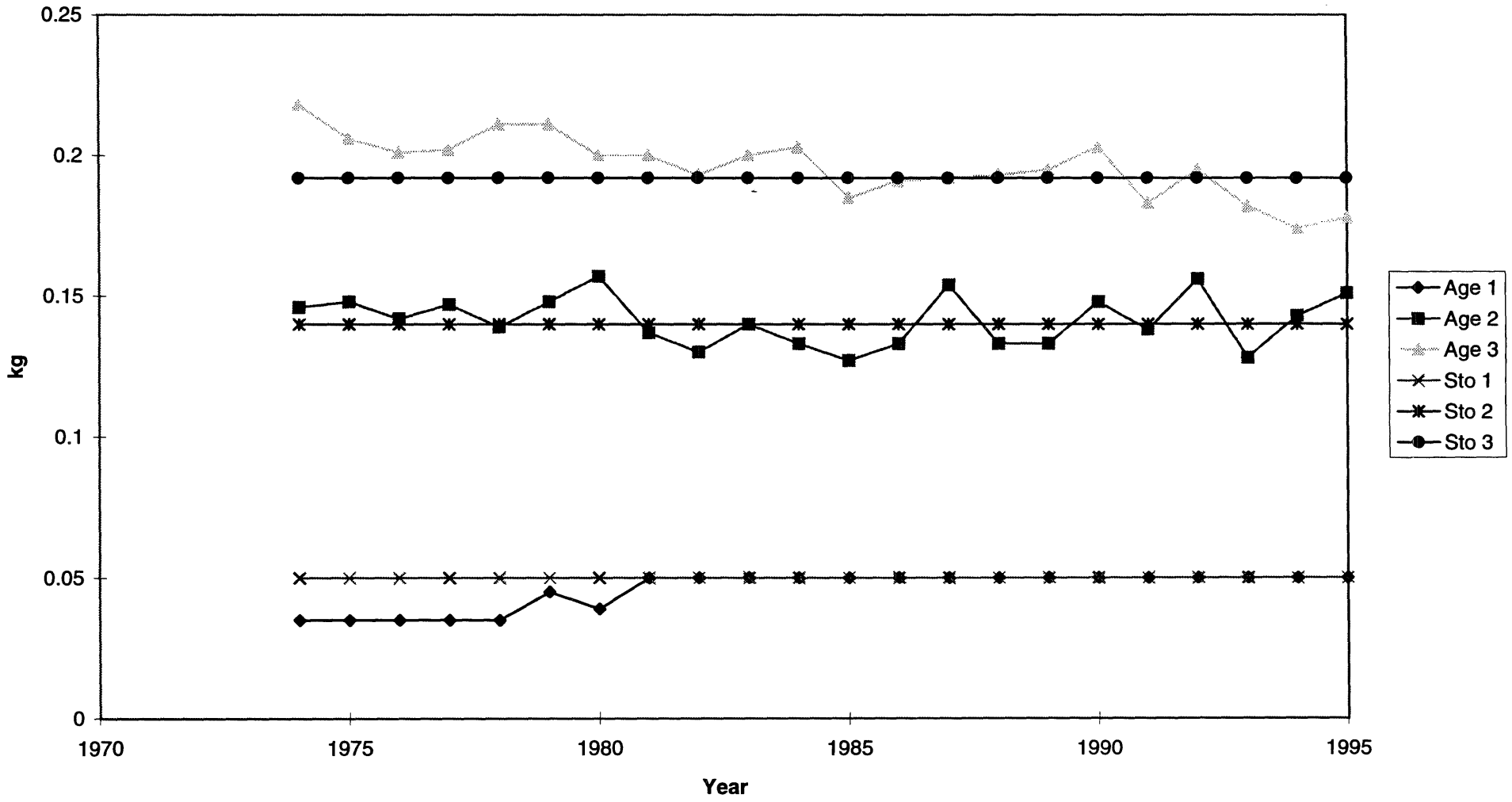


Figure 2.4.15 Weight at age.

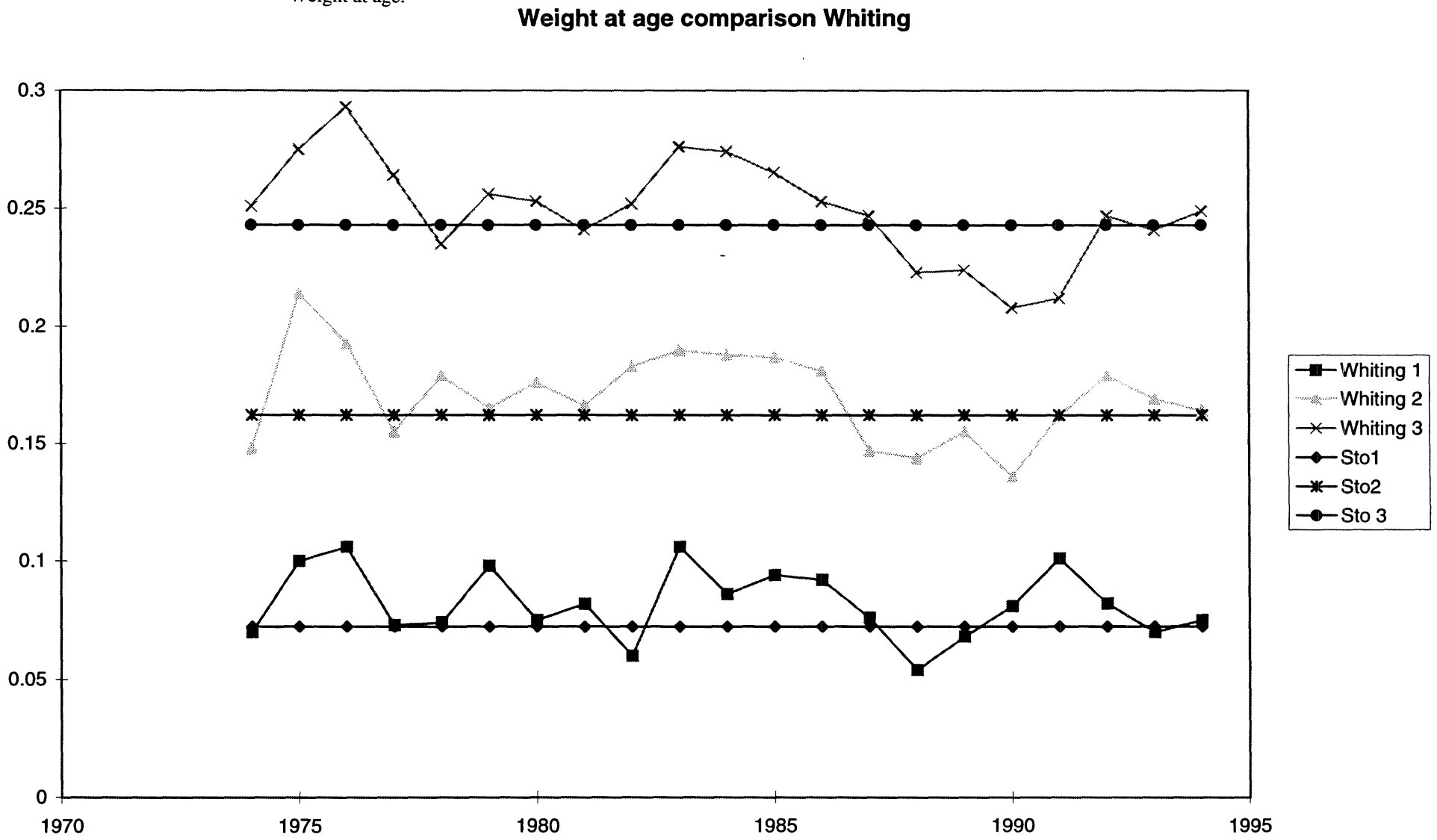
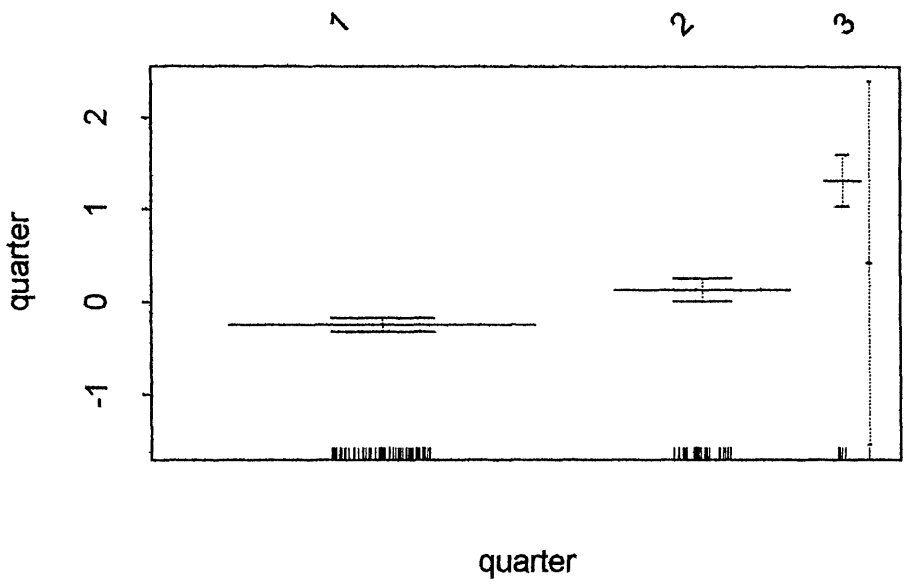
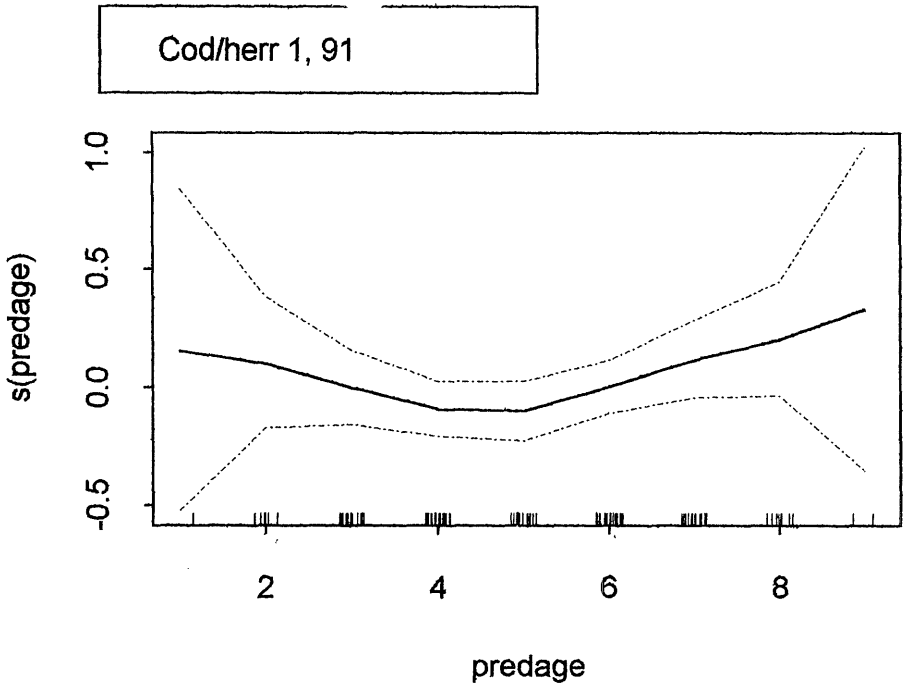


Figure 2.5.1


1
2
3
quarter
-1
0
1
2
quarter


Cod/herr 1, 91
s(predage)
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0.5
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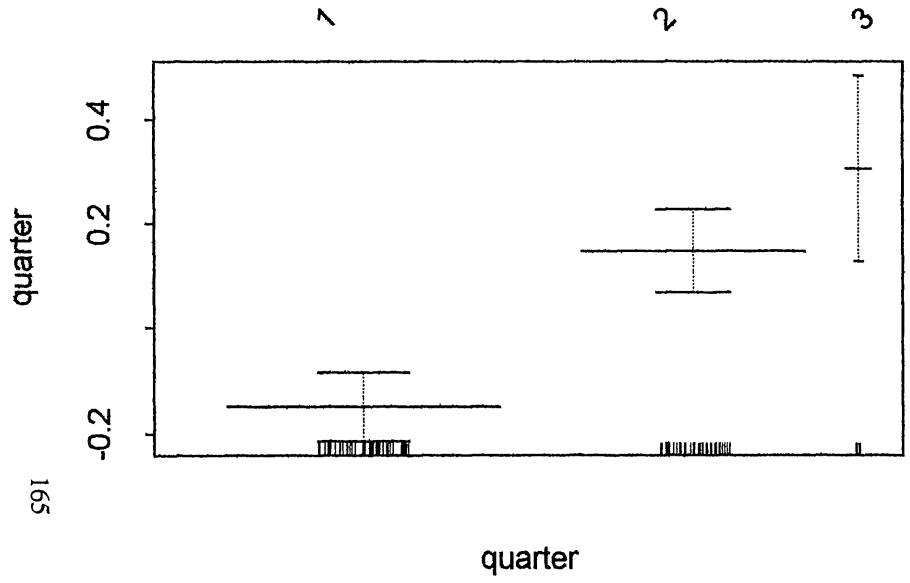
2
4
6
8
predage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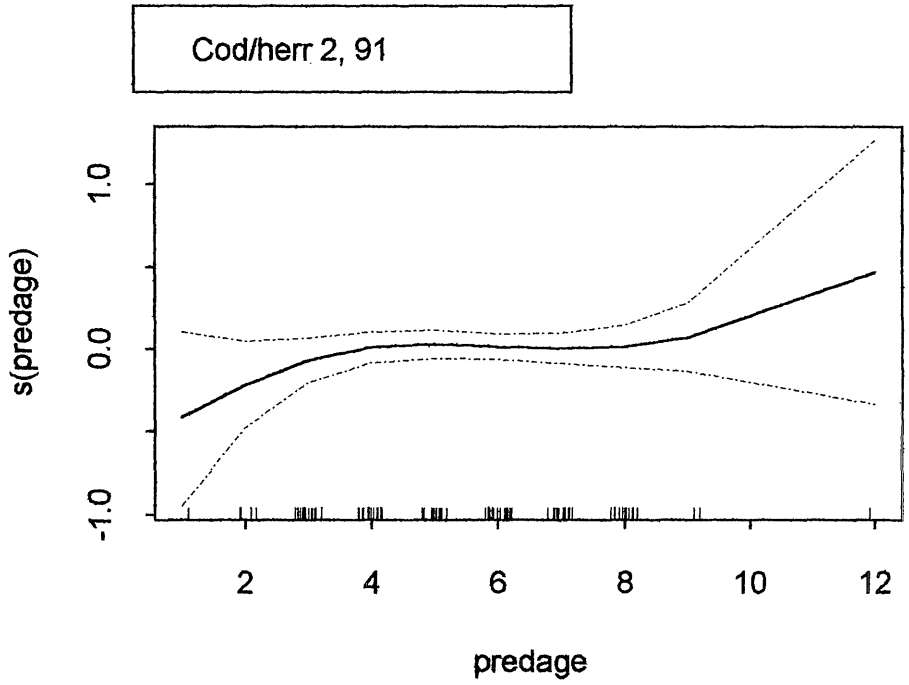
3
quarter
-0.2
0.2
0.4
quarter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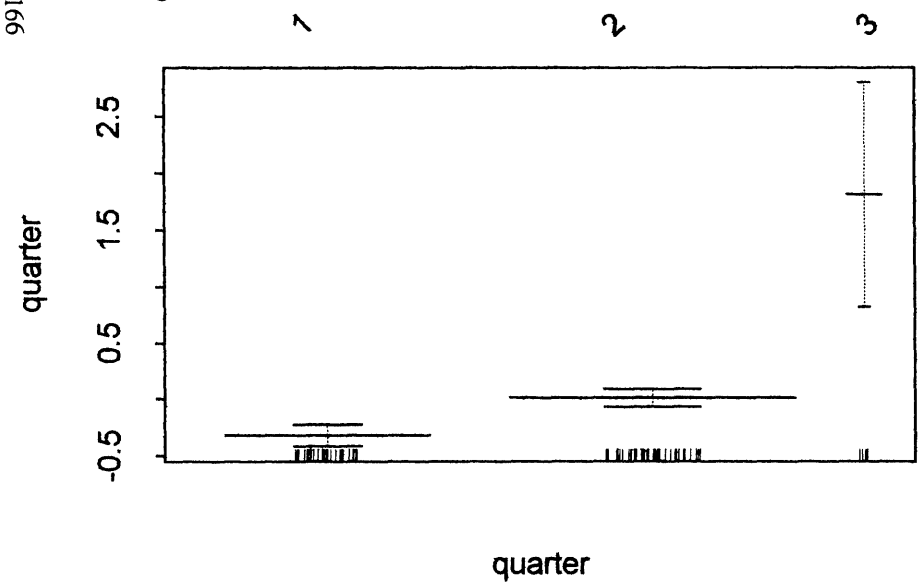
4
6
8
10
12
predage

Figure 2.5.2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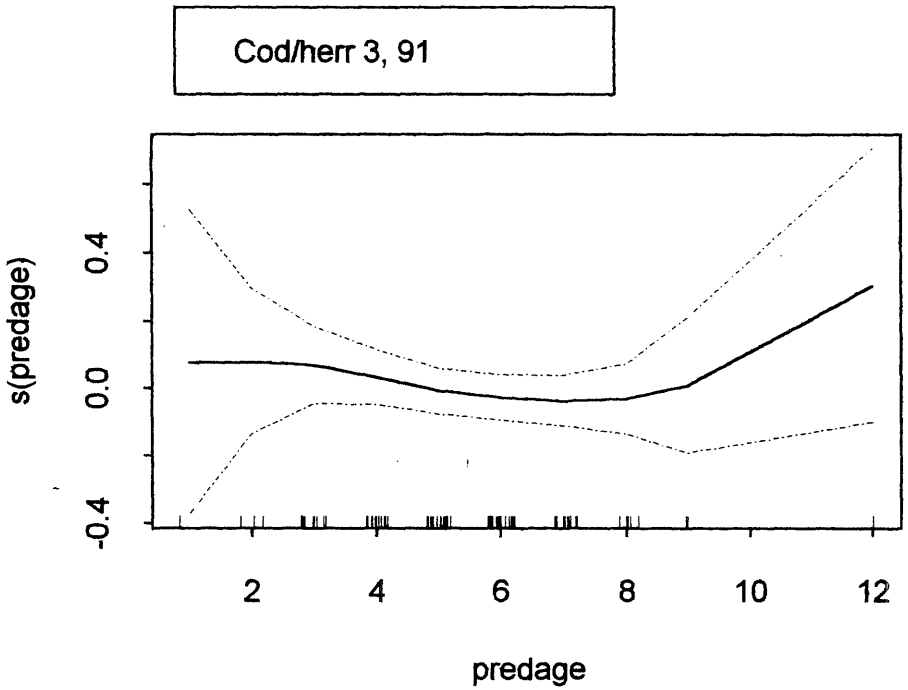
-0.5
0.5
1.5
2.5
quarter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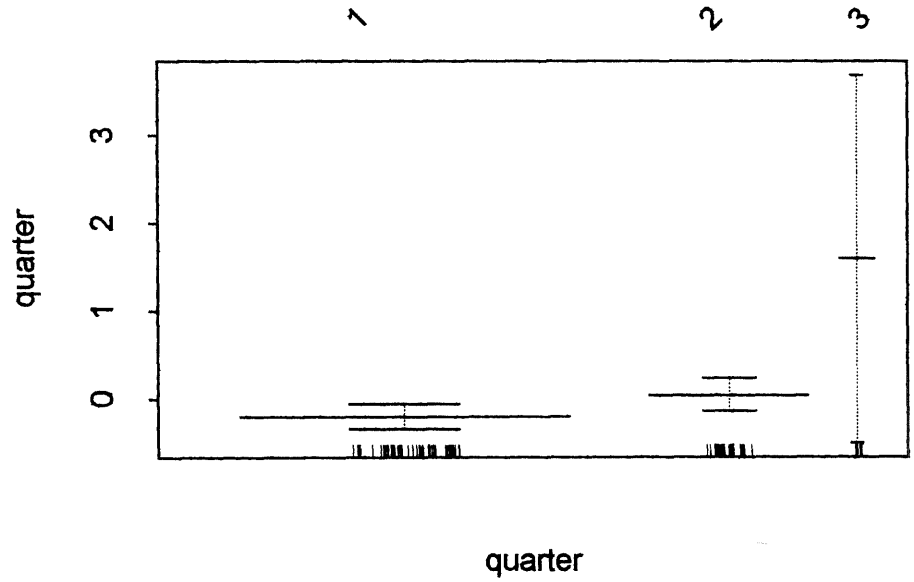
8
10
12
predage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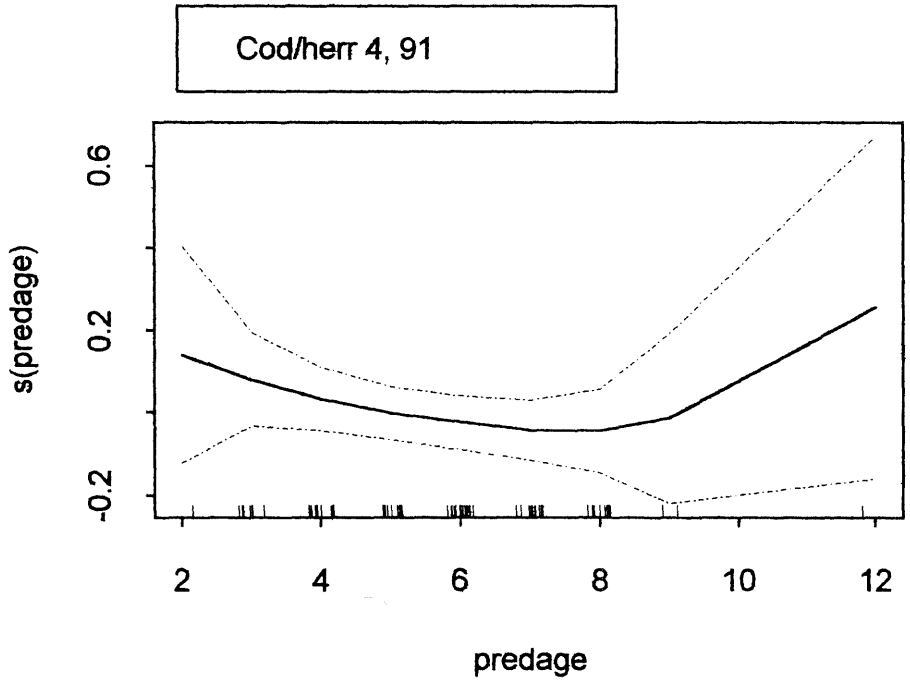
3
quarter
0
1
2
3
quarter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-0.2
0.2
0.6
2
4
6
8
10
12
predage

Figure 2.5.3

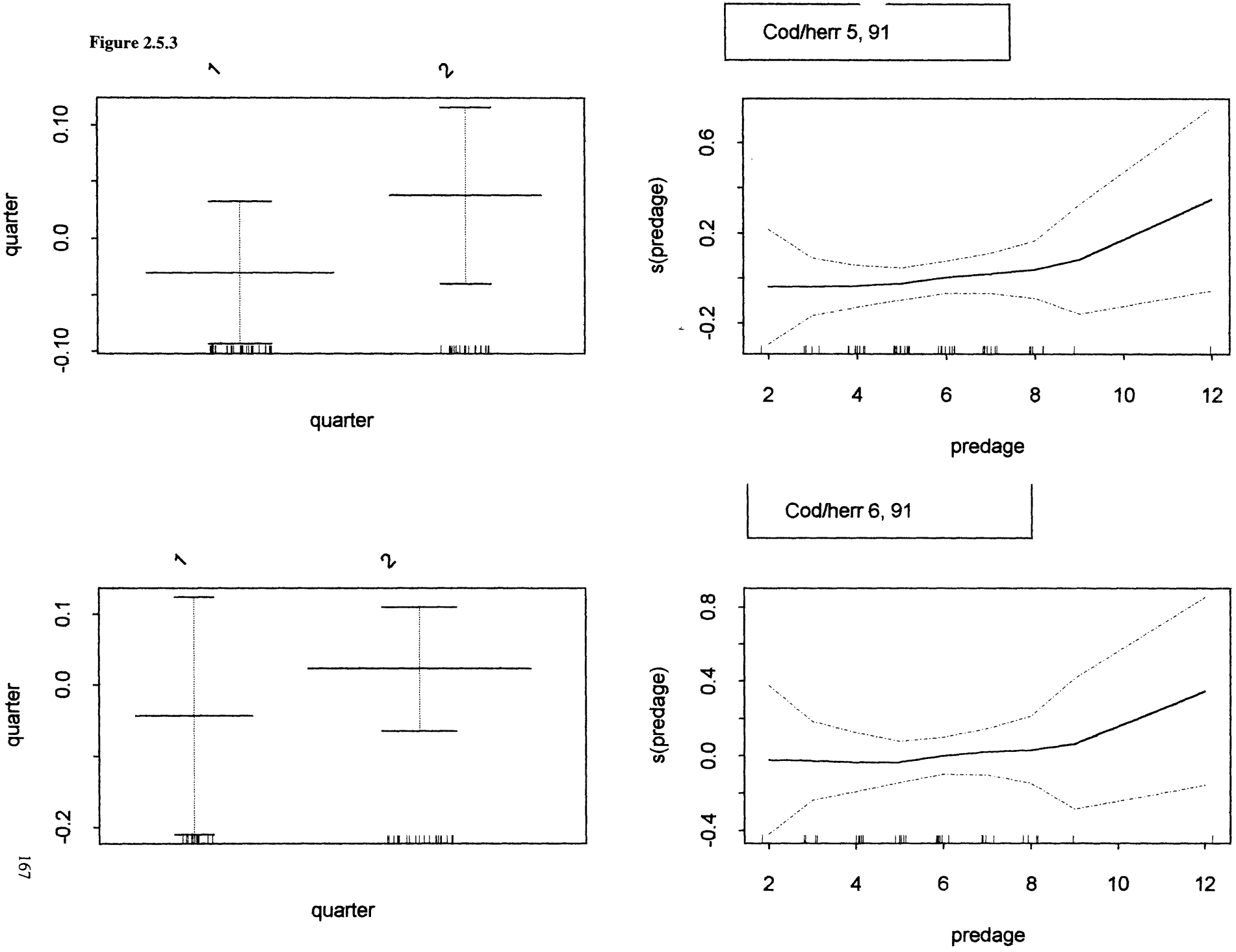
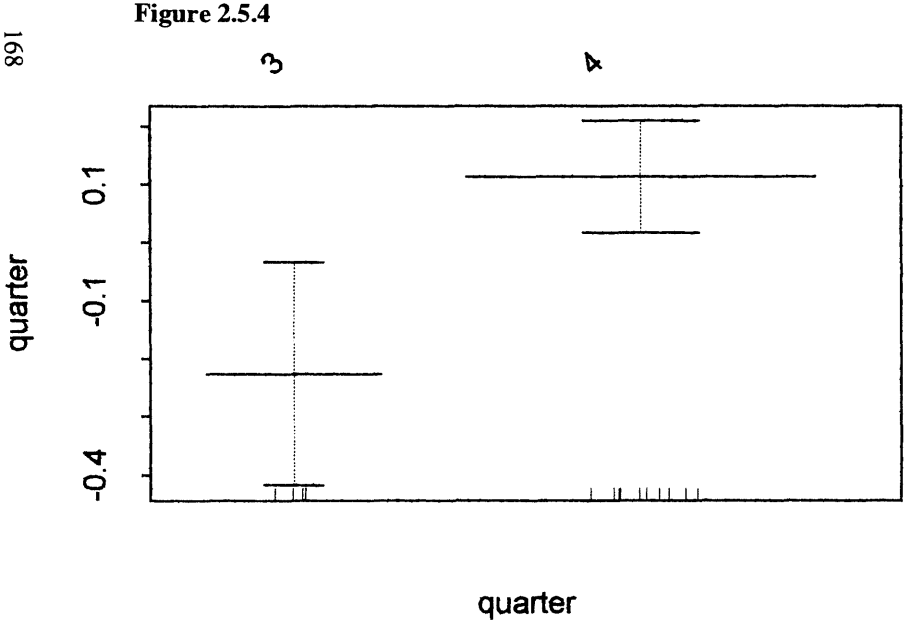
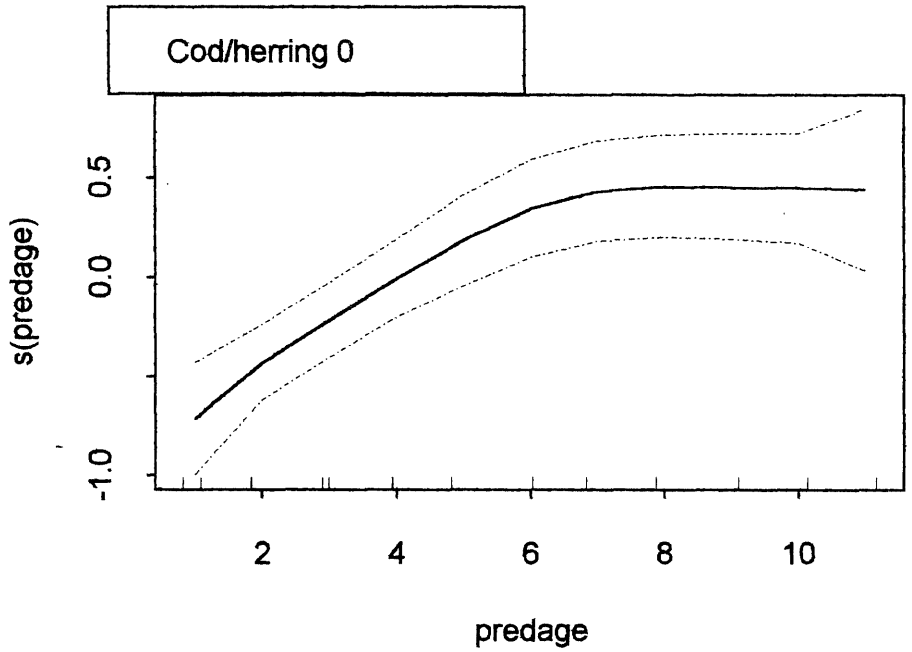
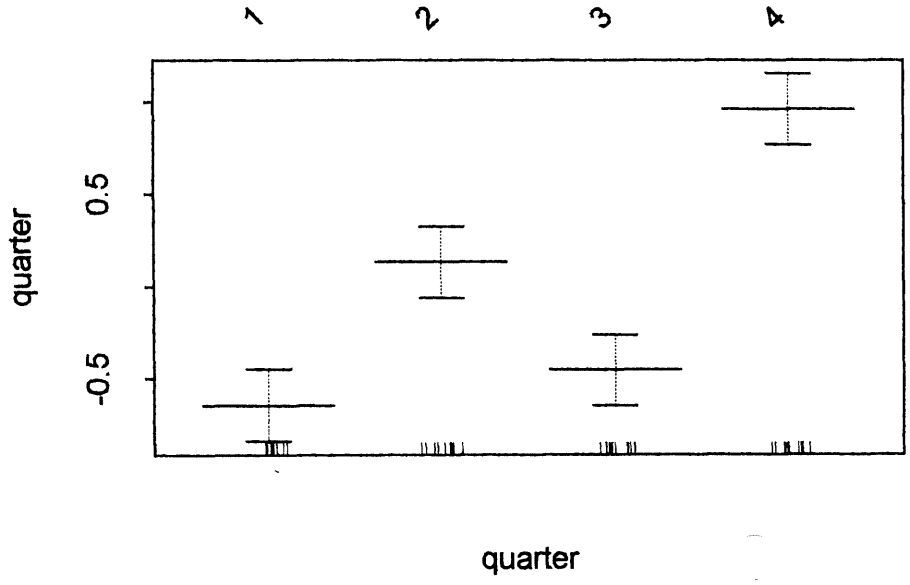

Cod/herr 5, 91
1
2
0.10
0.0
-0.10
quarter
quarter
s(predage)
0.6
0.2
-0.2
2
4
6
8
10
12
predage
Cod/herr 6, 91
1
2
0.1
0.0
-0.2
quarter
quarter
s(predage)
0.8
0.4
0.0
-0.4
2
4
6
8
10
12
predage

Figure 2.5.4


3
4
quarter
0.1
-0.1
-0.4
quarter


Cod/herring 0
s(predage)
0.5
0.0
-1.0
2
4
6
8
10
predage


1
2
3
4
quarter
0.5
-0.5
quarter

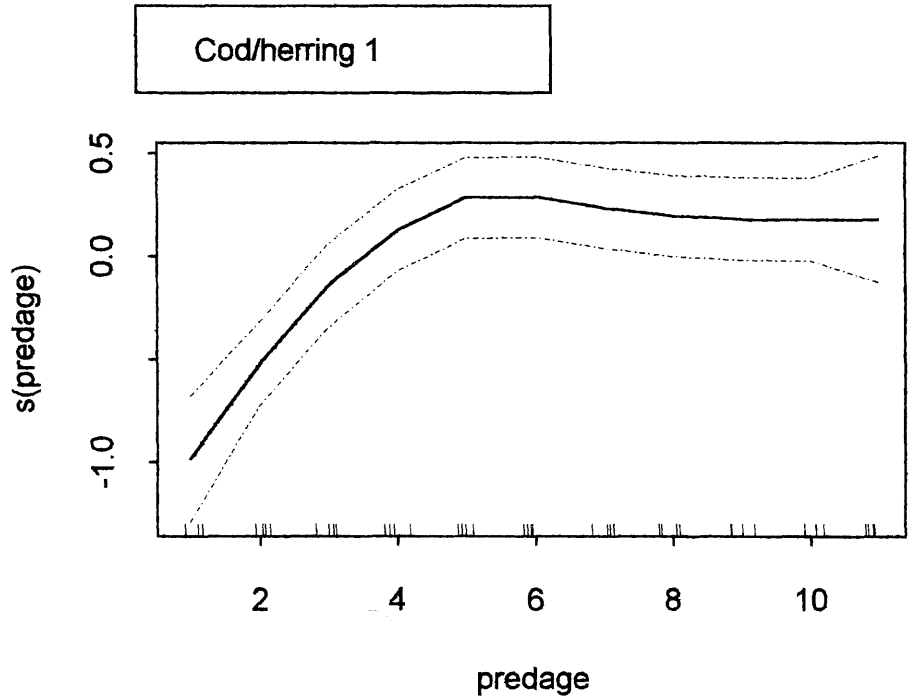

Cod/herring 1
s(predage)
0.5
0.0
-1.0
2
4
6
8
10
predage

Figure 2.5.5

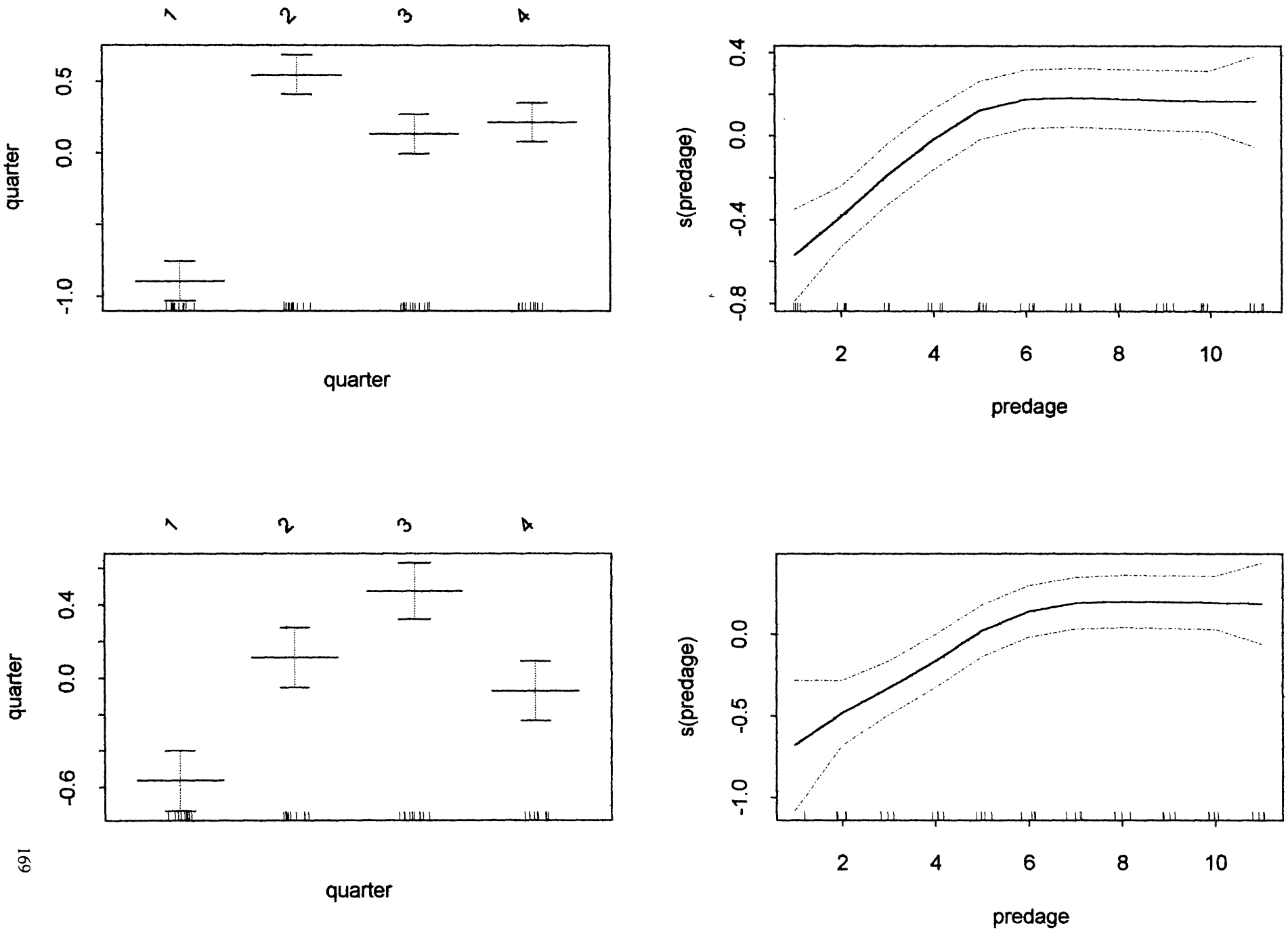
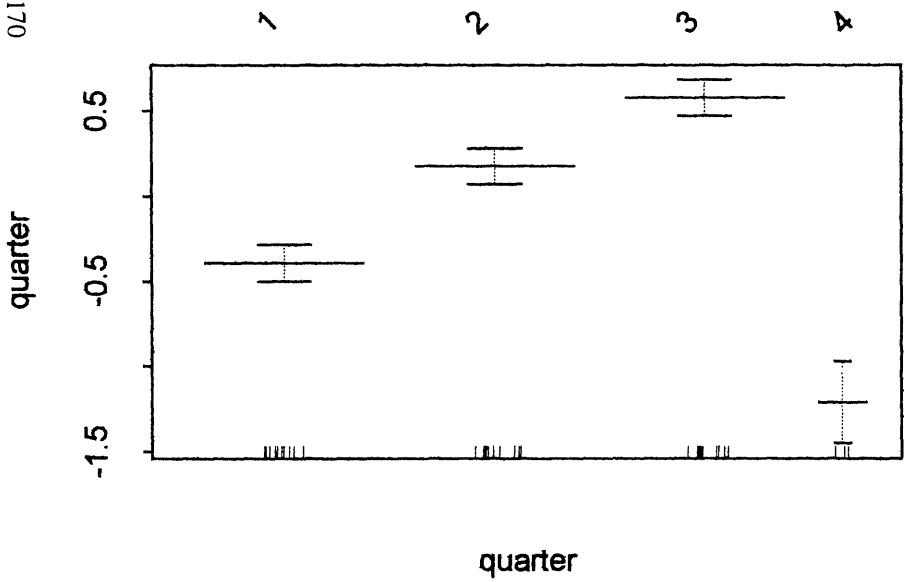
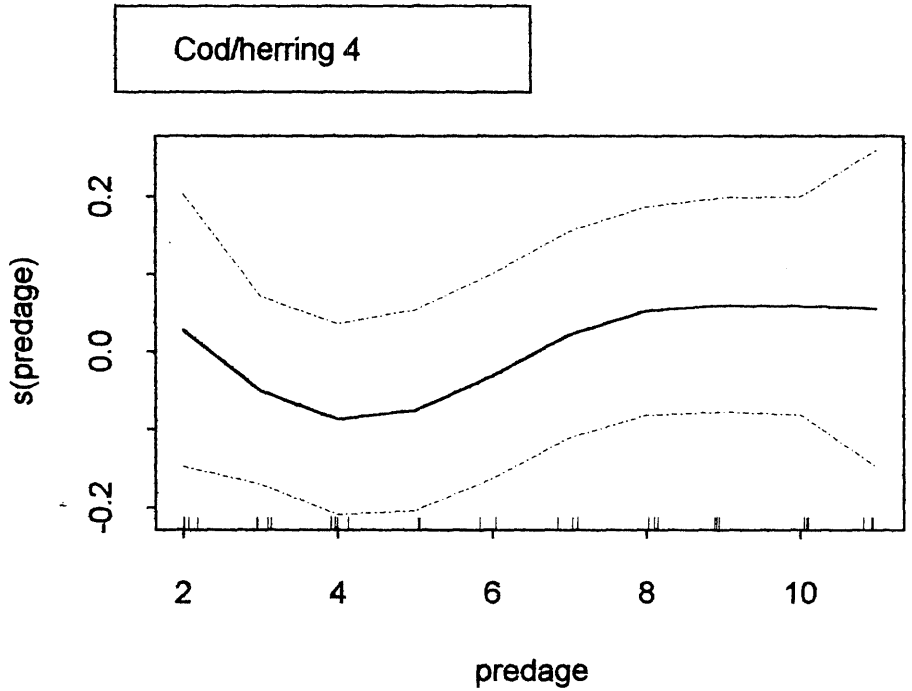
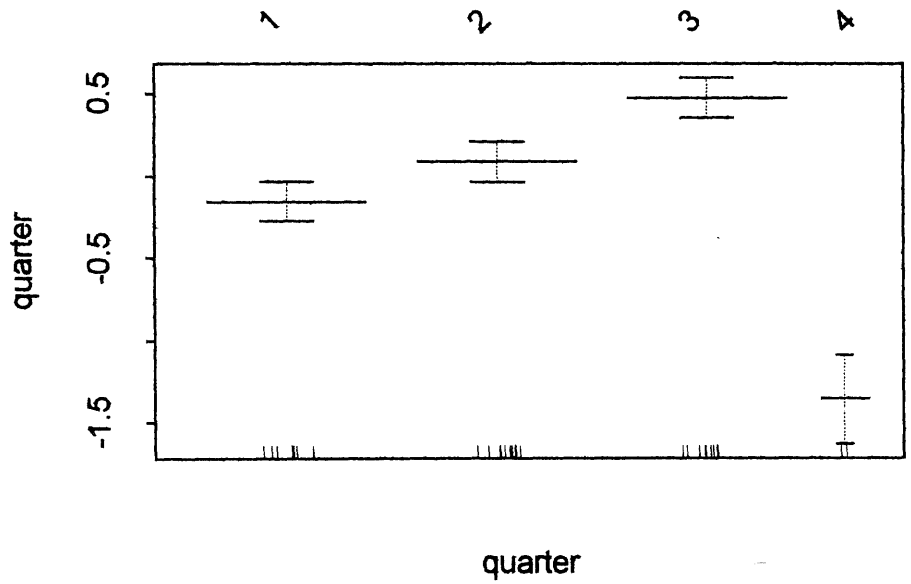

1
2
3
4
quarter
0.5
0.0
-1.0
quarter
s(predage)
0.4
0.0
-0.4
-0.8
2
4
6
8
10
predage
1
2
3
4
quarter
0.4
0.0
-0.6
quarter
s(predage)
0.0
-0.5
-1.0
2
4
6
8
10
predage

Figure 2.5.6


1
2
3
4
0.5
-0.5
-1.5
quarter
quarter


Cod/herring 4
0.2
0.0
-0.2
s(predage)
2
4
6
8
10
predage


1
2
3
4
0.5
-0.5
-1.5
quarter
quarter

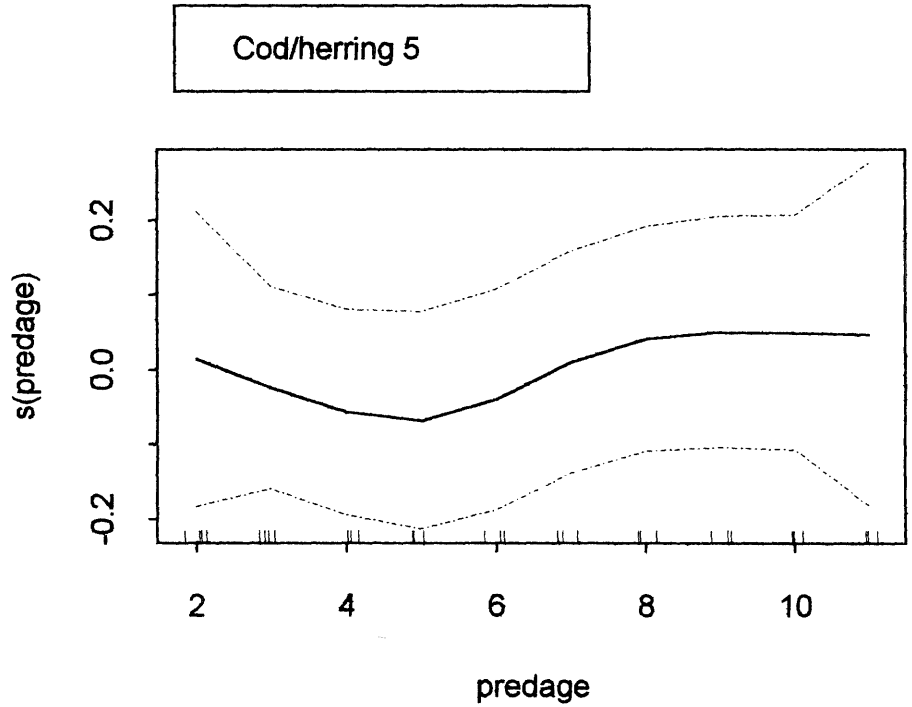

Cod/herring 5
0.2
0.0
-0.2
s(predage)
2
4
6
8
10
predage

Figure 2.5.7

Herring

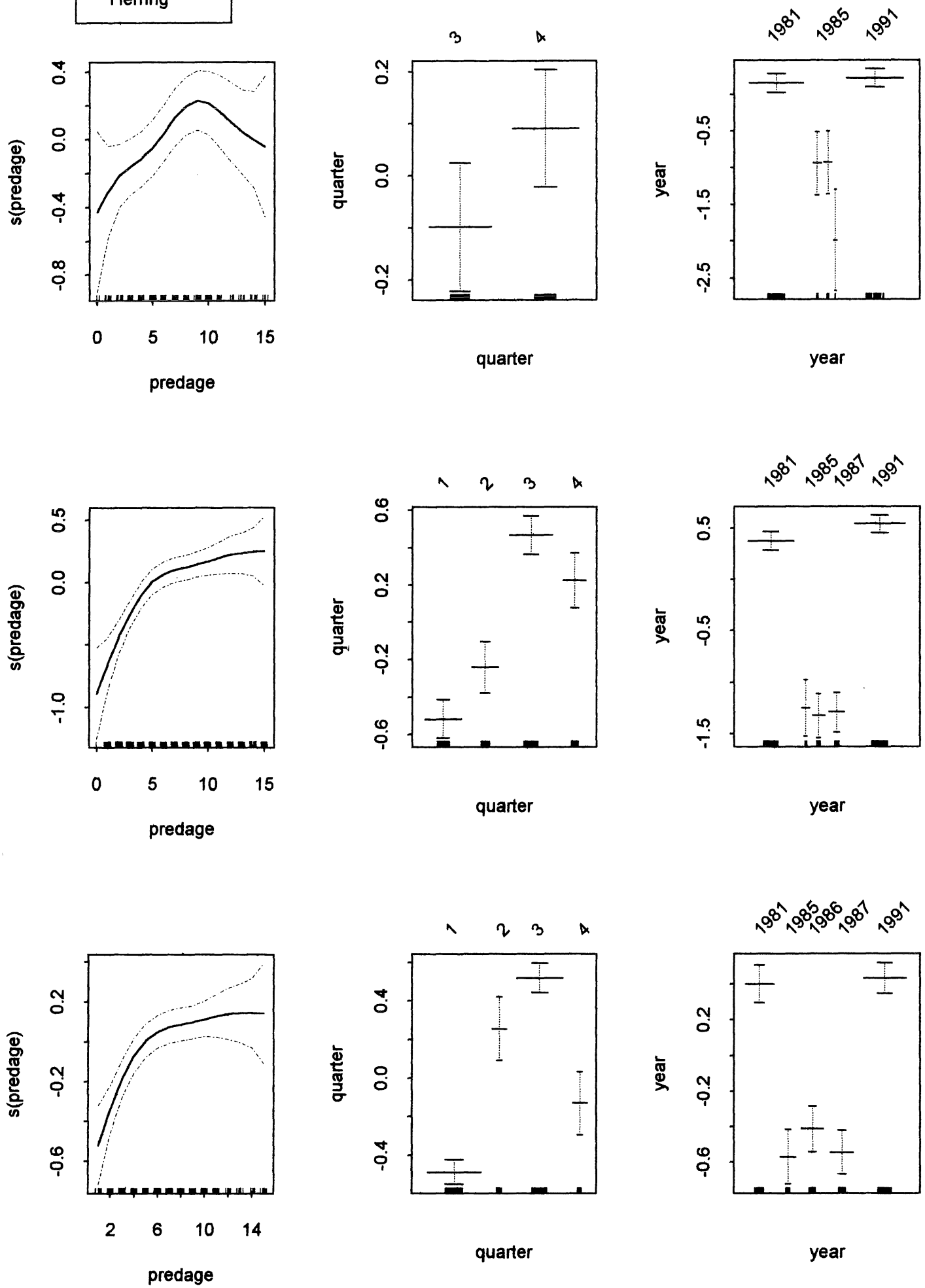


Figure 2.5.8 -

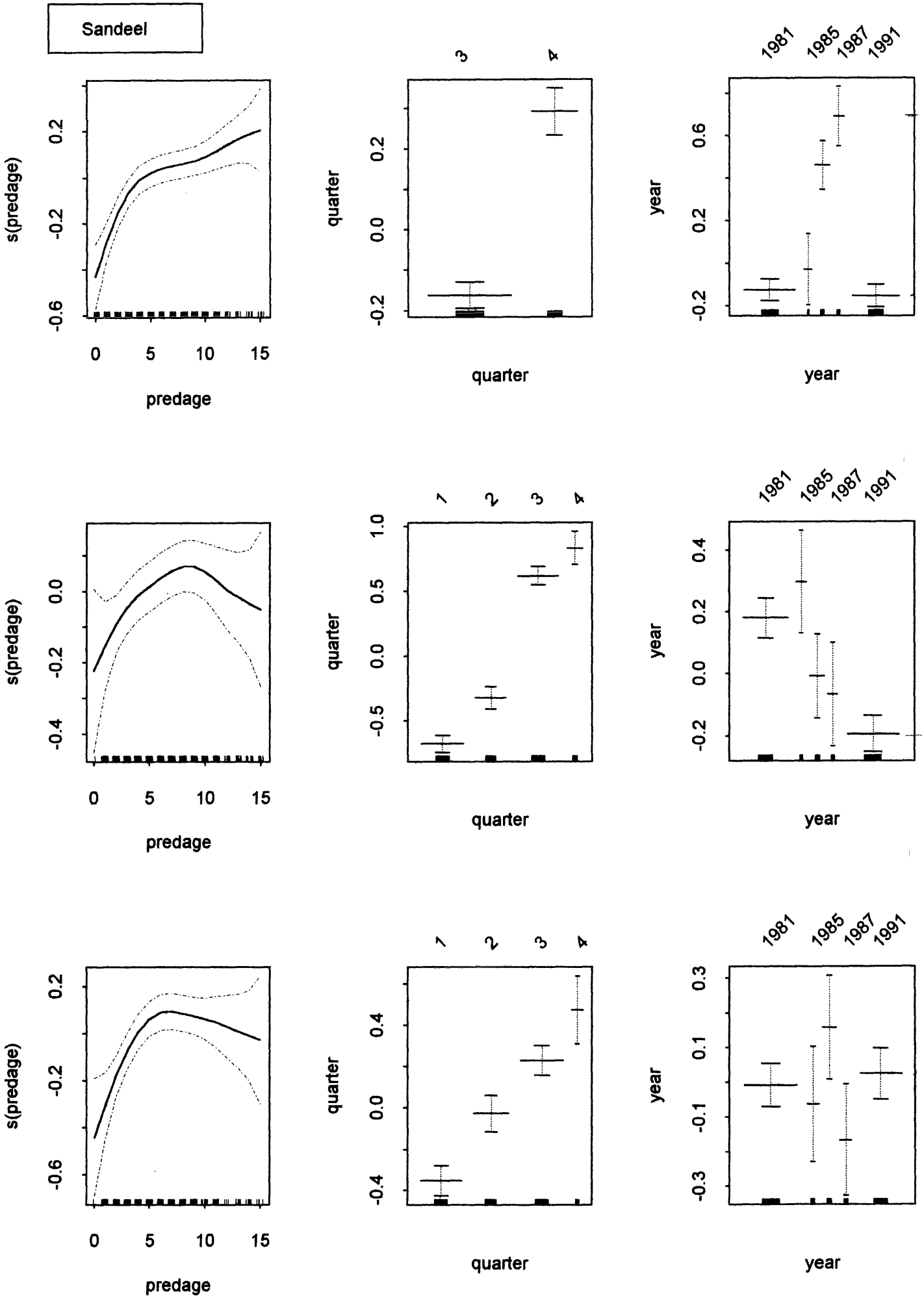


Figure 3.1.2.1

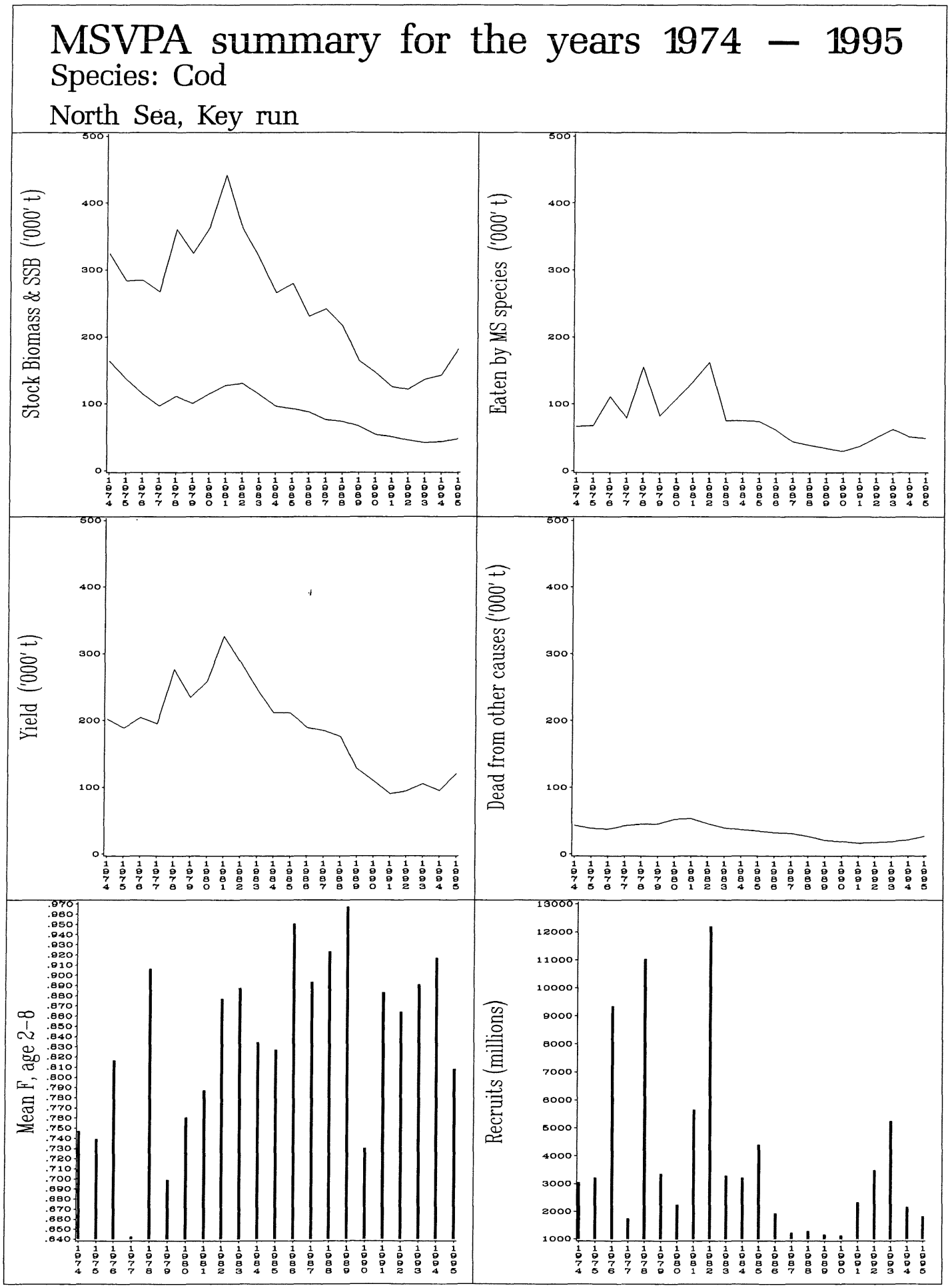

MSVPA summary for the years 1974 — 1995
Species: Cod
North Sea, Key run
Stock Biomass & SSB ('000' t)
Eaten by MS species ('000' t)
Yield ('000' t)
Dead from other causes ('000' t)
Mean F, age 2–8
Recruits (millions)

Figure 3.1.2.2

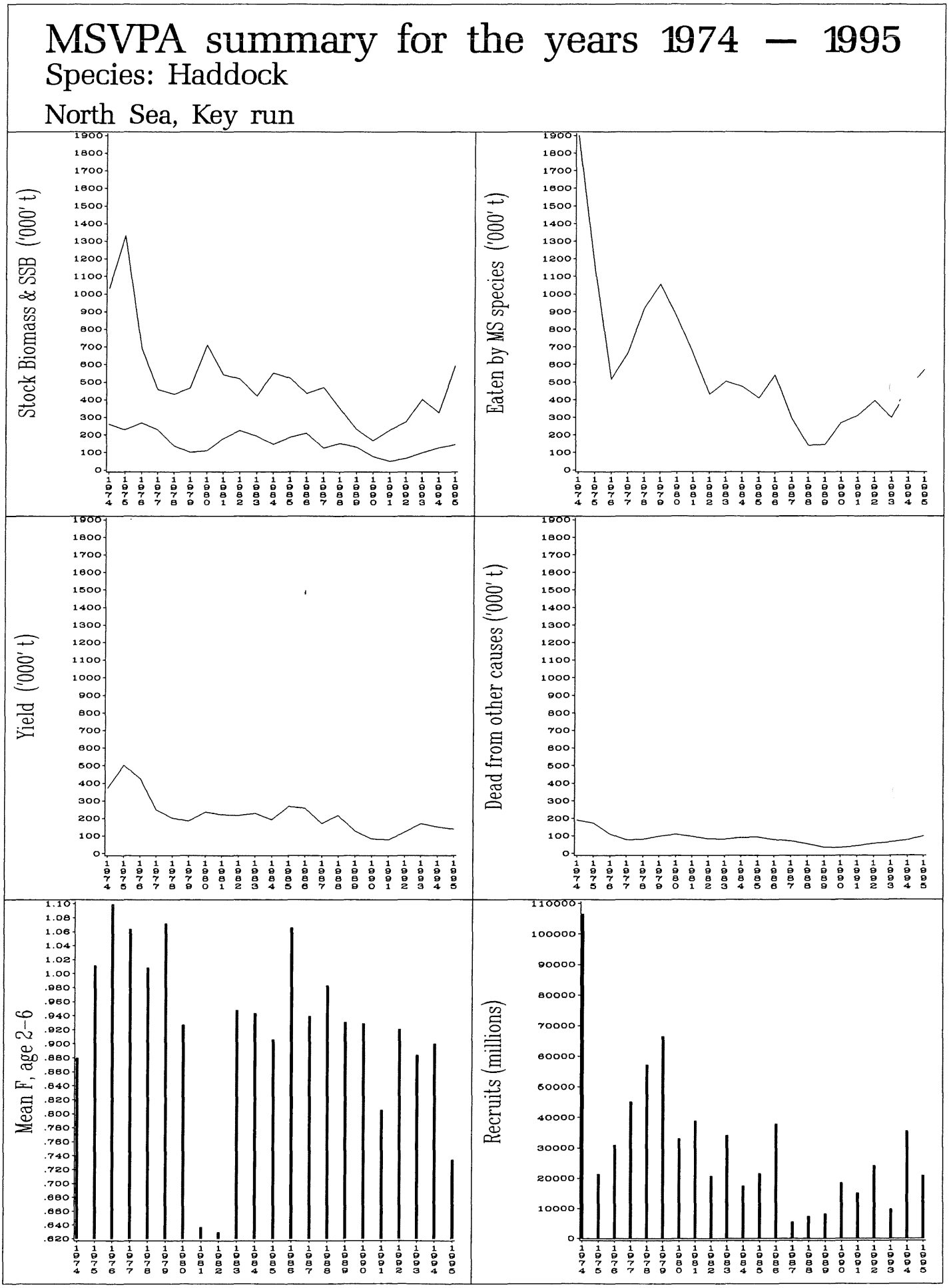

MSVPA summary for the years 1974 — 1995
Species: Haddock
North Sea, Key run
Stock Biomass & SSB ('000' t)
Eaten by MS species ('000' t)
Yield ('000' t)
Dead from other causes ('000' t)
Mean F, age 2–6
Recruits (millions)

Figure 3.1.2.3

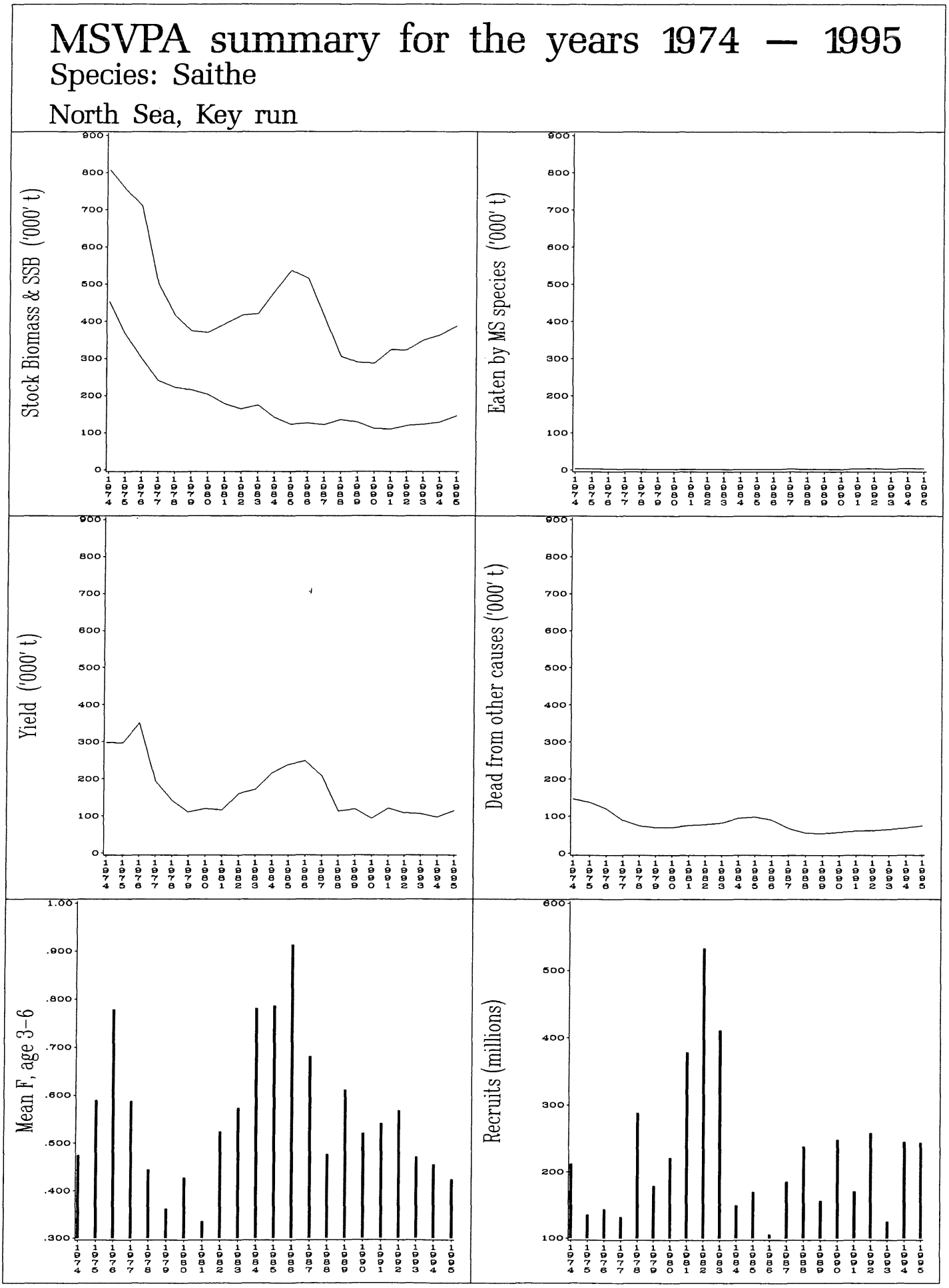

MSVPA summary for the years 1974 — 1995
Species: Saithe
North Sea, Key run
Stock Biomass & SSB ('000' t)
Eaten by MS species ('000' t)
Yield ('000' t)
Dead from other causes ('000' t)
Mean F, age 3-6
Recruits (millions)

Figure 3.1.2.4

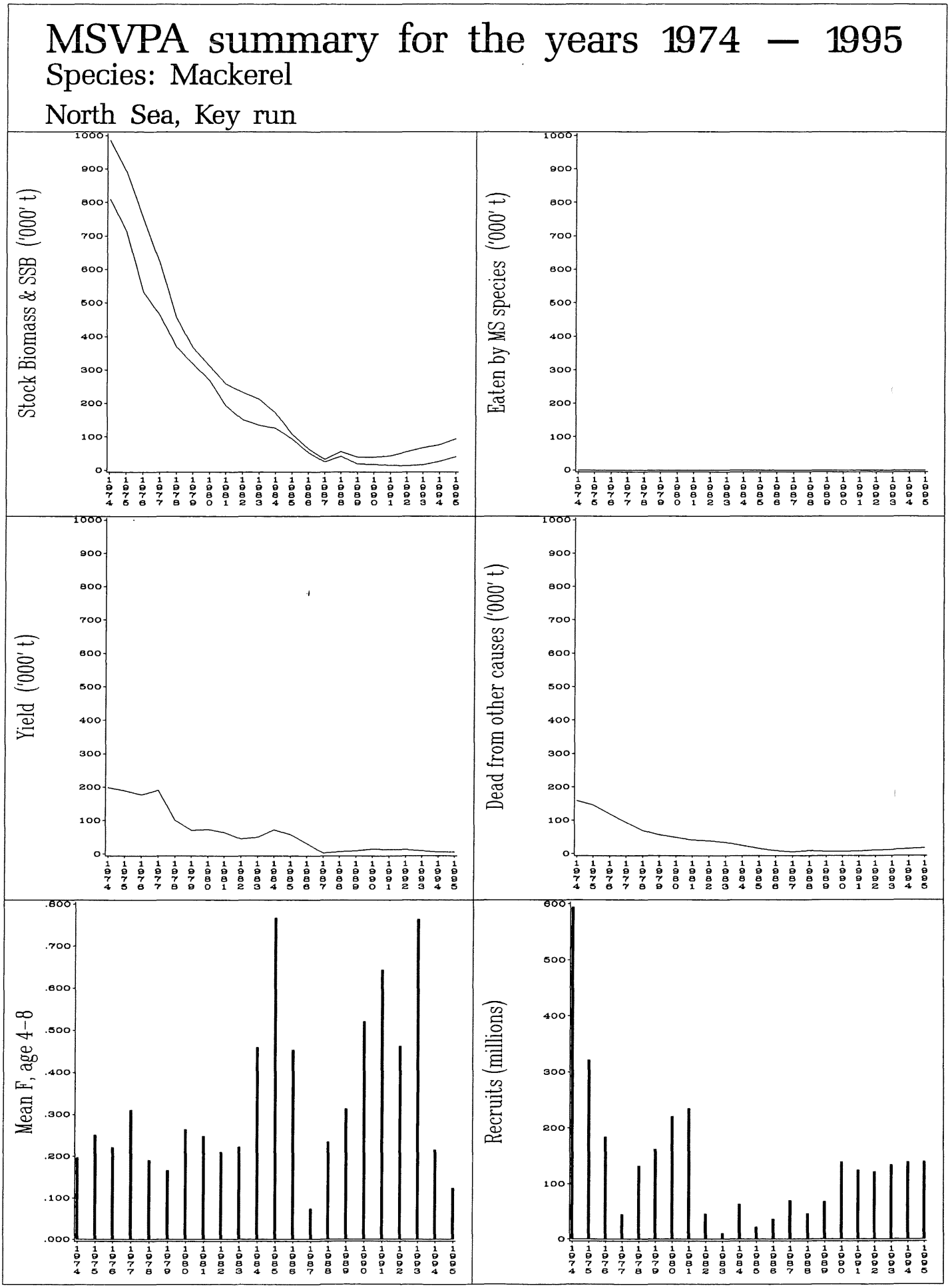

MSVPA summary for the years 1974 — 1995
Species: Mackerel
North Sea, Key run
Stock Biomass & SSB ('000' t)
Eaten by MS species ('000' t)
Yield ('000' t)
Dead from other causes ('000' t)
Mean F, age 4-8
Recruits (millions)

Figure 3.1.2.5

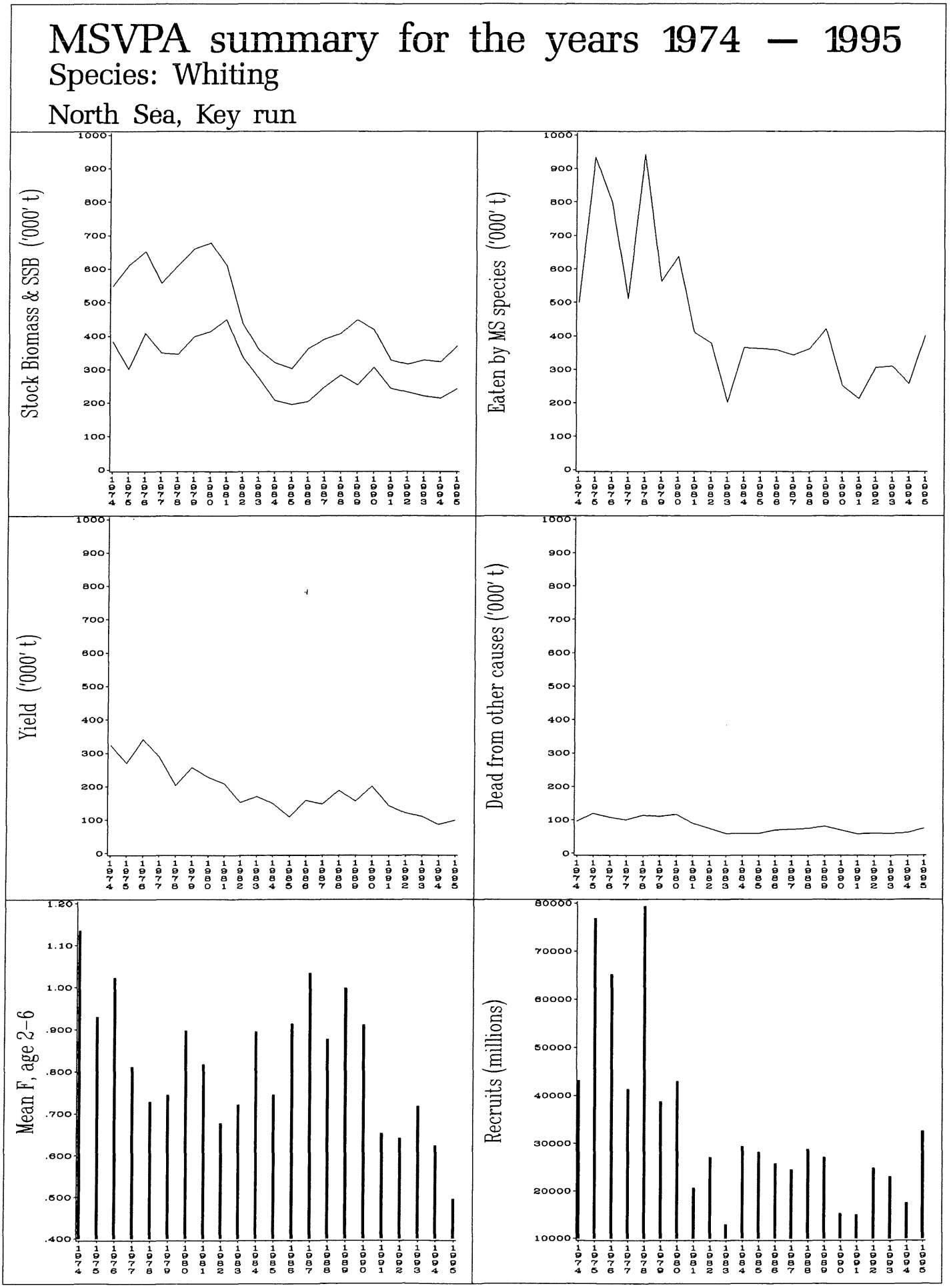

MSVPA summary for the years 1974 – 1995
Species: Whiting
North Sea, Key run
Stock Biomass & SSB ('000' t)
Eaten by MS species ('000' t)
Yield ('000' t)
Dead from other causes ('000' t)
Mean F, age 2–6
Recruits (millions)

Figure 3.1.2.6

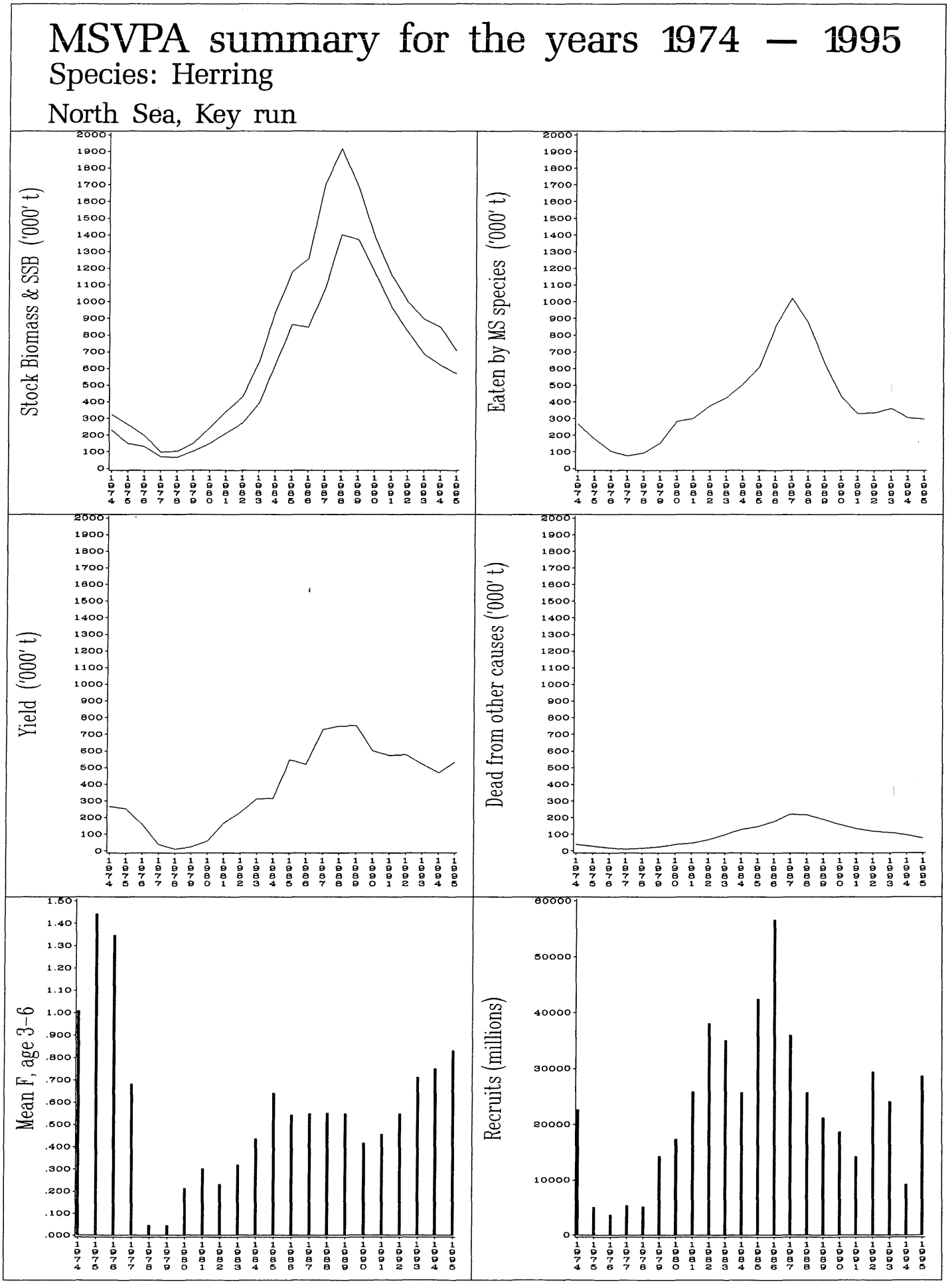

MSVPA summary for the years 1974 — 1995
Species: Herring
North Sea, Key run
Stock Biomass & SSB ('000' t)
Eaten by MS species ('000' t)
Yield ('000' t)
Dead from other causes ('000' t)
Mean F, age 3–6
Recruits (millions)

Figure 3.1.2.7

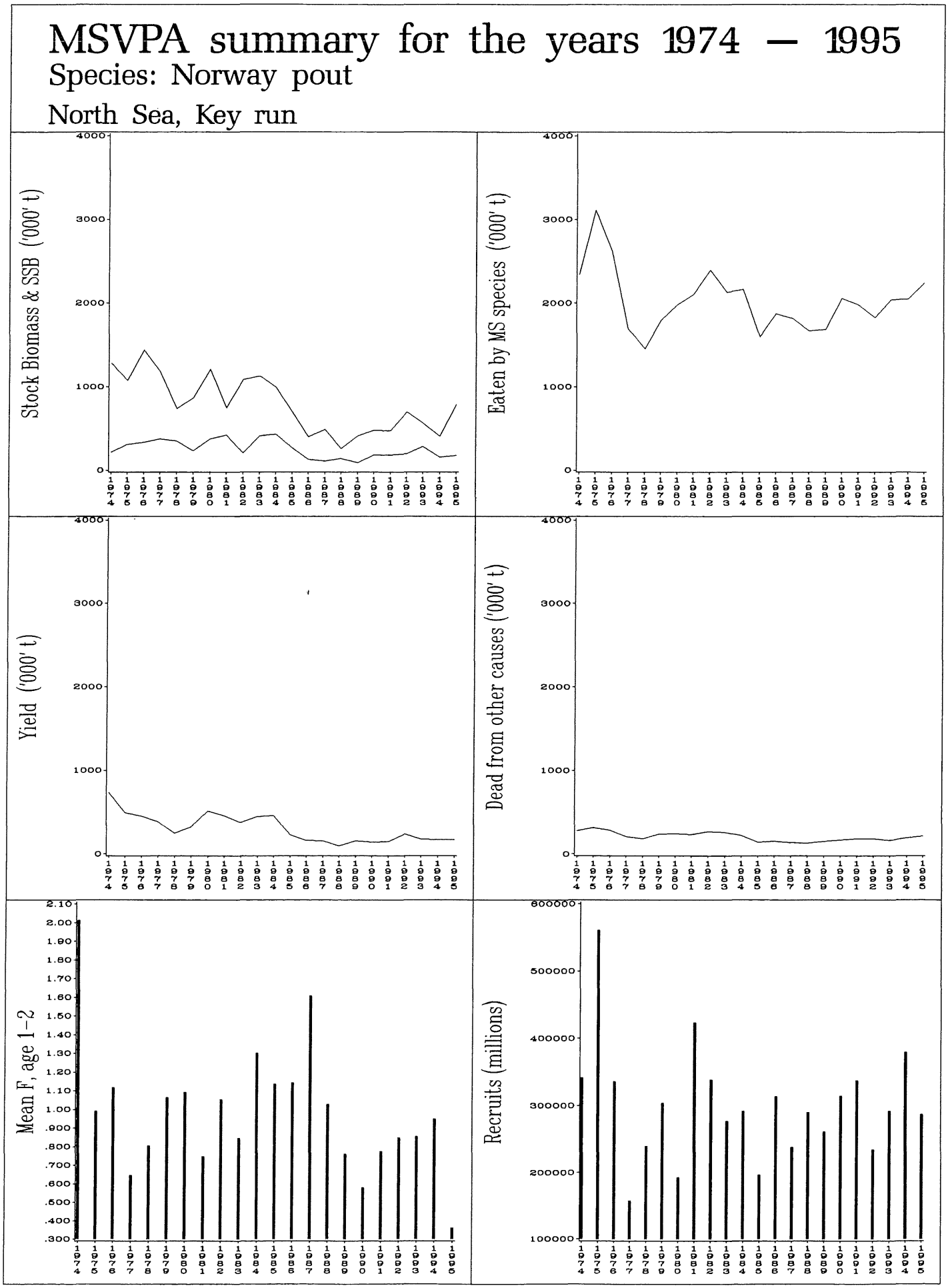

MSVPA summary for the years 1974 — 1995
Species: Norway pout
North Sea, Key run
Stock Biomass & SSB ('000' t)
Eaten by MS species ('000' t)
Yield ('000' t)
Dead from other causes ('000' t)
Mean F, age 1-2
Recruits (millions)

Figure 3.1.2.8

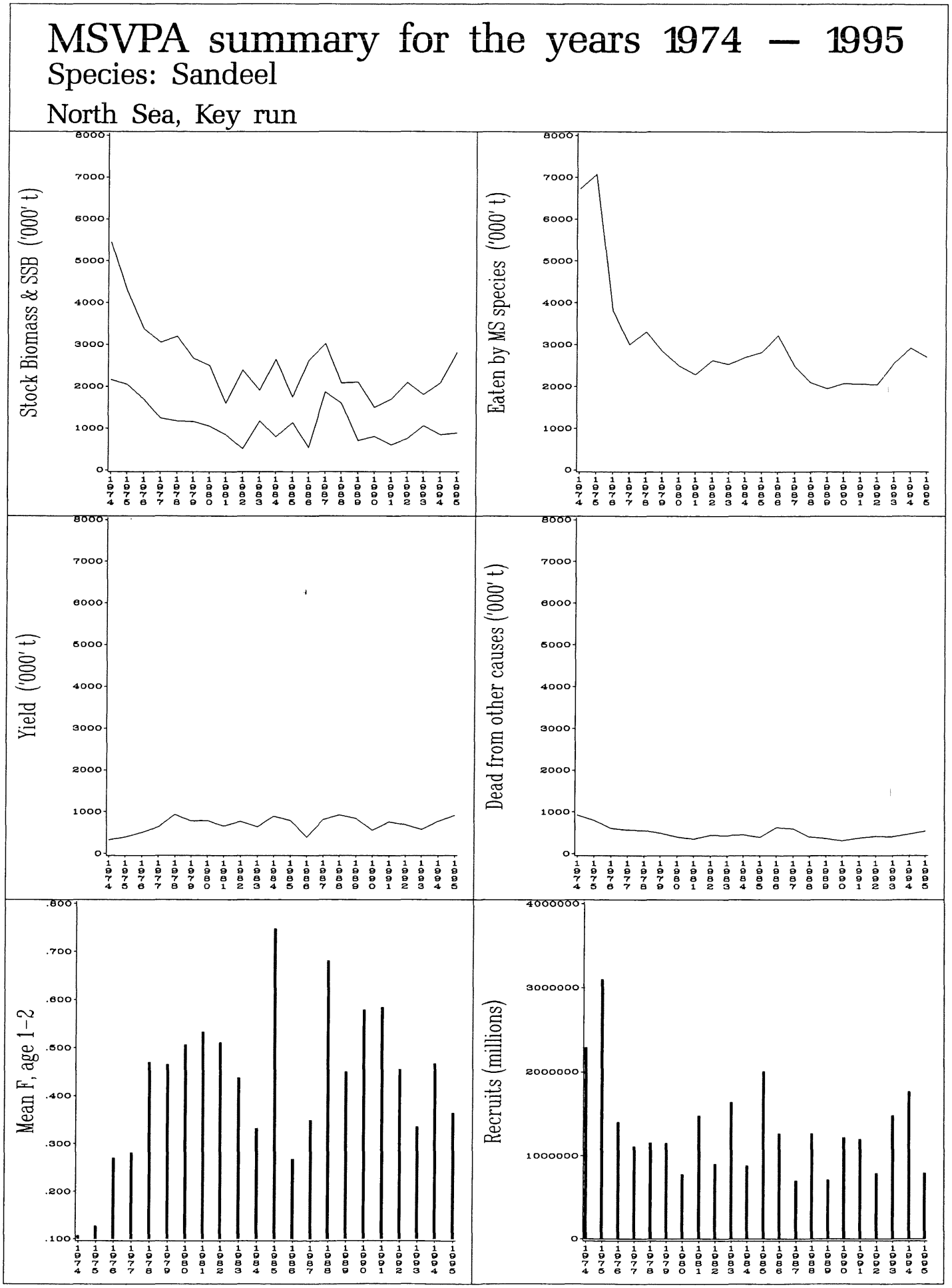

MSVPA summary for the years 1974 — 1995
Species: Sandeel
North Sea, Key run
Stock Biomass & SSB ('000' t)
Eaten by MS species ('000' t)
Yield ('000' t)
Dead from other causes ('000' t)
Mean F, age 1-2
Recruits (millions)

Figure 3.1.2.9

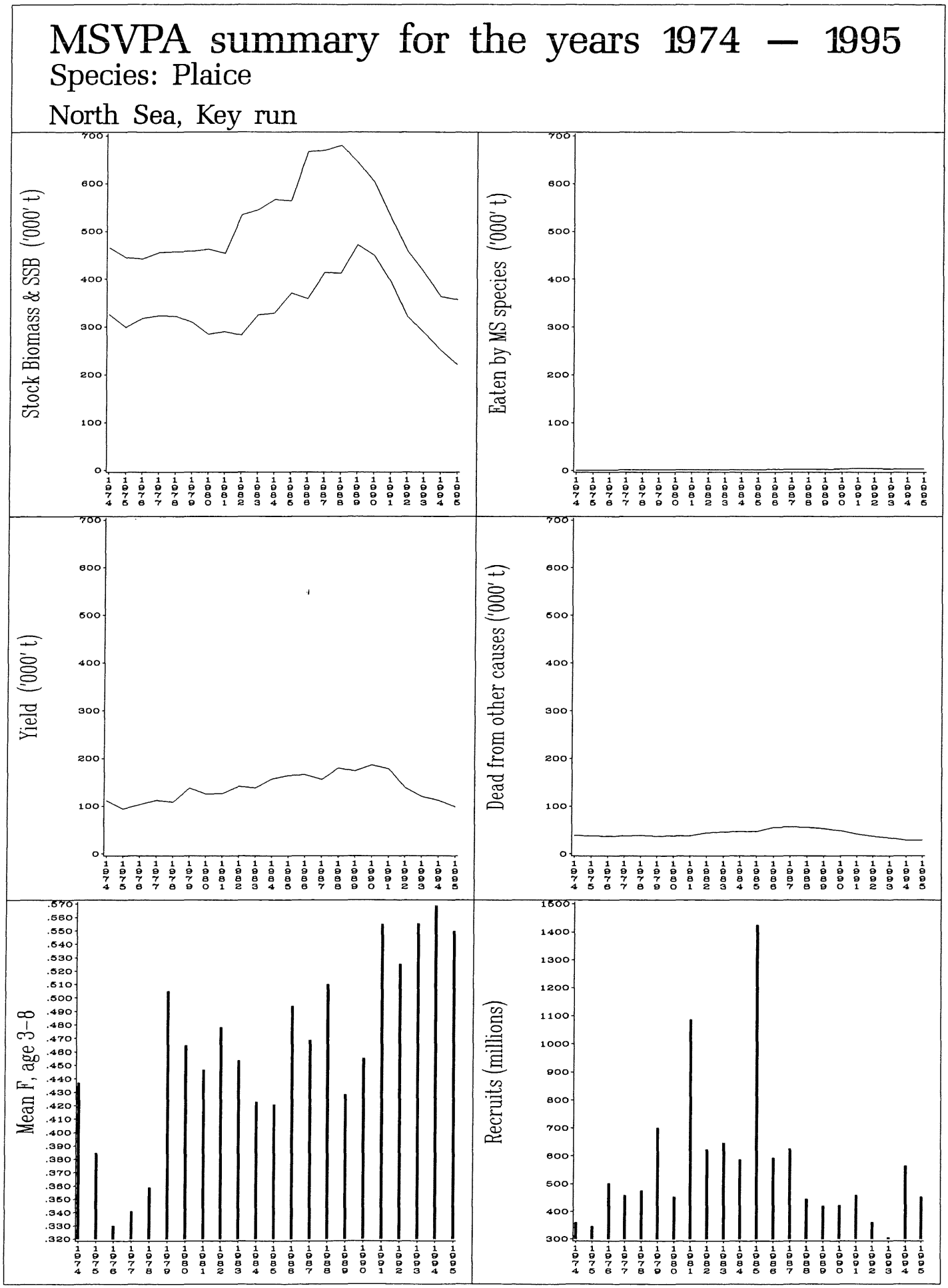

MSVPA summary for the years 1974 — 1995
Species: Plaice
North Sea, Key run
Stock Biomass & SSB ('000' t)
Eaten by MS species ('000' t)
Yield ('000' t)
Dead from other causes ('000' t)
Mean F, age 3-8
Recruits (millions)

Figure 3.1.2.10

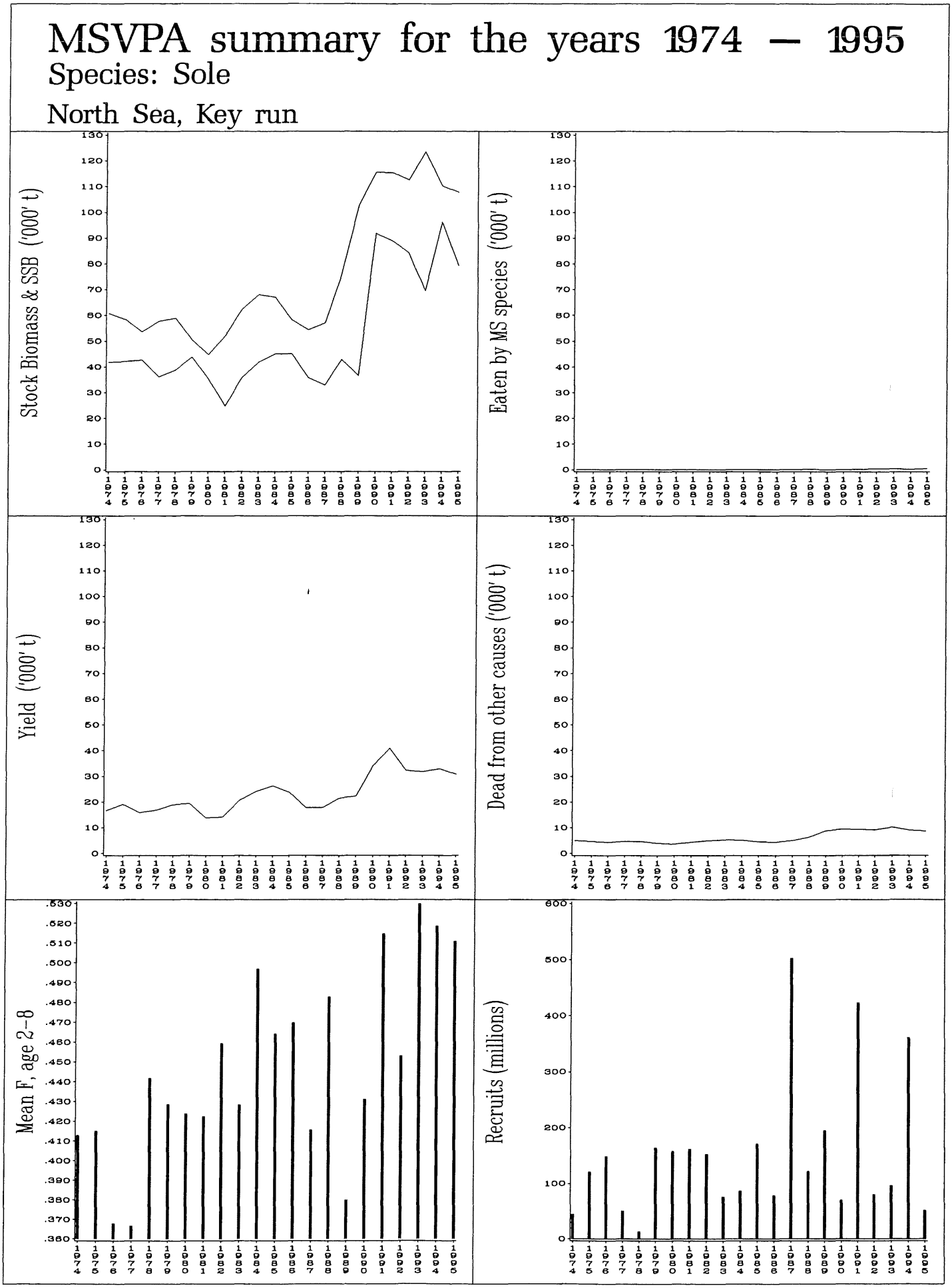


Figure 3.1.2.11

Key run 1995 compared to key run 1997.
The Biomass units include all MSVPA species summed over species and ages.
The eaten biomass of other food is not included.

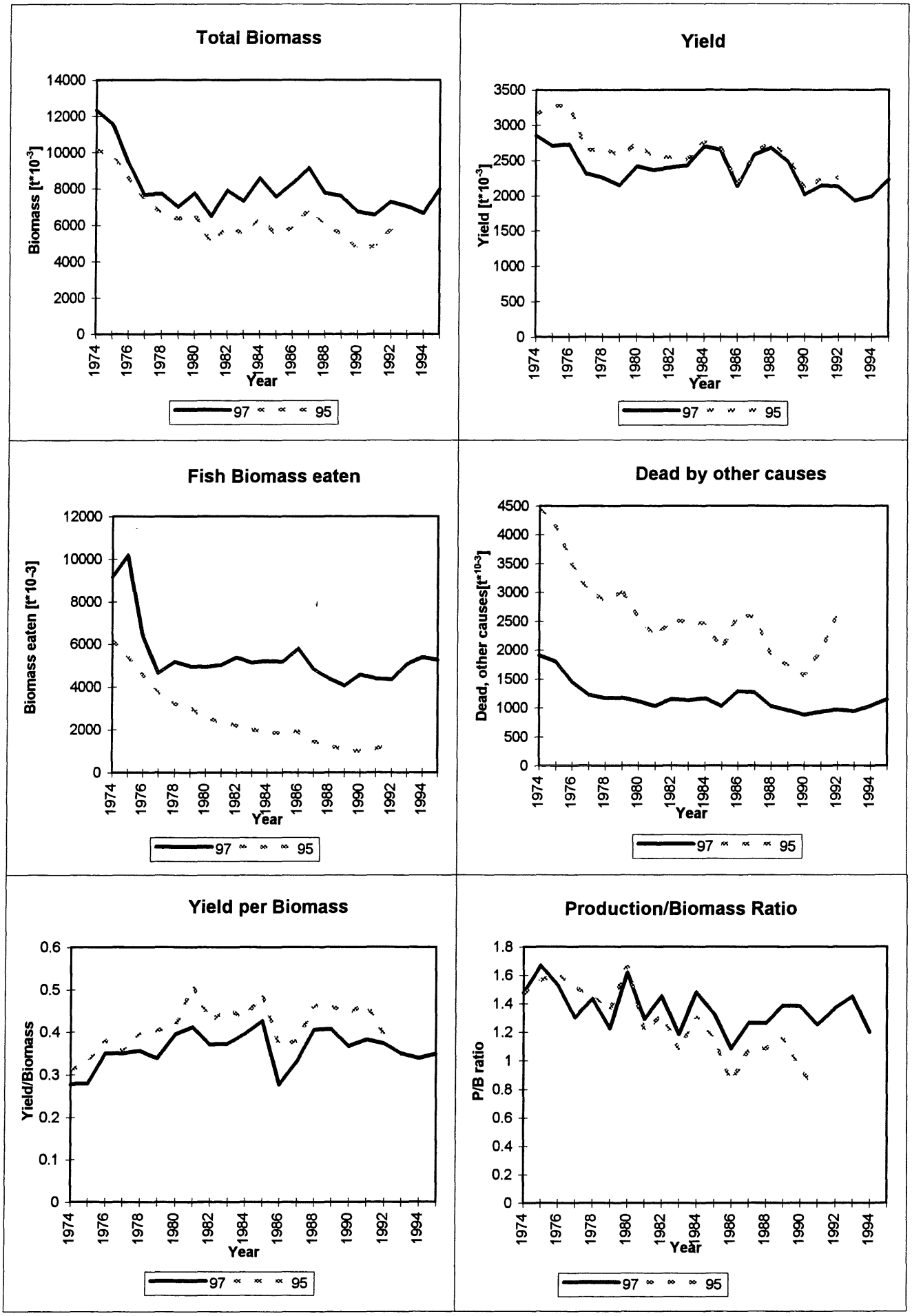
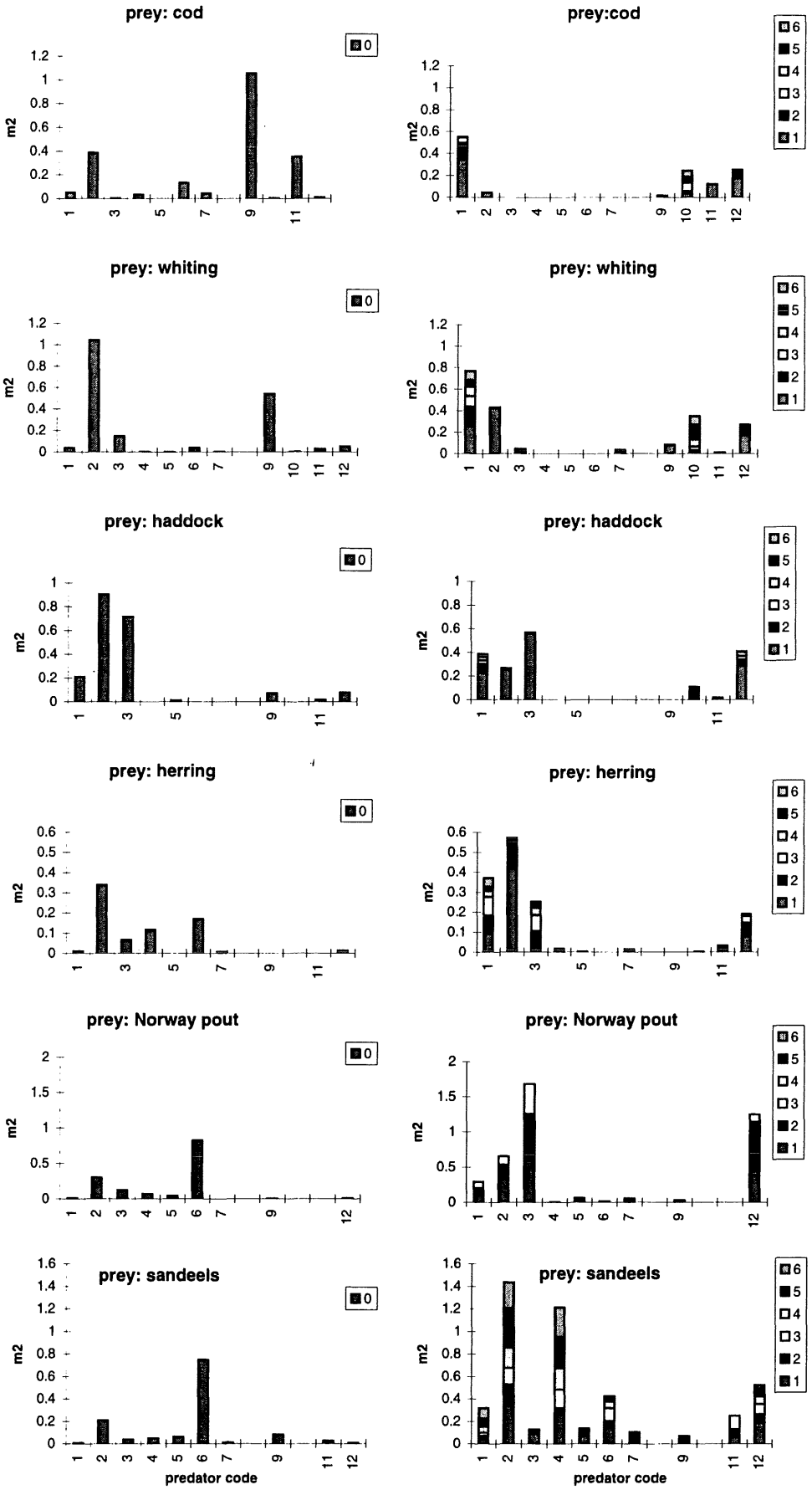


Figure 3.1.2.12

Translation of the predator code in the M2 bar charts		
1	=	cod
2	=	whiting
3	=	saithe
4	=	mackerel
5	=	haddock
6	=	w. mackerel
7	=	starry ray
8	=	horse mackerel
9	=	grey gurnards
10	=	seals
11	=	birds
12	=	other



M2 values from MSVPA + horse mackerel

Figure 3.2.1.1

Comparative summary output from the key run 1997 and the same key run with censored weights.
The Biomass units include all MSVPA species summed over species and ages.
The eaten biomass of other food is not included.

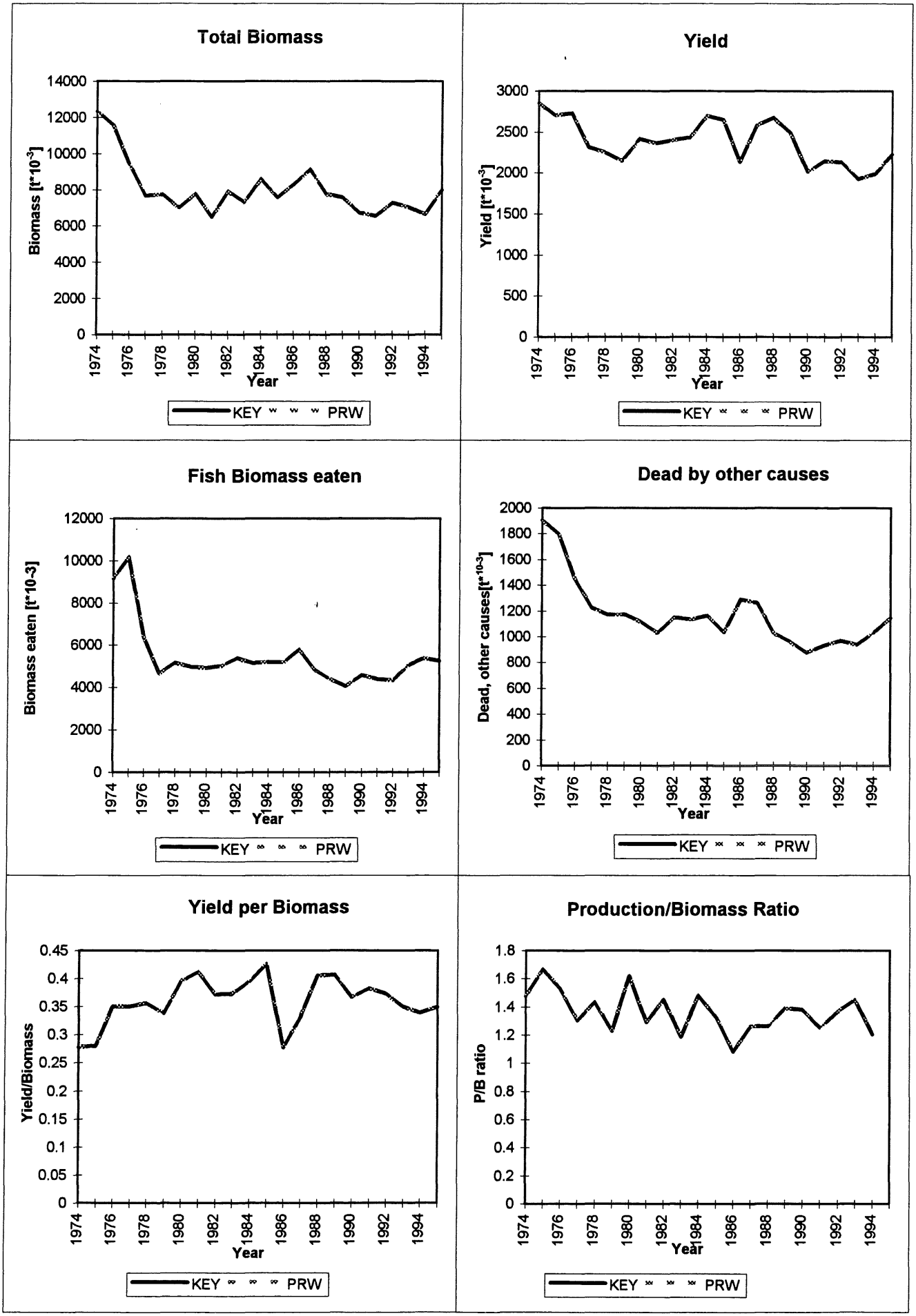


Figure 3.2.2.2.1

Comparative summary output from the key run (all stomach data), the 1981 run (only stomach data from 1981) and the 1991 run (stomach dta only from 1991) .
The Biomass units include all MSVPA species summed over species and ages.
The eaten biomass of other food is not included.

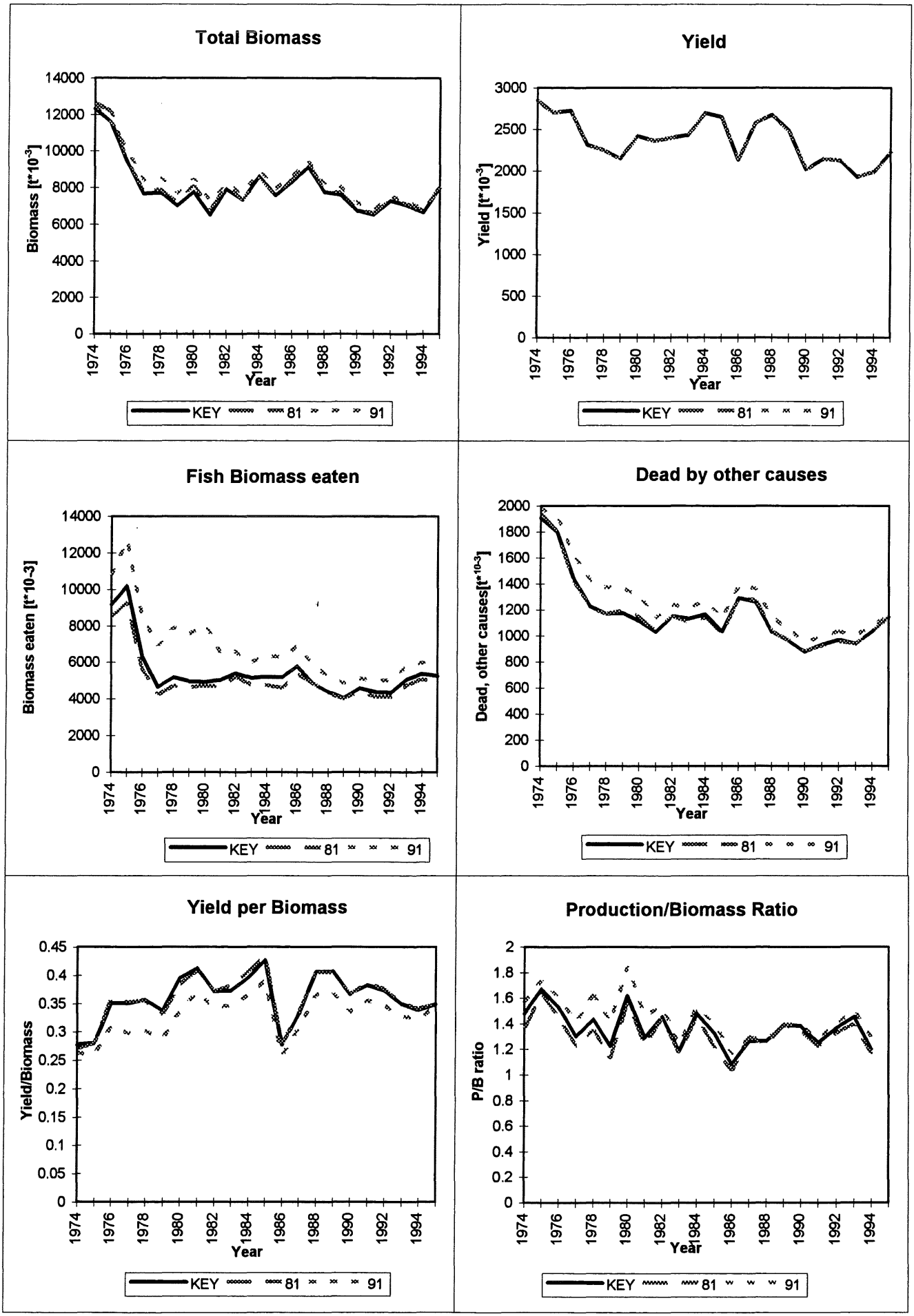
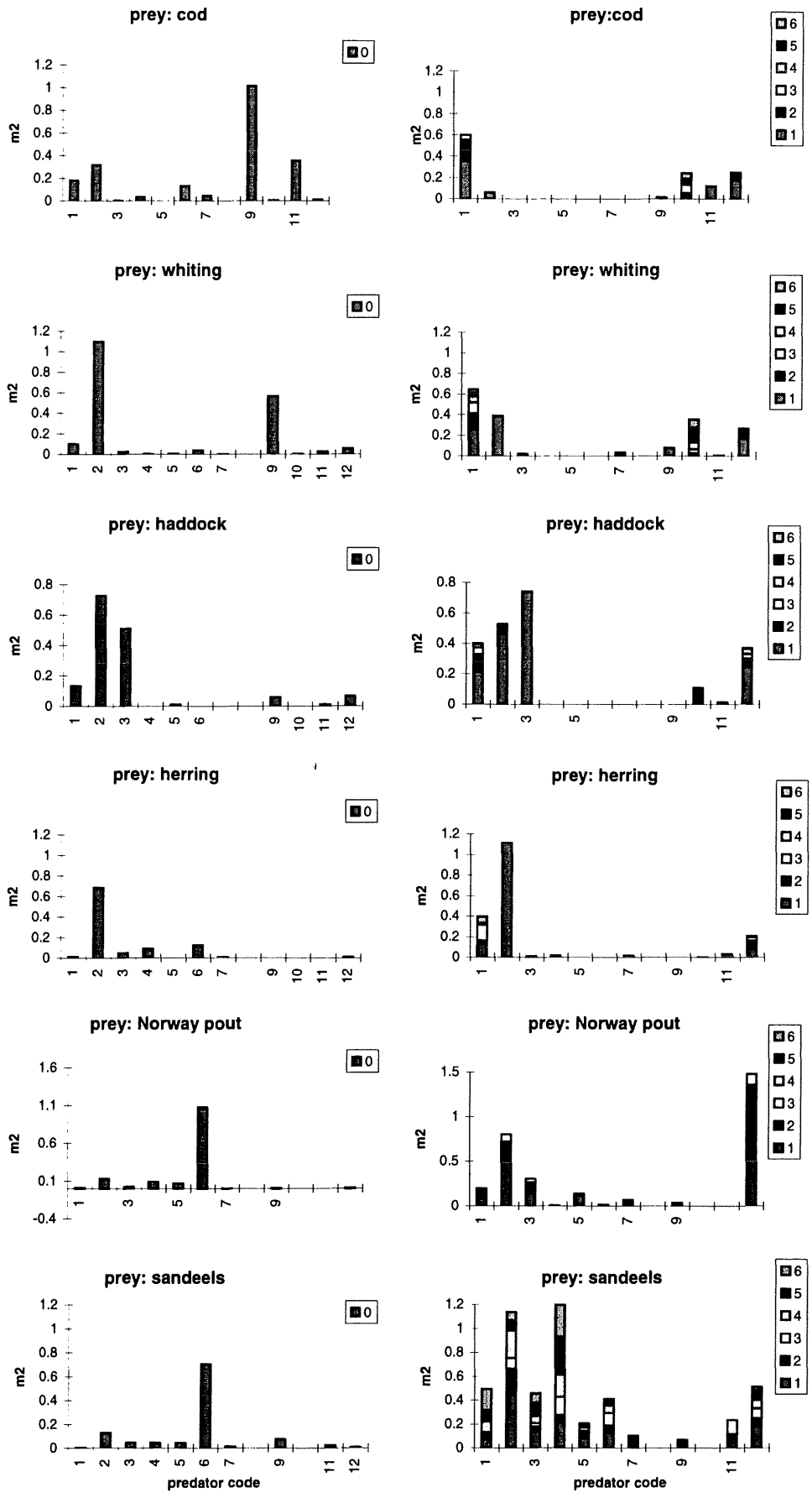


Figure 3.2.2.2

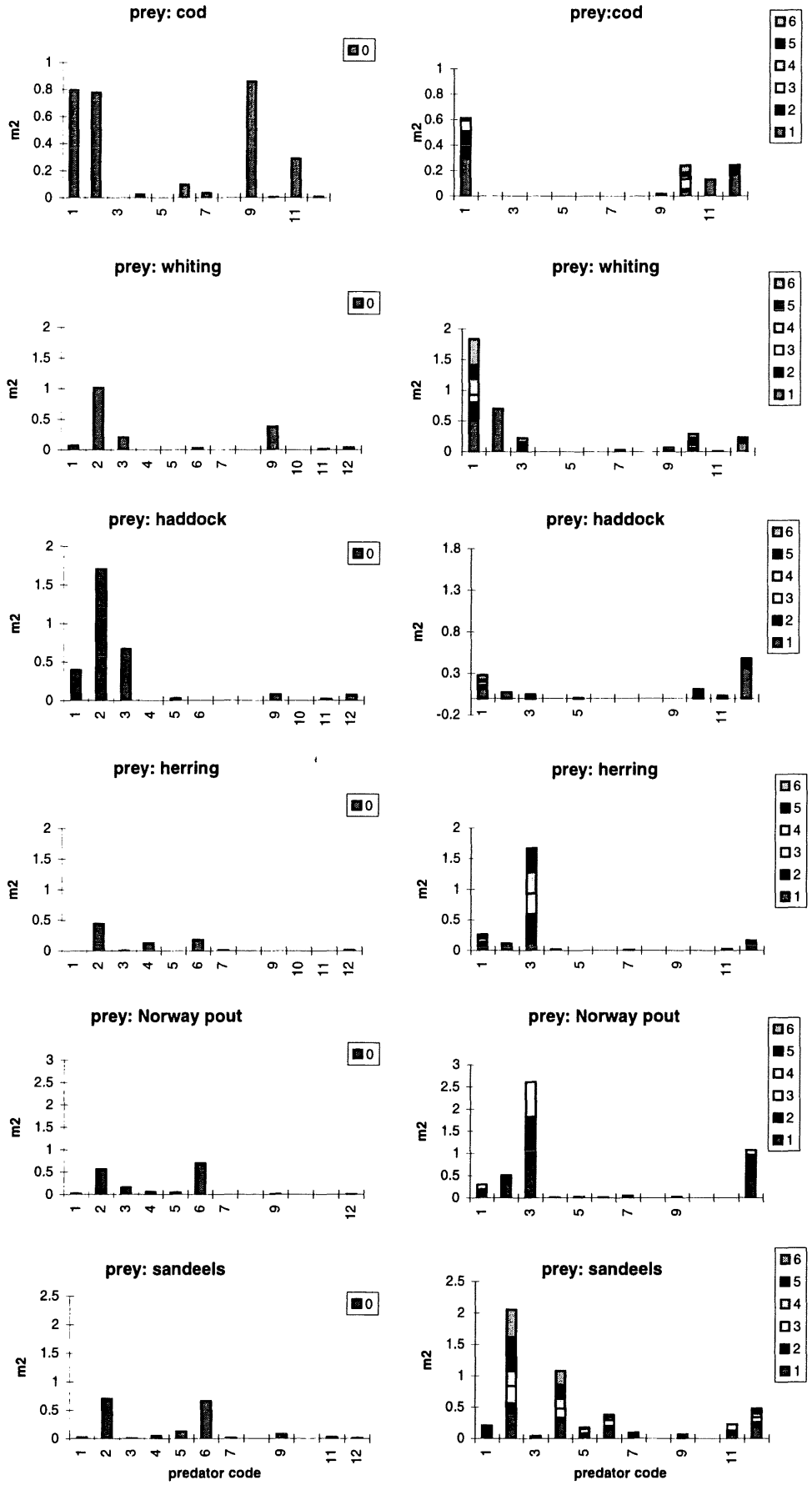
Translation of the predator code in the M2 bar charts		
1	=	cod
2	=	whiting
3	=	saithe
4	=	mackerel
5	=	haddock
6	=	w. mackerel
7	=	starry ray
8	=	horse mackerel
9	=	grey gurnards
10	=	seals
11	=	birds
12	=	other



M2 values from MSVPA 1981 data

Figure 3.2.2.3

Translation of the predator code in the M2 bar charts		
1	=	cod
2	=	whiting
3	=	saithe
4	=	mackerel
5	=	haddock
6	=	w. mackerel
7	=	starry ray
8	=	horse mackerel
9	=	grey gurnards
10	=	seals
11	=	birds
12	=	other



M2 values from MSVPA 1991 data

Figure 3.2.3.1

Comparative summary output from the key run 1997 and a run with only the 5 traditional predators (Cod, Whiting, Haddock, Saithe, Mackerel) and old values for M1.
The Biomass units include all MSVPA species summed over species and ages.
The eaten biomass of other food is not included.

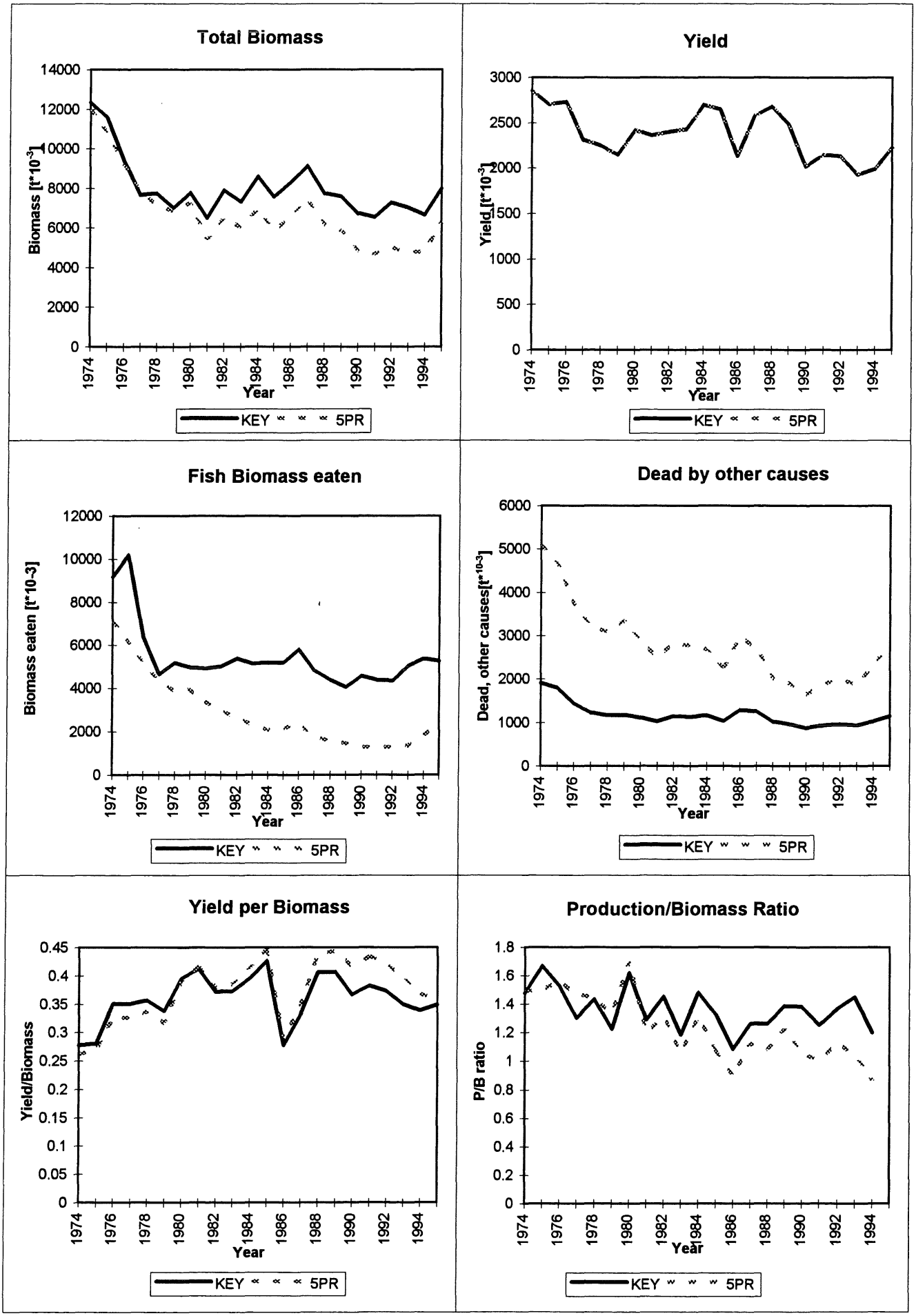
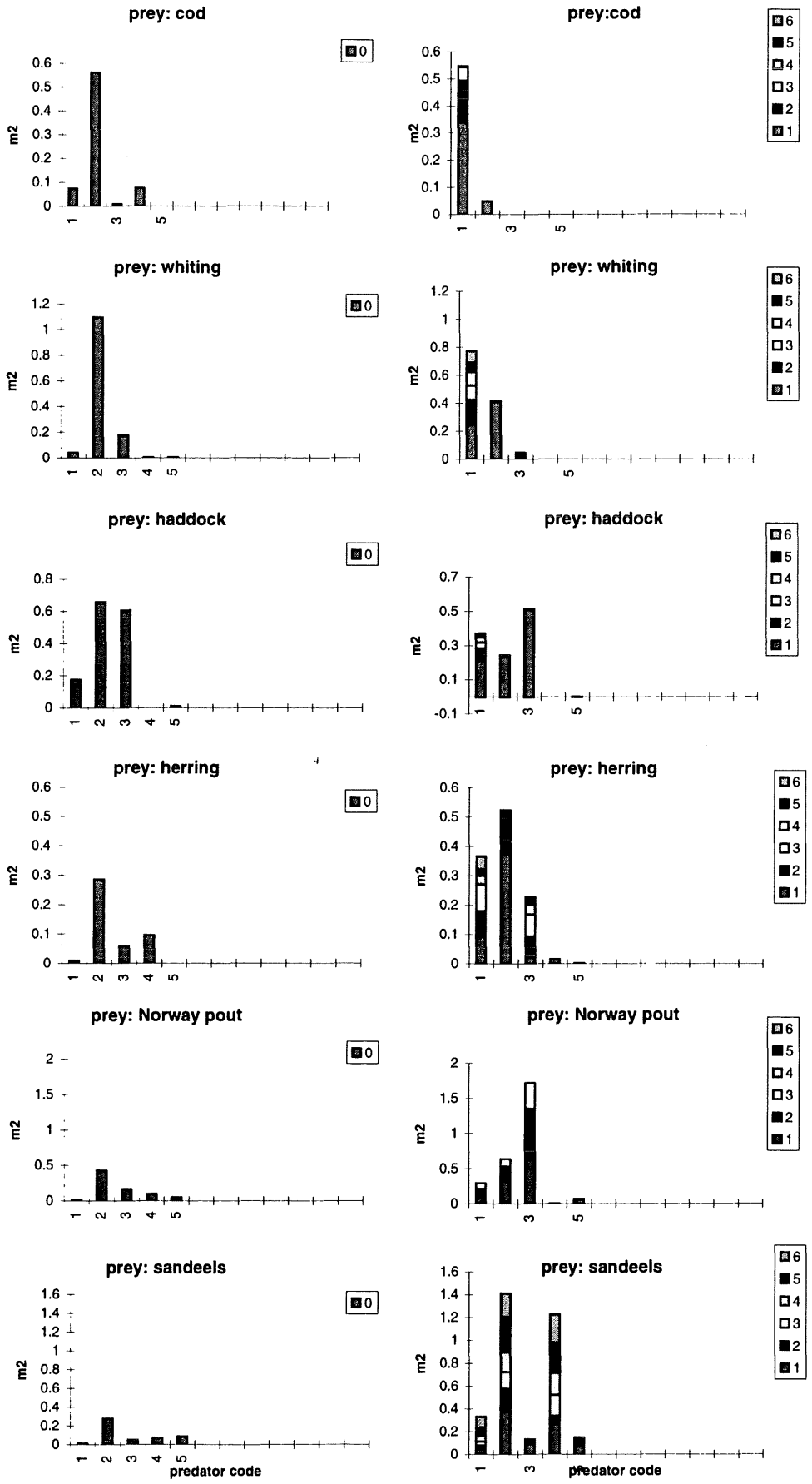


Figure 3.2.3.2

Translation of the predator code in the M2 bar charts		
1	=	cod
2	=	whiting
3	=	saithe
4	=	mackerel
5	=	haddock
6	=	w. mackerel
7	=	starry ray
8	=	horse mackerel
9	=	grey gurnards
10	=	seals
11	=	birds
12	=	other



M2 values from MSVPA run + only 5 main predators

Figure 3.2.4.1

Comparative summary output from the key run 1997 and a similar run with Horse Mackerel as additional predator.
The Biomass units include all MSVPA species summed over species and ages.
The eaten biomass of other food is not included.

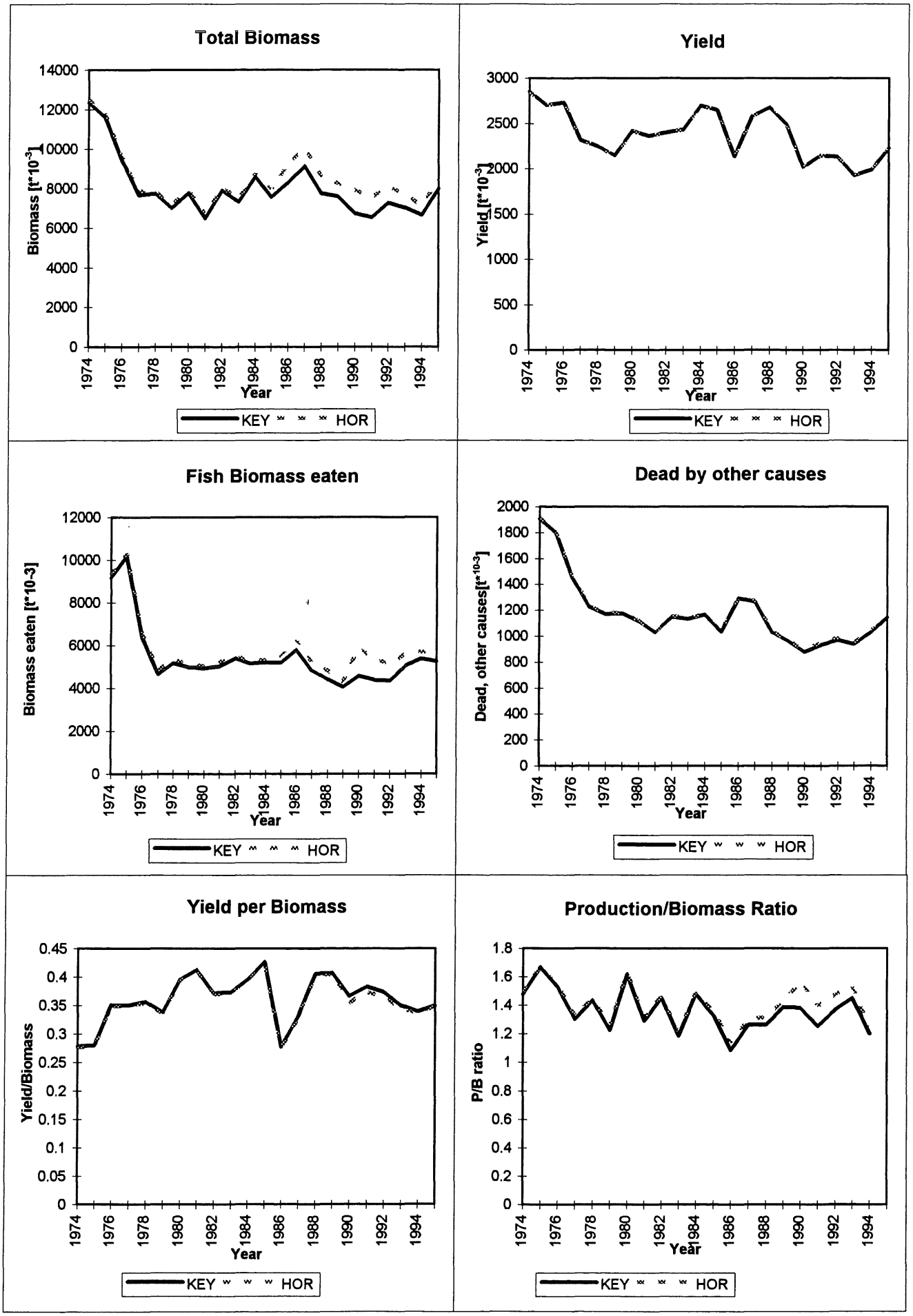
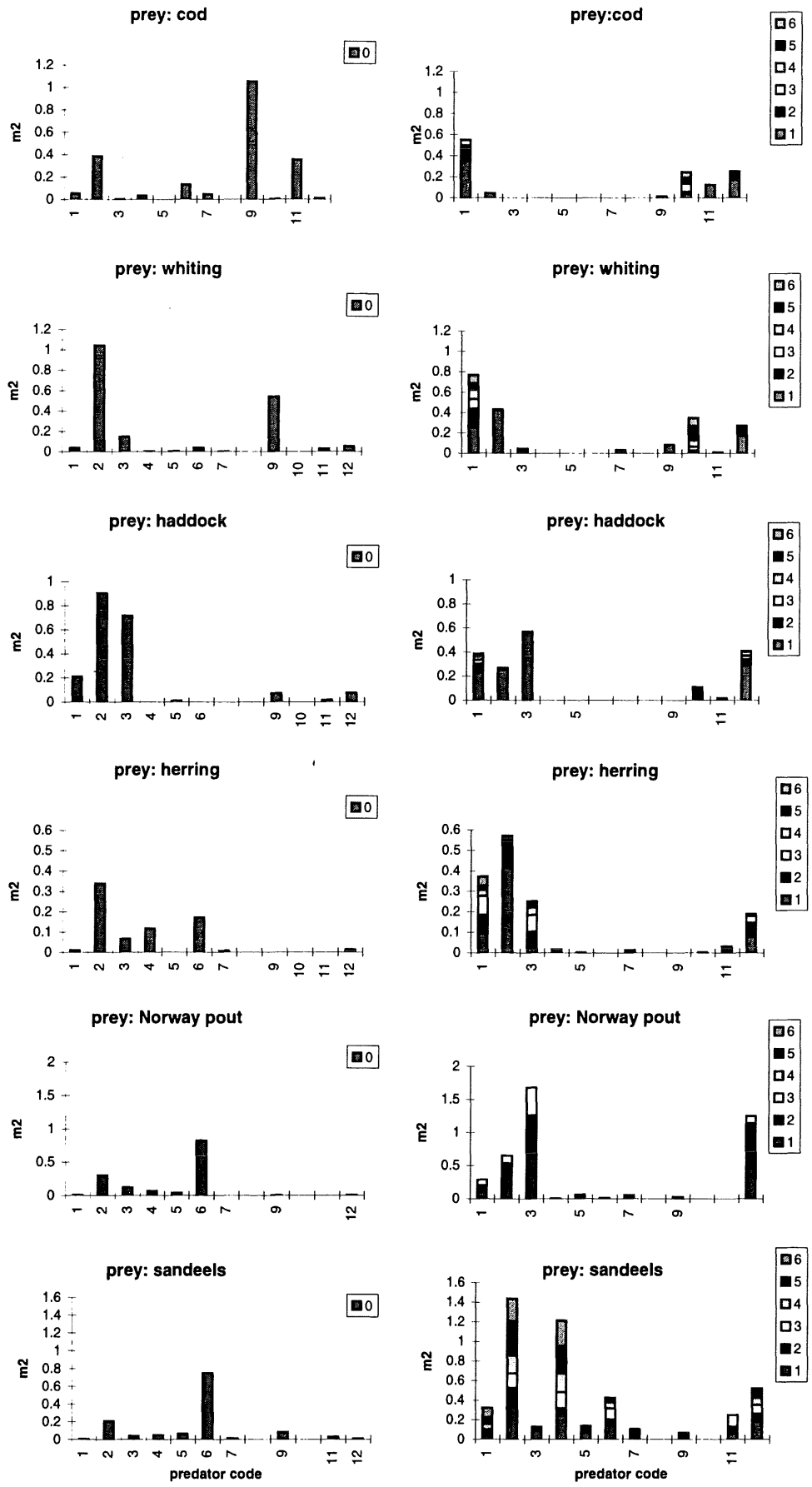


Figure 3.2.4.2

Translation of the predator code in the M2 bar charts		
1	=	cod
2	=	whiting
3	=	saithe
4	=	mackerel
5	=	haddock
6	=	w. mackerel
7	=	starry ray
8	=	horse mackerel
9	=	grey gurnards
10	=	seals
11	=	birds
12	=	other



M2 values from MSVPA keyrun

Figure 3.2.5.1

Comparative summary output from the key run 1997 and a similar run with the old consumption rates.
The Biomass units include all MSVPA species summed over species and ages.
The eaten biomass of other food is not included.

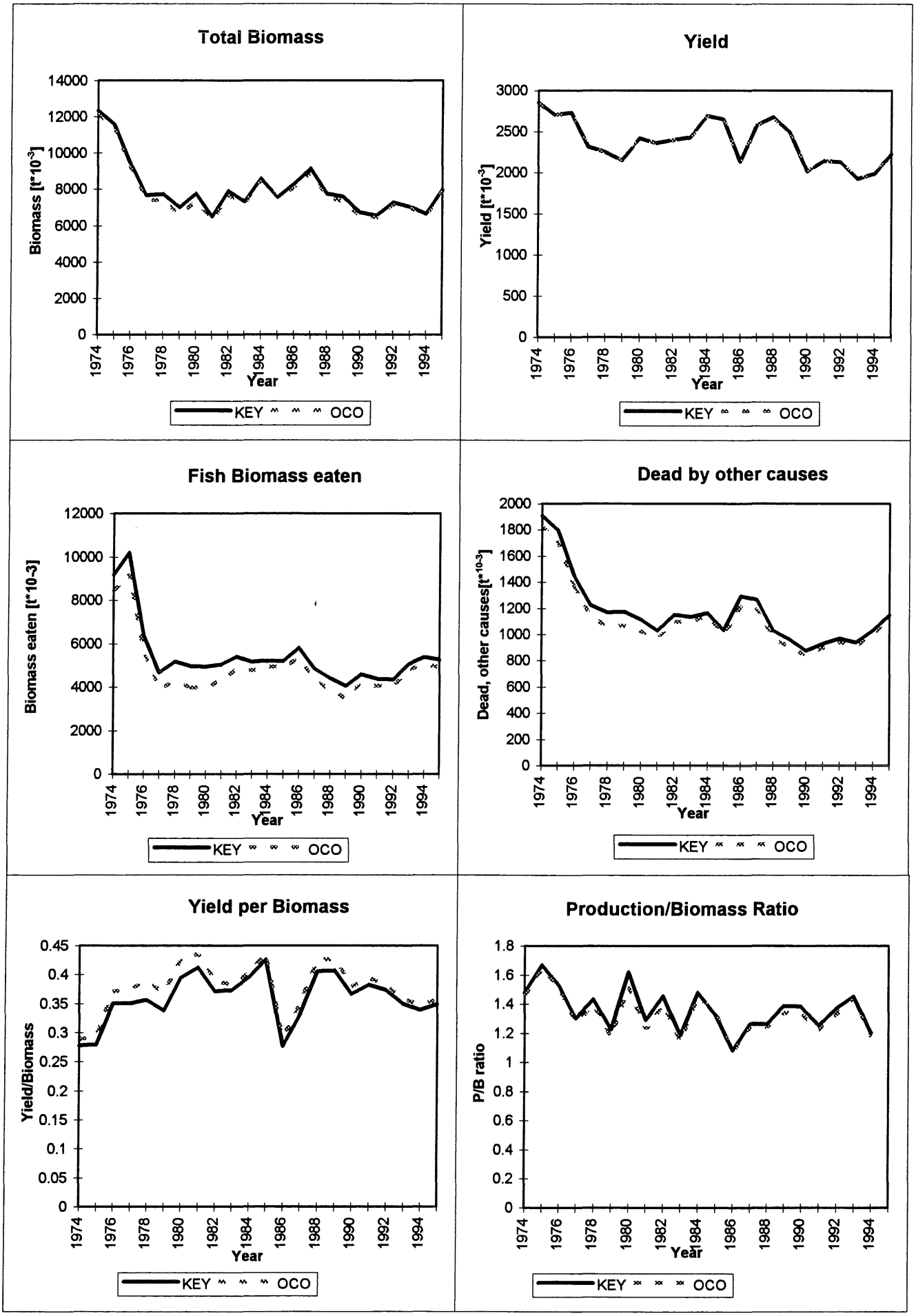
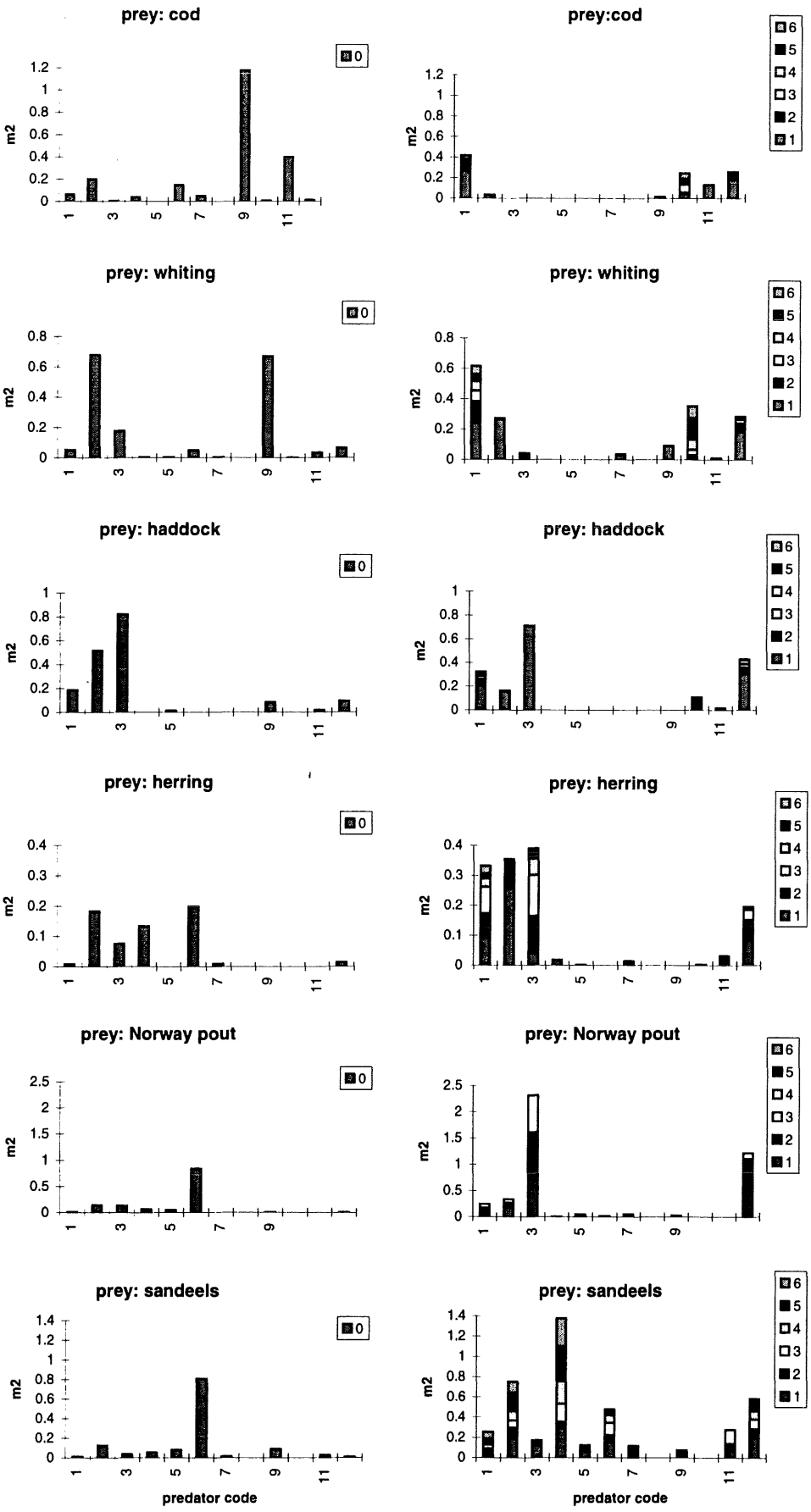


Figure 3.2.5.2

Translation of the predator code in the M2 bar charts		
1	=	cod
2	=	whiting
3	=	saithe
4	=	mackerel
5	=	haddock
6	=	w. mackerel
7	=	starry ray
8	=	horse mackerel
9	=	grey gurnards
10	=	seals
11	=	birds
12	=	other



M2 values from MSVPA old consumption estimates

Figure 3.3.1

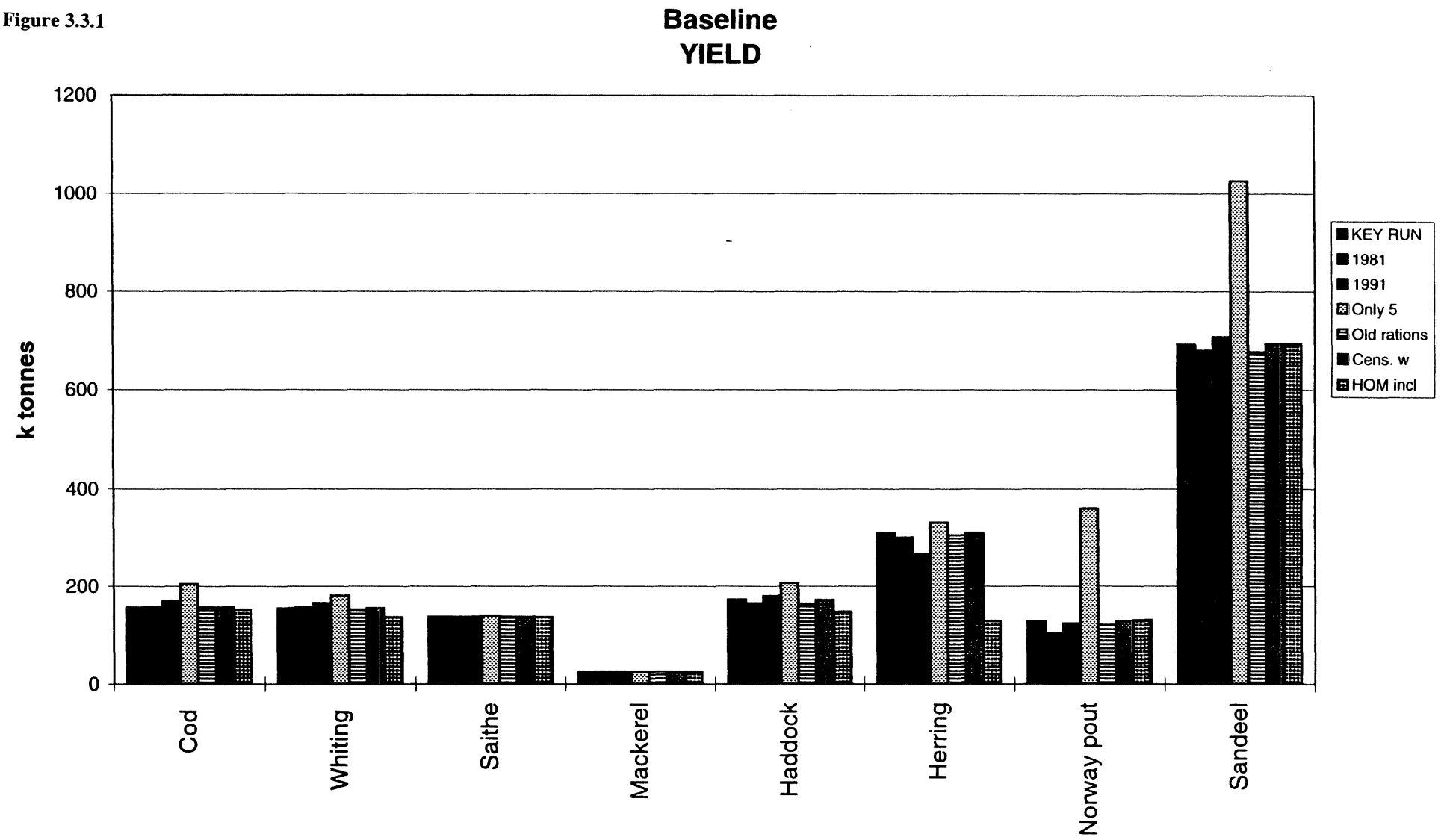

Baseline
YIELD
k tonnes
1200
1000
800
600
400
200
0
Cod
Whiting
Saithe
Mackerel
Haddock
Herring
Norway pout
Sandeel
KEY RUN
1981
1991
Only 5
Old rations
Cens. w
HOM incl

Figure 3.3.2

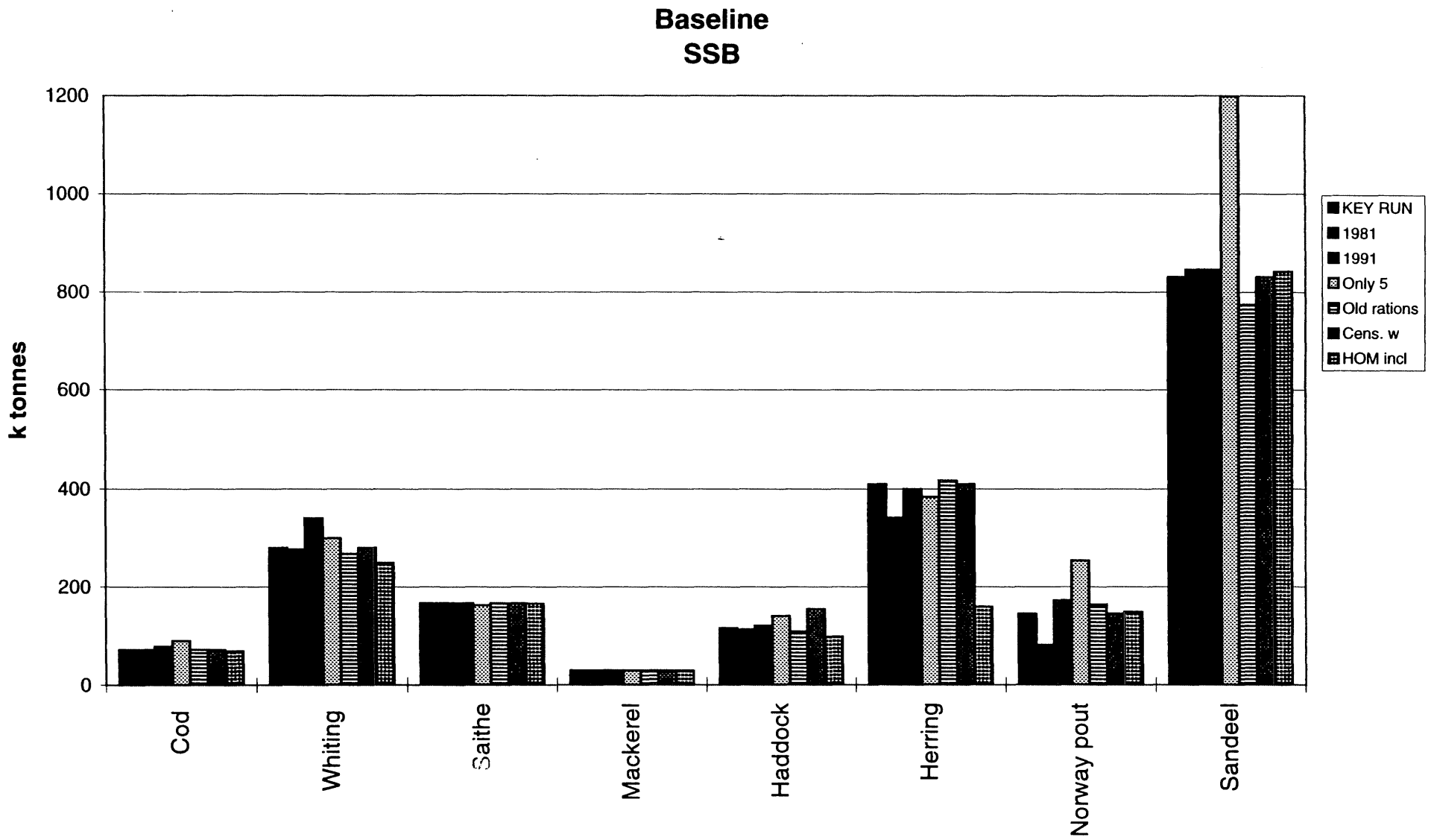

Baseline
SSB
k tonnes
1200
1000
800
600
400
200
0
Cod
Whiting
Saithe
Mackerel
Haddock
Herring
Norway pout
Sandeel
KEY RUN
1981
1991
Only 5
Old rations
Cens. w
HOM incl

Figure 3.3.3

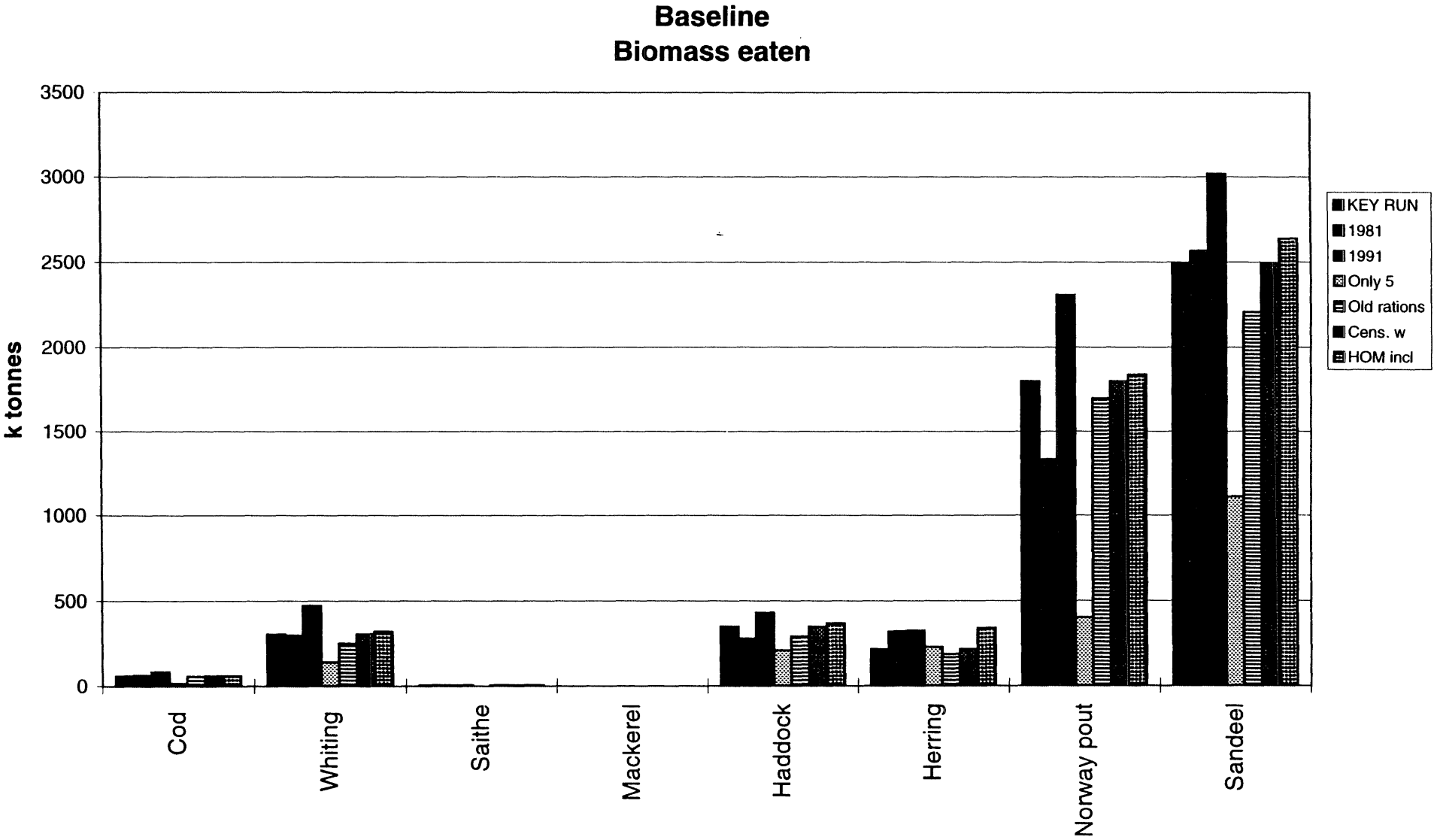

Baseline
Biomass eaten
k tonnes
3500
3000
2500
2000
1500
1000
500
0
Cod
Whiting
Saithe
Mackerel
Haddock
Herring
Norway pout
Sandeel
KEY RUN
1981
1991
Only 5
Old rations
Cens. w
HOM incl

Figure 3.4

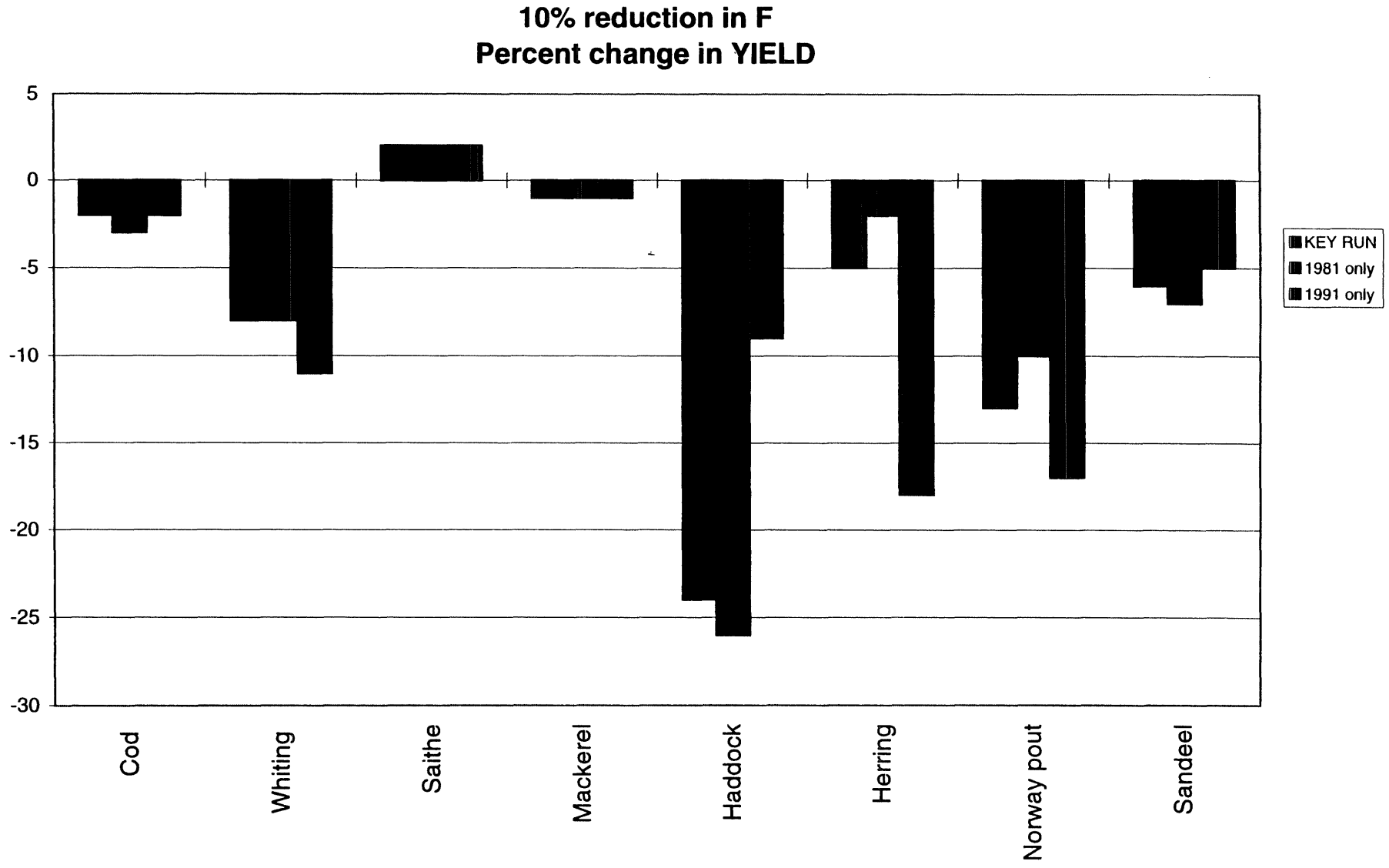

10% reduction in F
Percent change in YIELD
5
0
-5
-10
-15
-20
-25
-30
Cod
Whiting
Saithe
Mackerel
Haddock
Herring
Norway pout
Sandeel
KEY RUN
1981 only
1991 only

Figure 3.5

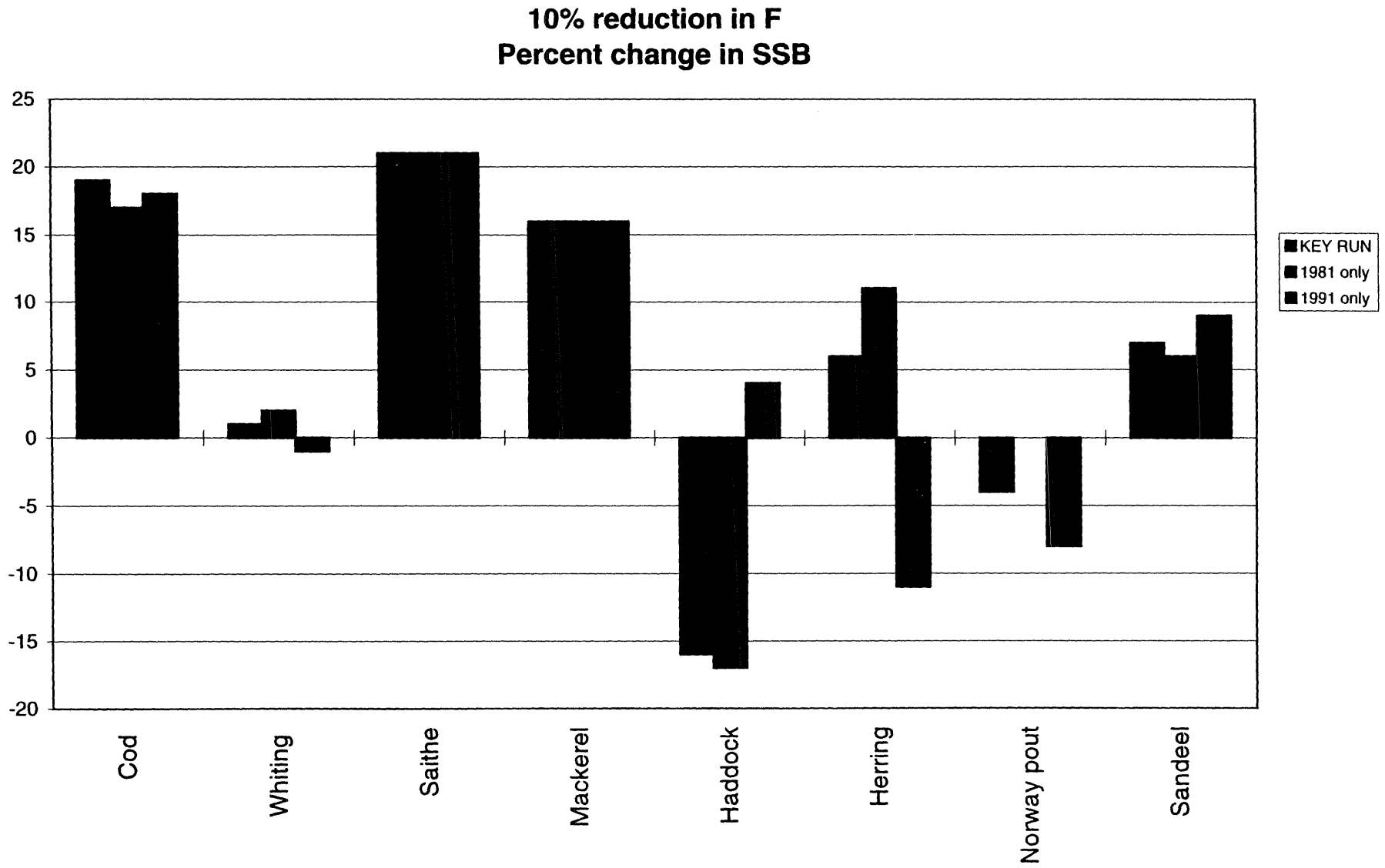

10% reduction in F
Percent change in SSB
25
20
15
10
5
0
-5
-10
-15
-20
KEY RUN
1981 only
1991 only
Cod
Whiting
Saithe
Mackerel
Haddock
Herring
Norway pout
Sandeel

Figure 4.2.1 Family of curves describing yield (Y) per recruit (R), spawning stock biomass (S) per recruit, and yield as a function of fishing mortality (F). The steps to relate the curves are described in the text (based on Figure 1 of Sissenwine and Shepherd (1987)).

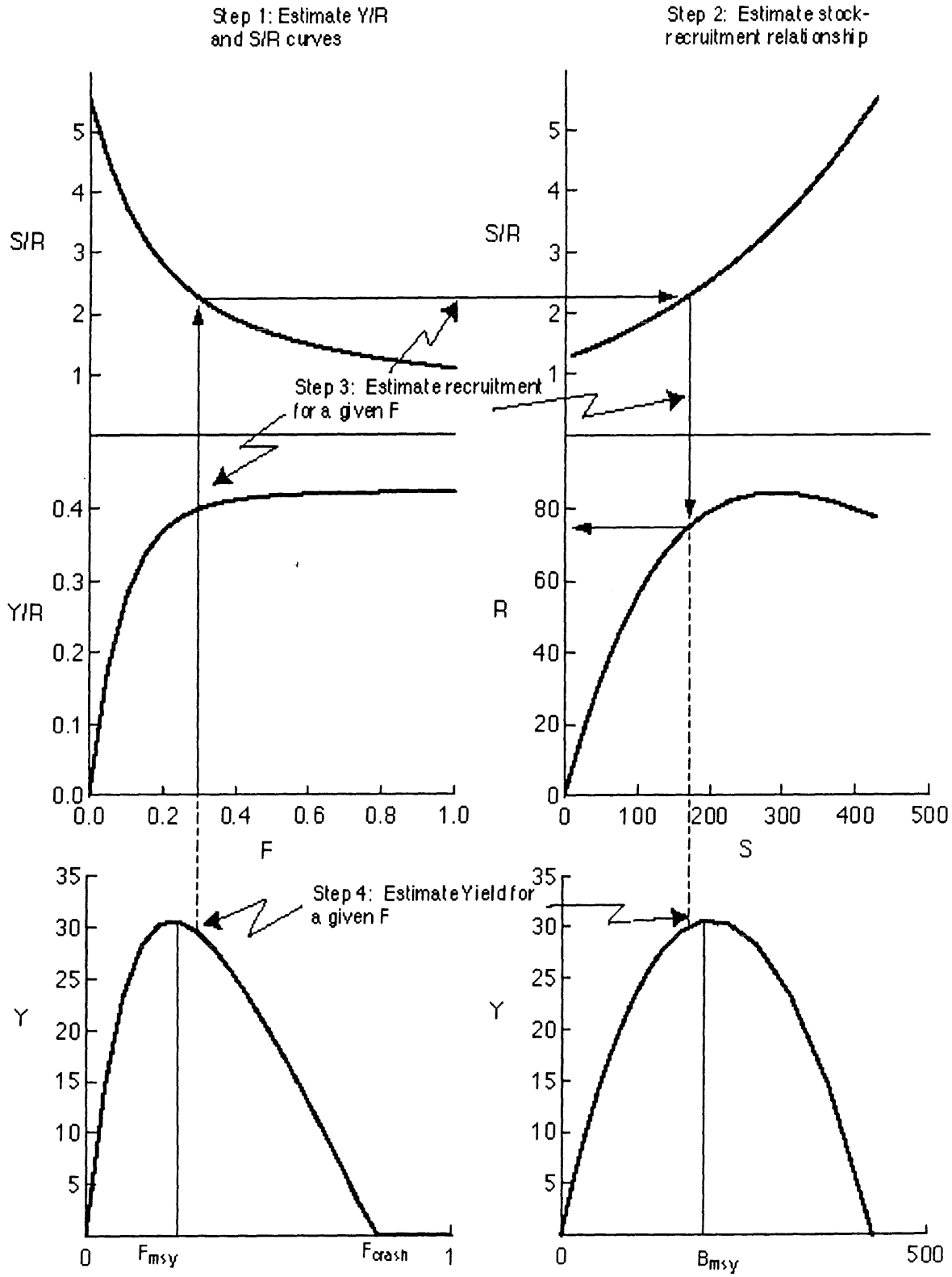


Figure 4.2.2 Comparison of Construction of Yield Curves for Multi- Species and Single Species Assessments of a Stock
Case 1. A Species whos spawning stock Cannibalizes its pre recruit ages

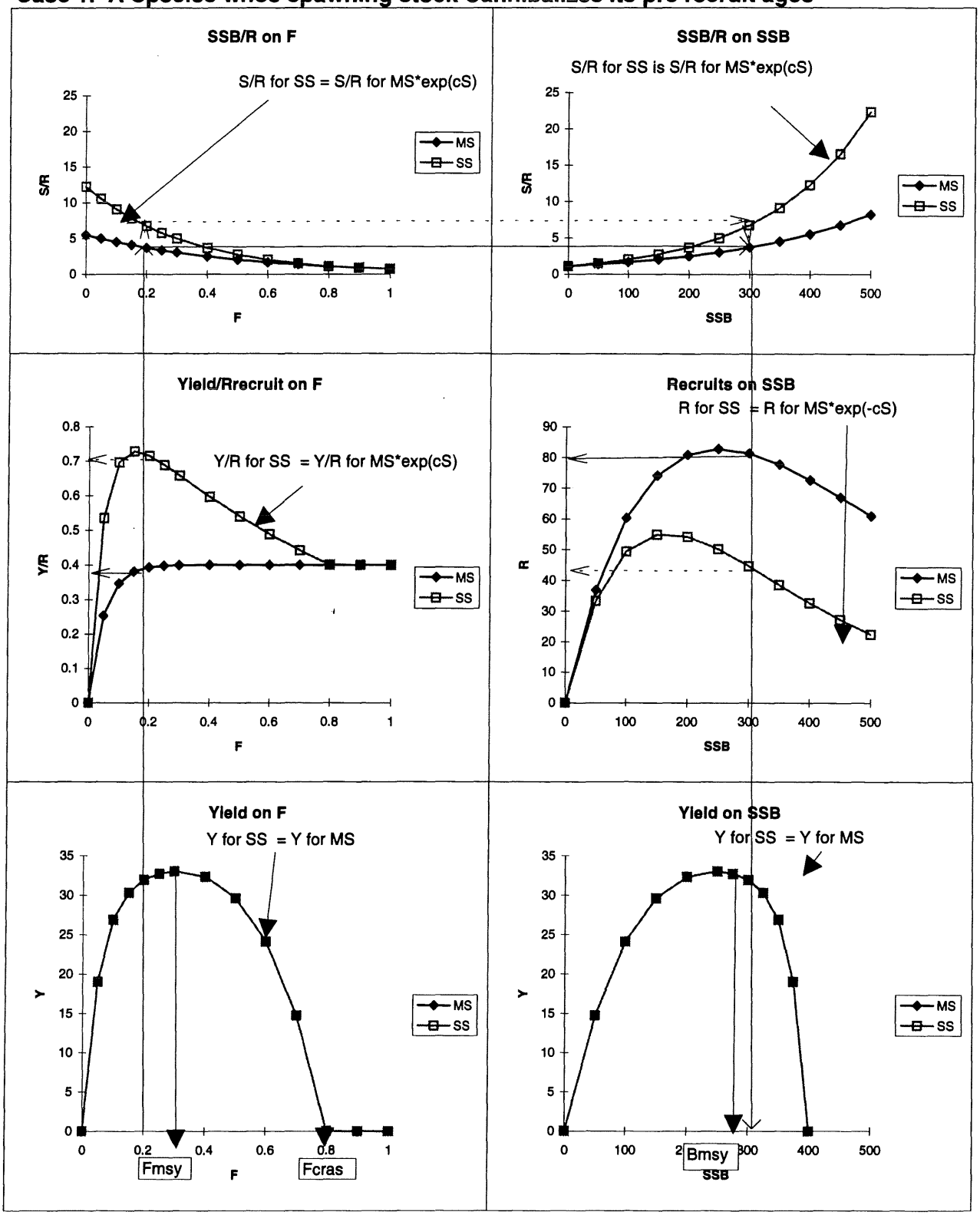


Figure 4.2.3 Comparison of Construction of Yield Curves for Multi- Species and Single Species Assessments of a Stock
Case 2 A Forage Species; eaten at all ages by a predator of constant biomass

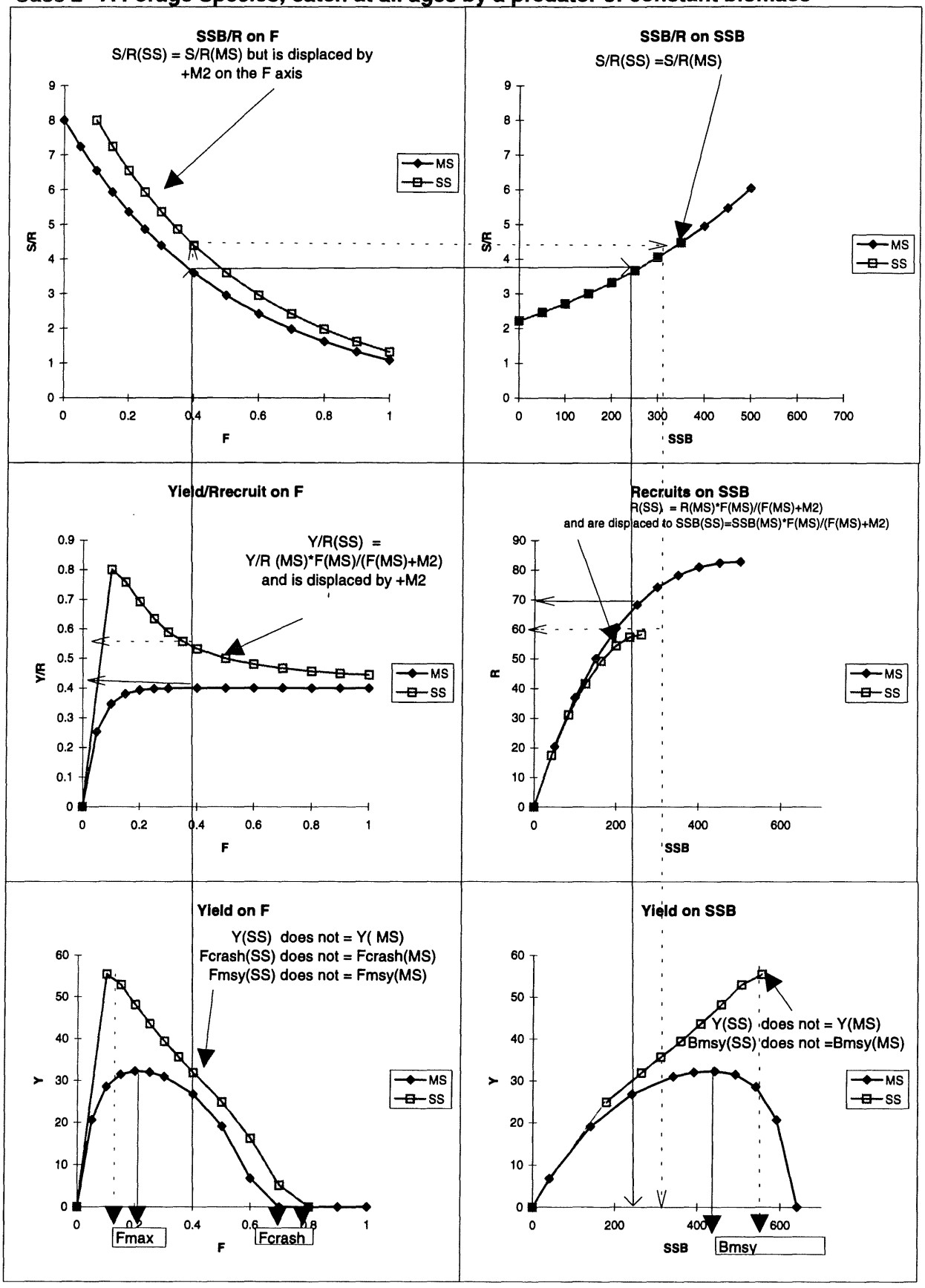


Figure 4.2.4 Possible distortions to construction of overall yield curves consequent on ignoring multispecies effects

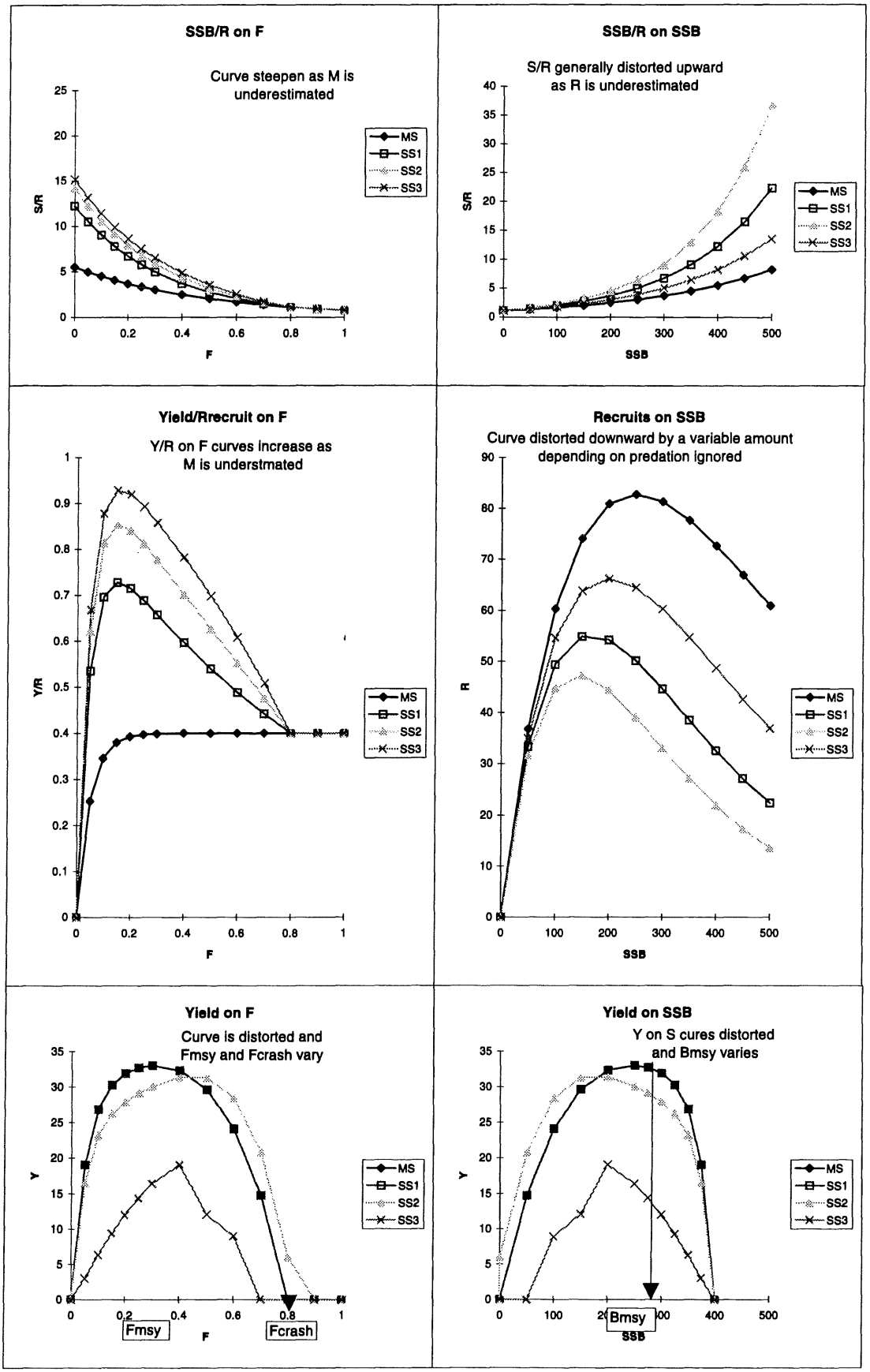


Figure 4.2.2.1

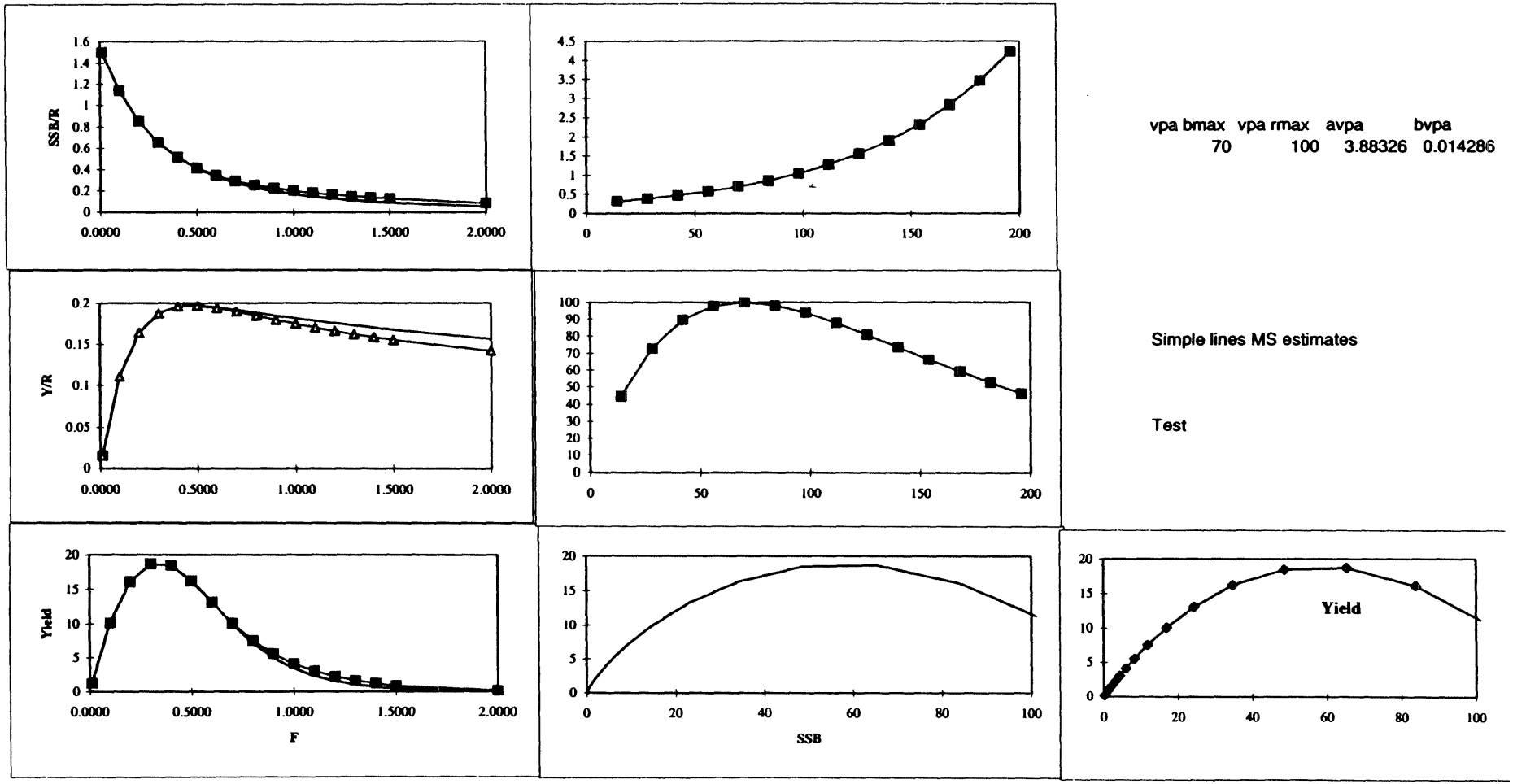
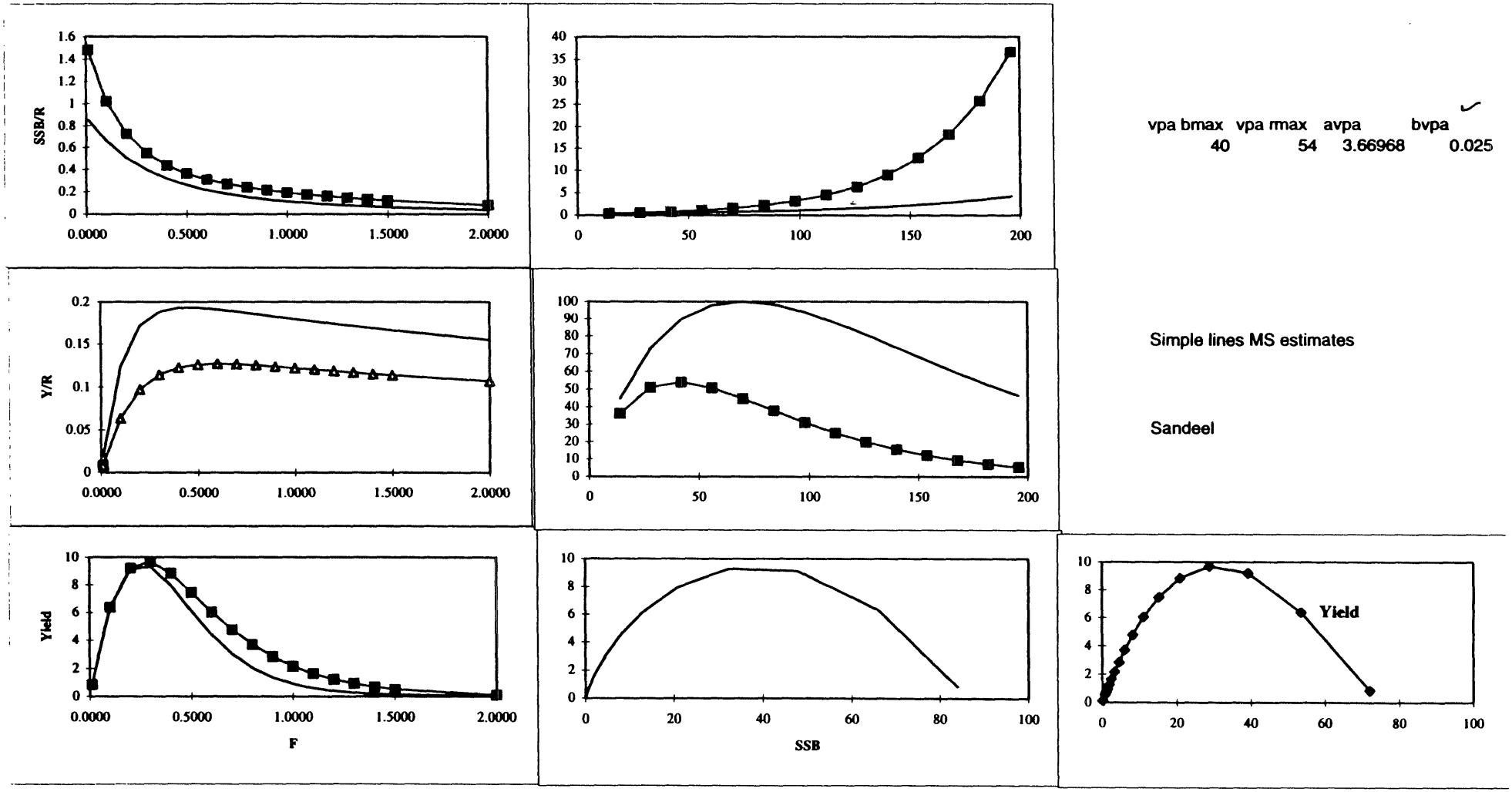

SSB/R
Y/R
Yield
F
SSB
Yield
vpa bmax vpa rmax avpa bvpa
70 100 3.88326 0.014286
Simple lines MS estimates
Test

Figure 4.2.2.2

YPR



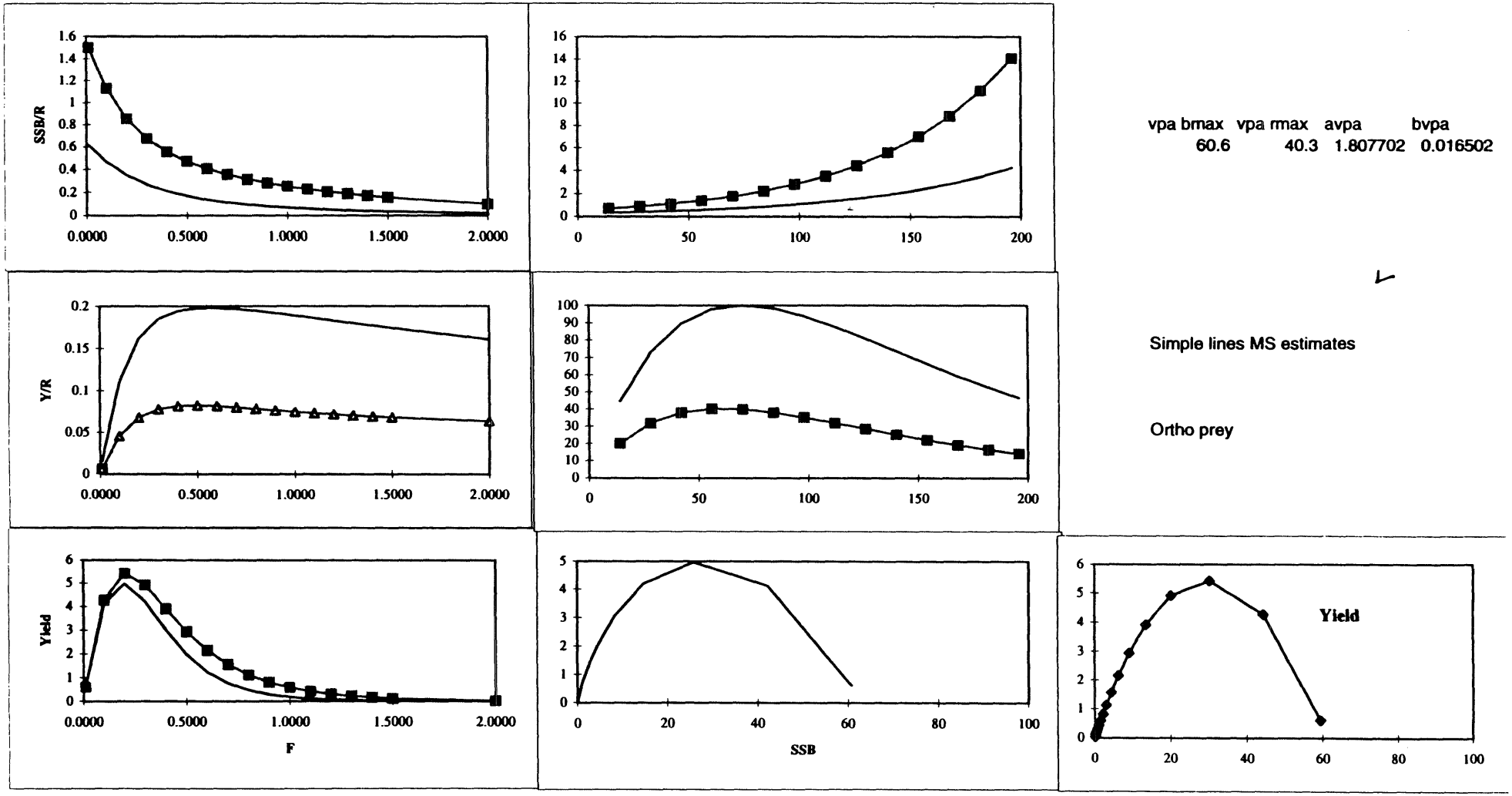
vpa bmax	vpa rmax	avpa	bvpa
40	54	3.66968	0.025

Simple lines MS estimates

Sandeel

Figure 4.2.2.3

YPR



vpa bmax vpa rmax avpa bvpa
60.6 40.3 1.807702 0.016502

Simple lines MS estimates

Ortho prey

Figure 4.2.2.4

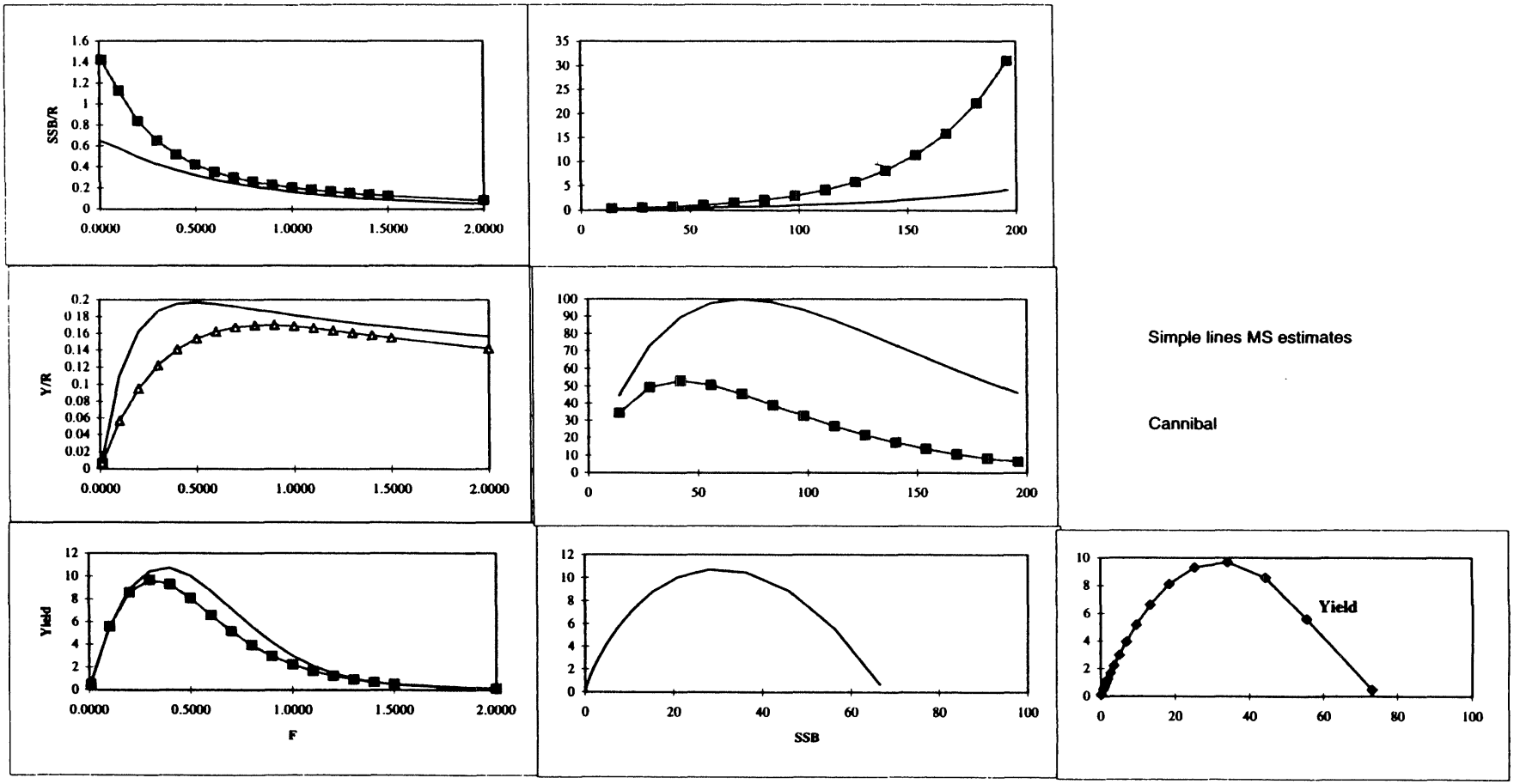
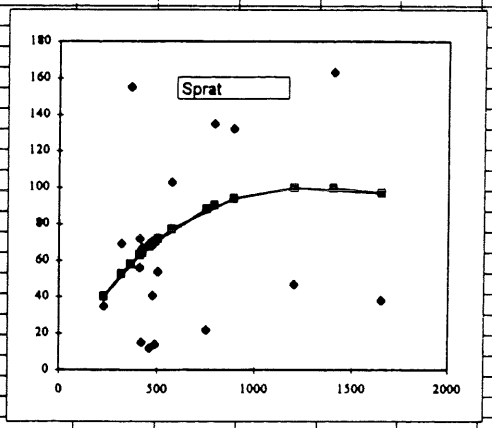
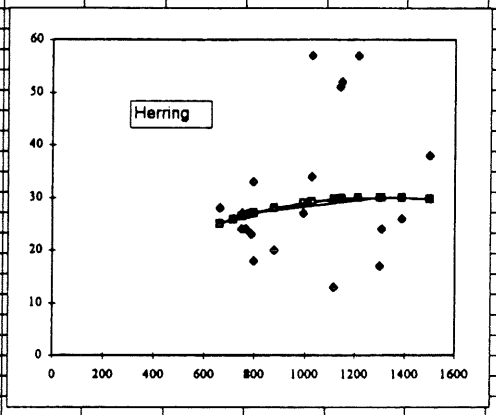

SSB/R
Y/R
Yield
F
SSB
Yield
Simple lines MS estimates
Cannibal

Figure 4.3.2.1

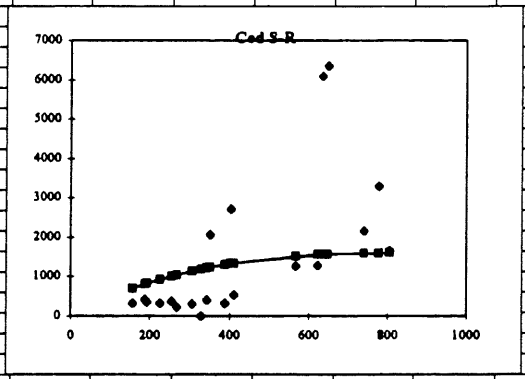
Table 10.6 ICES CM 1997/assess:12				vpa bmax	vpa rmax	avpa	bvpa
	sprat			1300	100	0.209099	0.000769
	Year	ssb (K)	age 0(M)				
	1977	492	14	70.4616			
	1978	793	135	90.09583			
	1979	753	22	88.22454			
	1980	471	68	68.55258			
	1981	479	41	69.28925			
	1982	365	155	57.63781			
	1983	320	69	52.31158			
	1984	230	35	40.29417			
	1985	424	15	63.98382			
	1986	506	54	71.69038			
	1987	463	12	67.80418			
	1988	414	56	62.9572			
	1989	426	67	64.18681			
	1990	412	72	62.74952			
	1991	574	103	77.18009			
	1992	890	132	93.84615			
	1993	1201	47	99.69488			
	1994	1653	38	96.91742			
	1995	1403	163	99.70222			



				vpa bmax	vpa rmax	avpa	bvpa
	Herring			1300	30	0.06273	0.000769
	Year	ssb (K)	age 0(M)				
	1977	1388	26	29.93429			
	1978	1308	24	29.99943			
	1979	1501	38	29.67632			
	1980	1213	57	29.92975			
	1981	1028	57	29.24414			
	1982	1139	51	29.75002			
	1983	1146	52	29.77212			
	1984	1028	34	29.24414			
	1985	1299	17	29.99999			
	1986	796	33	27.06846			
	1987	1117	13	29.67334			
	1988	878	20	28.03181			
	1989	715	26	25.87715			
	1990	787	23	26.94833			
	1991	663	28	24.97444			
	1992	748	24	26.39293			
	1993	797	18	27.08163			
	1994	993	27	29.01934			
	1995	752	27	26.45255			
		766	24	26.6564			



Cod	Year	ssb (K)	age 0(M)				
	1977	352	2057	1232.473			
	1978	404	2715	1325.523			
	1979	648	6352	1567.187			
	1980	634	6093	1560.398			
	1981	778	3305	1599.384			
	1982	741	2153	1595.429			
	1983	805	1650	1599.969			
	1984	623	1278	1554.554			
	1985	568	1264	1518.182			
	1986	411	534	1336.742			
	1987	389	318	1300.464			
	1988	344	406	1216.568			
	1989	267	223	1039.657			
	1990	225	325	923.34			
	1991	193	353	824.3435			
	1992	158	326	705.0313			
	1993	188	420	808.0219			
	1994	254	381	1005.24			
	1995	306	308	1134.823			
	1996	329	2	1185.542			



				vpa bmax	vpa rmax	avpa	bvpa
	Cod			800	1600	5.436564	0.00125

Figure 4.3.1.2

MSFOR - Central Baltic

with Sparholt's SSB-recruitment relationship

	Overall	Cod	Herring	Sprat	Prey F	Prey S-R
F-multiplier	1	1.5	1	1	1	TRUE
M1-multiplier		1	1	1		
Recruitment-multiplier		1	1	1		
Food intake-multiplier		1				
Oth. food-multiplier		1				

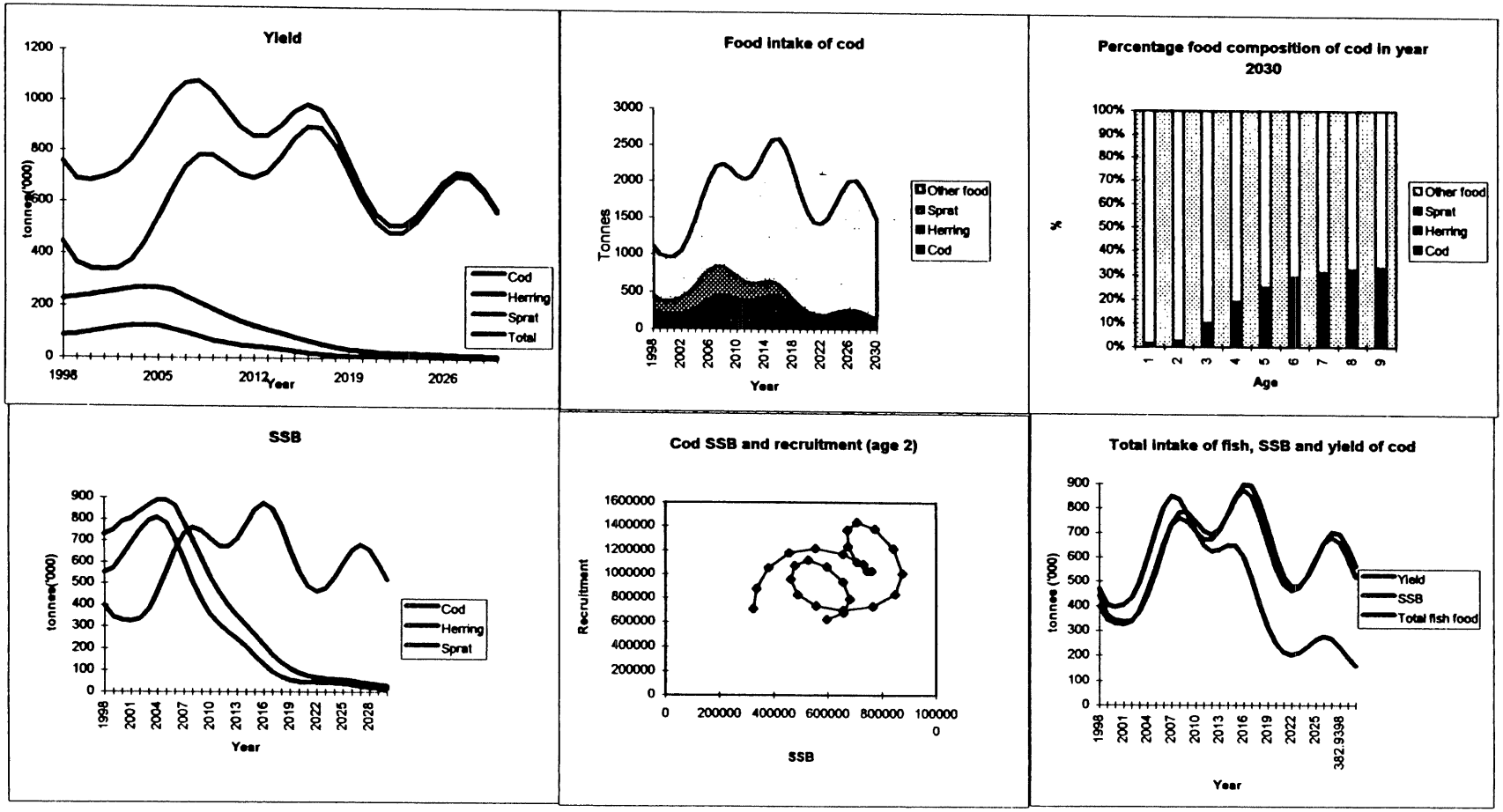


Figure 4.3.1.3

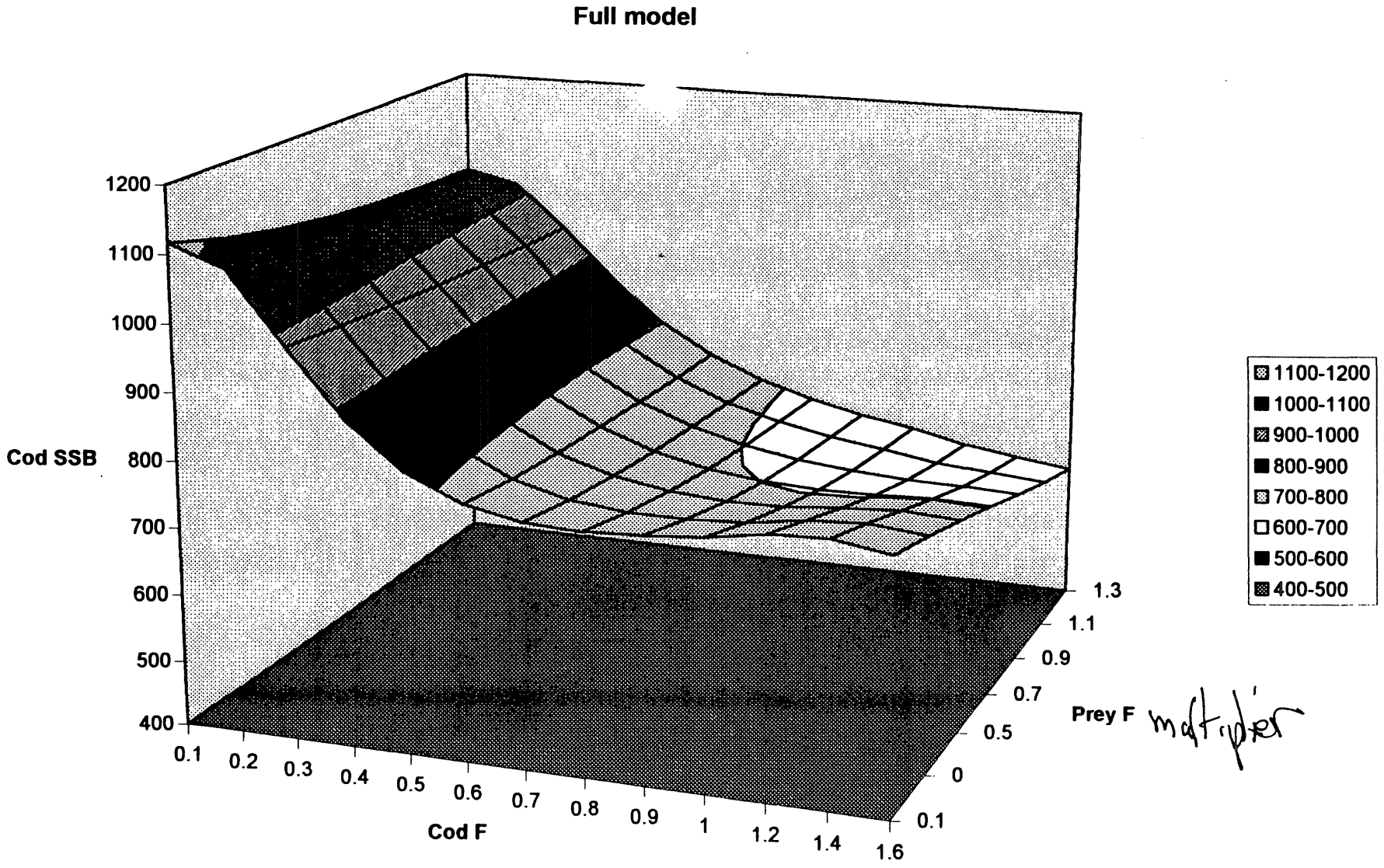

Full model
Cod SSB
1200
1100
1000
900
800
700
600
500
400
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.2
1.4
1.6
Cod F
1.3
1.1
0.9
0.7
0.5
0
0.1
Prey F multiplier
1100-1200
1000-1100
900-1000
800-900
700-800
600-700
500-600
400-500

Figure 4.3.1.4

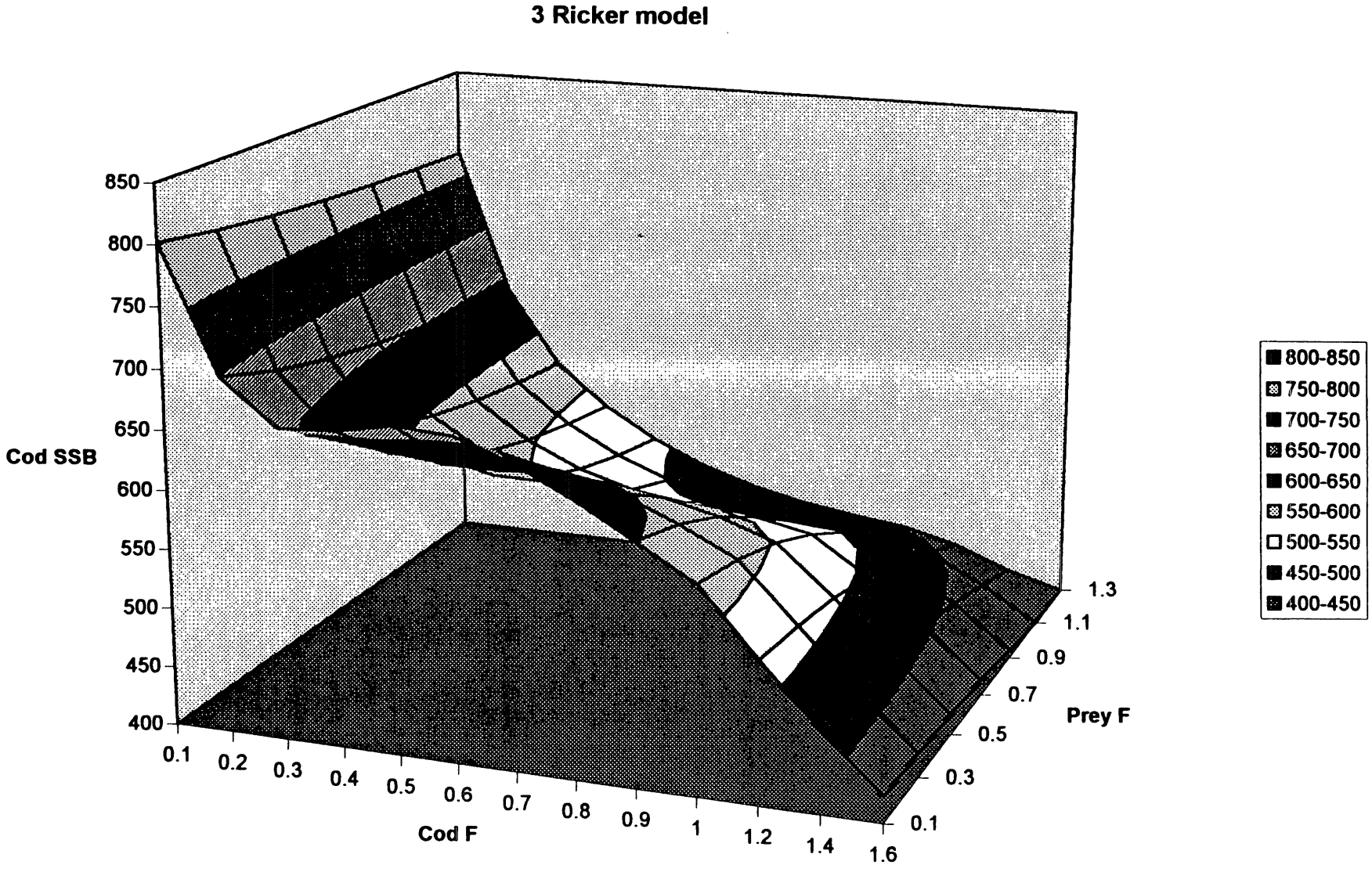

3 Ricker model
Cod SSB
850
800
750
700
650
600
550
500
450
400
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.2
1.4
1.6
Cod F
1.3
1.1
0.9
0.7
0.5
0.3
0.1
Prey F
800-850
750-800
700-750
650-700
600-650
550-600
500-550
450-500
400-450

Figure 4.3.1.5

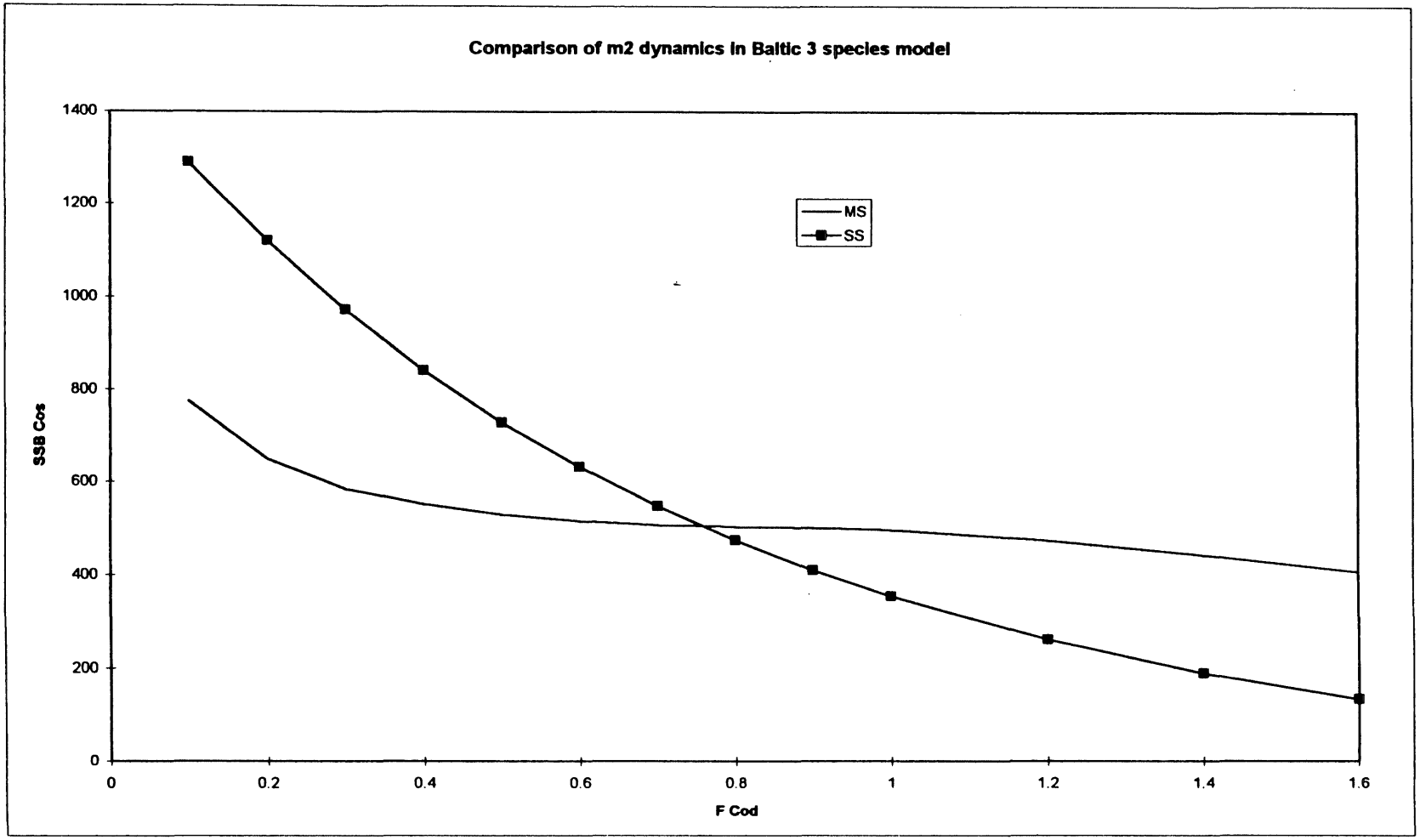

Comparison of m2 dynamics in Baltic 3 species model
SSB Cod
F Cod
MS
SS
0
200
400
600
800
1000
1200
1400
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6

Figure 4.3.1.6

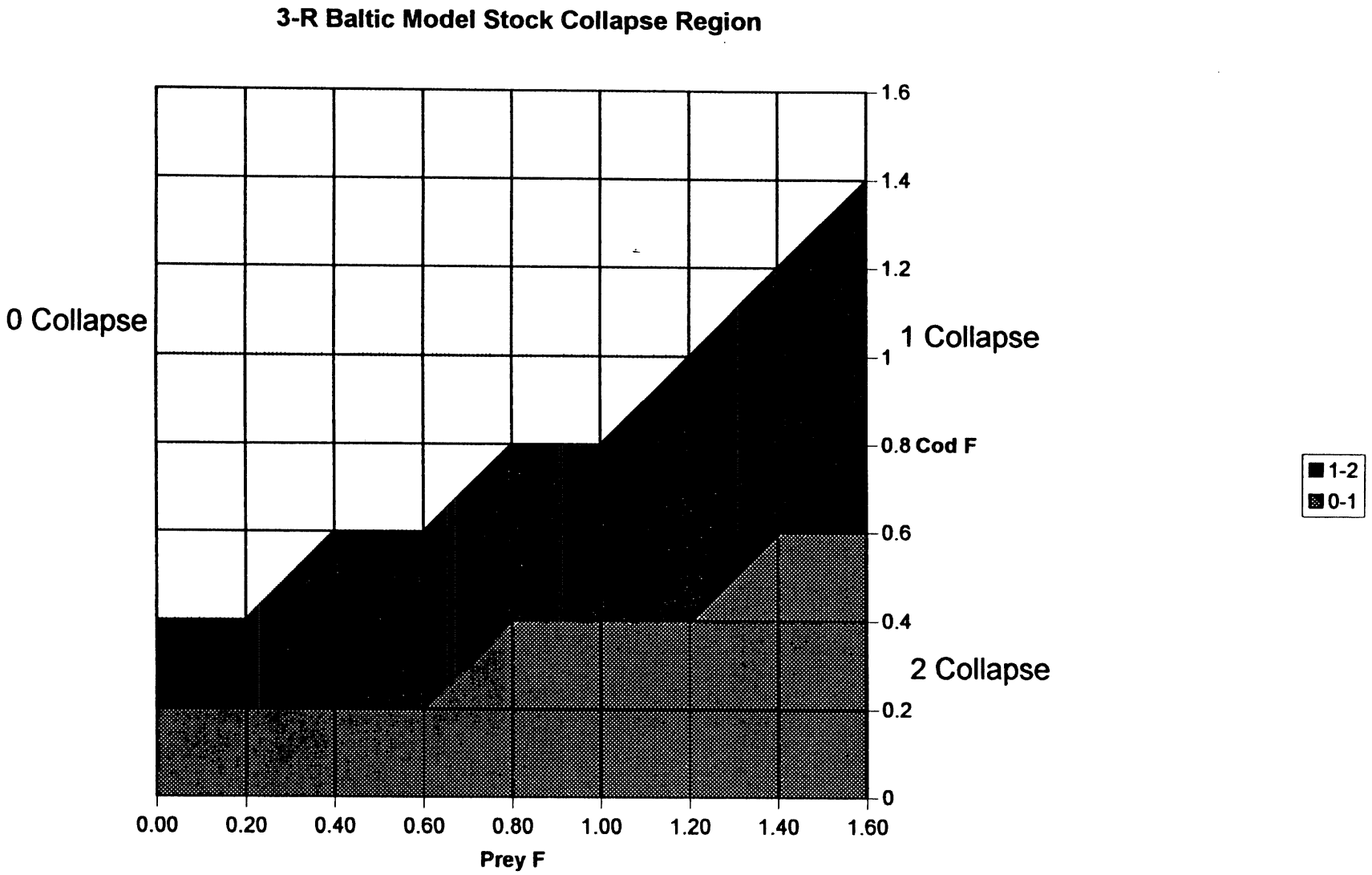

3-R Baltic Model Stock Collapse Region
0 Collapse
1 Collapse
2 Collapse
1.6
1.4
1.2
1
0.8 Cod F
0.6
0.4
0.2
0
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
Prey F
1-2
0-1

Figure 4.4.1.1

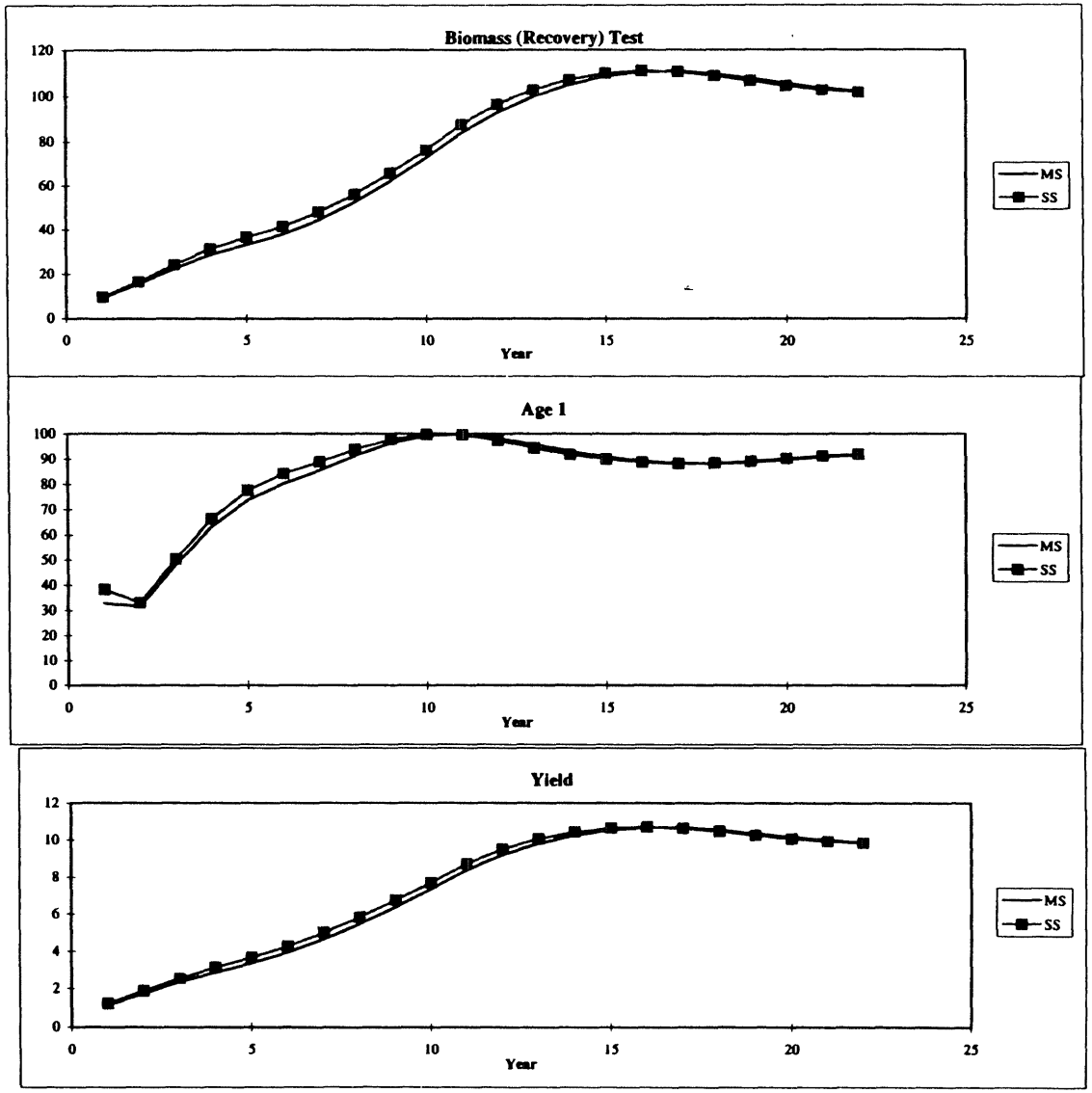

Biomass (Recovery) Test
120
100
80
60
40
20
0
0
5
10
15
20
25
Year
MS
SS
Age 1
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
Year
MS
SS
Yield
12
10
8
6
4
2
0
0
5
10
15
20
25
Year
MS
SS

Figure 4.4.1.2

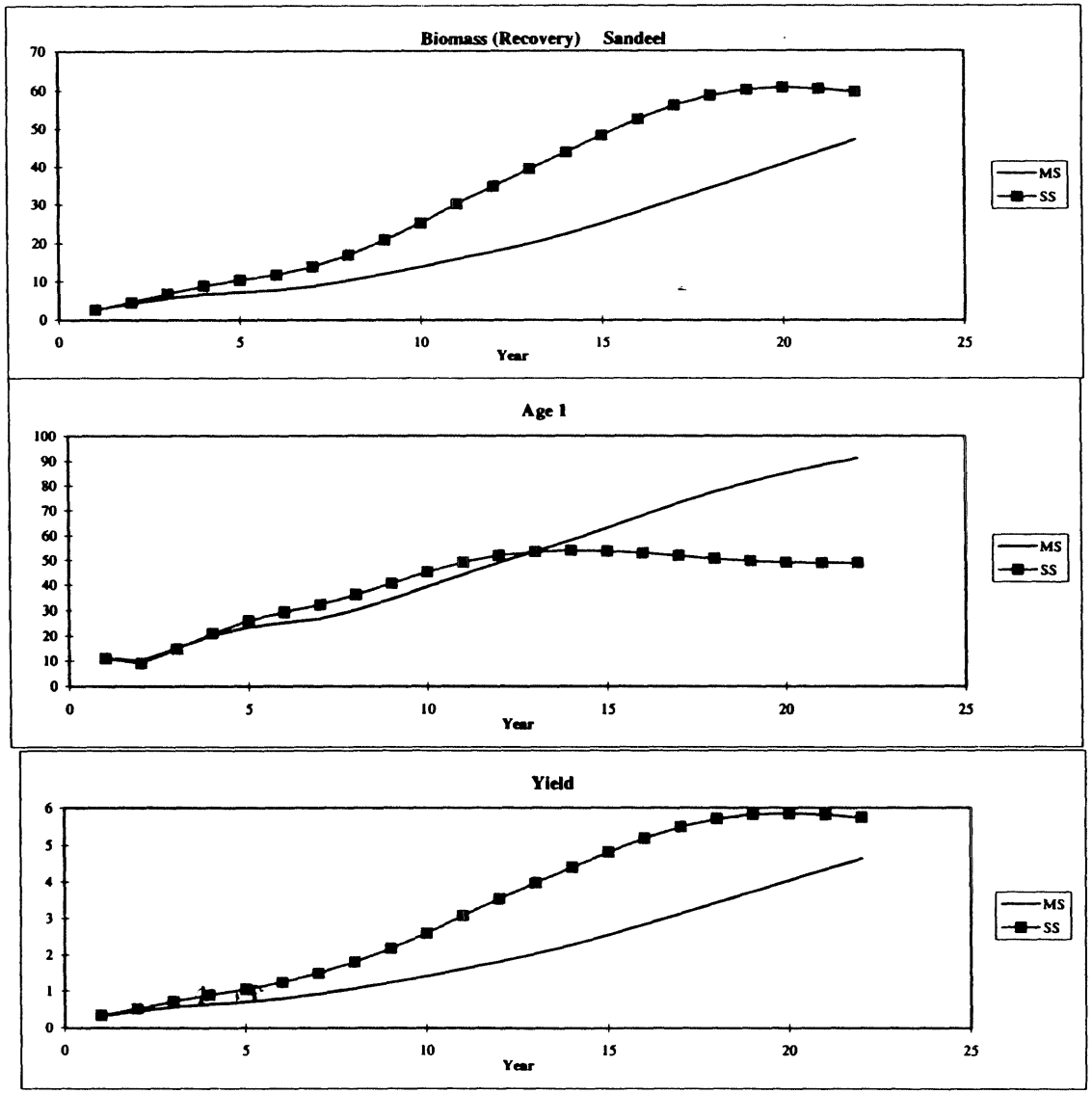

Biomass (Recovery) Sandeel
70
60
50
40
30
20
10
0
0
5
10
15
20
25
Year
MS
SS
Age 1
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
Year
MS
SS
Yield
6
5
4
3
2
1
0
0
5
10
15
20
25
Year
MS
SS

Figure 4.4.1.3

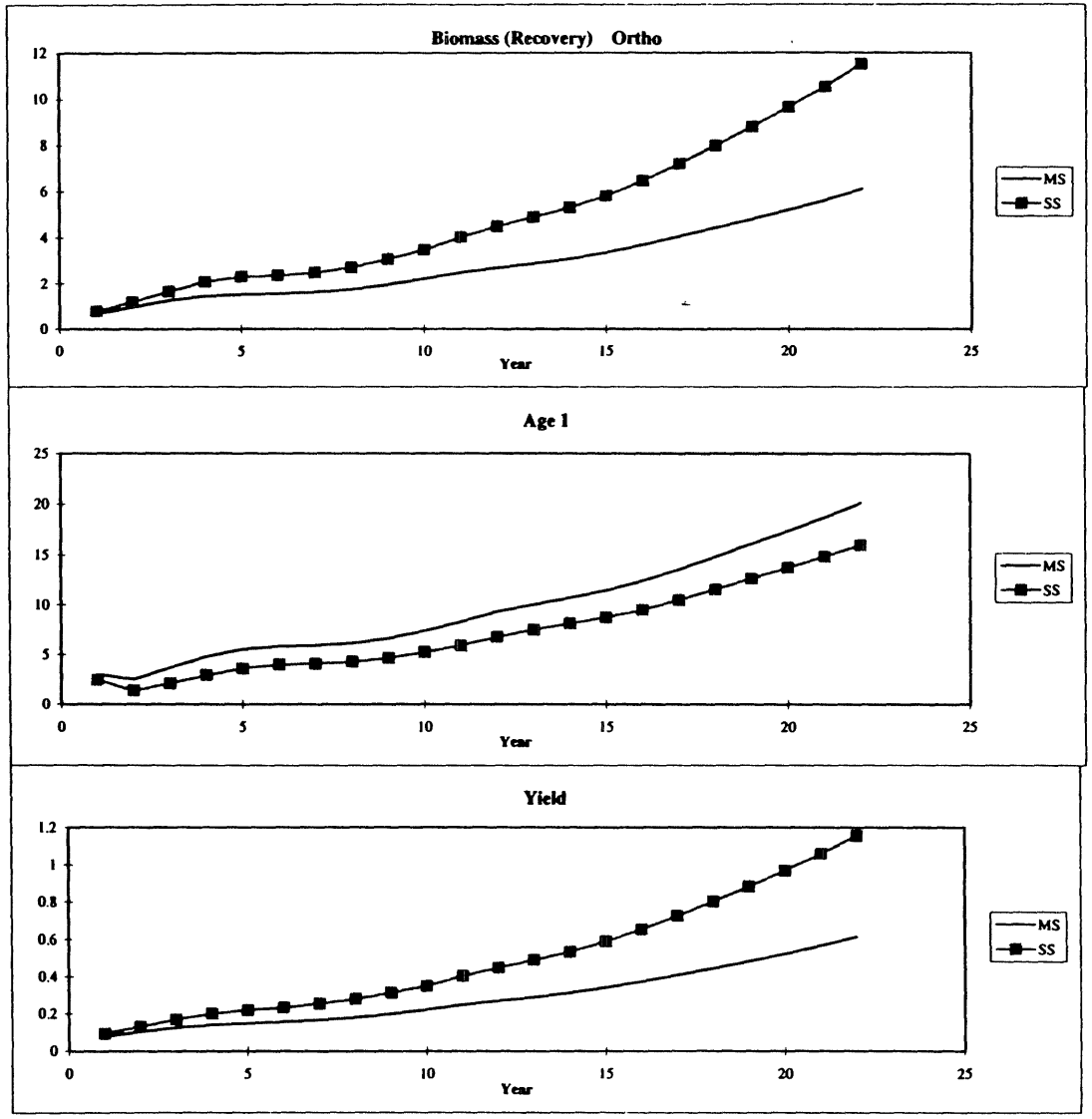
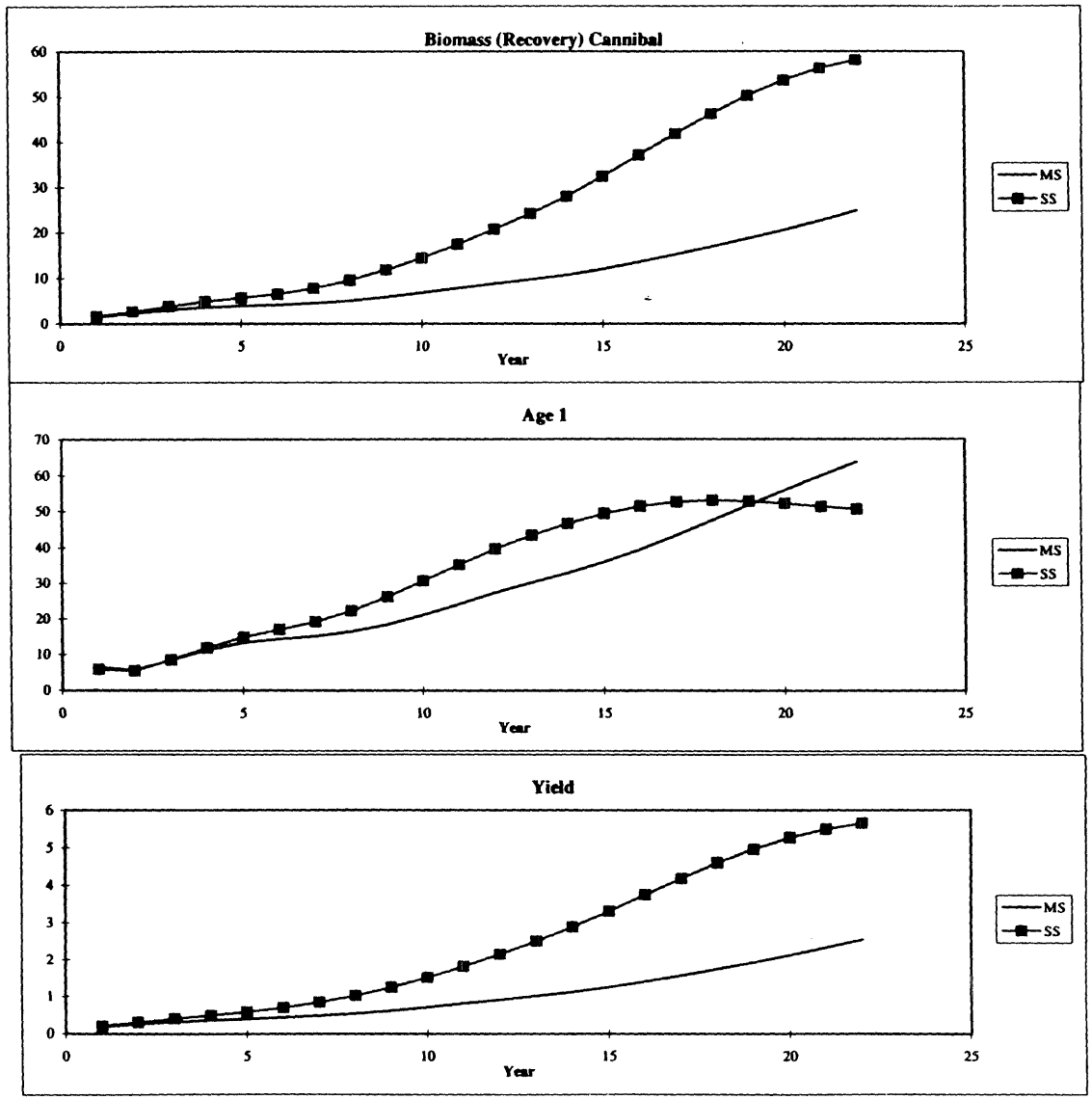

Biomass (Recovery) Ortho
12
10
8
6
4
2
0
0
5
10
15
20
25
Year
MS
SS
Age 1
25
20
15
10
5
0
0
5
10
15
20
25
Year
MS
SS
Yield
1.2
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
Year
MS
SS

Figure 4.4.1.4


Biomass (Recovery) Cannibal
60
50
40
30
20
10
0
0
5
10
15
20
25
Year
MS
SS
Age 1
70
60
50
40
30
20
10
0
0
5
10
15
20
25
Year
MS
SS
Yield
6
5
4
3
2
1
0
0
5
10
15
20
25
Year
MS
SS

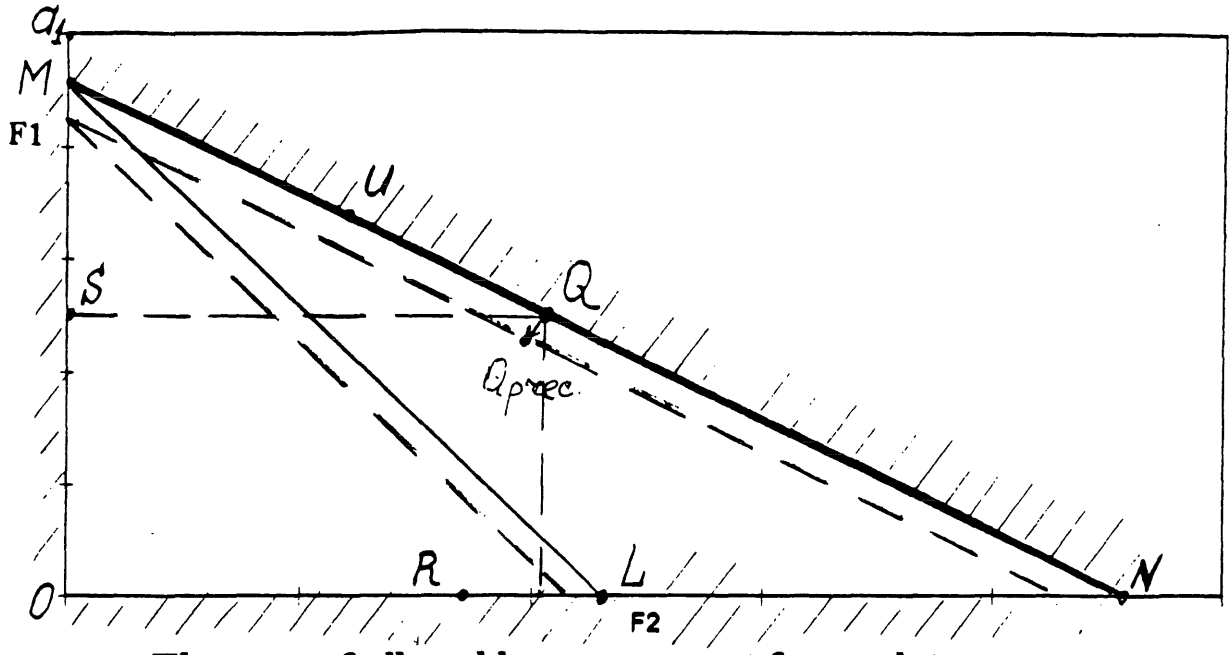


Figure 4.6.1 **The area of allowable management for predator-prey system-unshaded triangle MON**

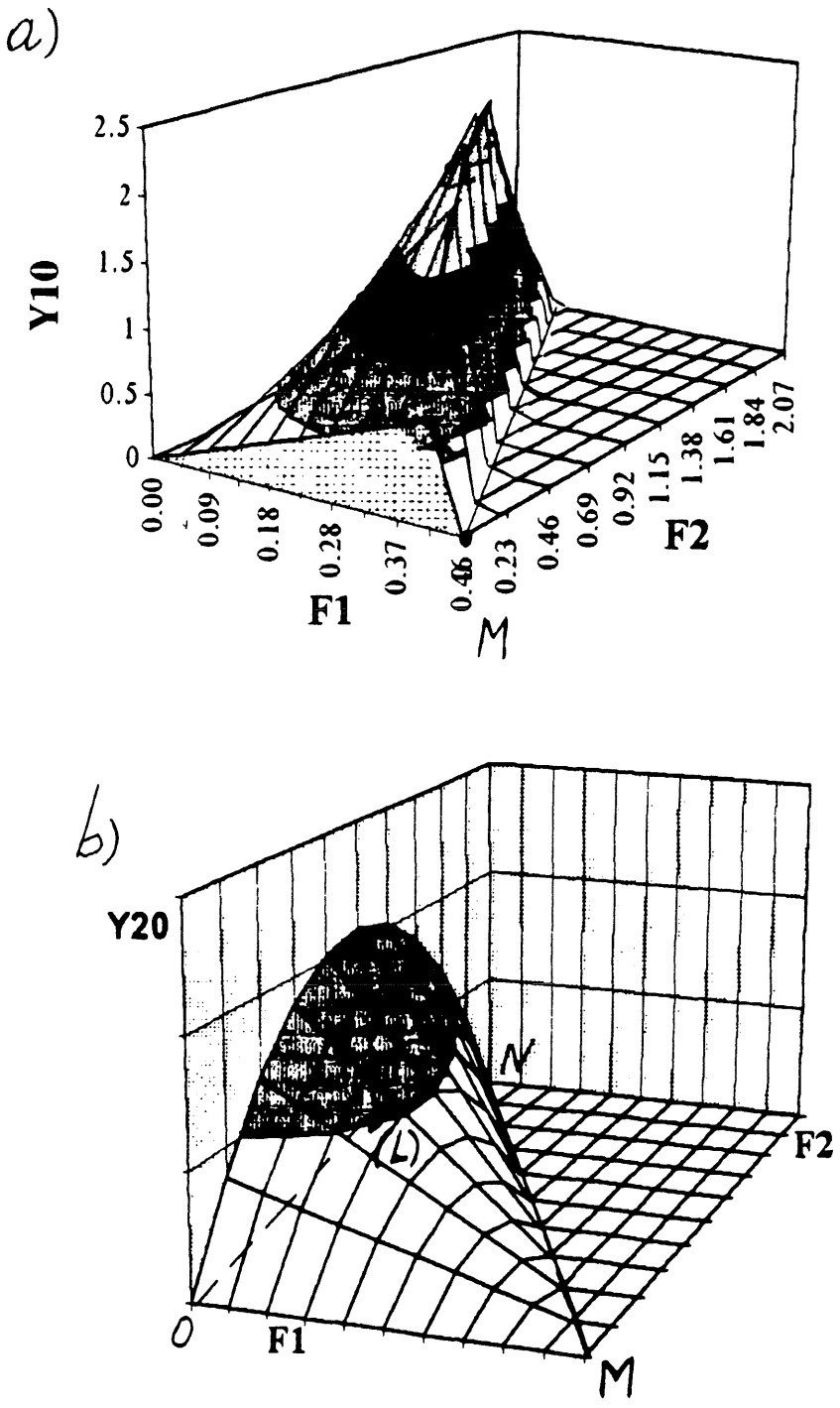


Figure 4.6.2 **Sustainable yield for the prey species Y10(a) and for the predator species Y20 (b) in the allowable area of management**

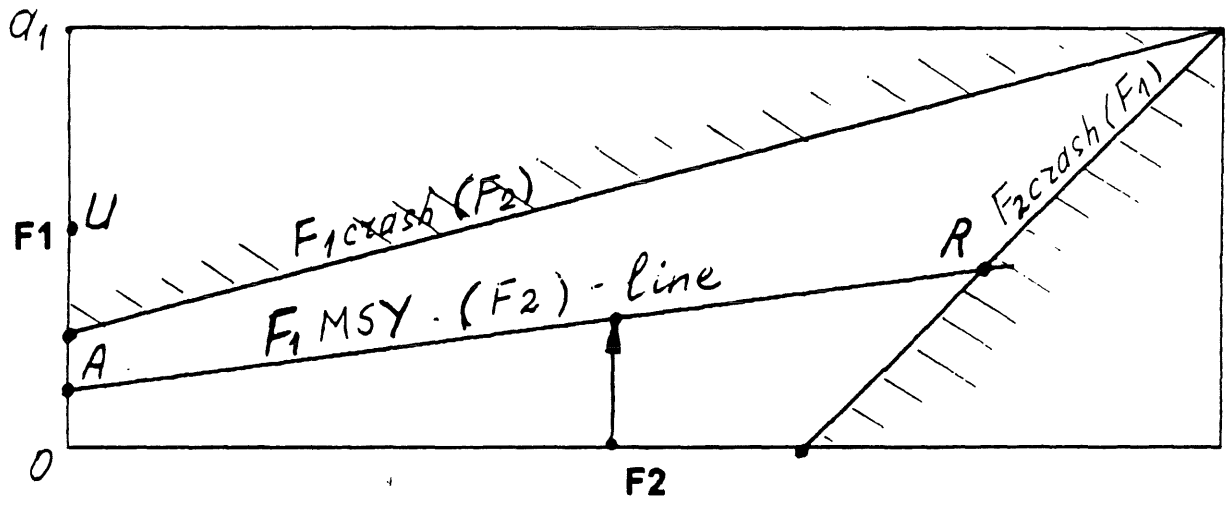


Figure 4.6.3 **The area of allowable management for two competing species.**

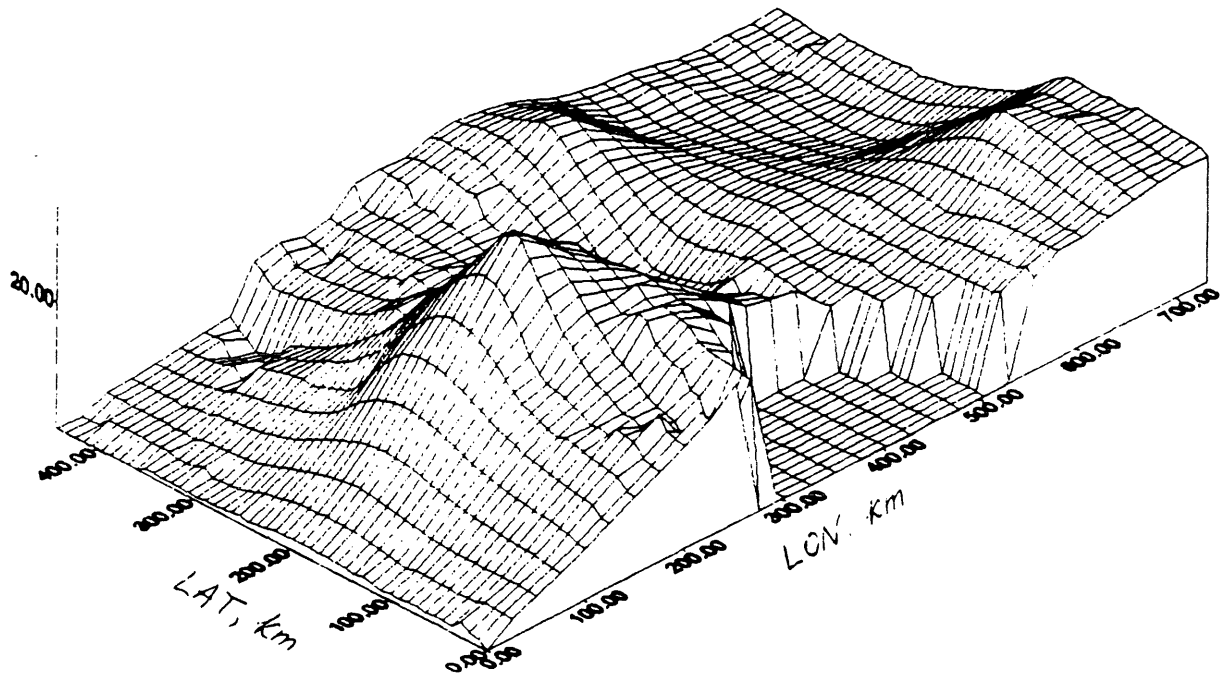


Figure 7.1.1a Surface of Wtot(LON,LAT) for 1990, 1 quarter.
The origin point LON,LAT corresponds to 16.65; 69.52.
Shore line is blanked-out.

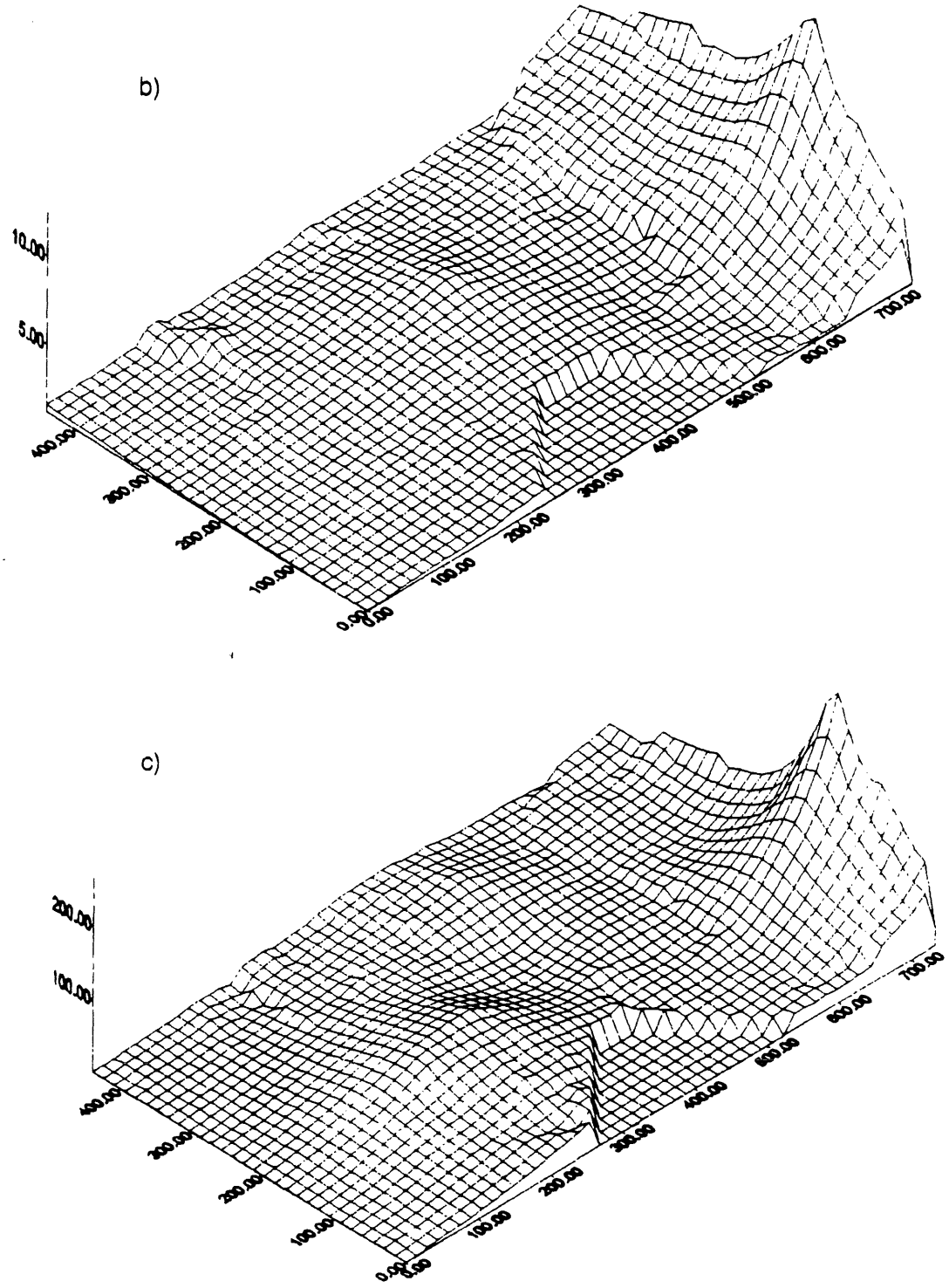


Figure 7.1.1b,c Surface of NH(LON,LAT)-b and Wtot*NH(LON,LAT)-c for 1990,1quarter; shore line is blanked-out.

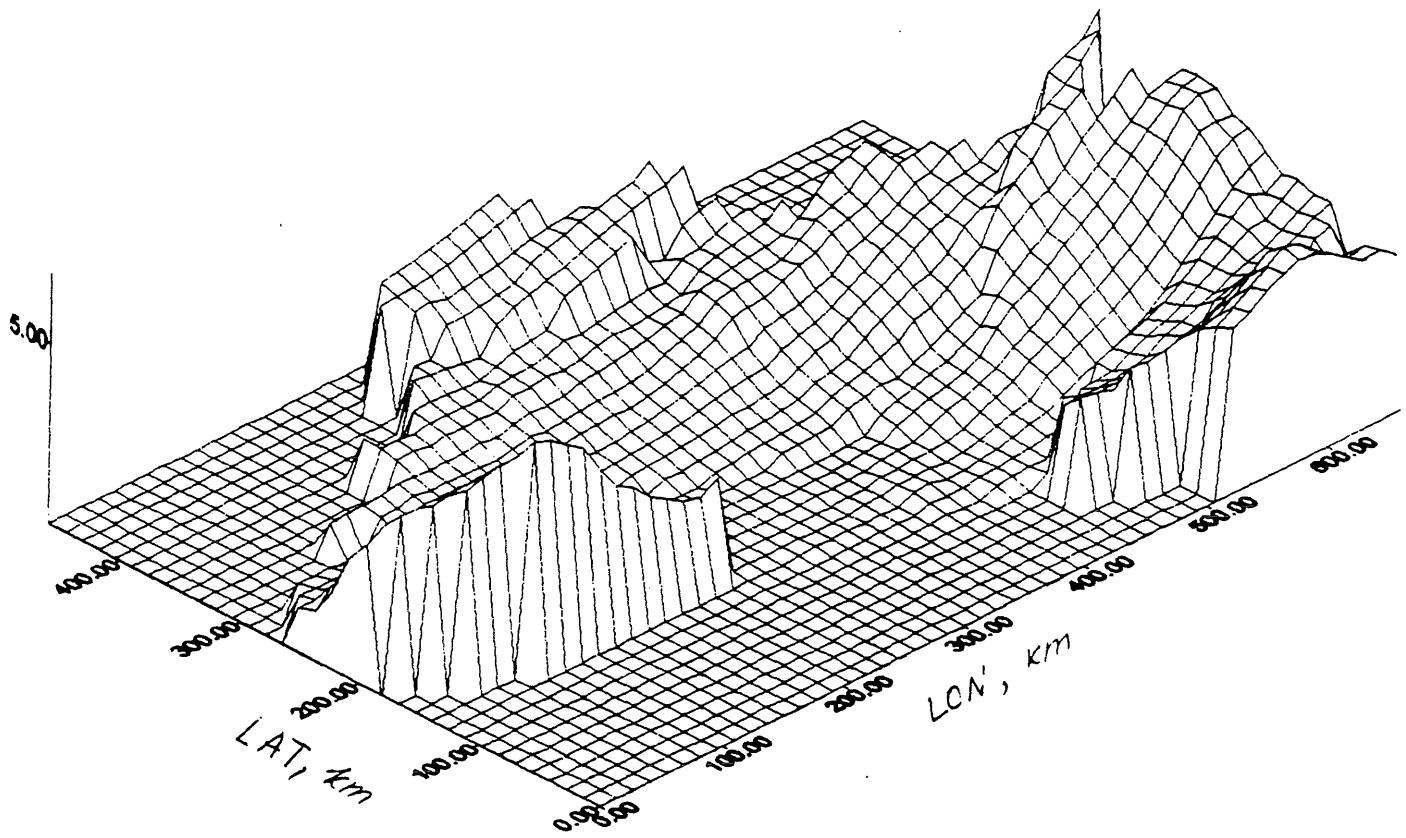


Figure 7.1.2a Surface of Wtot(LON,LAT) for 1987, I quarter

The origin point {Lon;Lat} corresponds to {18.85; 69.62}.

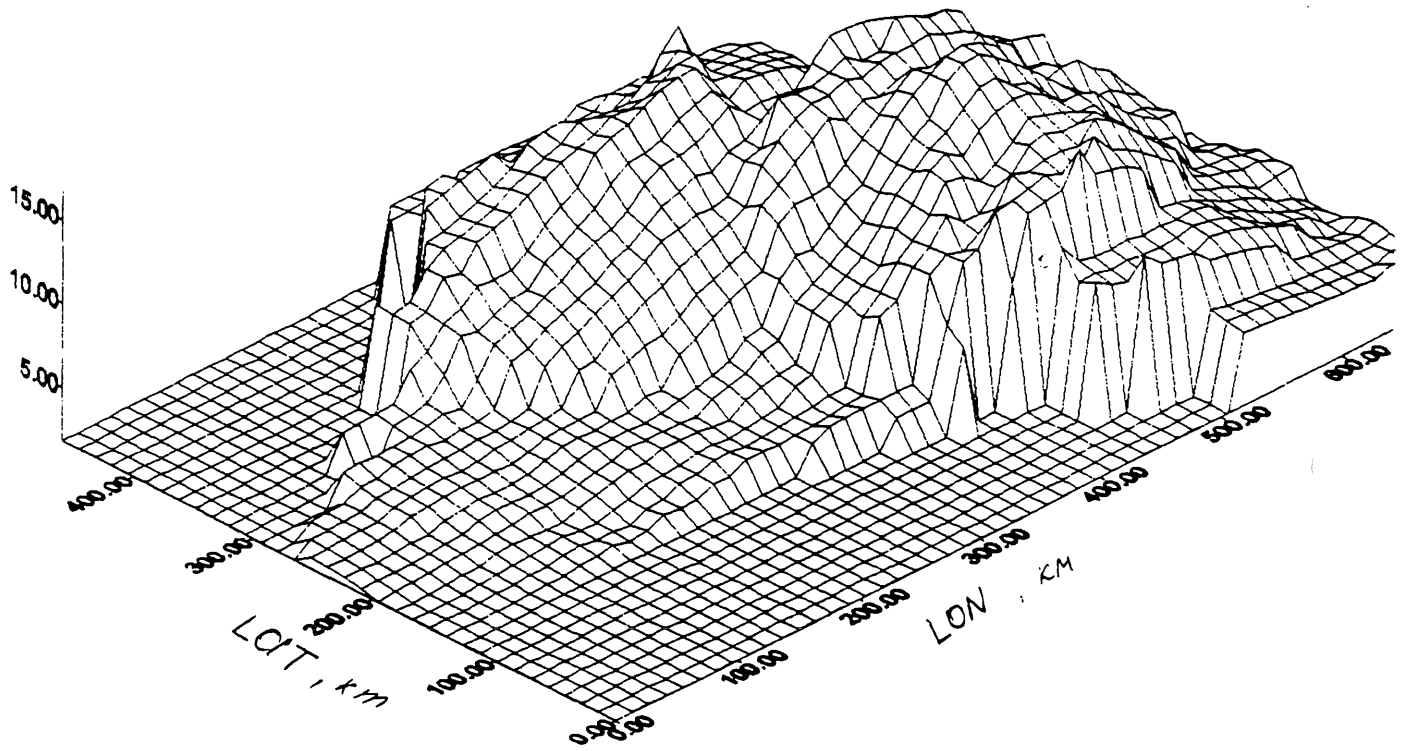


Figure 7.1.2b Surface of NH(LON,LAT) for 1987, I quarter.

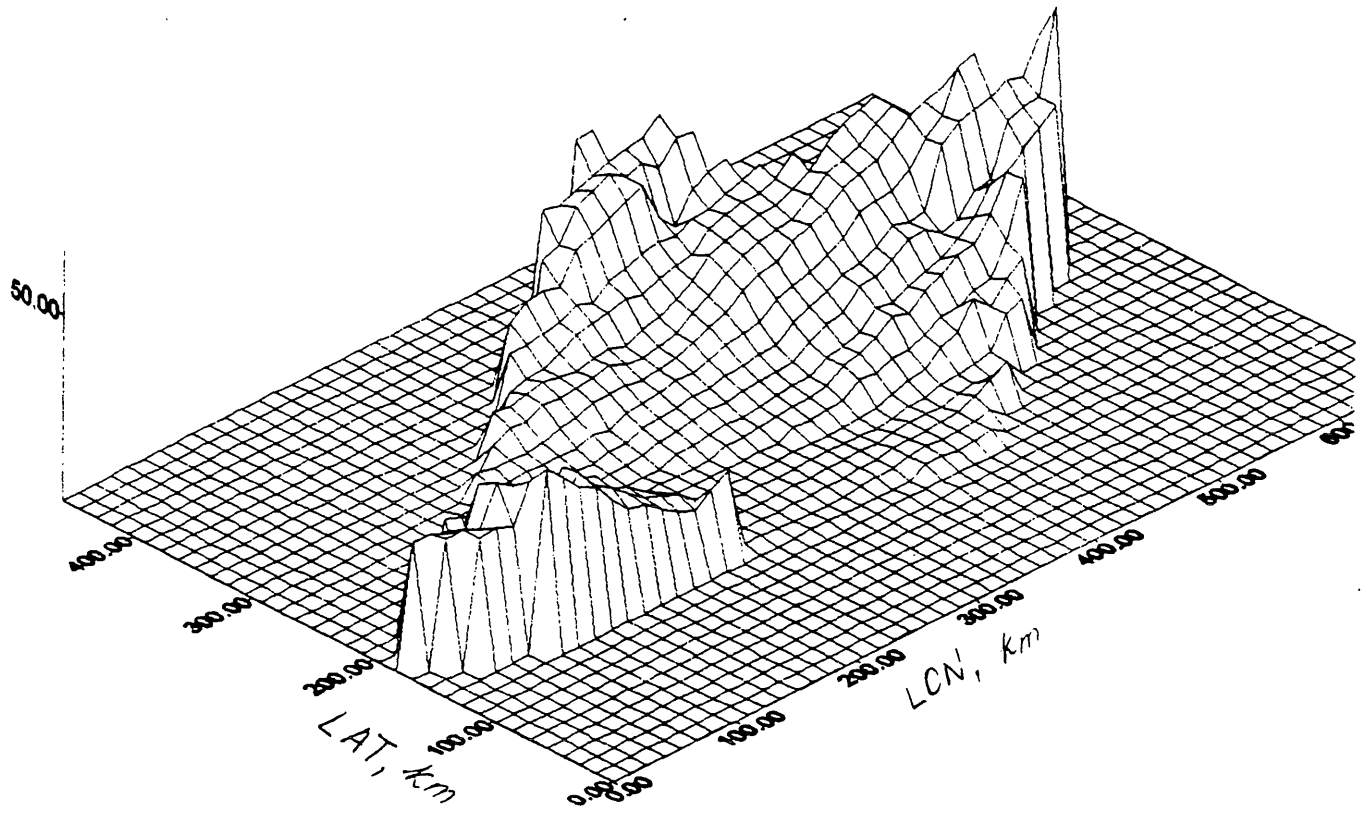


Figure 7.1.2c Surface of Wtot * NH for 1987, I quarter.

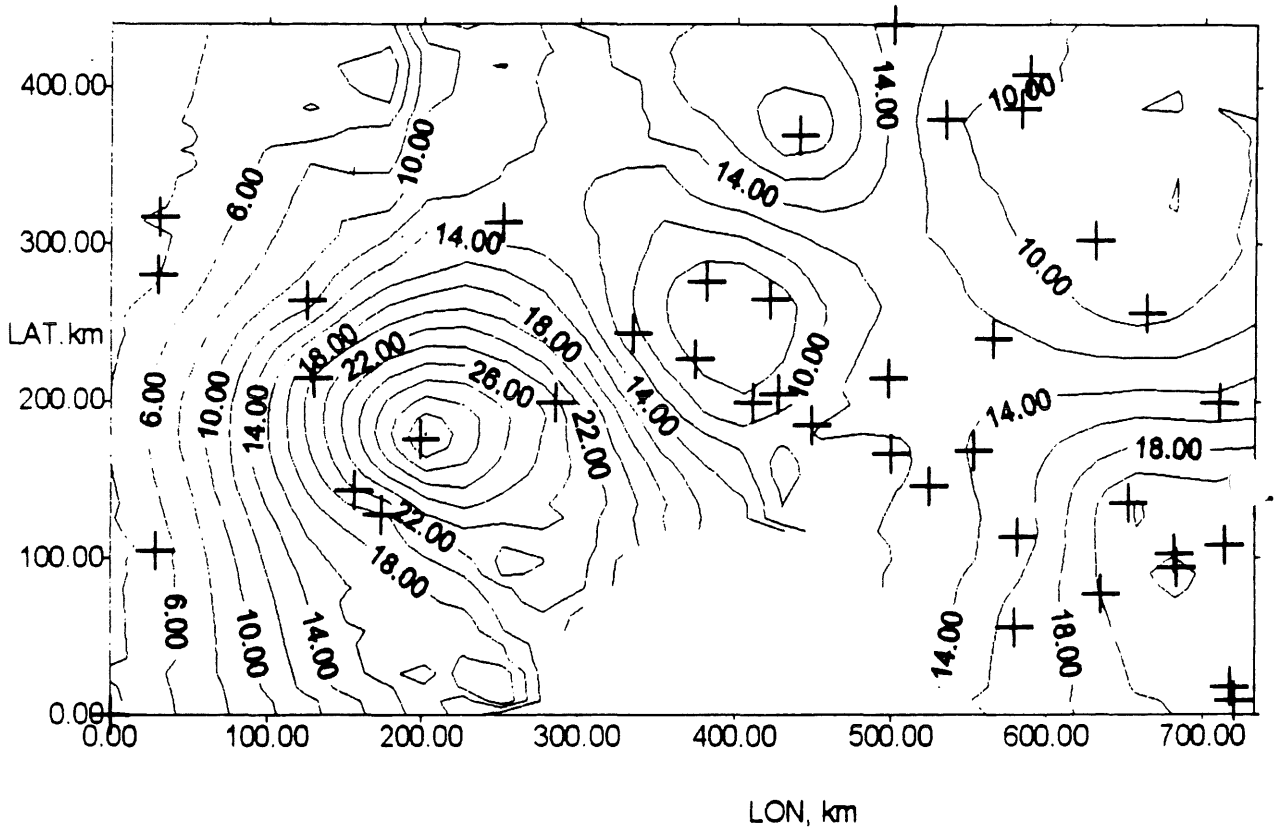


Figure 7.1.3a Contour map of Wtot and location of stations for 1990,1 quarter

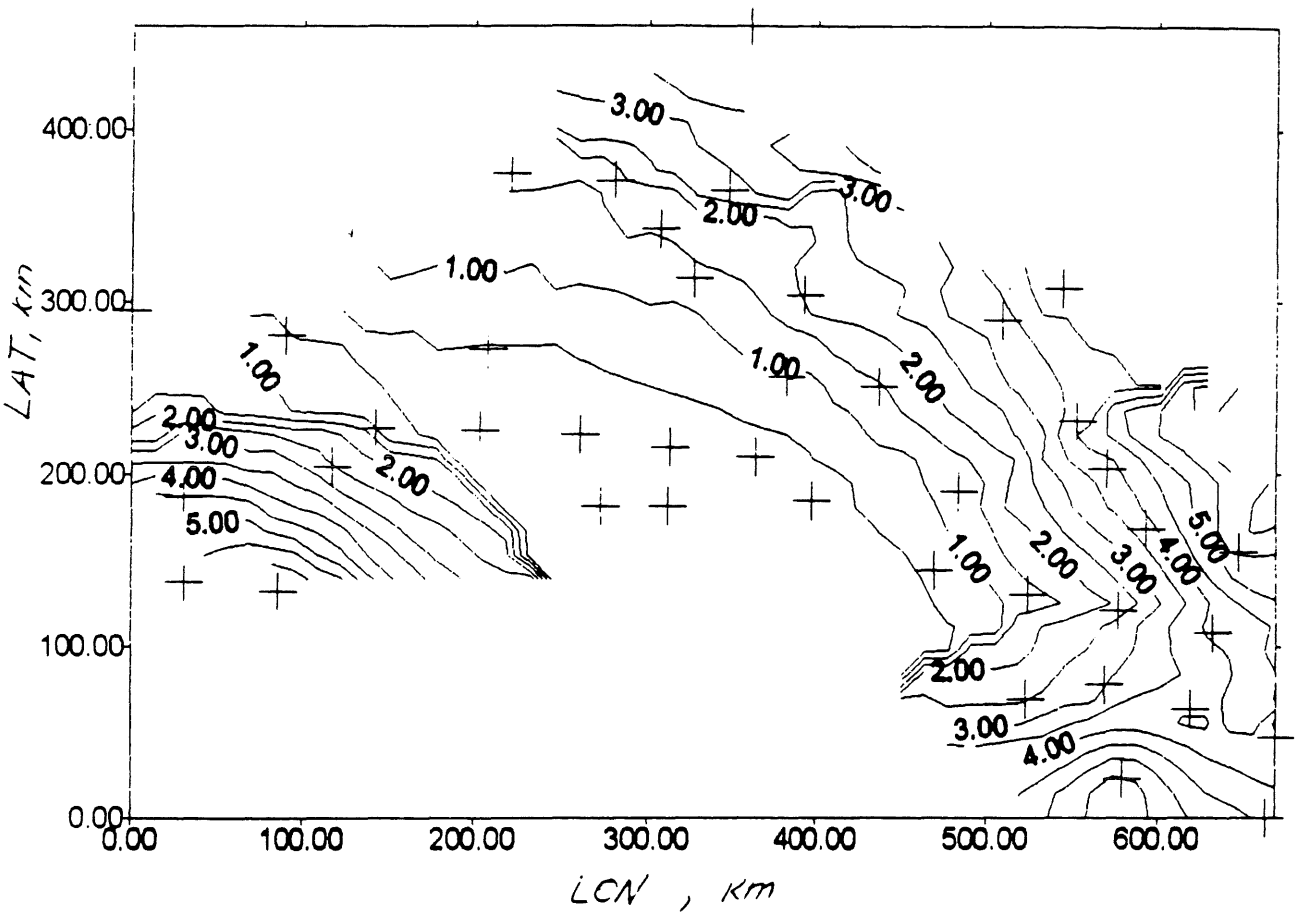


Figure 7.1.3b Contour map of Wtot and locations of stations for 1987, I quarter

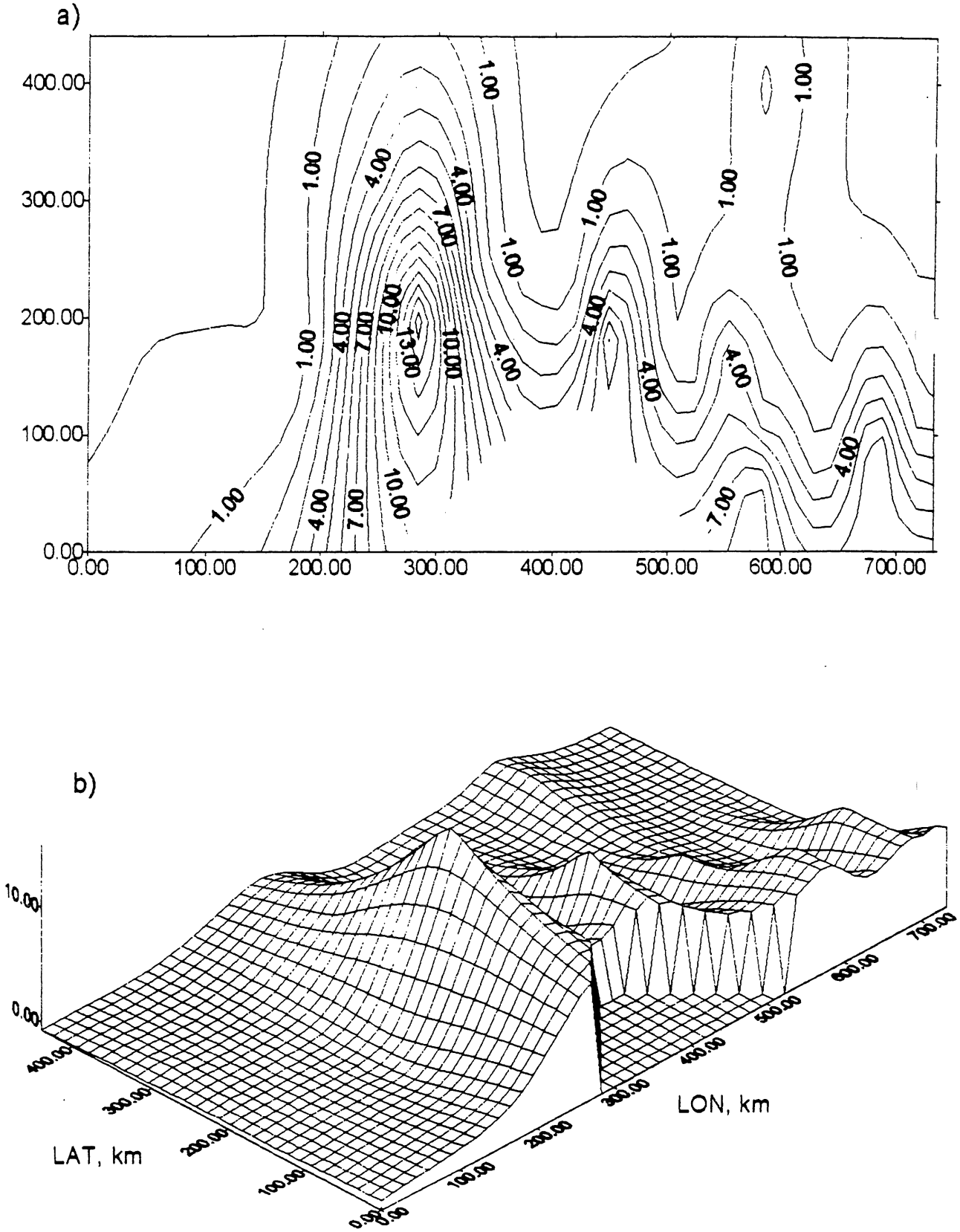


Figure 7.2.1a Contour map (a) and surface (b) for spatial distribution of capelin-3 weight in stomach of cod-3 for 1990, Q=1.
Shore line is blanked-out.

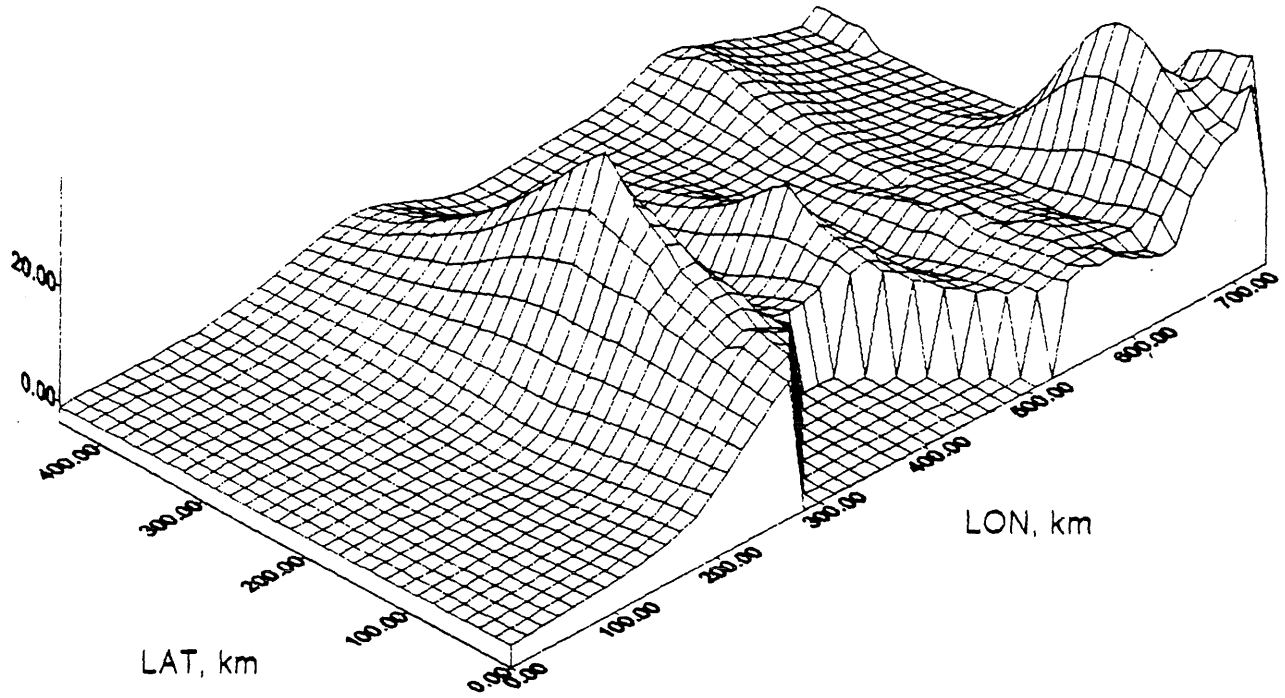


Figure 7.2.1b Surface for spatial distribution of product of capelin-3 weight (in stomach of cod-3) AND NH for 1990, Q=1

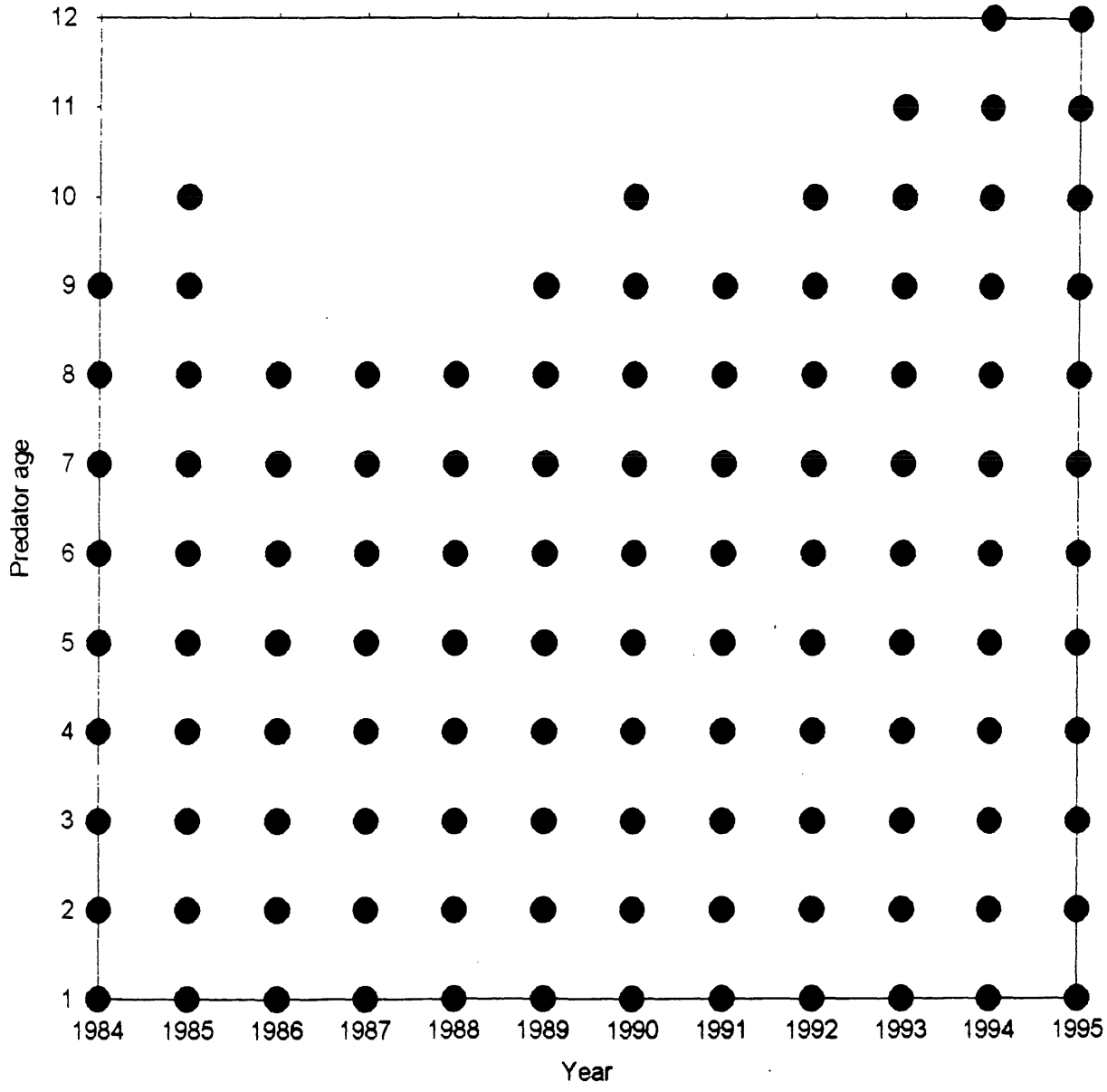


Figure 7.2.2a **Available data for analysis Wtot(Y,a) for Q=1 (Nstom>=5)**

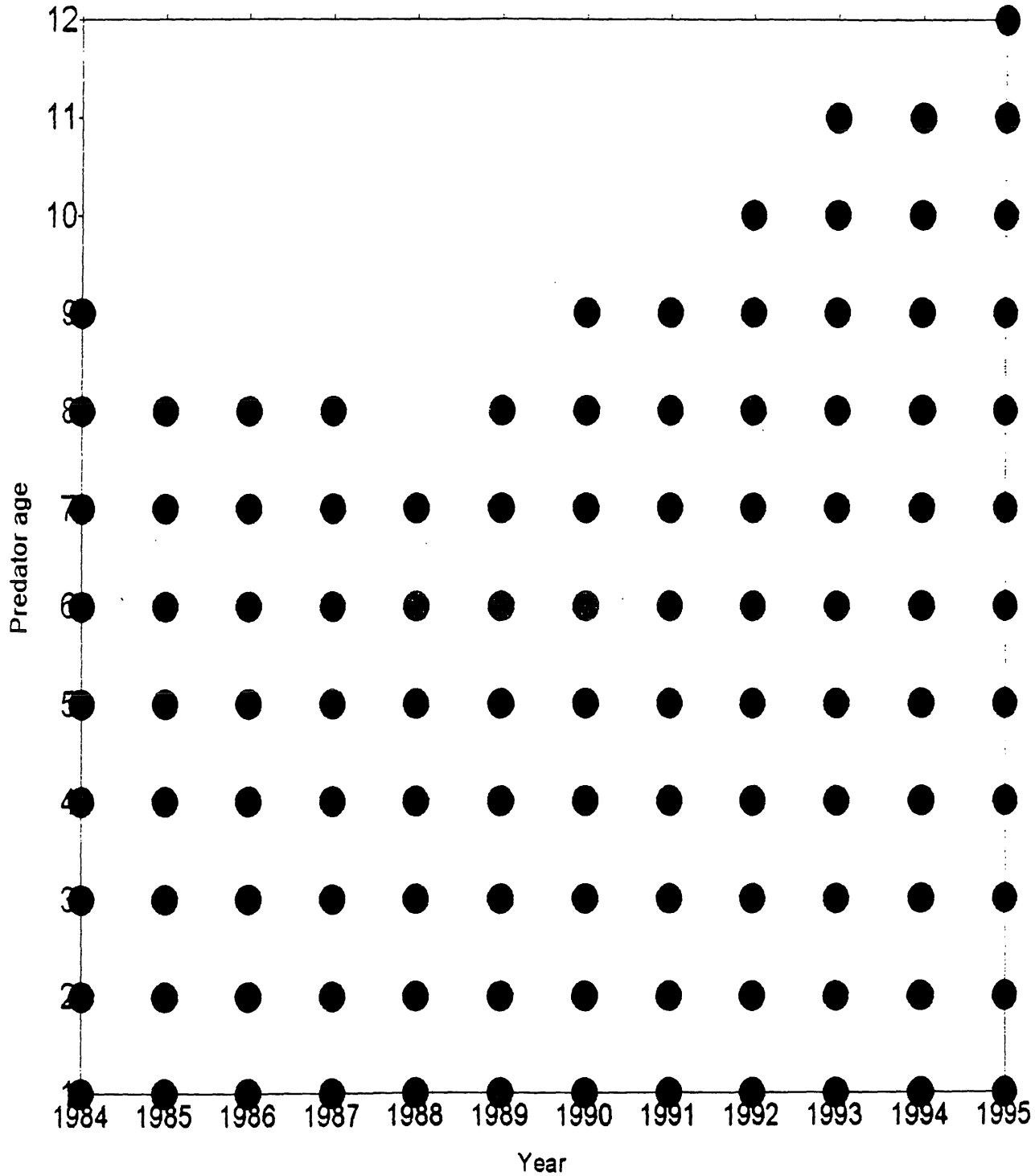


Figure 7.2.2b Available data for analysis Wtot(Y,a) for Q=3 (Nstom>=5).

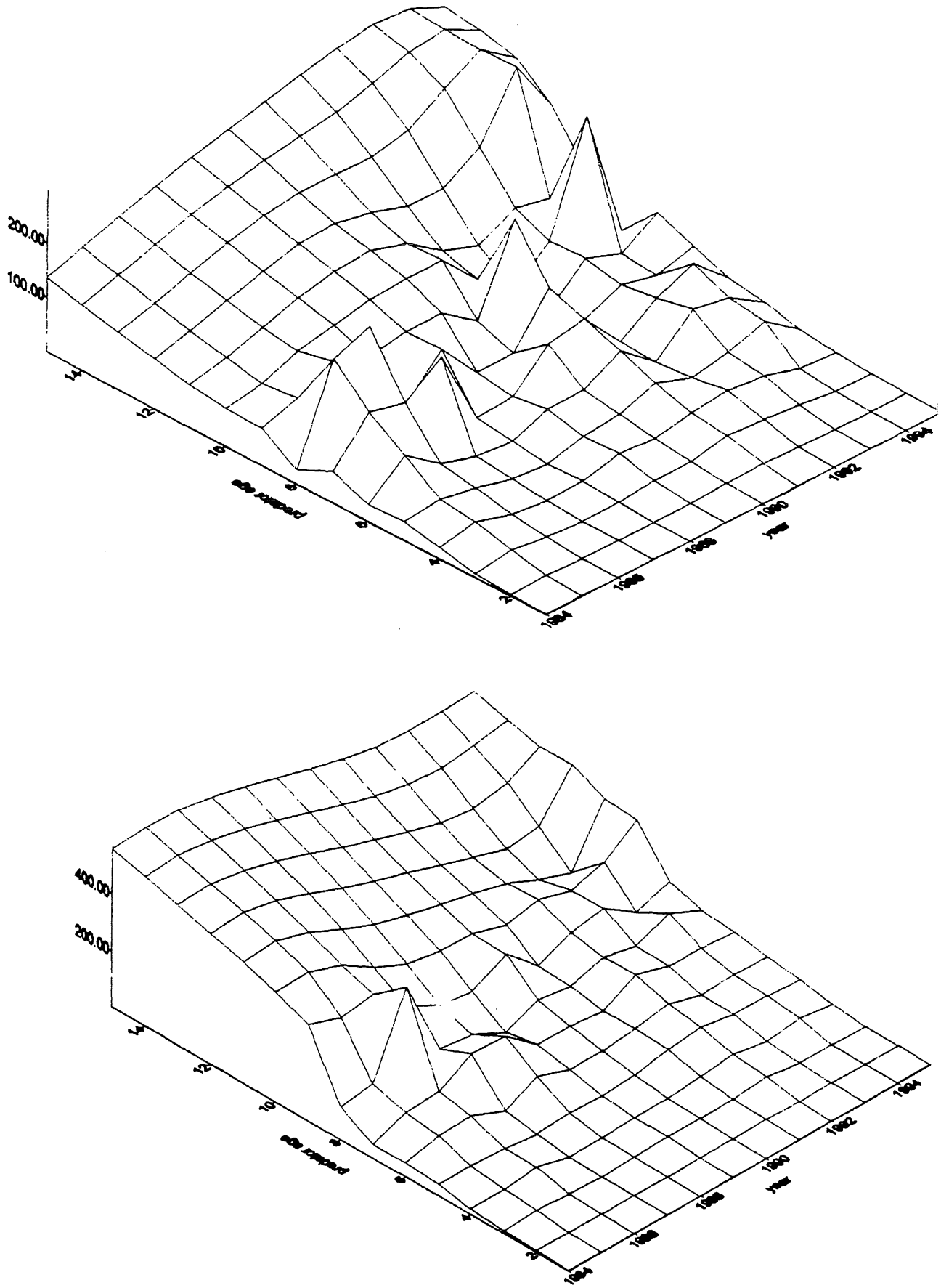
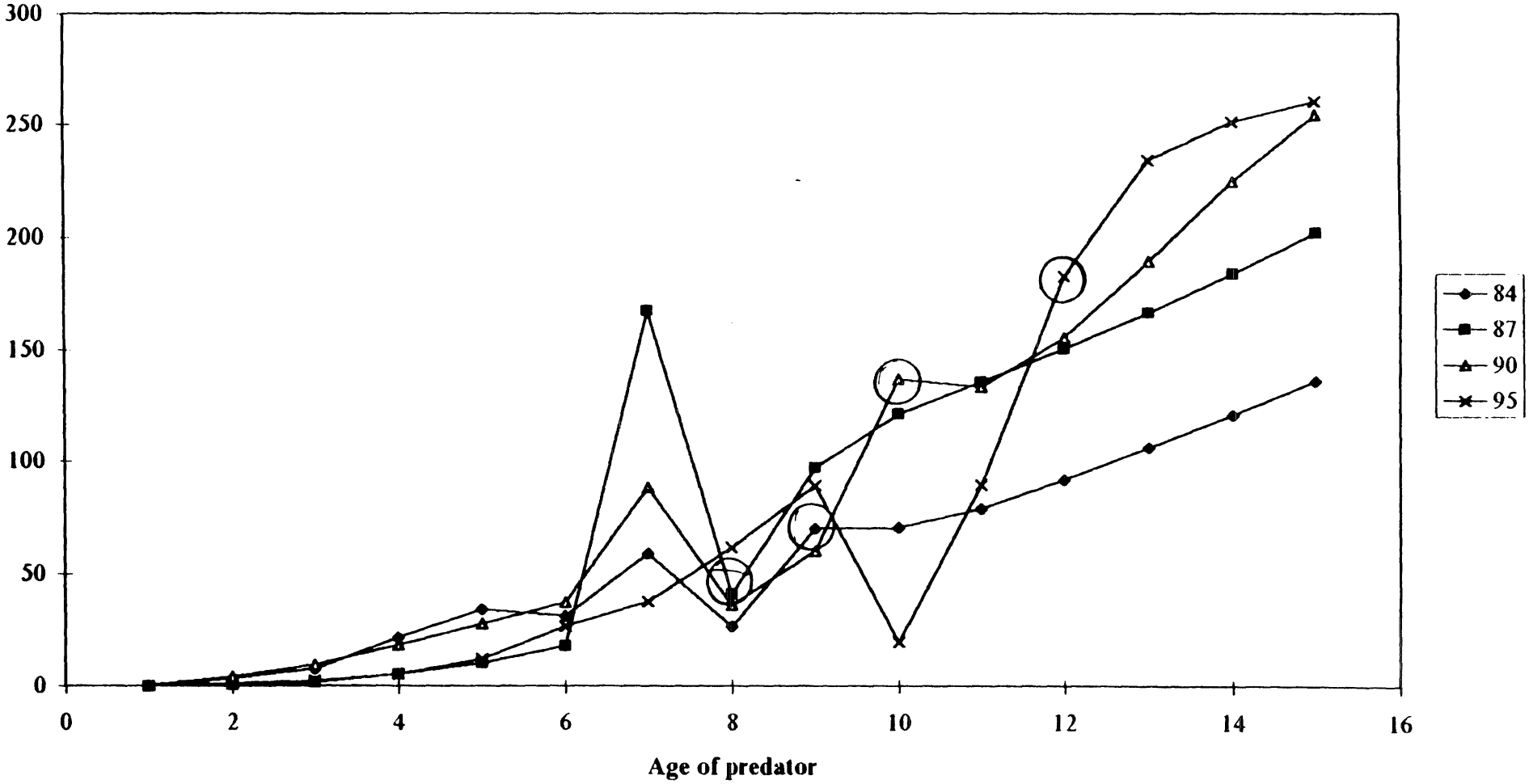


Figure 7.2.3a,b **Surface Wtot(y,a) for 1quarter (a) and 3quarter(b) as result of kriging.**

Figure 7.2.4

Relationship Wtot(age) as result of kriging for 1984,1987,1990 and 1995, Q=1.



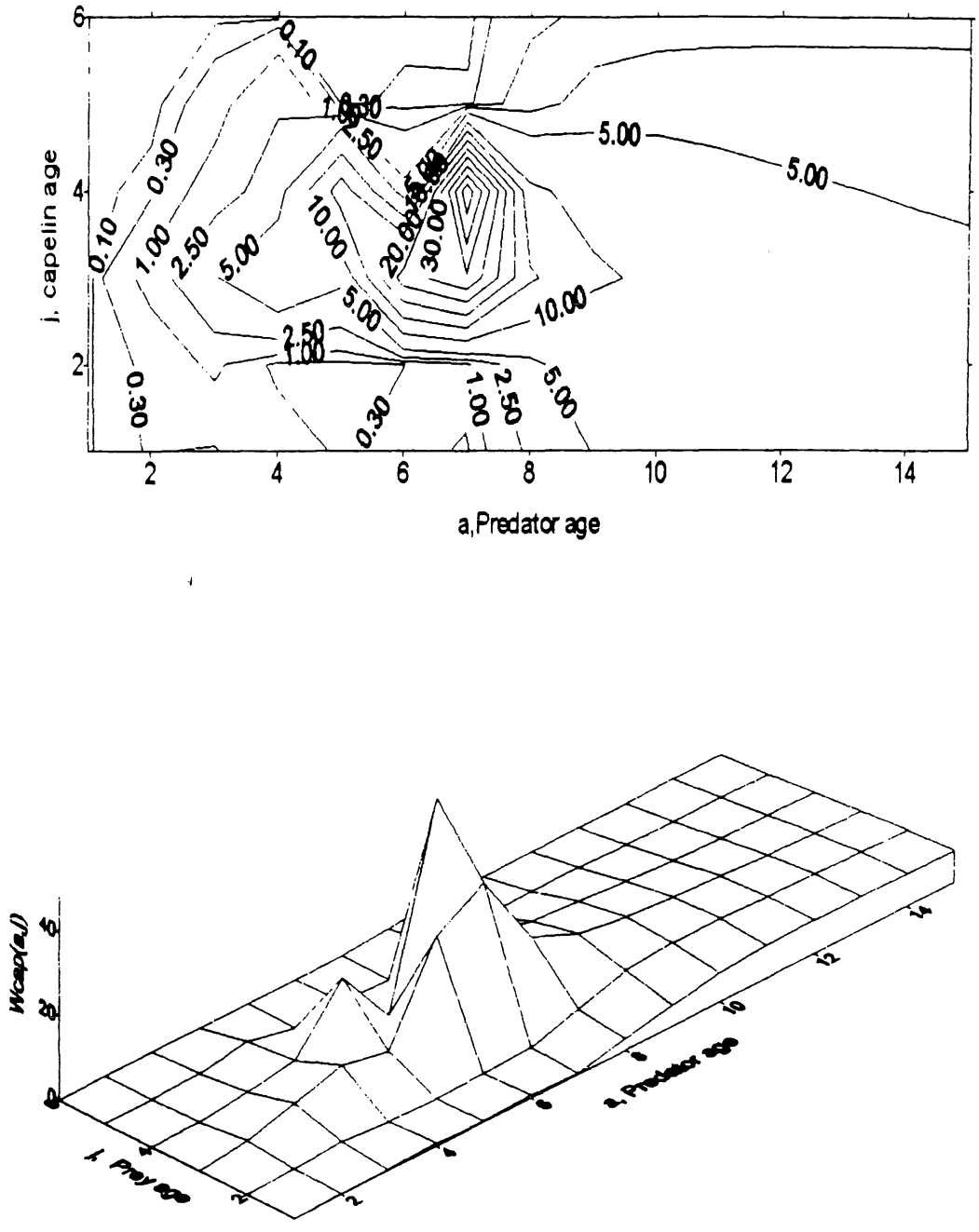


Figure 7.2.5 Contour map and surface of capelin weight in cod stomachs Wcap(a,j)- as function of the Predator age, a anf Prey(capelin) age, j for 1 quarter of 1990.

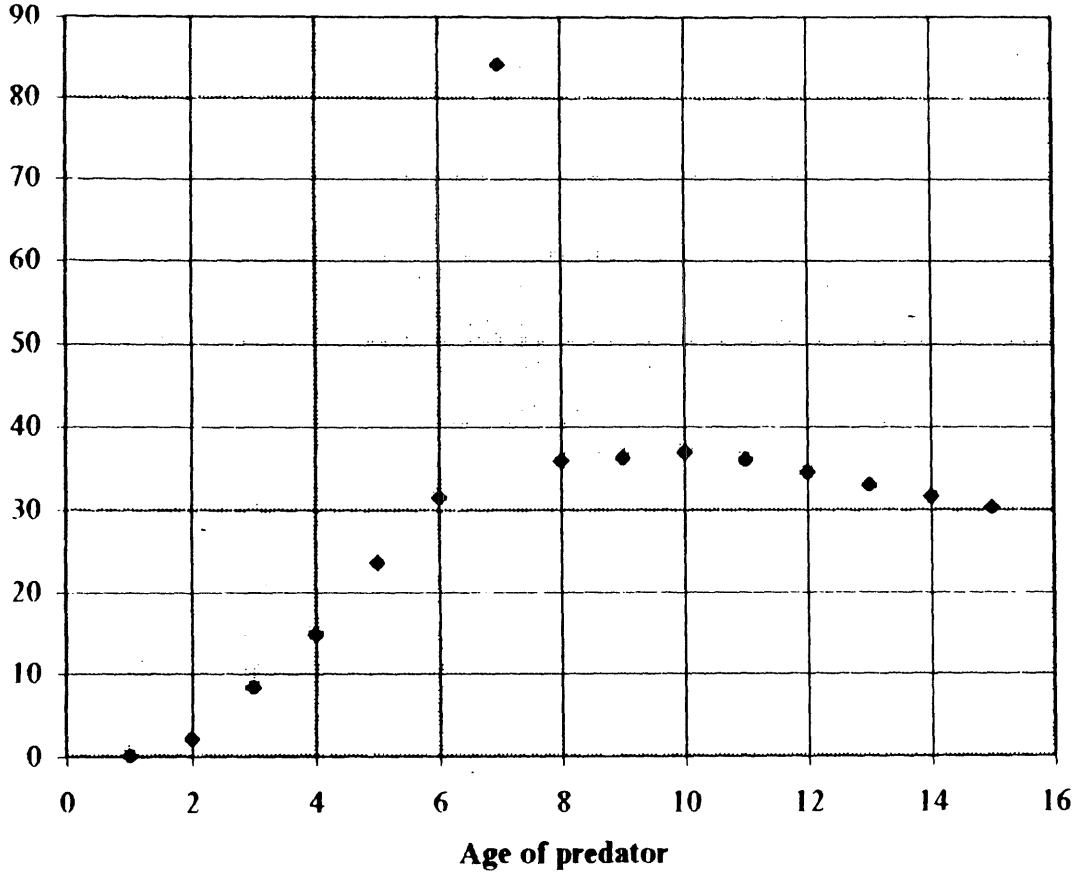


Figure 7.2.6 Weight of capelin(g) in cod stomachs summed by prey ages as function of cod age. Result of kriging approximation.