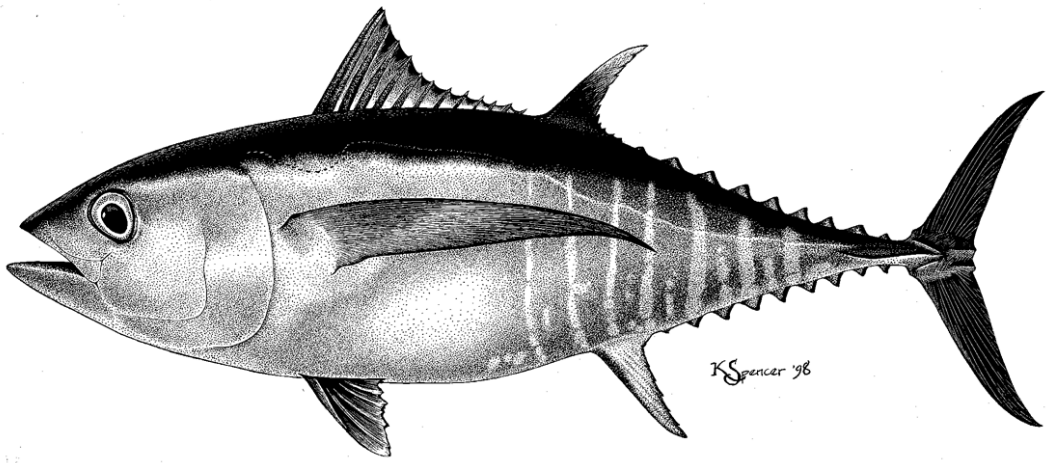
ASSESSMENT OF BIGEYE TUNA (*THUNNUS OBESUS*) IN THE EASTERN PACIFIC OCEAN

January 1975 – December 2005



CIAT
IATTC

Overview of assessment

- Age-structured, statistical, catch-at-length model (A-SCALA).
- Quarterly time step from 1975 to the start of 2005.
- No net movement of fish between the eastern and western Pacific.

Major changes

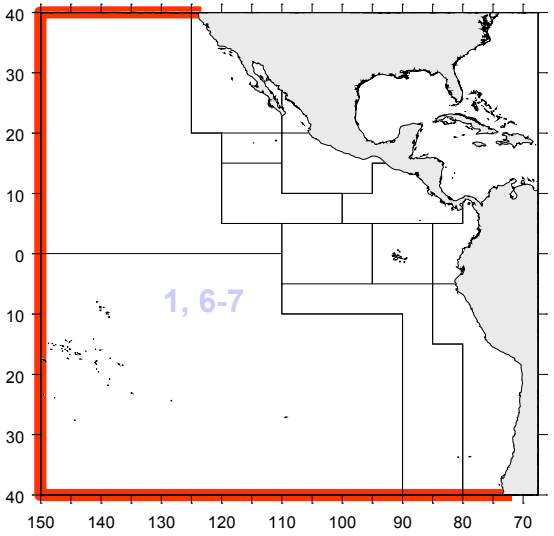
- No major model changes except new and updated catch, effort, and length-frequency data.

Sensitivity analyses

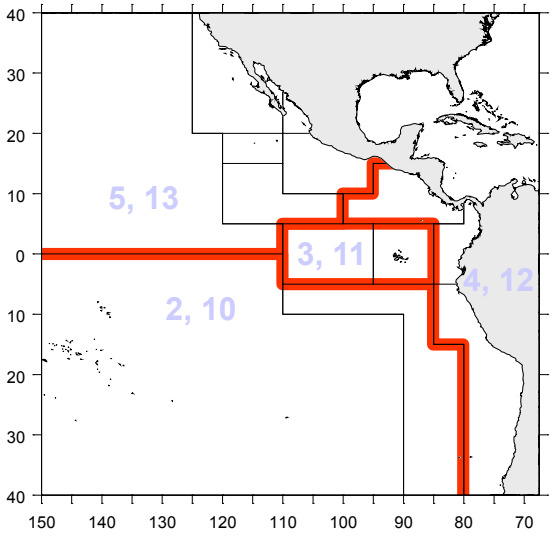
- Spawner-recruitment relationship (steepness = 0.75)
- Assumed value for the asymptotic length parameter of the Richards growth curve
- Inclusion of the Chinese Taipei longline length-frequcy data
- Relationship between recruitment an the el Nino index

Bigeye fishery definitions

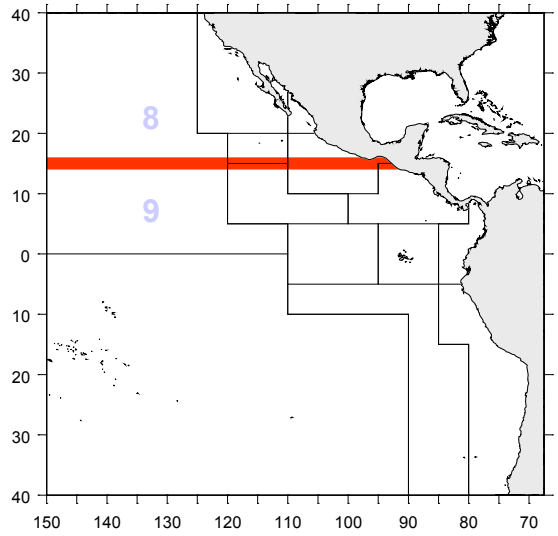
Early FLT (1)
Early & Recent UNA (6, 7)



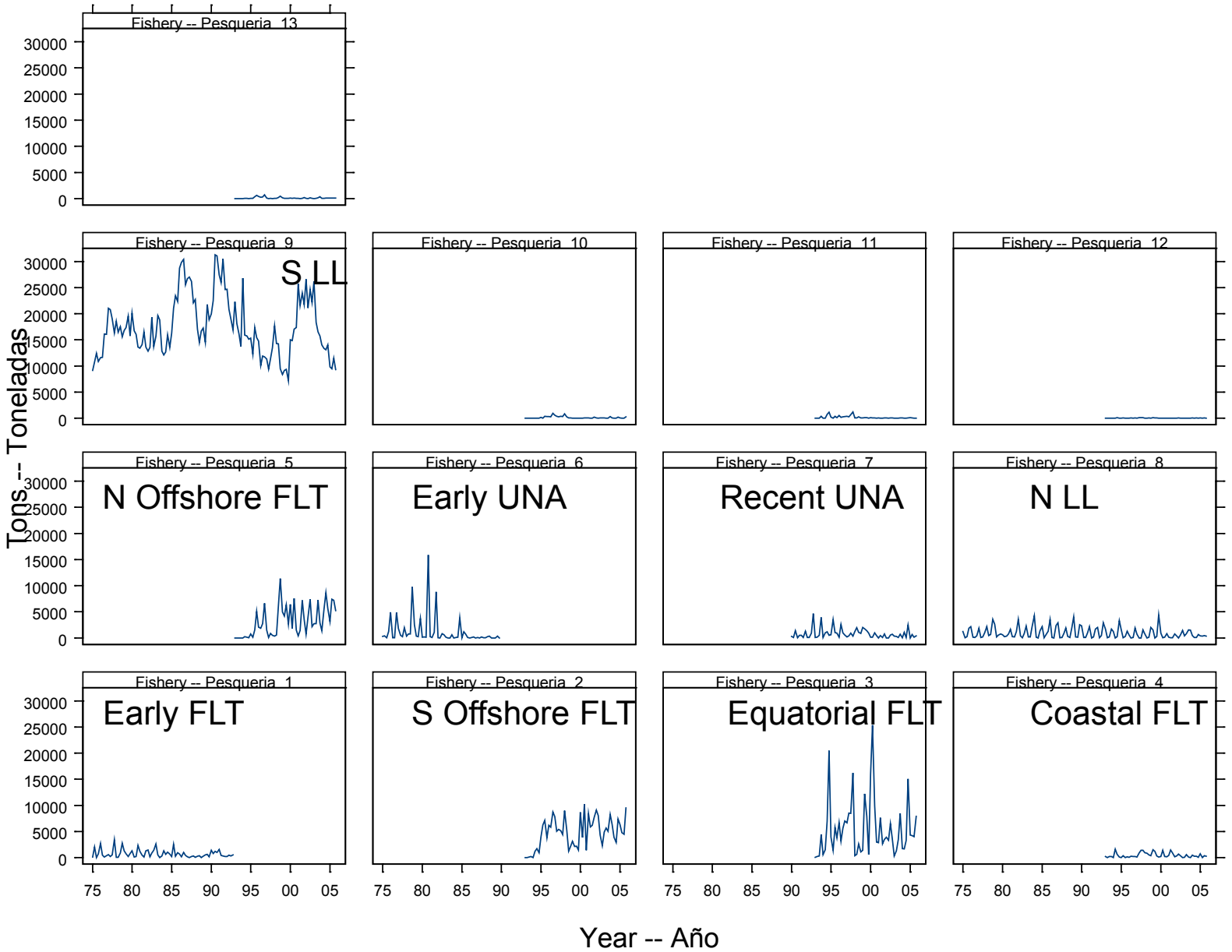
Recent FLT (2-5)
Discards (10-13)



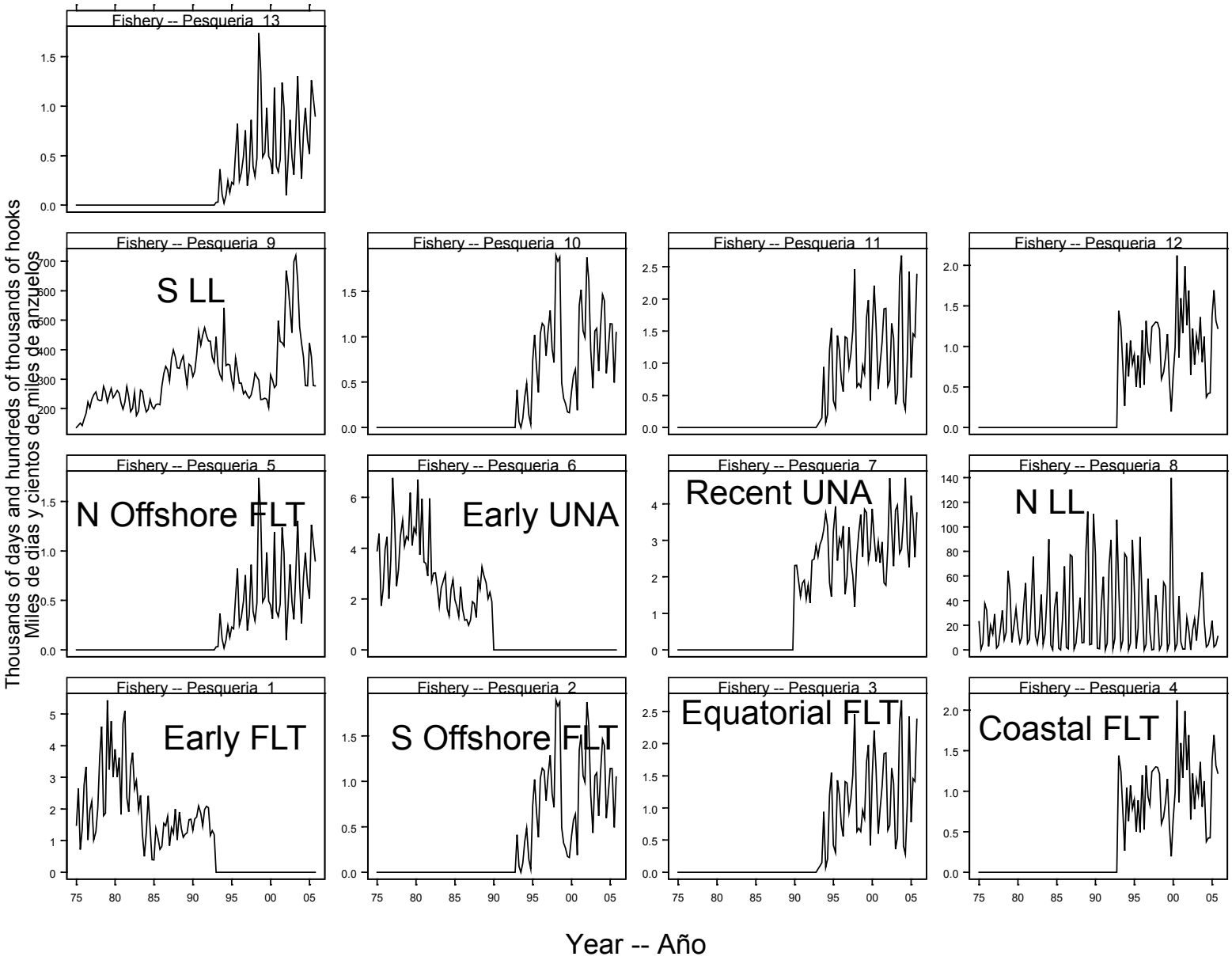
N Longline (8)
S Longline (9)



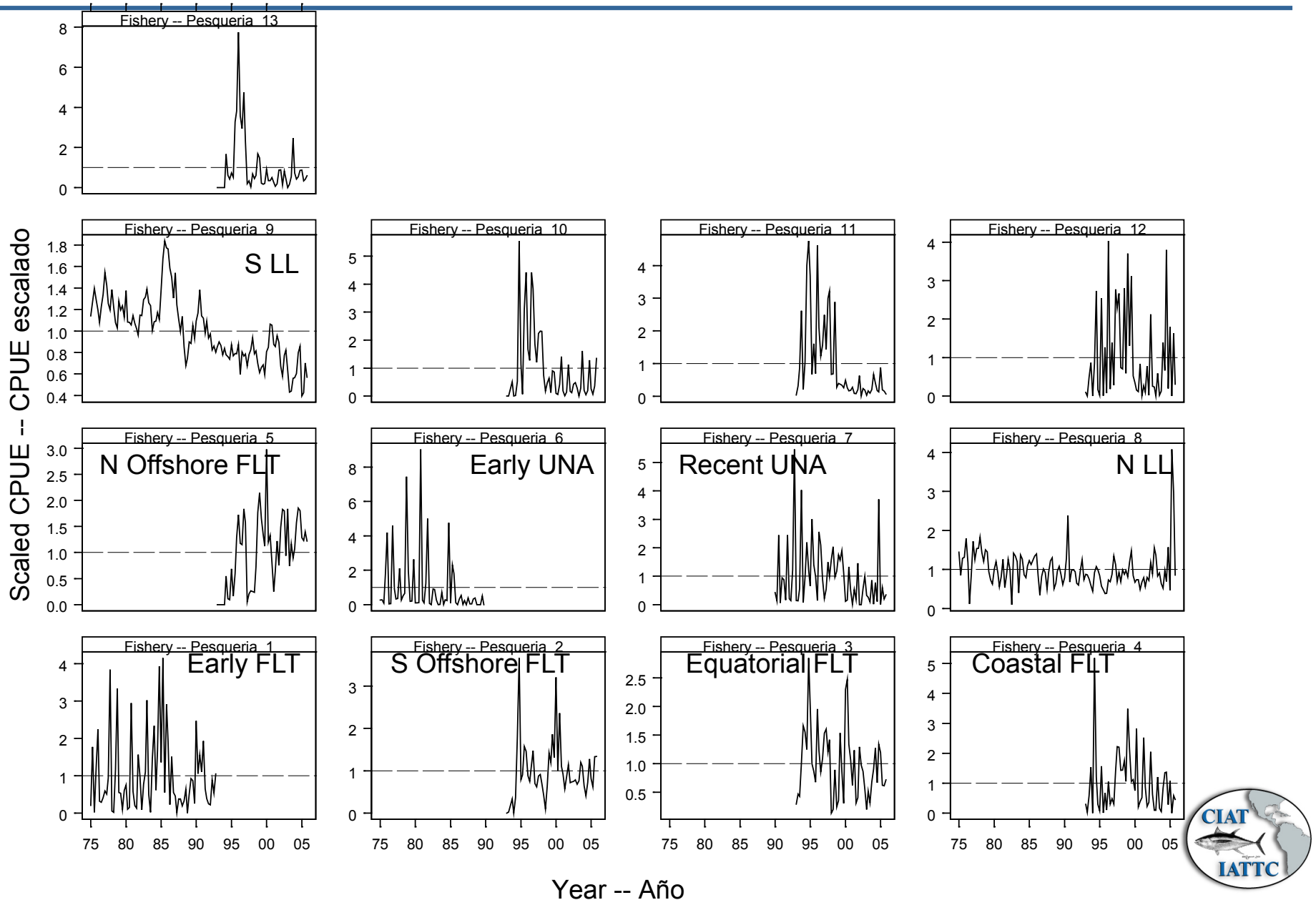
Catch


Fishery -- Pesqueria 13
Fishery -- Pesqueria 9
S LL
Fishery -- Pesqueria 10
Fishery -- Pesqueria 11
Fishery -- Pesqueria 12
Fishery -- Pesqueria 5
N Offshore FLT
Fishery -- Pesqueria 6
Early UNA
Fishery -- Pesqueria 7
Recent UNA
Fishery -- Pesqueria 8
N LL
Fishery -- Pesqueria 1
Early FLT
Fishery -- Pesqueria 2
S Offshore FLT
Fishery -- Pesqueria 3
Equatorial FLT
Fishery -- Pesqueria 4
Coastal FLT
Tons -- Toneladas
0
5000
10000
15000
20000
25000
30000
75
80
85
90
95
00
05
Year -- Año

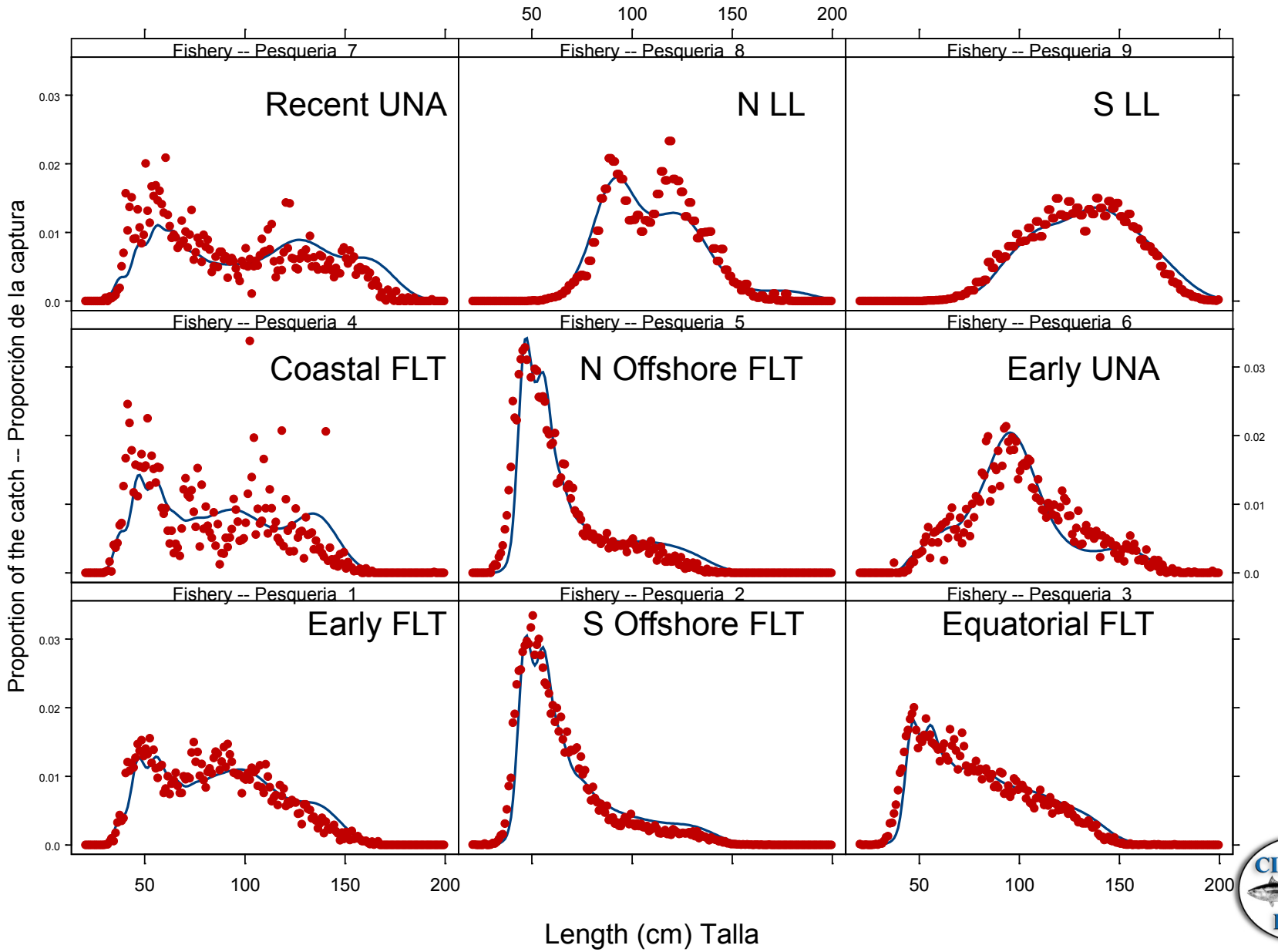
Effort


Fishery -- Pesqueria 13
Fishery -- Pesqueria 9
S LL
Fishery -- Pesqueria 10
Fishery -- Pesqueria 11
Fishery -- Pesqueria 12
Fishery -- Pesqueria 5
N Offshore FLT
Fishery -- Pesqueria 6
Early UNA
Fishery -- Pesqueria 7
Recent UNA
Fishery -- Pesqueria 8
N LL
Fishery -- Pesqueria 1
Early FLT
Fishery -- Pesqueria 2
S Offshore FLT
Fishery -- Pesqueria 3
Equatorial FLT
Fishery -- Pesqueria 4
Coastal FLT
Thousands of days and hundreds of thousands of hooks
Miles de dias y cientos de miles de anzuelos
75 80 85 90 95 00 05
Year -- Año

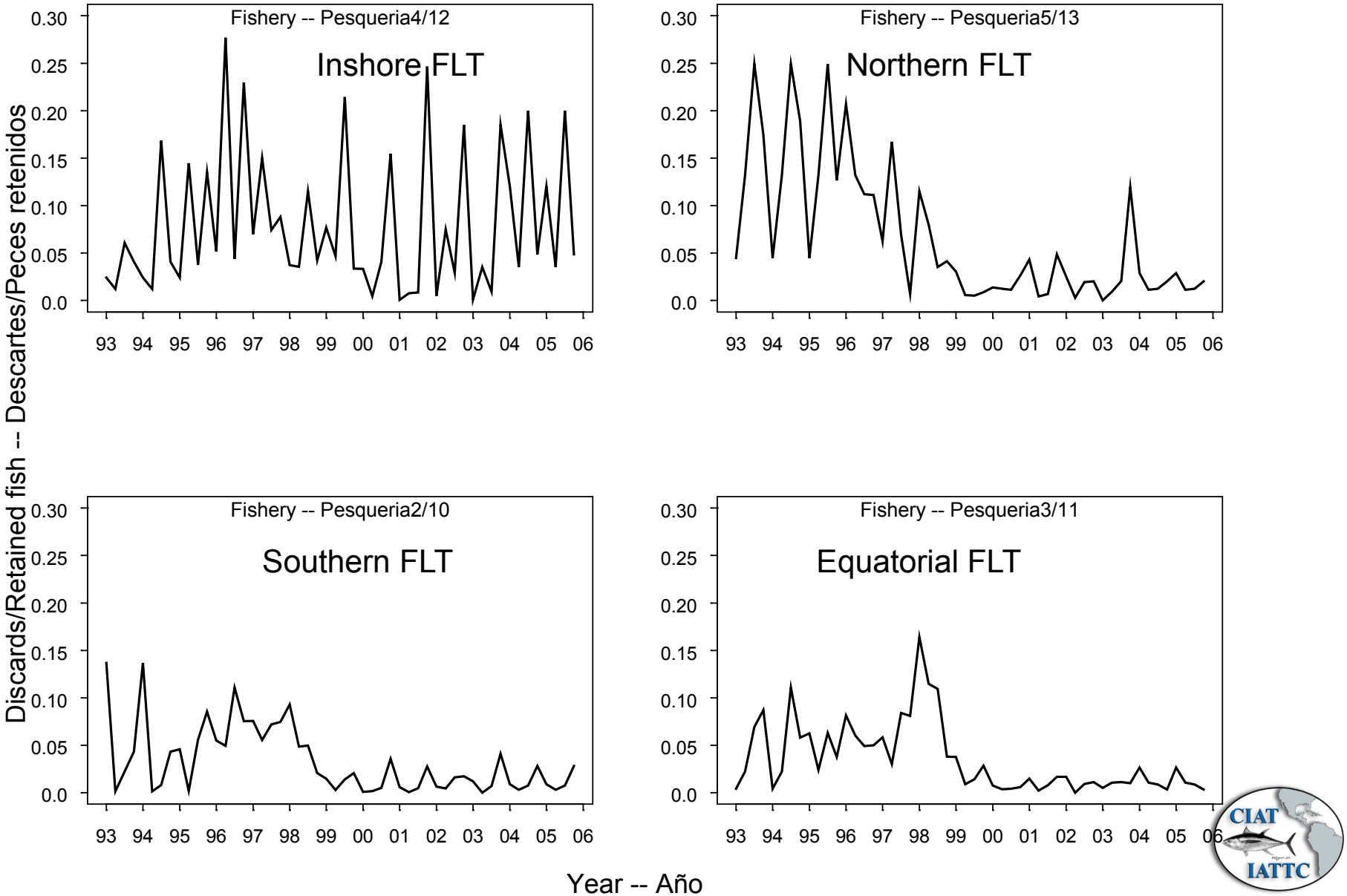
CPUE


Fishery -- Pesqueria 13
Fishery -- Pesqueria 9
S LL
Fishery -- Pesqueria 10
Fishery -- Pesqueria 11
Fishery -- Pesqueria 12
Fishery -- Pesqueria 5
N Offshore FLT
Fishery -- Pesqueria 6
Early UNA
Fishery -- Pesqueria 7
Recent UNA
Fishery -- Pesqueria 8
N LL
Fishery -- Pesqueria 1
Early FLT
Fishery -- Pesqueria 2
S Offshore FLT
Fishery -- Pesqueria 3
Equatorial FLT
Fishery -- Pesqueria 4
Coastal FLT
Scaled CPUE -- CPUE escalado
75 80 85 90 95 00 05
Year -- Año

Length frequency data



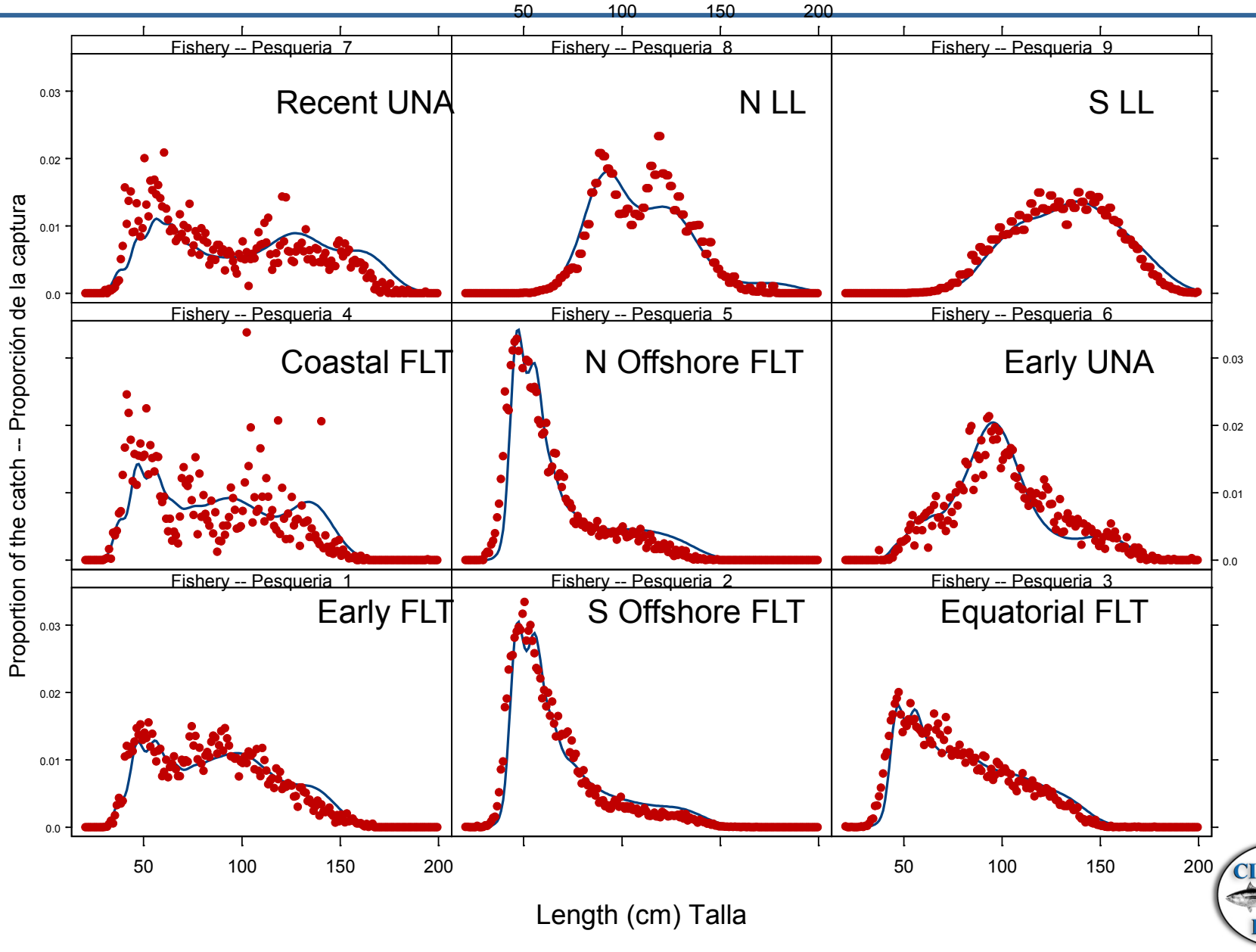
Discards


Fishery -- Pesqueria4/12
Inshore FLT
Fishery -- Pesqueria5/13
Northern FLT
Fishery -- Pesqueria2/10
Southern FLT
Fishery -- Pesqueria3/11
Equatorial FLT
Discards/Retained fish -- Descartes/Peces retenidos
0.30
0.25
0.20
0.15
0.10
0.05
0.0
93 94 95 96 97 98 99 00 01 02 03 04 05 06
Year -- Año

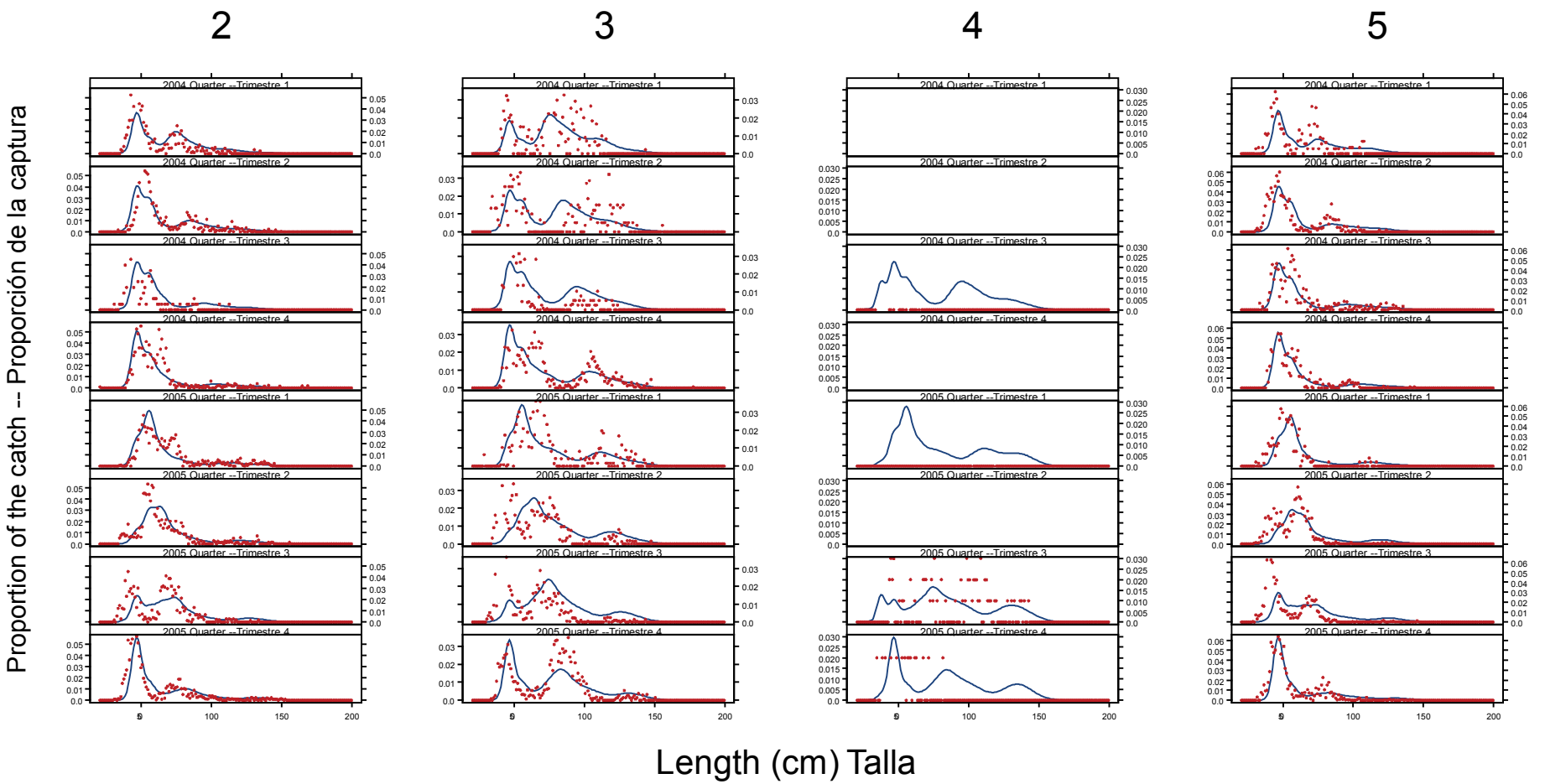
Results

- Fit to the length frequency
- Growth
- Fishing mortality
- Selectivity
- Recruitment
- Biomass
- Catchability

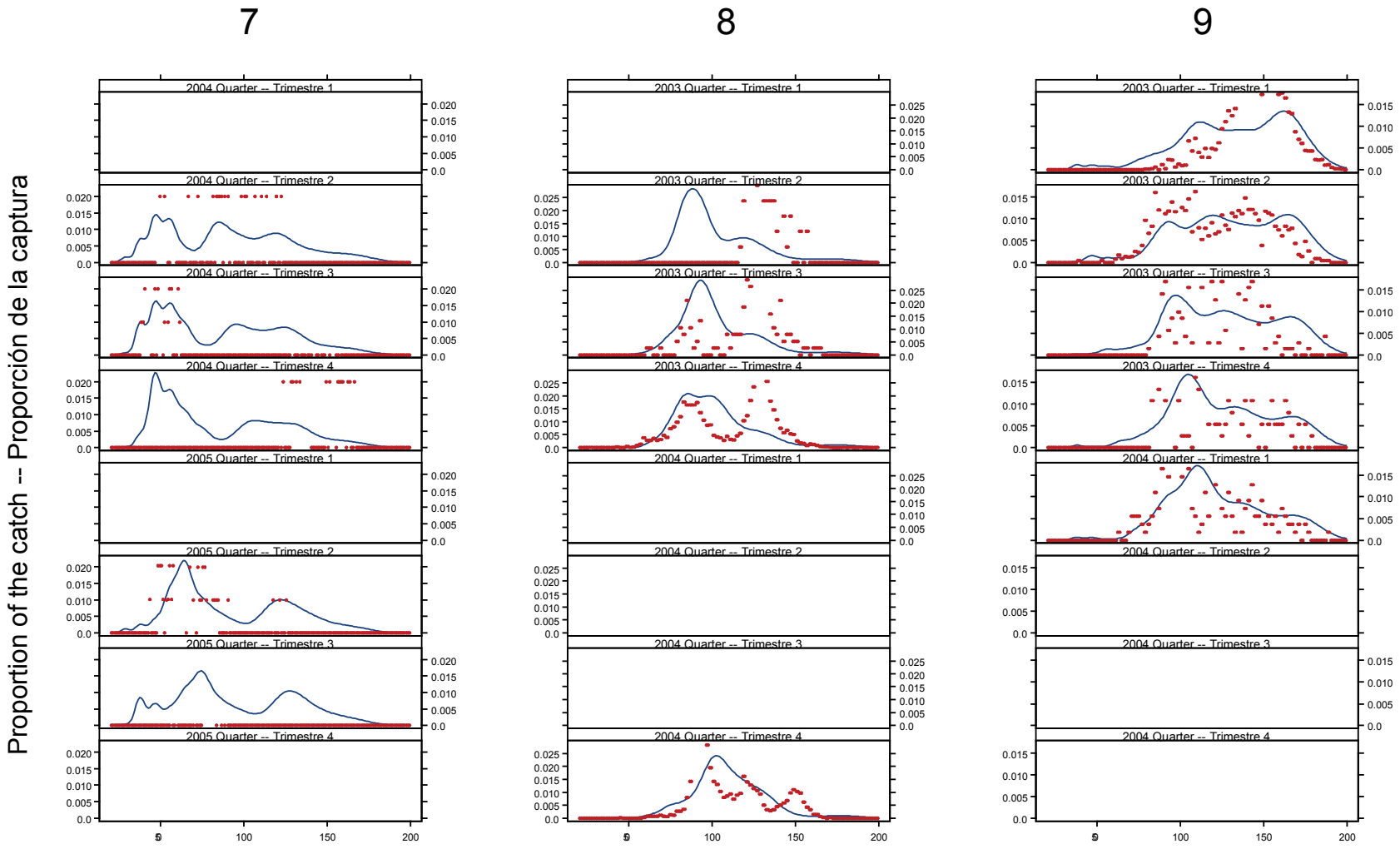
Average fit to the length frequency data



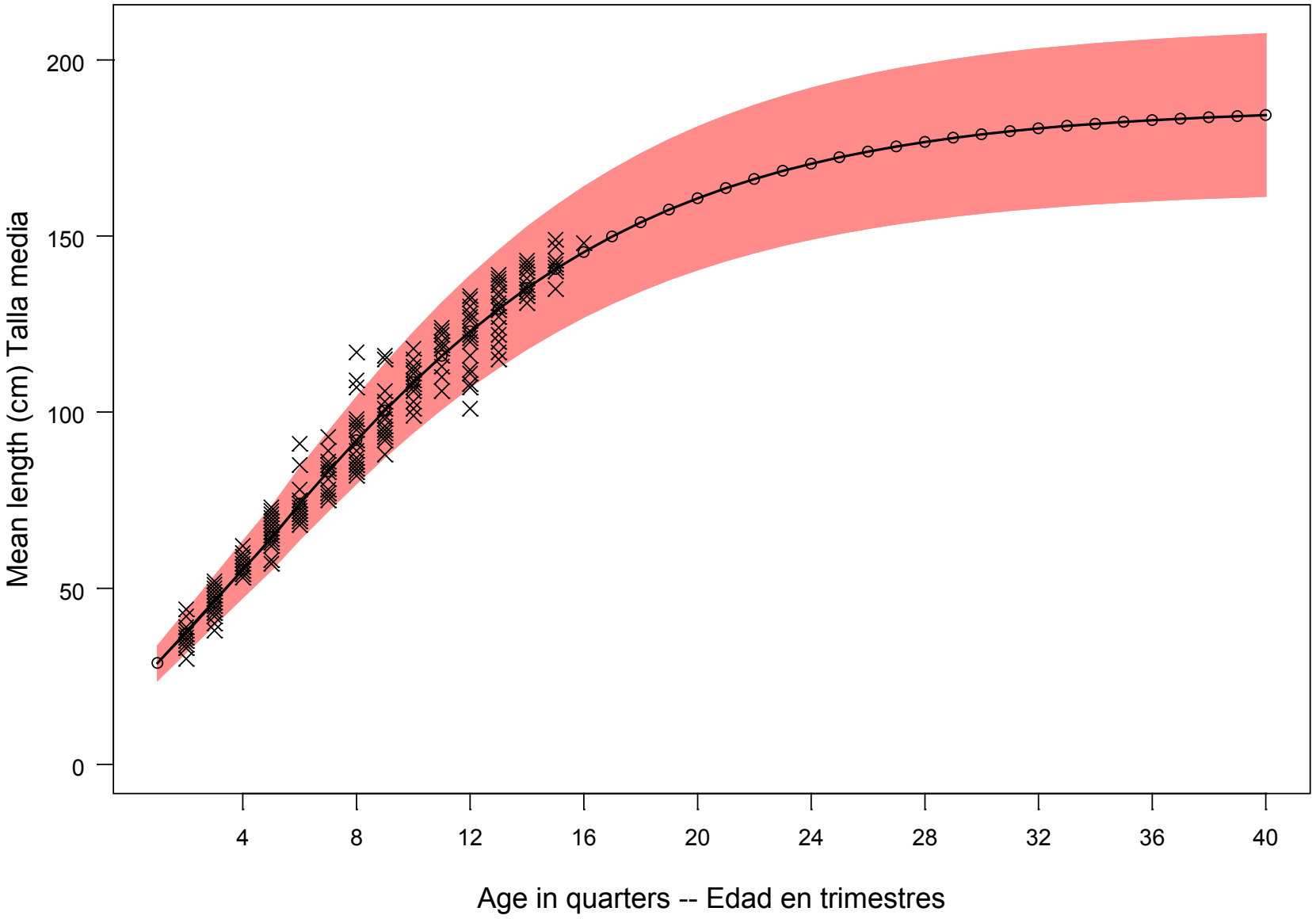
Fit to recent length frequency data



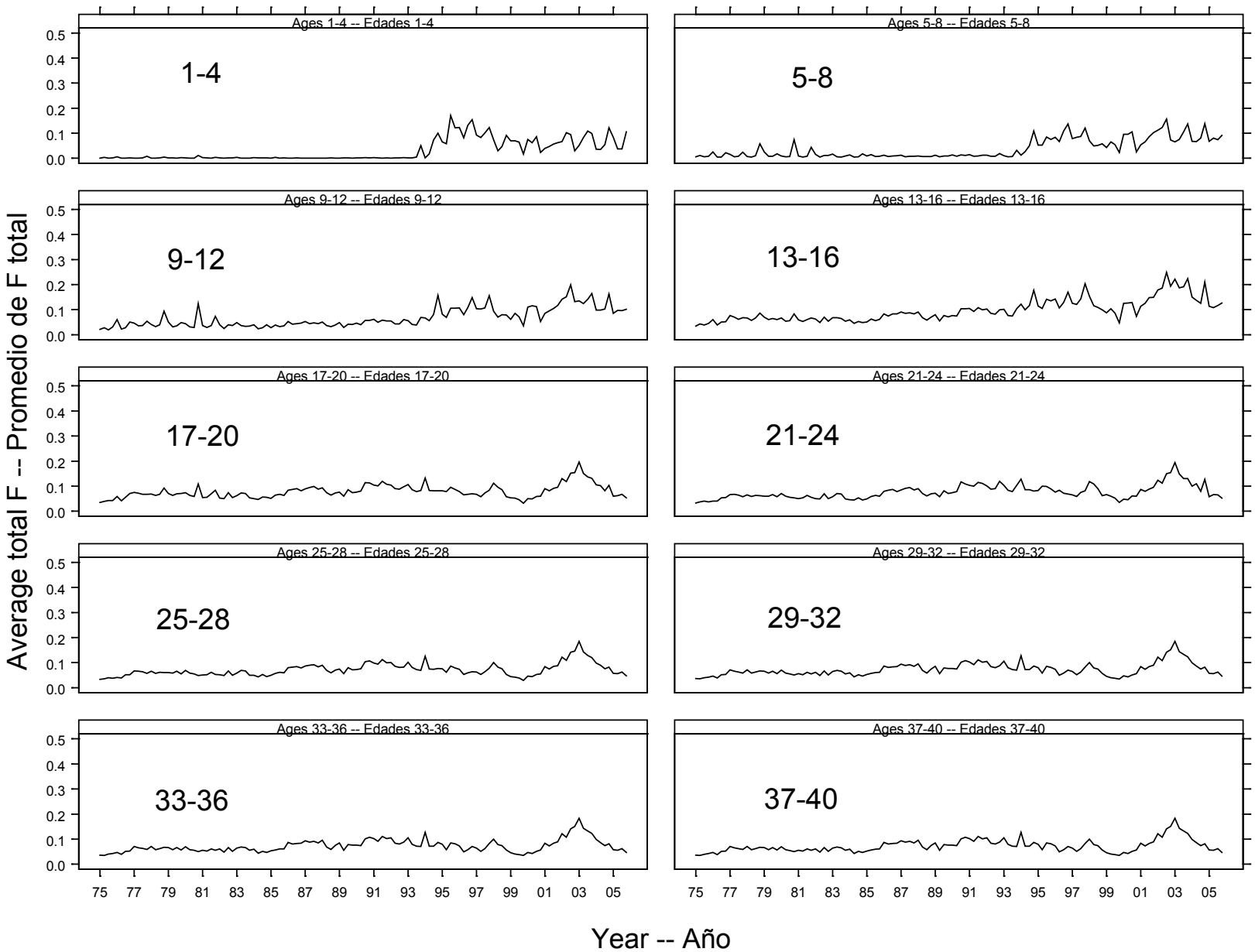
Fit to recent length frequency data



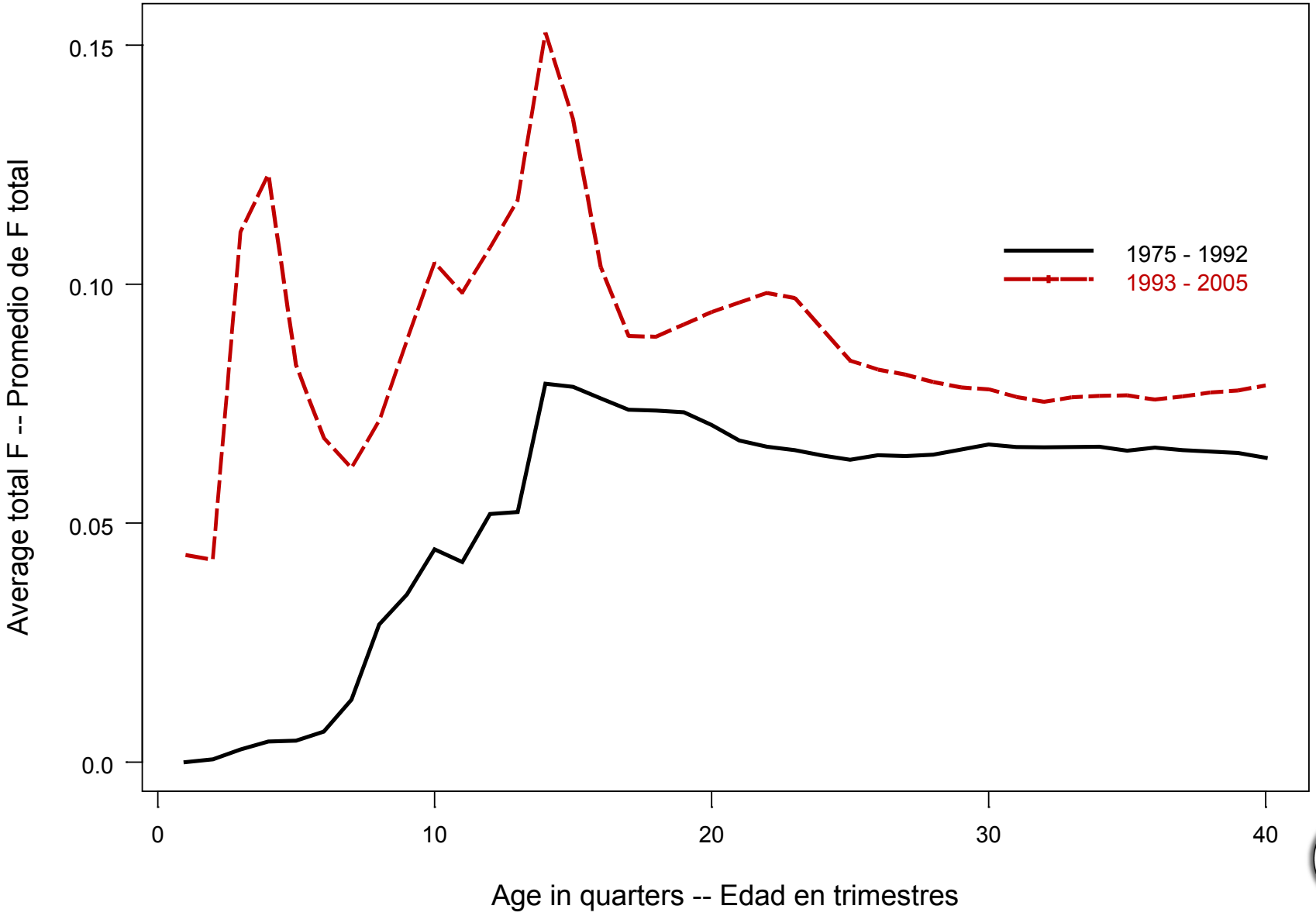
Growth


Mean length (cm) Talla media
0
50
100
150
200
4
8
12
16
20
24
28
32
36
40
Age in quarters -- Edad en trimestres

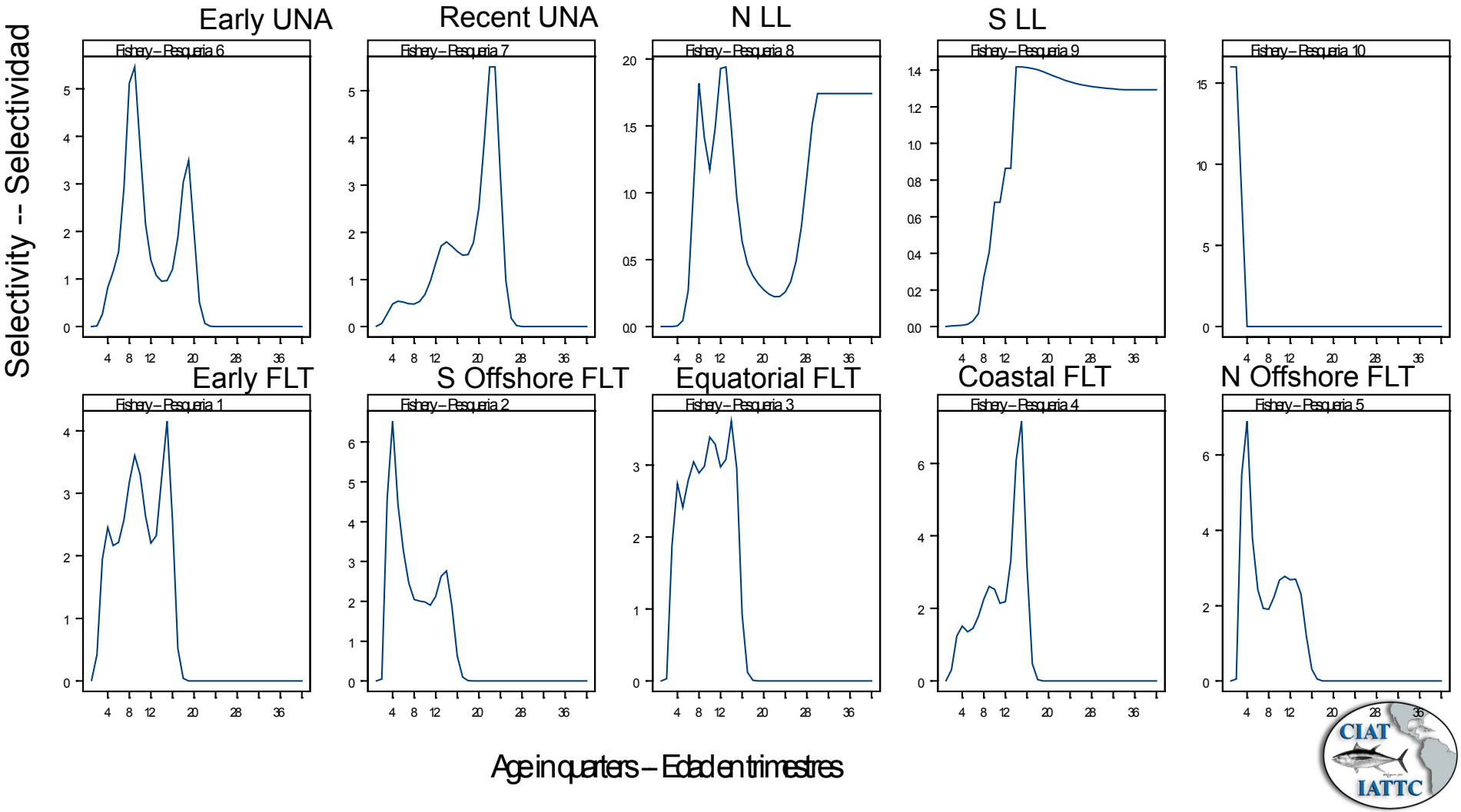
Fishing mortality



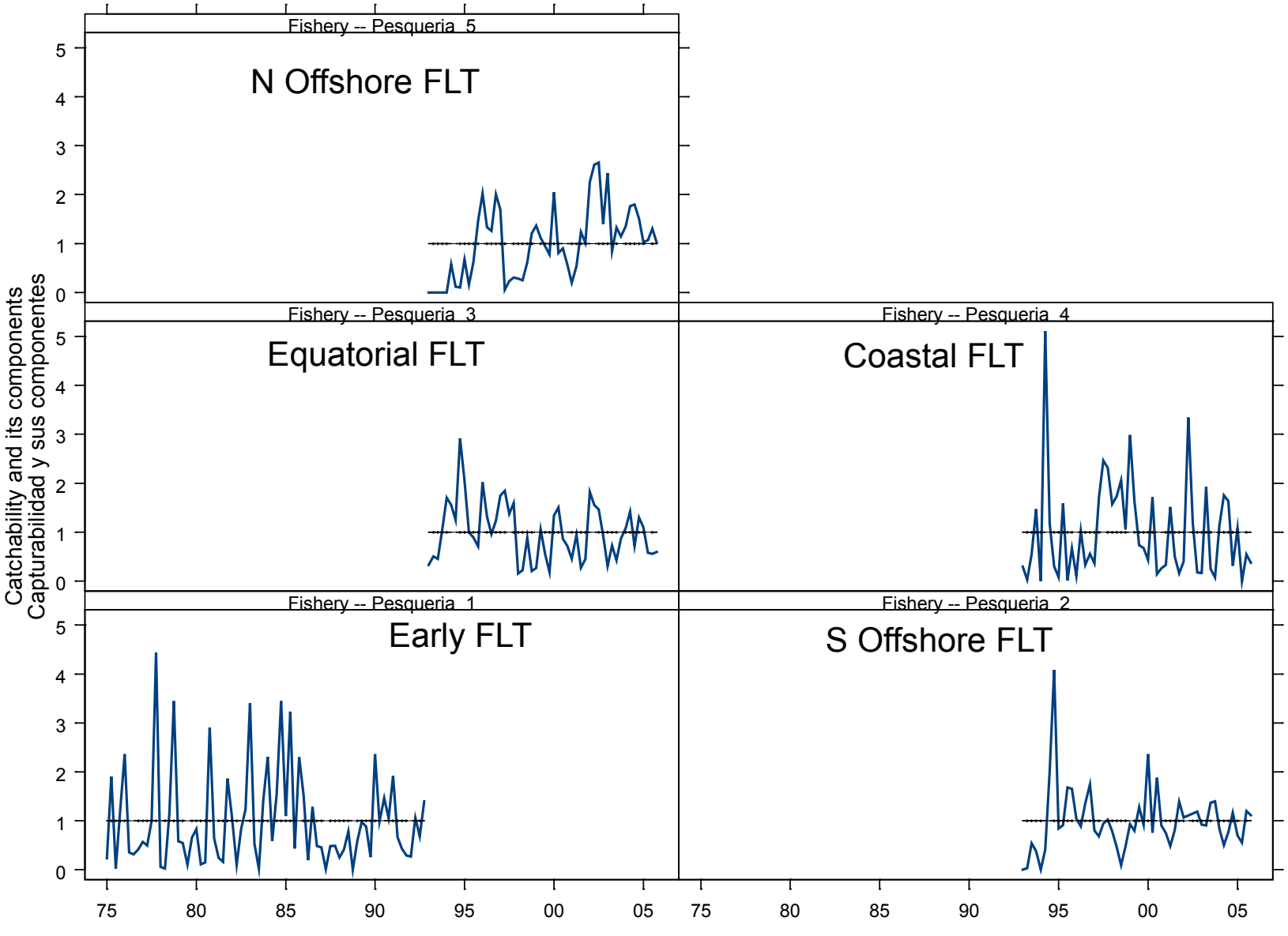
Age-specific fishing mortality



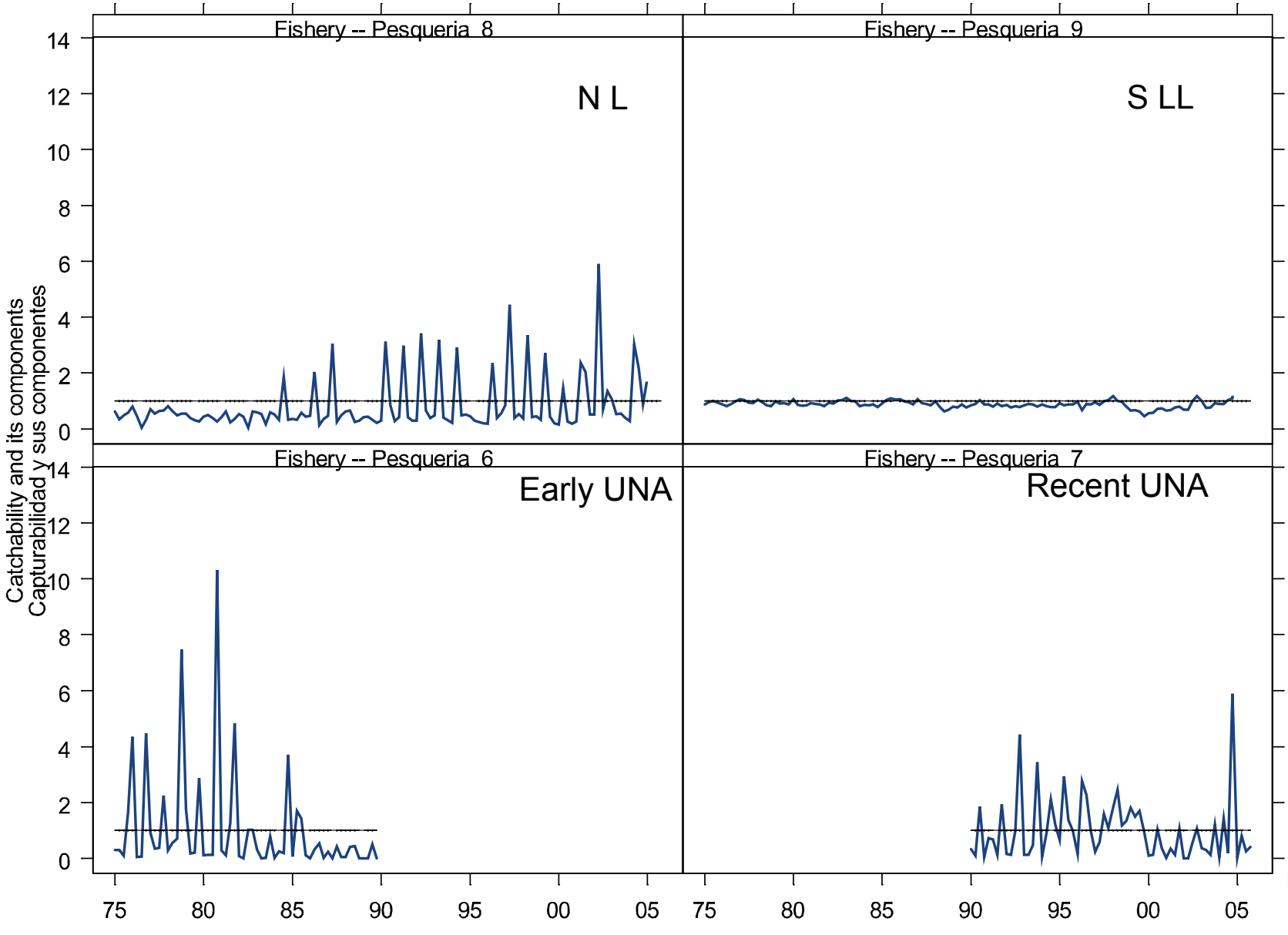
Selectivity



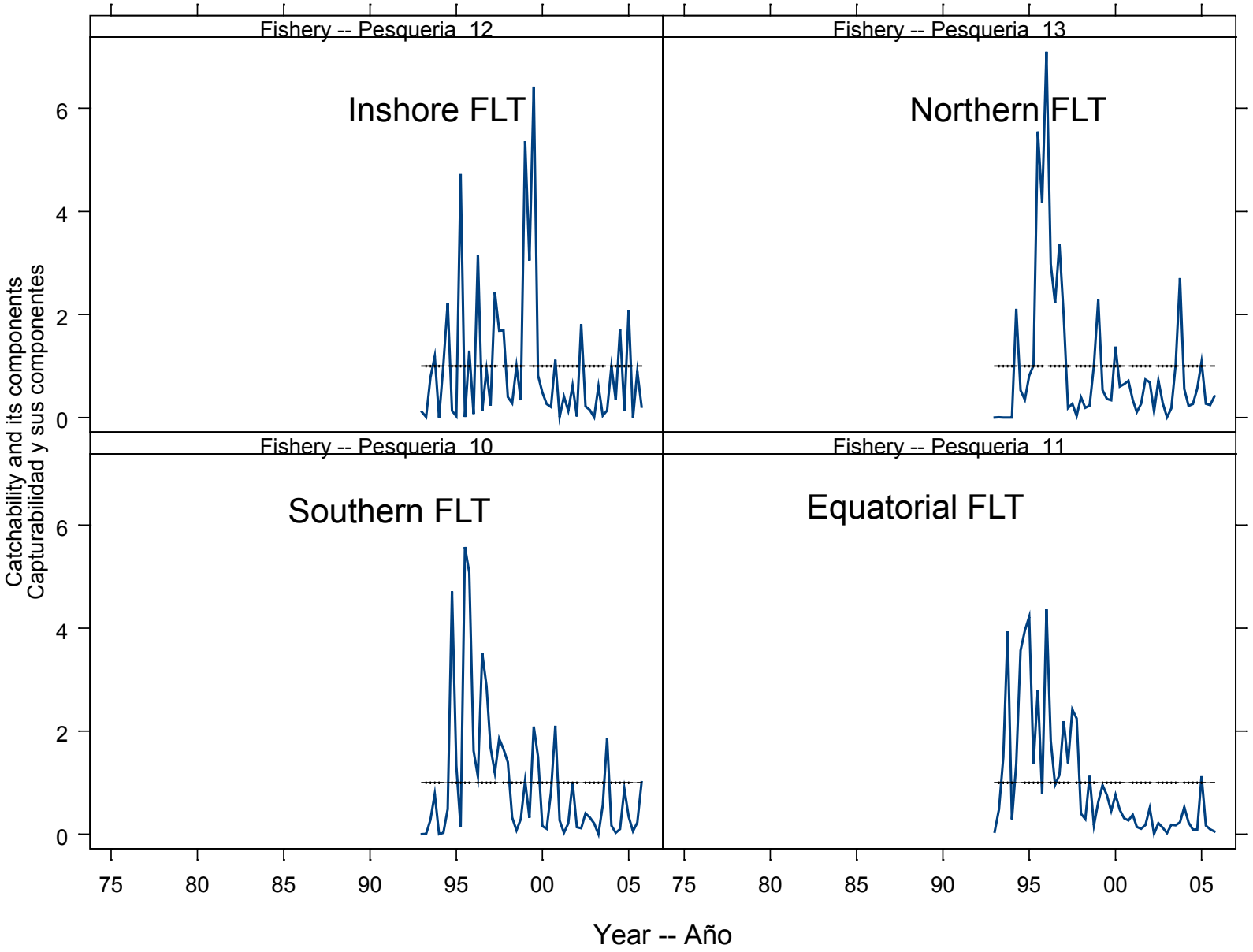
Catchability



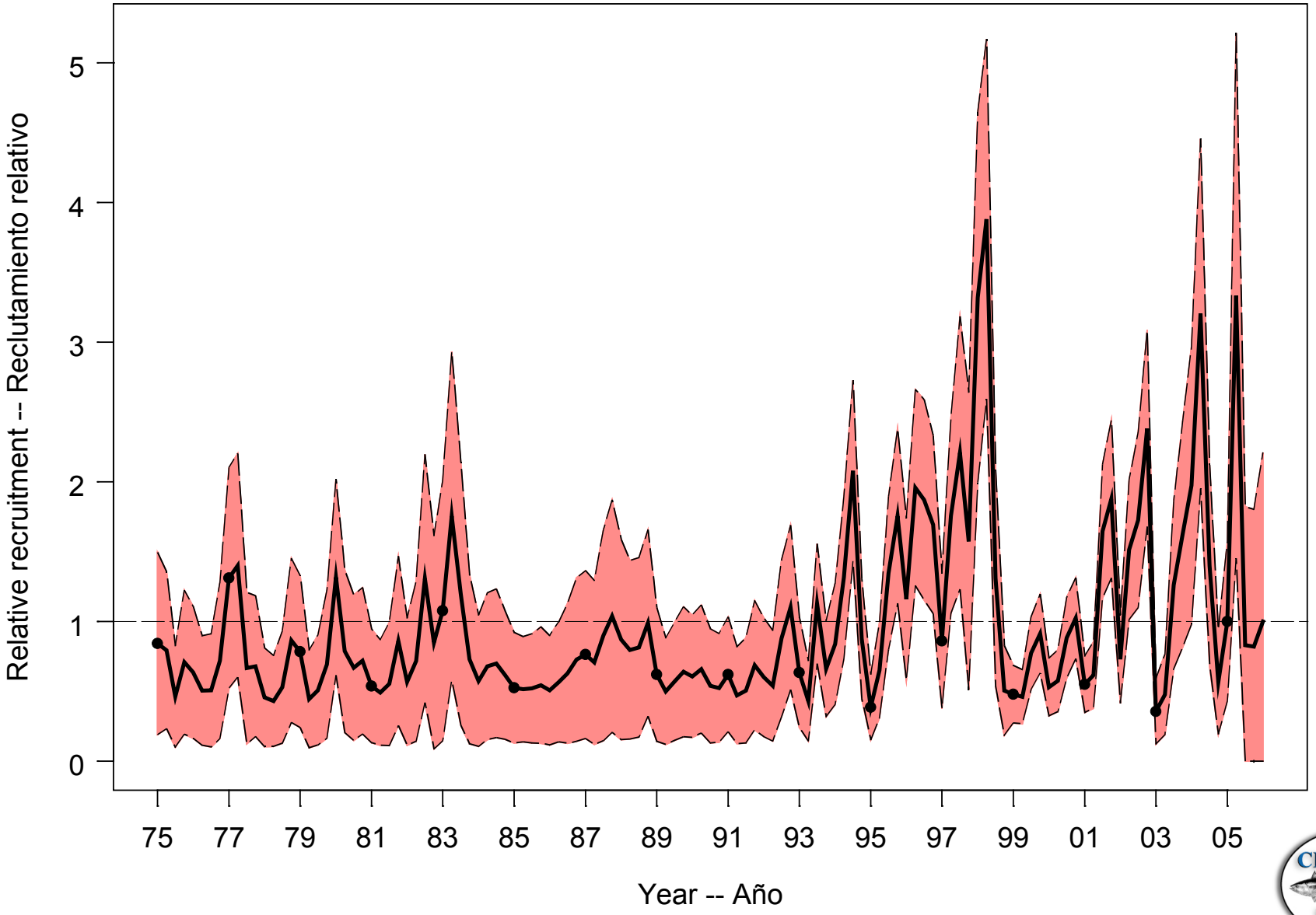
Catchability



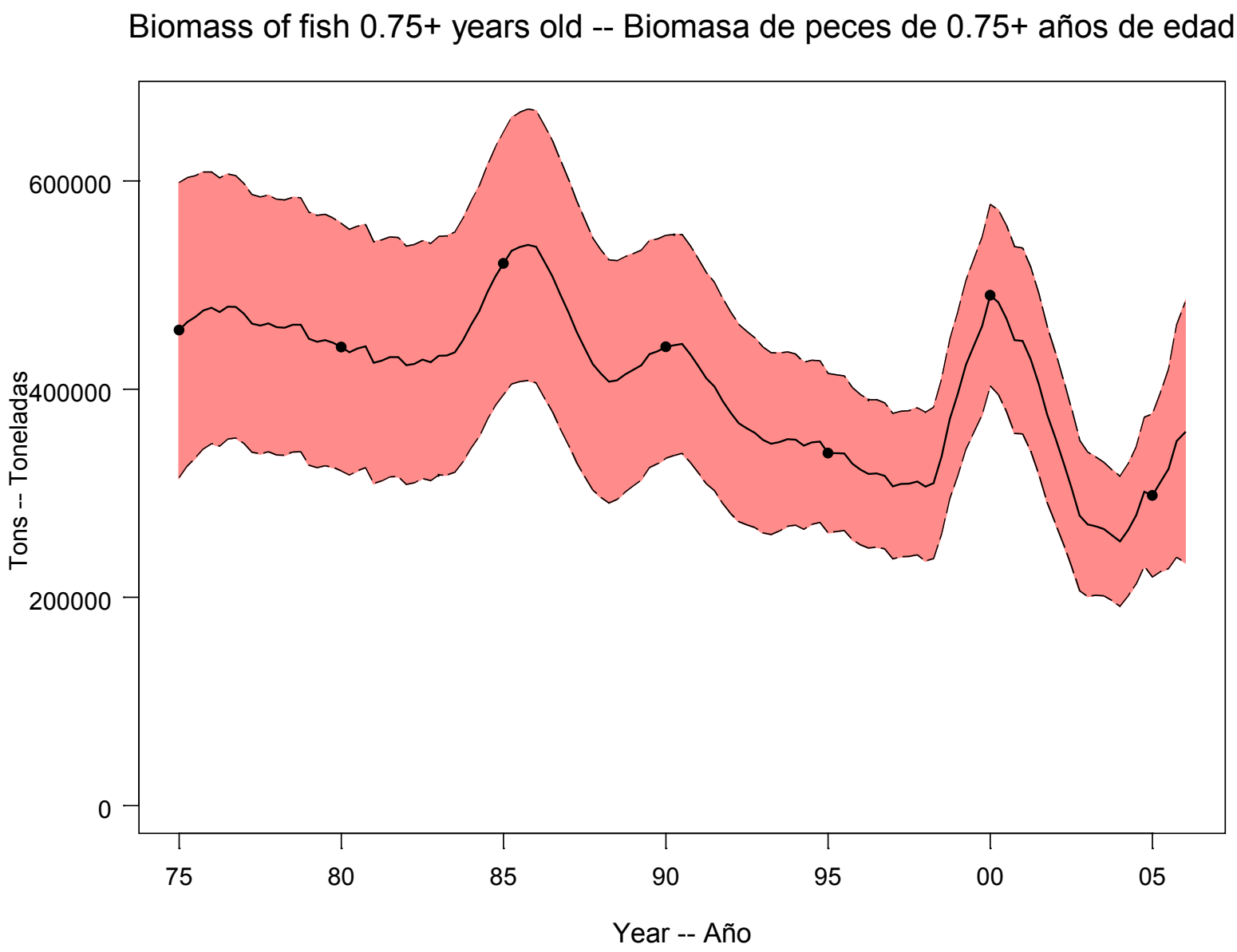
Catchability



Recruitment

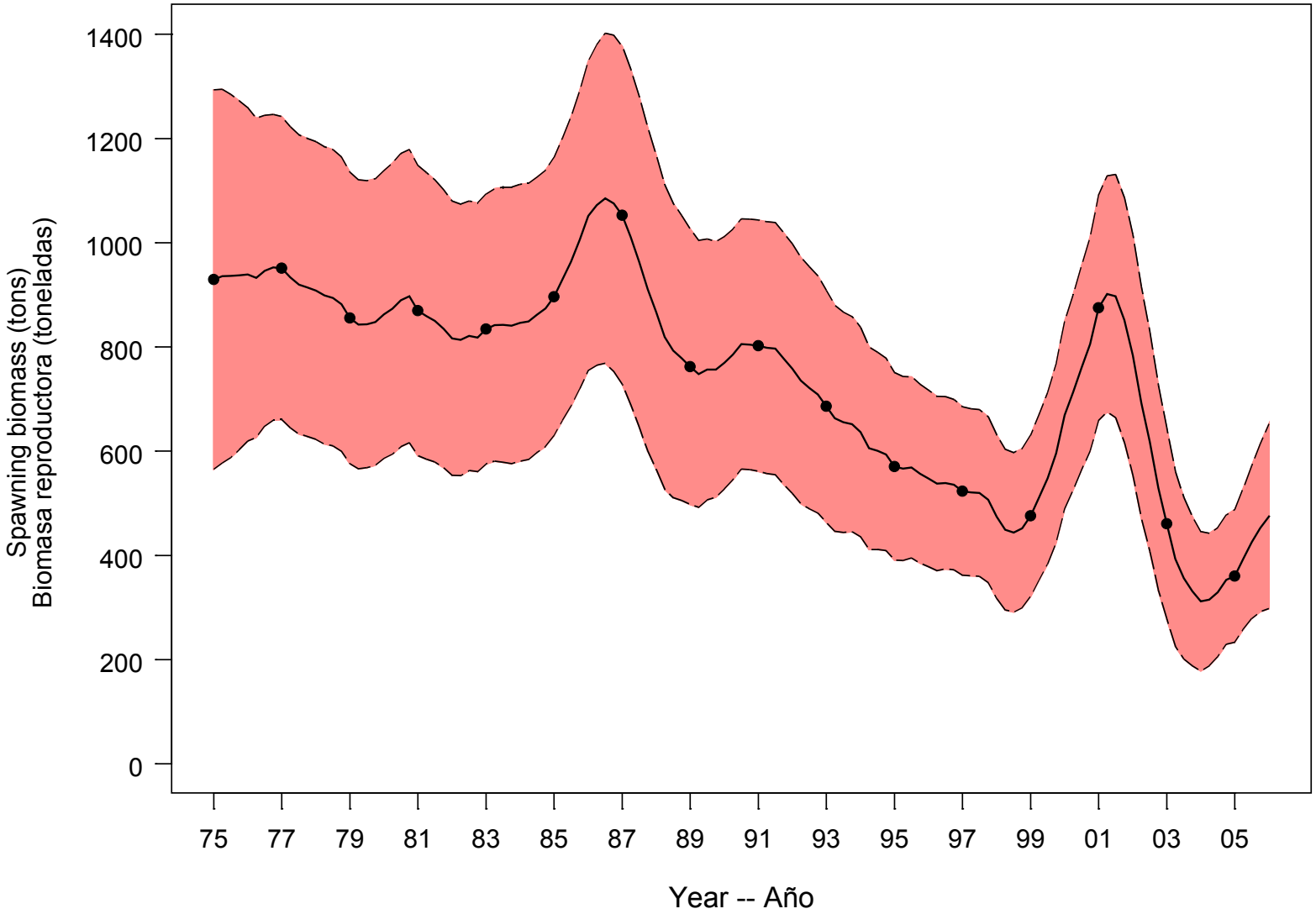


Biomass

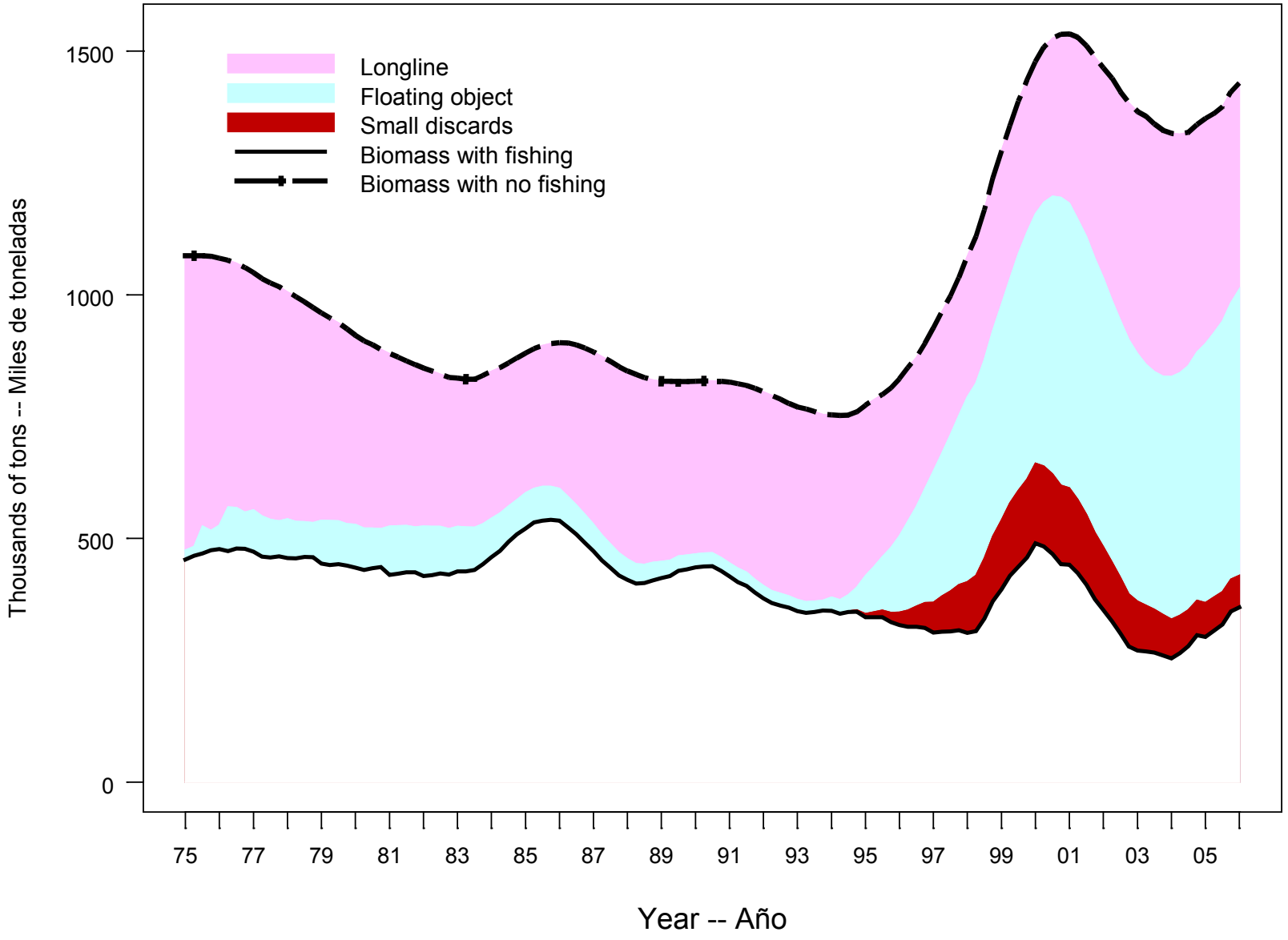

Biomass of fish 0.75+ years old -- Biomasa de peces de 0.75+ años de edad
600000
400000
200000
0
Tons -- Toneladas
75
80
85
90
95
00
05
Year -- Año

Spawning biomass

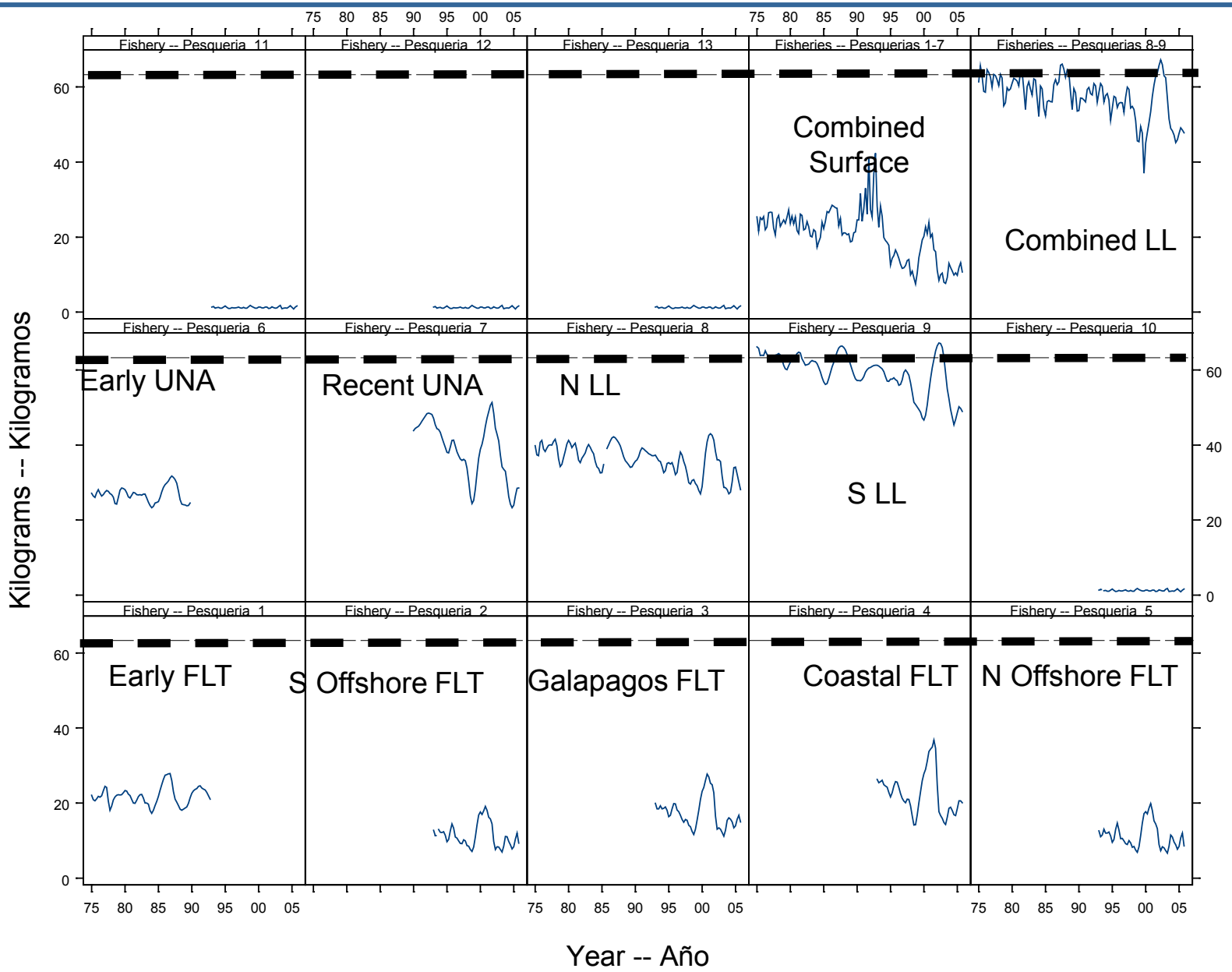
Population fecundity -- Fecundidad de la poblacion



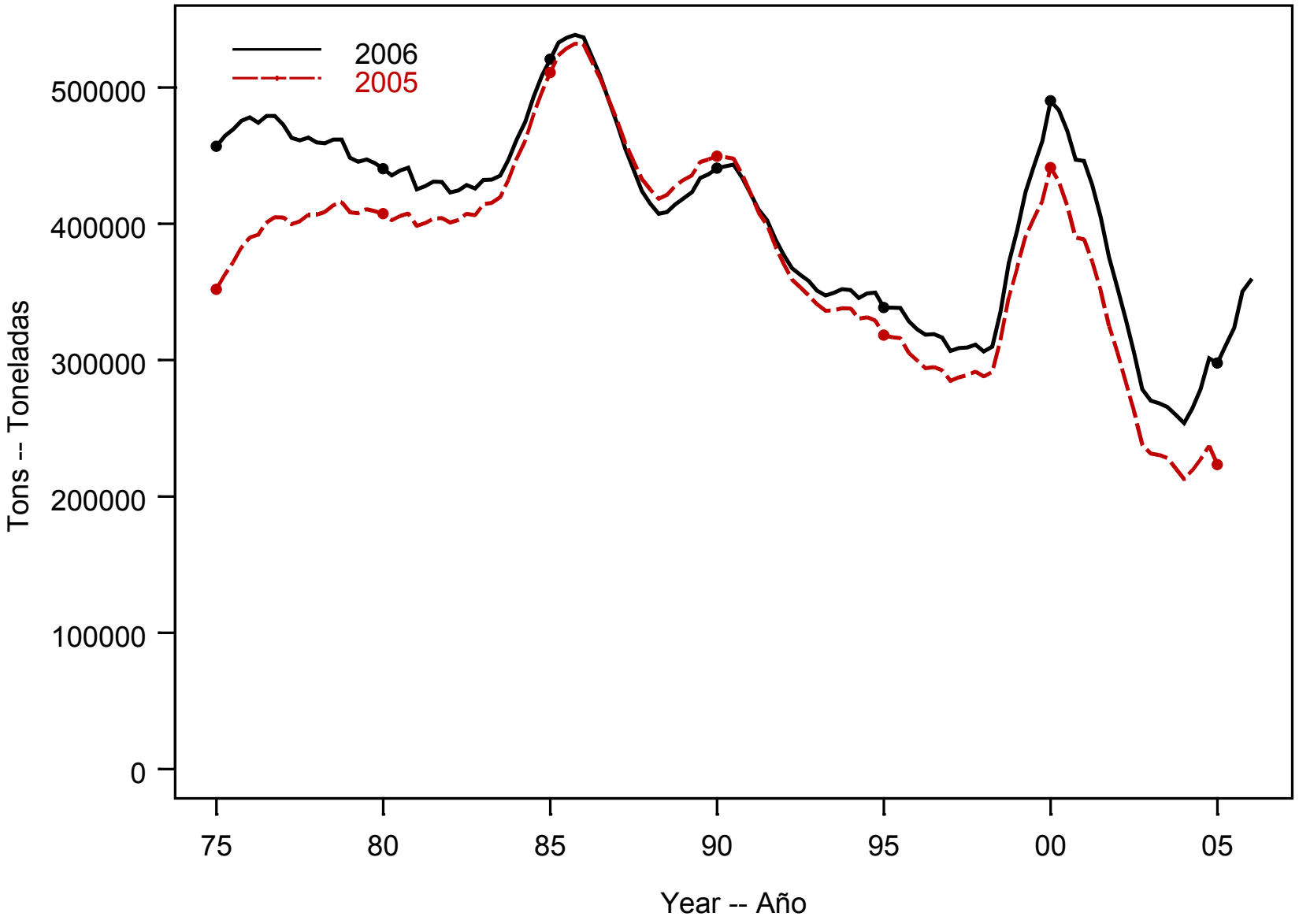
No-fishing plot



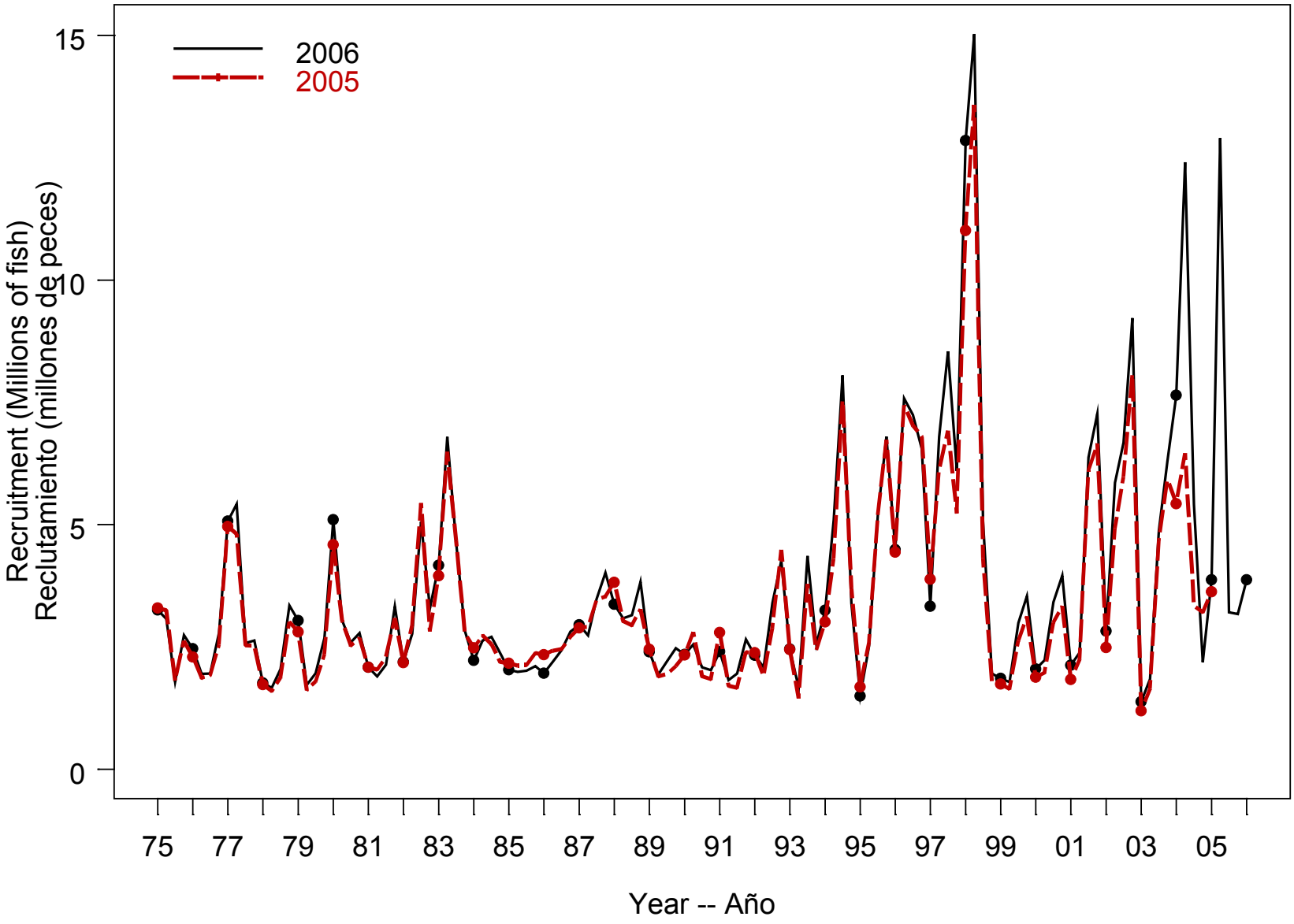
Average weight



Biomass


2006
2005
500000
400000
300000
200000
100000
0
Tons -- Toneladas
75
80
85
90
95
00
05
Year -- Año

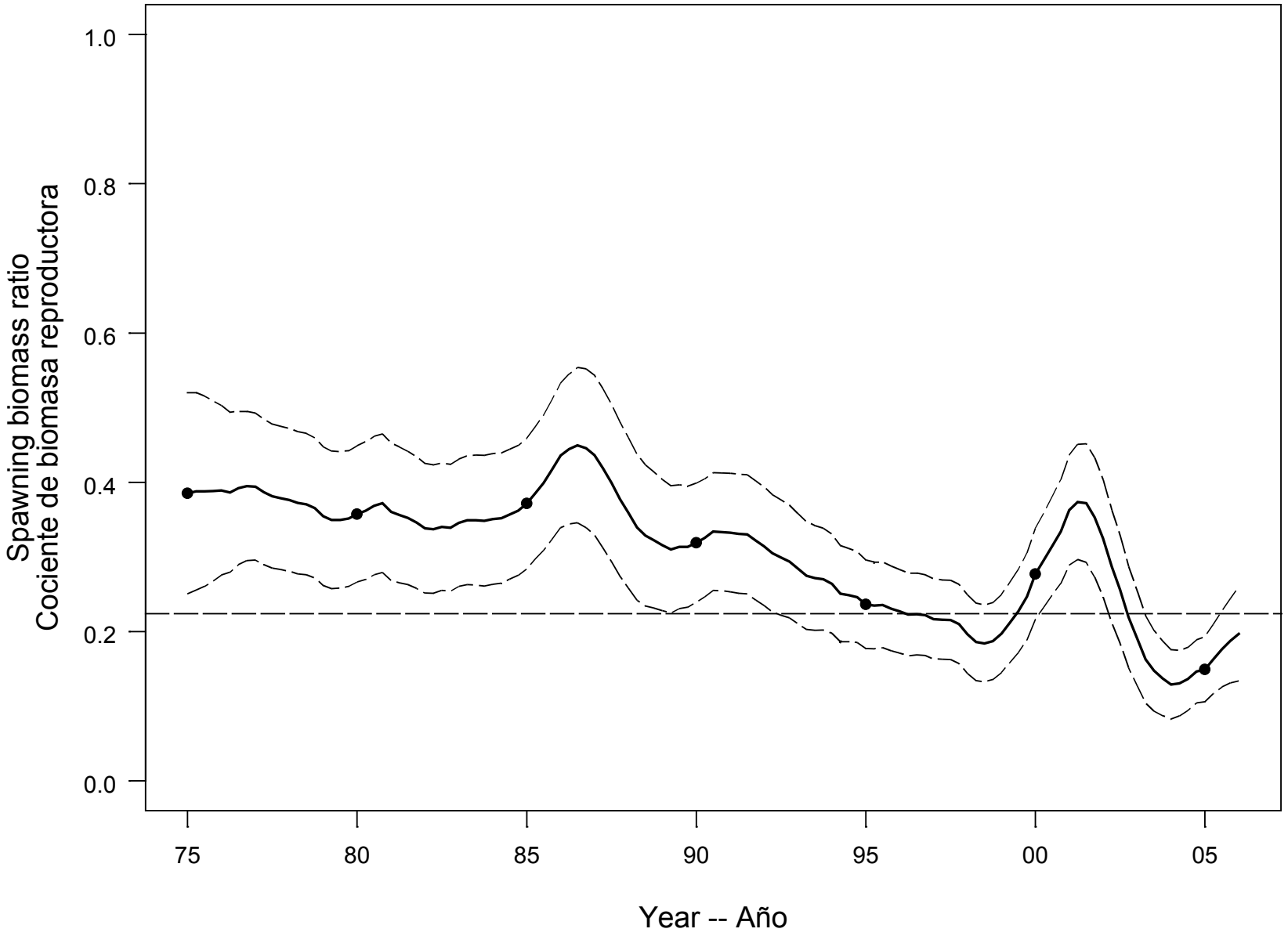
Recruitment



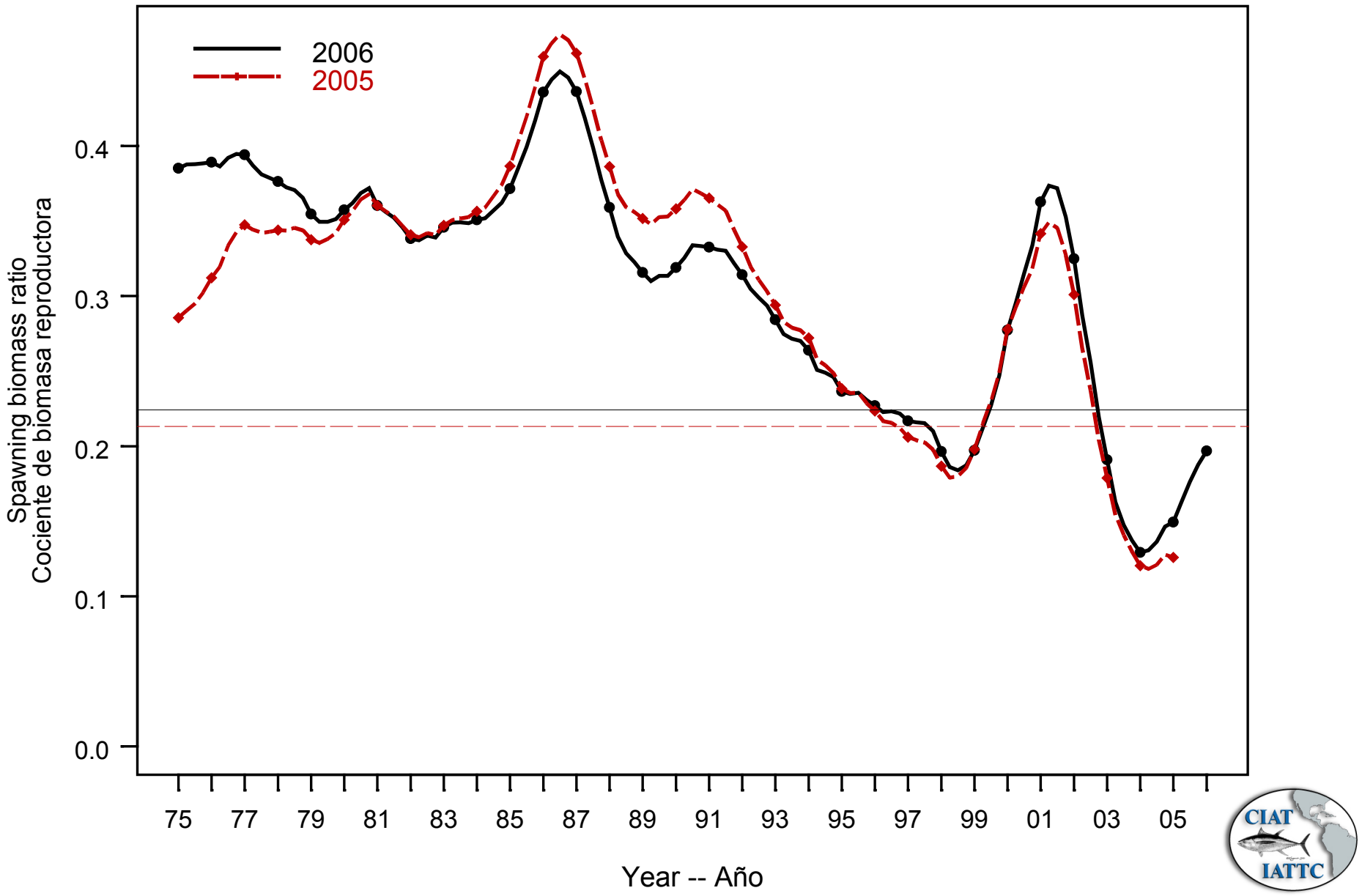
Comparisons to reference points

- Spawning biomass depletion
- Yield curve

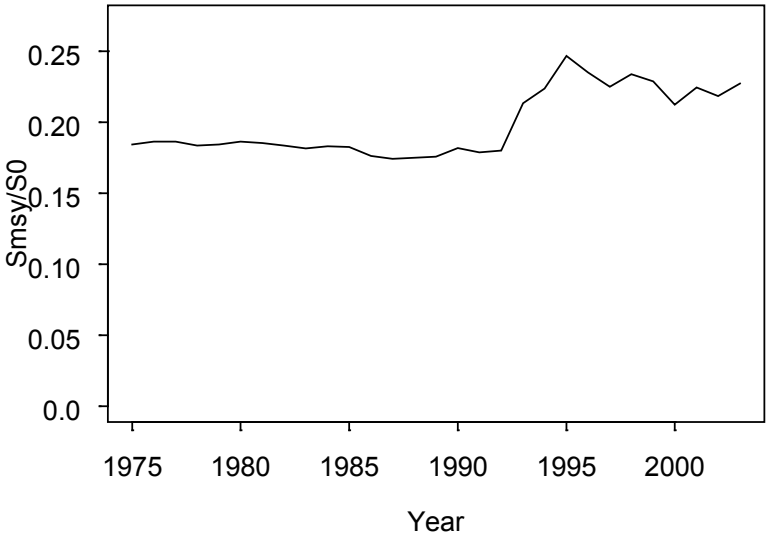
Spawning biomass ratio

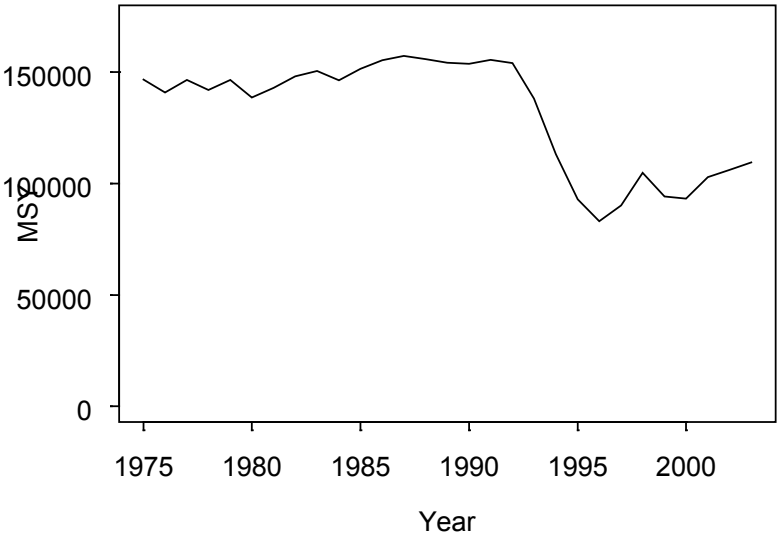


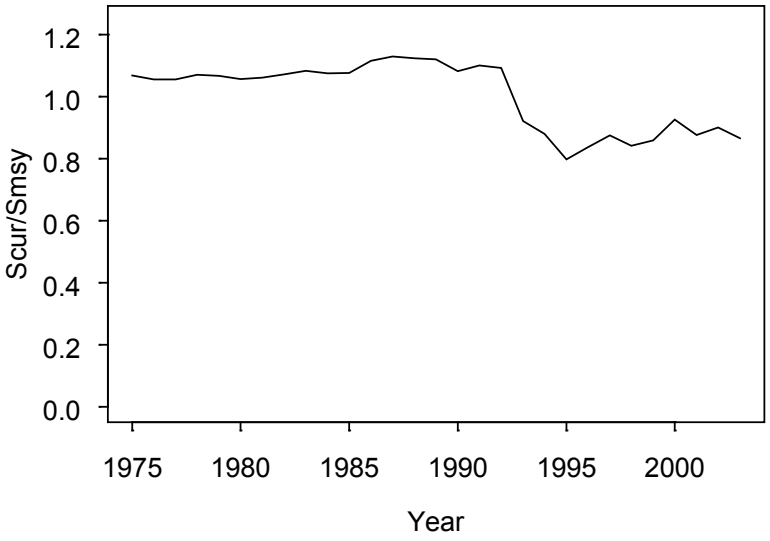
SBR comparison with last year

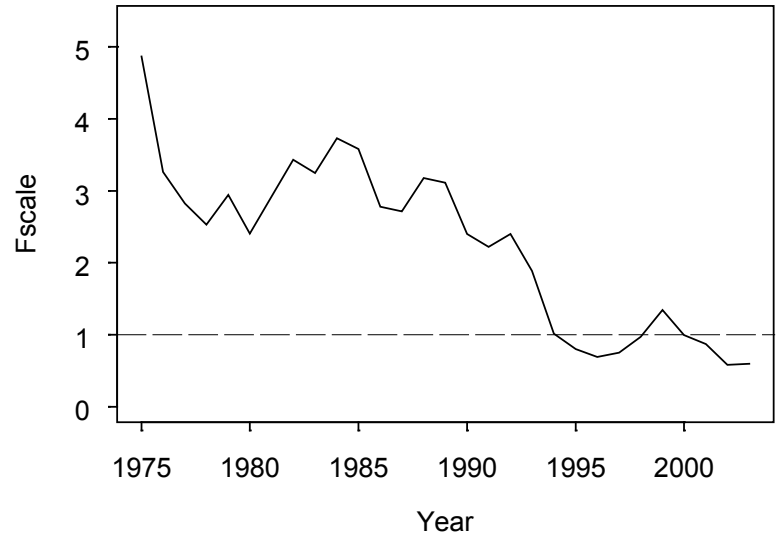


Time varying indicators

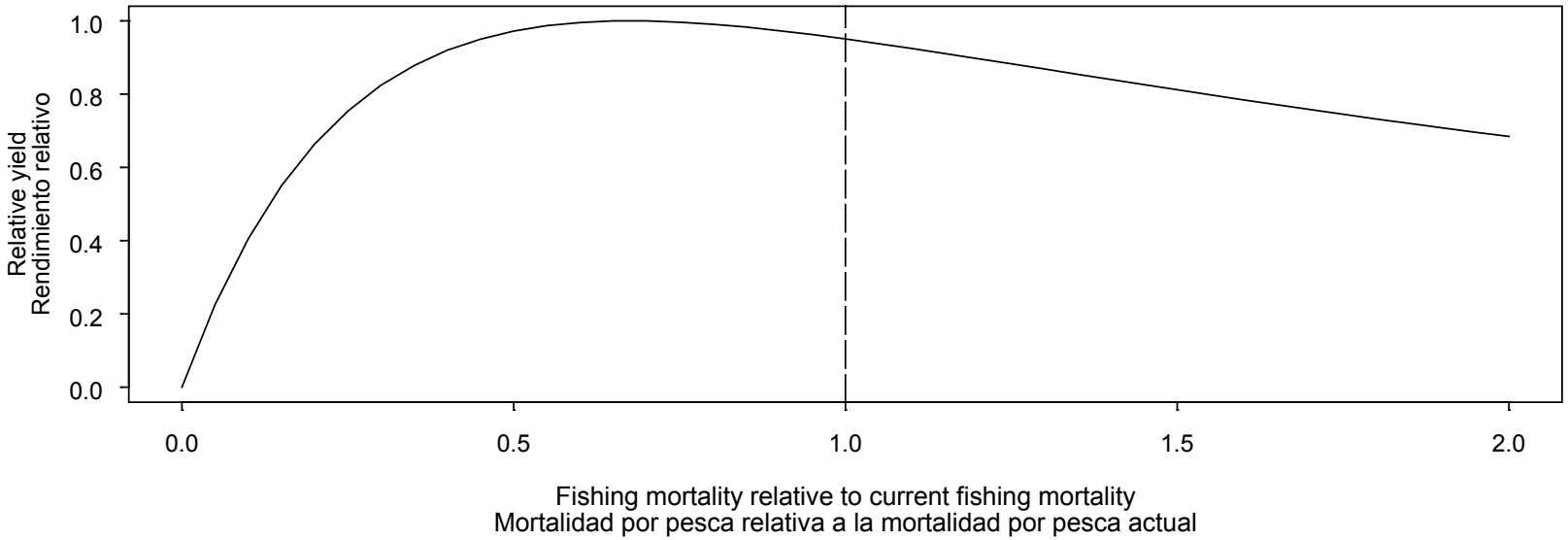


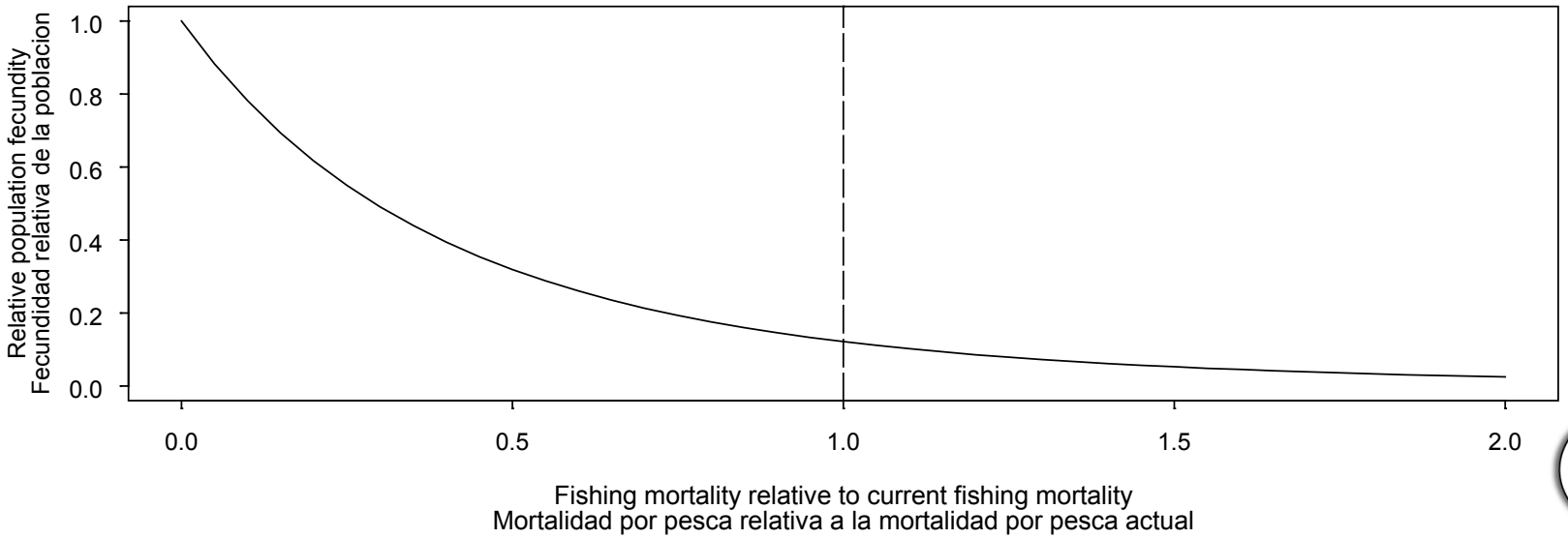






Yield curve


Relative yield
Rendimiento relativo
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
Fishing mortality relative to current fishing mortality
Mortalidad por pesca relativa a la mortalidad por pesca actual


Relative population fecundity
Fecundidad relativa de la poblacion
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
Fishing mortality relative to current fishing mortality
Mortalidad por pesca relativa a la mortalidad por pesca actual

AMSY-quantities

	Base case
AMSY (mt)	106,722
*B*AMSY (mt)	326,329
*S*AMSY	541
BAMSY/B0	0.30
SAMSY/S0	0.22
*C*recent/AMSY	1.00
*B*recent/*B*AMSY	1.10
*S*recent/*S*AMSY	0.88
F multiplier	0.68

AMSY-quantities -- assumed F

	F's 2003 & 2004 – Base case	F's 2002 & 2003	F's 2004 & 2005
AMSY (mt)	106,722	107,710	98,665
***B*AMSY (mt)**	326,329	326,197	314,958
***S*AMSY**	541	538	531
BAMSY/B0	0.30	0.30	0.29
SAMSY/S0	0.22	0.22	0.22
***C*recent/AMSY**	1.00	0.99	1.08
***B*recent/*B*AMSY**	1.10	1.10	1.14
***S*recent/*S*AMSY**	0.88	0.88	0.89
***F* multiplier**	0.68	0.59	0.86

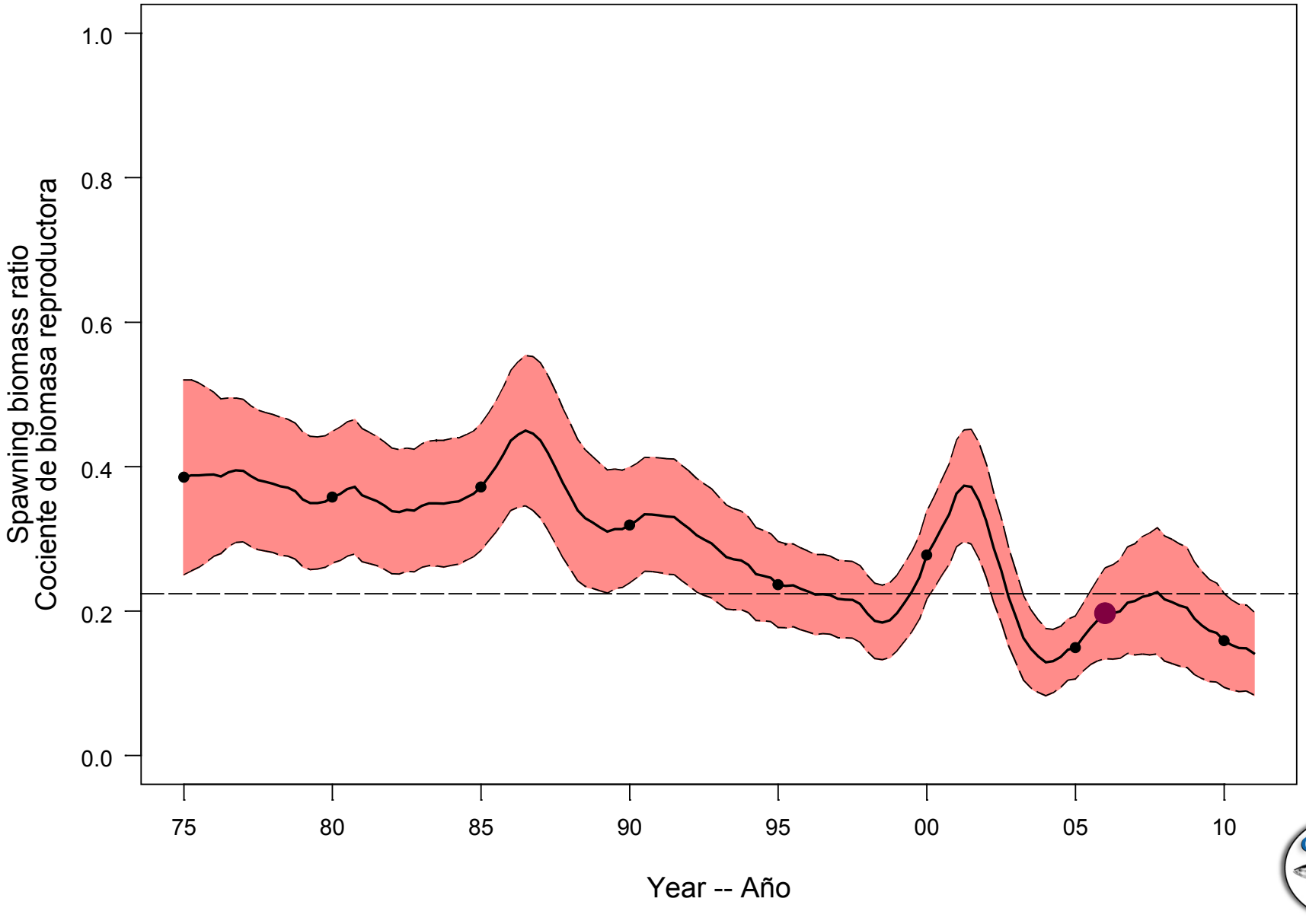
AMSY-quantities – by fishery

	All gears	Purse-seine only	Longline only	Purse-seine scaled	Longline scaled
AMSY	106,722	62,116	159,174	145,593	104,371
B_{AMSY}	326,329	247,230	335,377	495,020	171,896
S_{AMSY}	541	436	415	852	177
B_{AMSY}/B_0	0.30	0.23	0.31	0.46	0.16
S_{AMSY}/S_0	0.22	0.18	0.17	0.35	0.07
F multiplier	0.68	1.53	2.20	0.00	1.86

Forward simulations

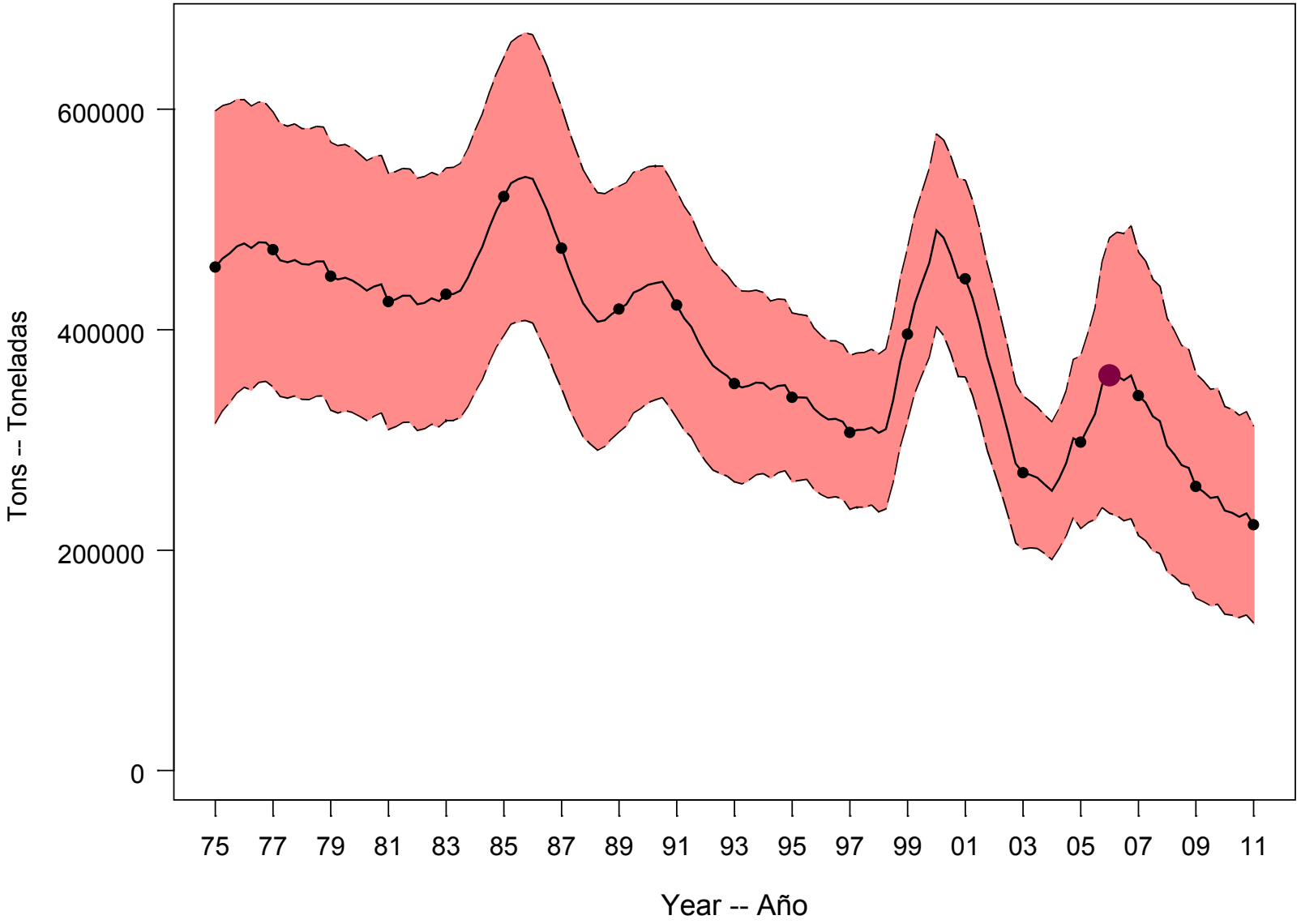
- Spawning biomass depletion
- Biomass
- Surface fishery catch
- Longline catch

Spawning biomass ratio

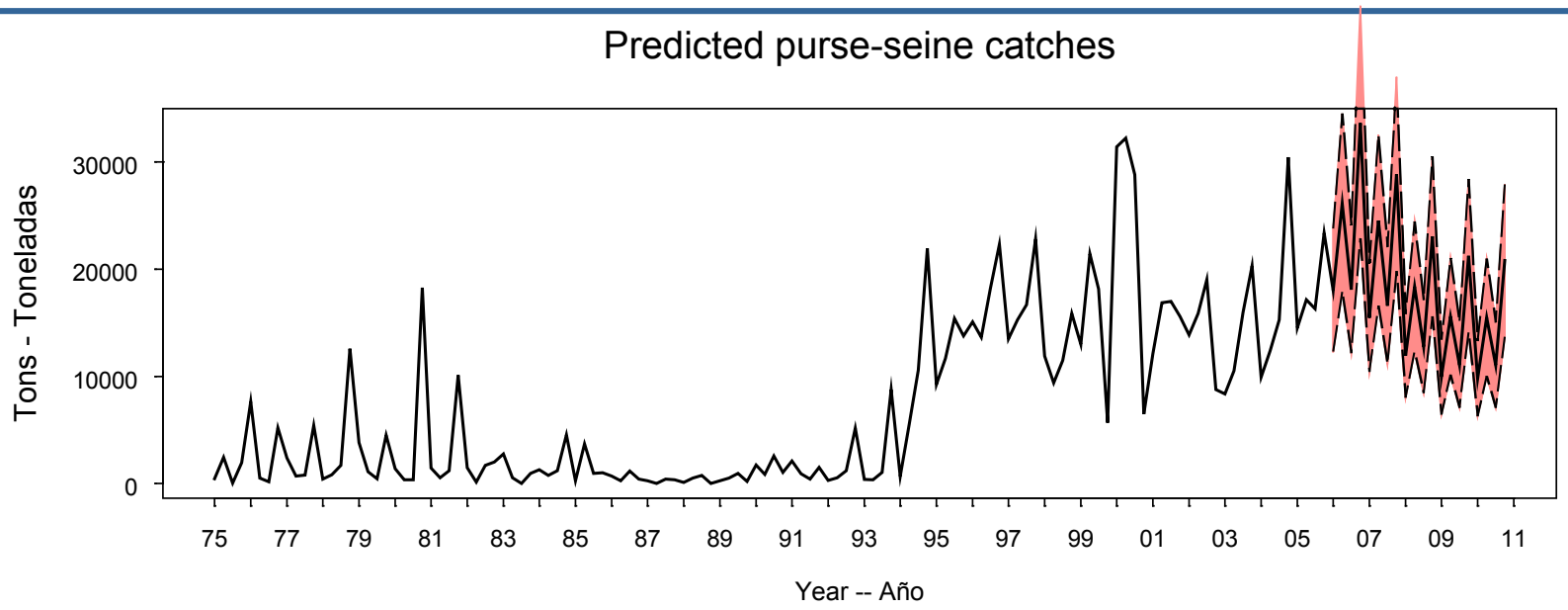


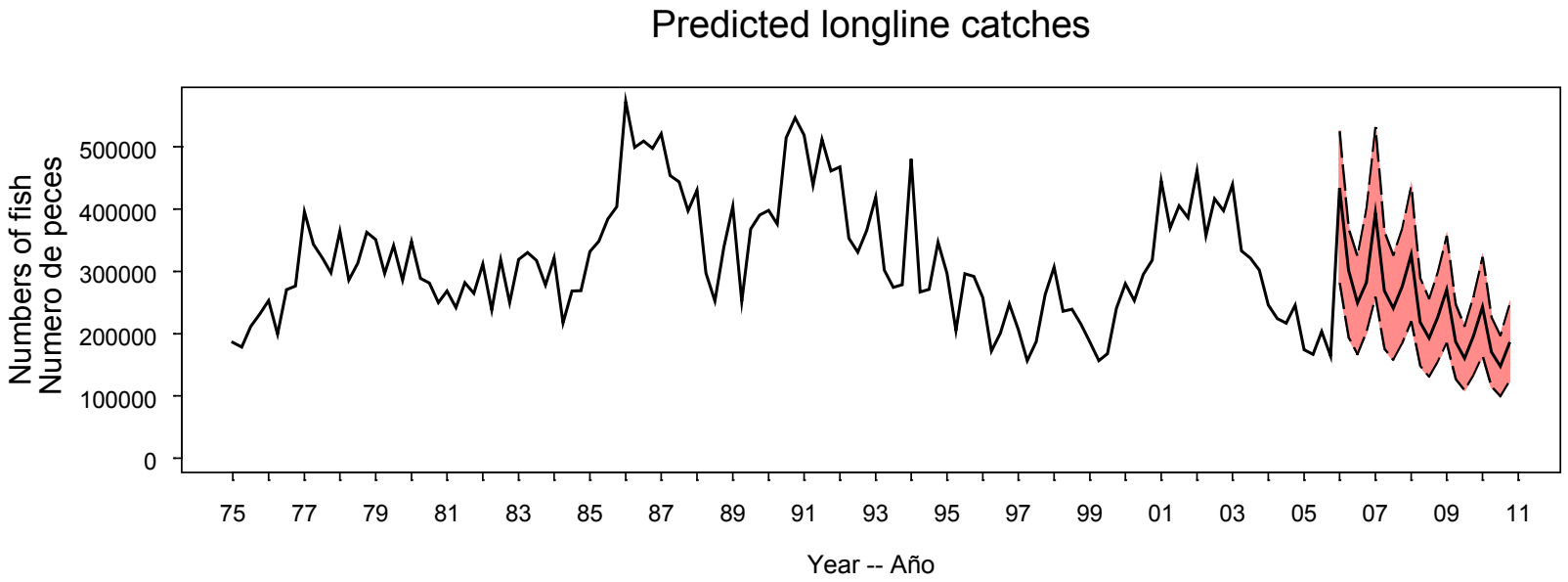
Biomass

Biomass of fish 0.75+ years old -- Biomasa de peces de 0.75+ años de edad



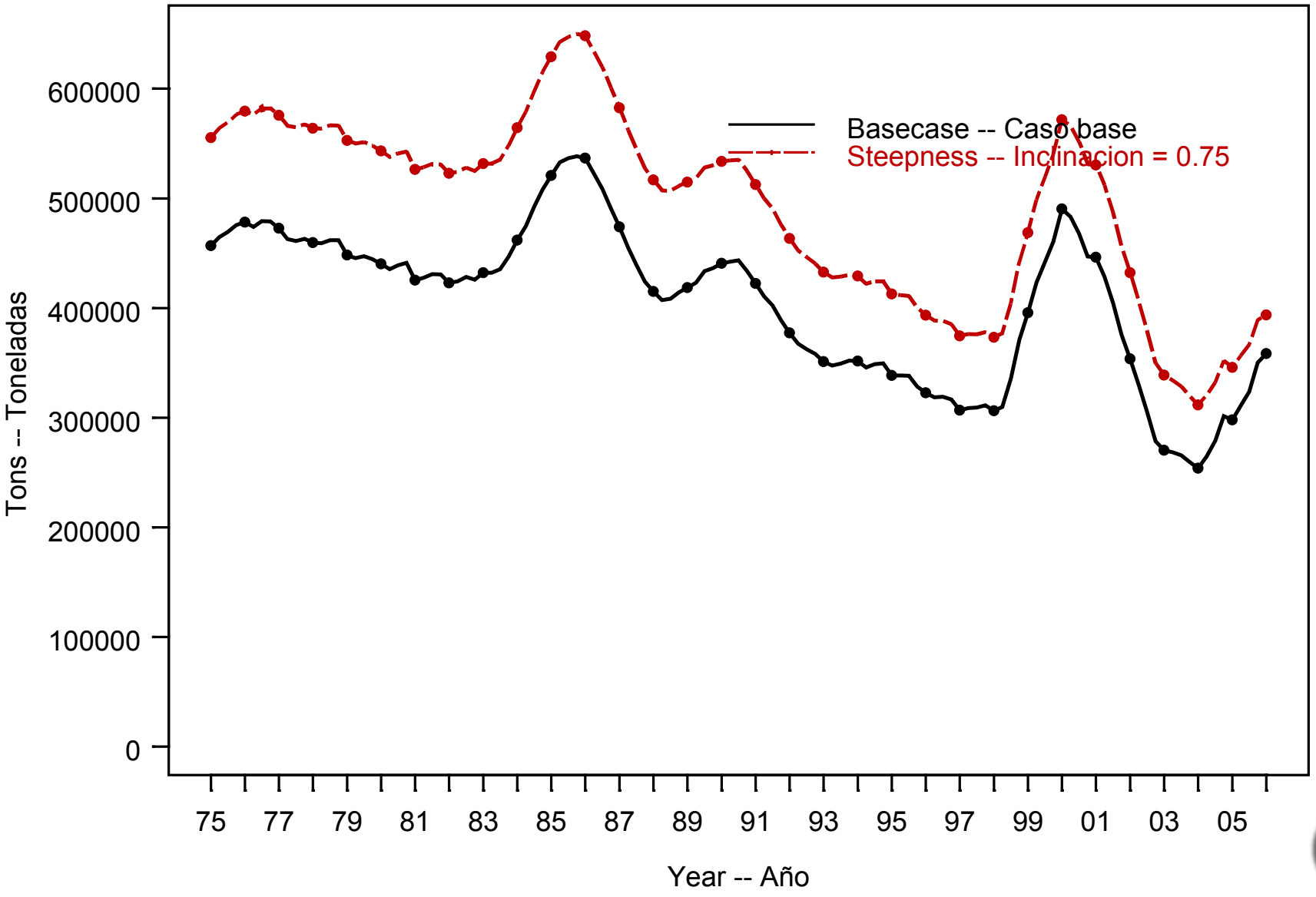
Predicted catches



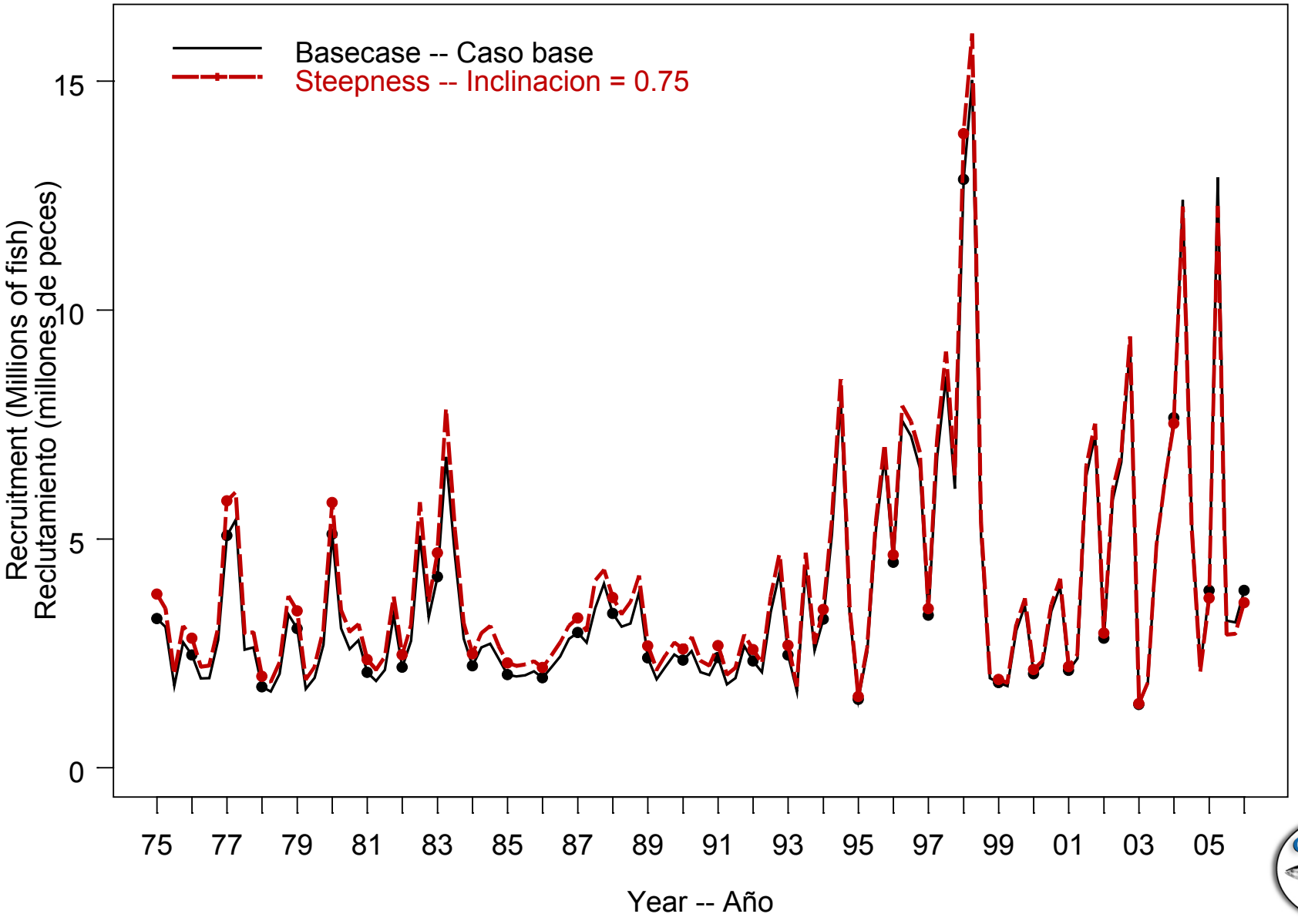


Stock-recruitment relationship (h = 0.75)

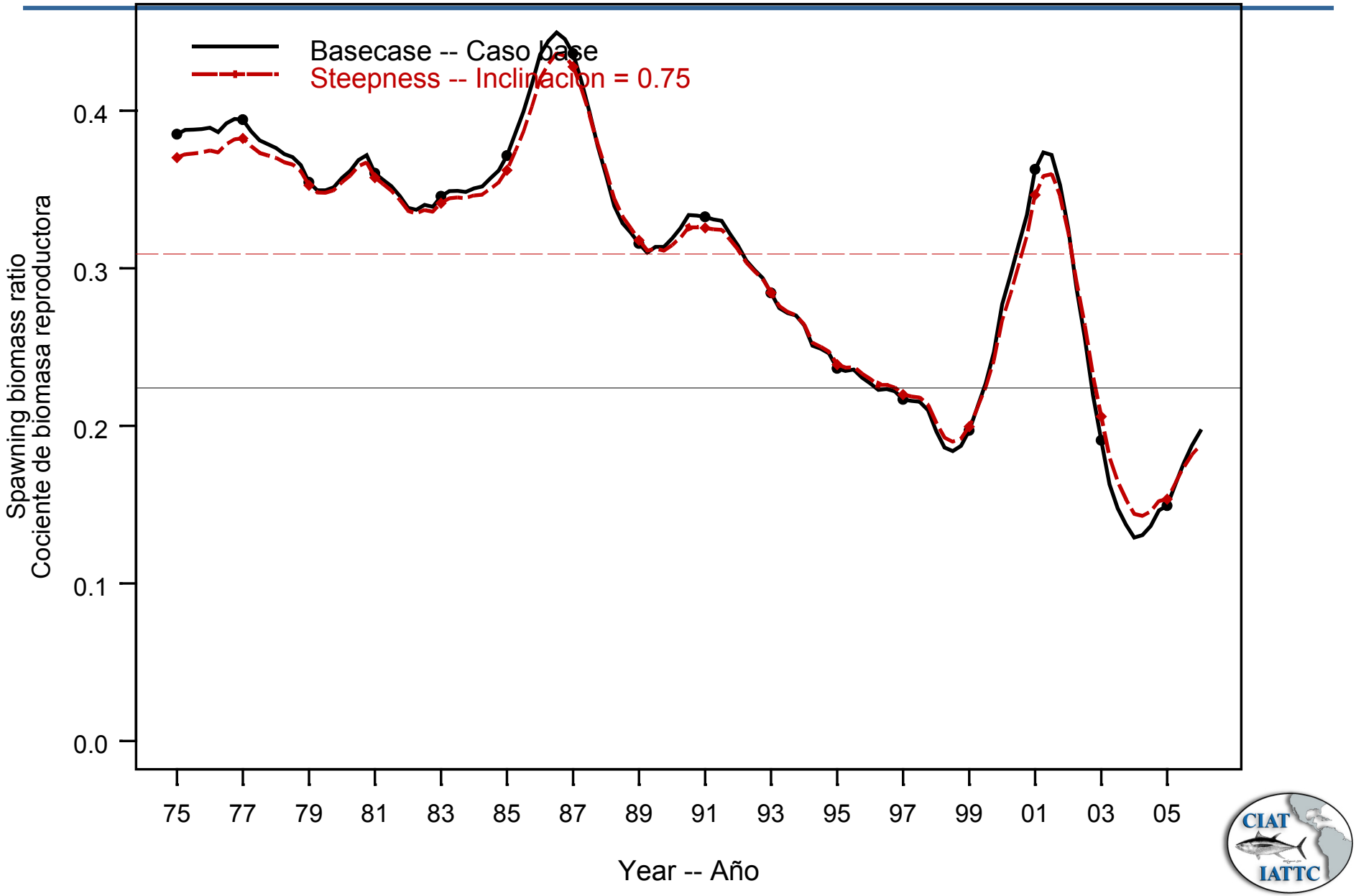
Biomass


Basecase -- Caso base
Steepness -- Inclinacion = 0.75
Tons -- Toneladas
600000
500000
400000
300000
200000
100000
0
75
77
79
81
83
85
87
89
91
93
95
97
99
01
03
05
Year -- Año

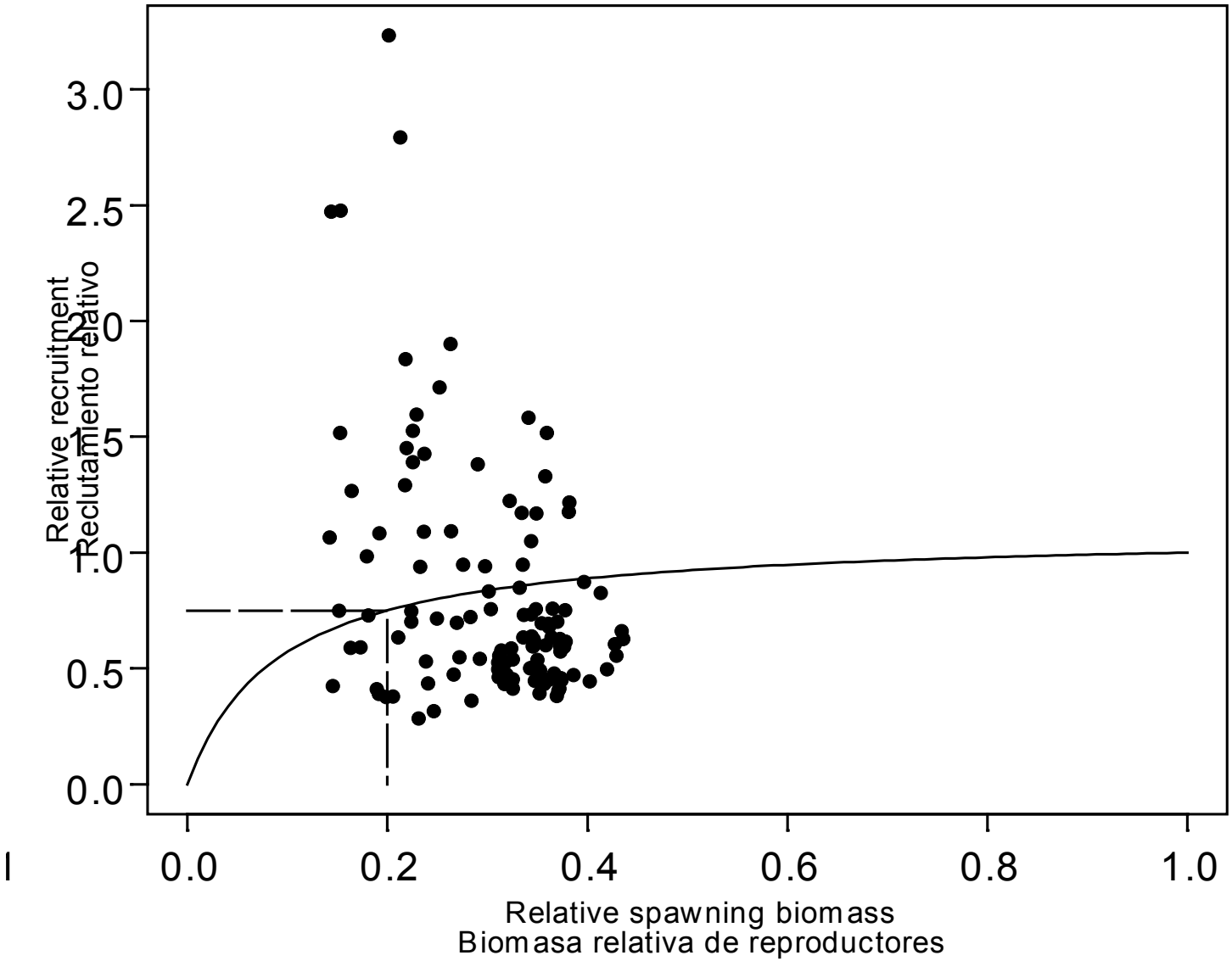
Recruitment



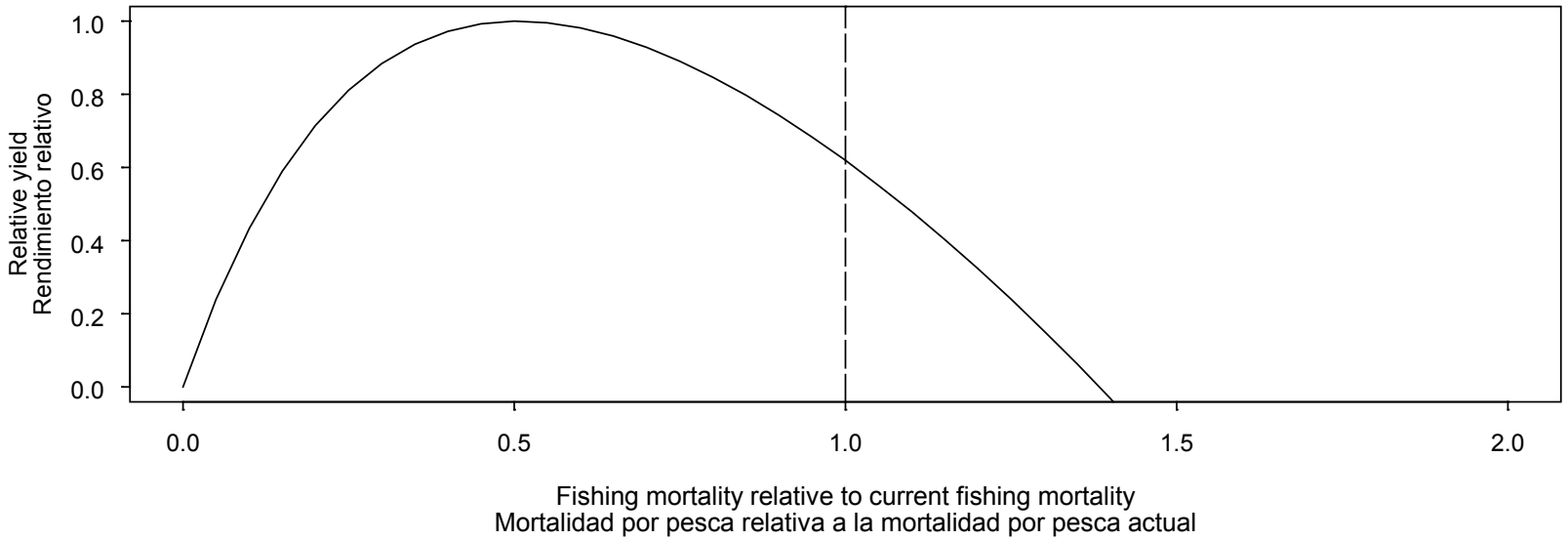
Spawning biomass ratio

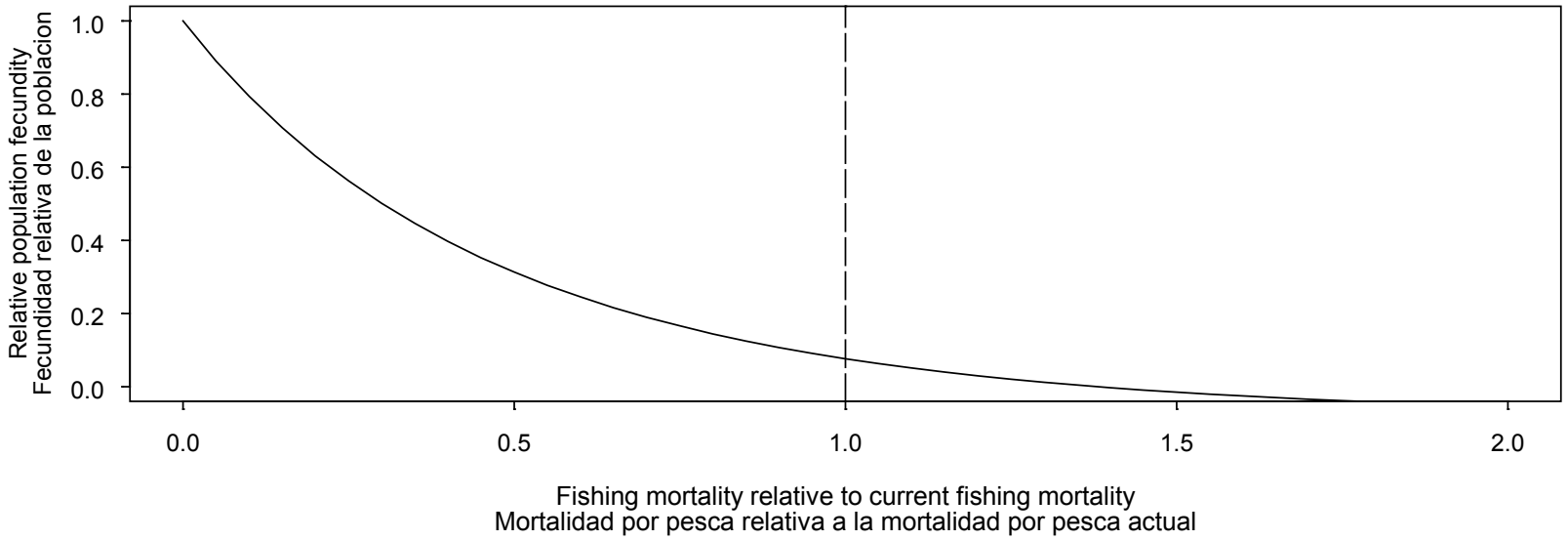


Spawner-recruitment curve



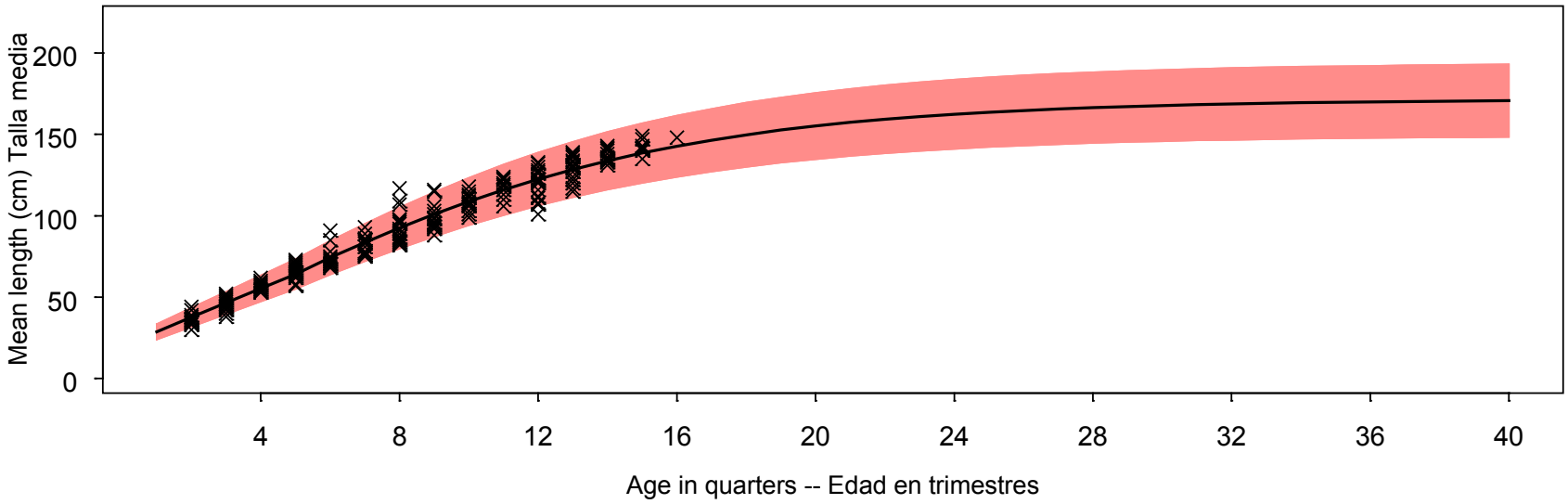
Yield curve

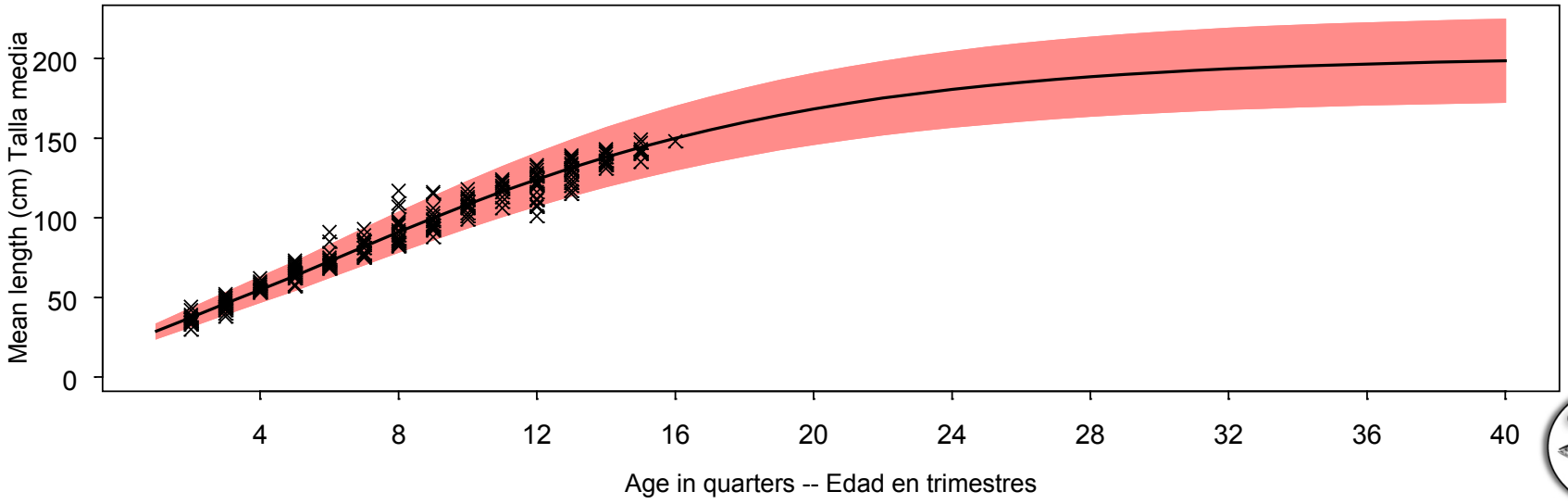

Relative yield
Rendimiento relativo
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
Fishing mortality relative to current fishing mortality
Mortalidad por pesca relativa a la mortalidad por pesca actual


Relative population fecundity
Fecundidad relativa de la poblacion
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
Fishing mortality relative to current fishing mortality
Mortalidad por pesca relativa a la mortalidad por pesca actual

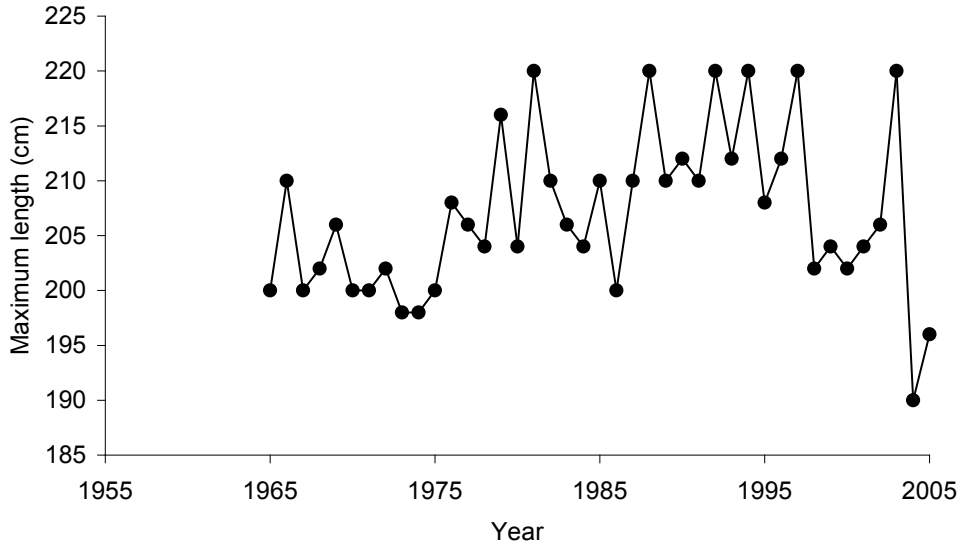
Assumed value for the asymptotic length parameter of the Richards growth curve

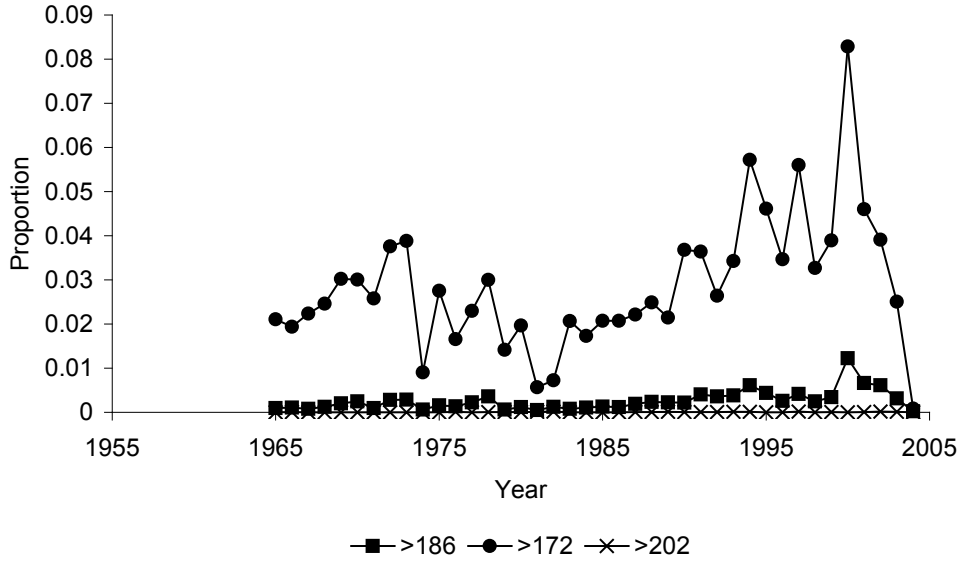
Growth curves





Maximum length

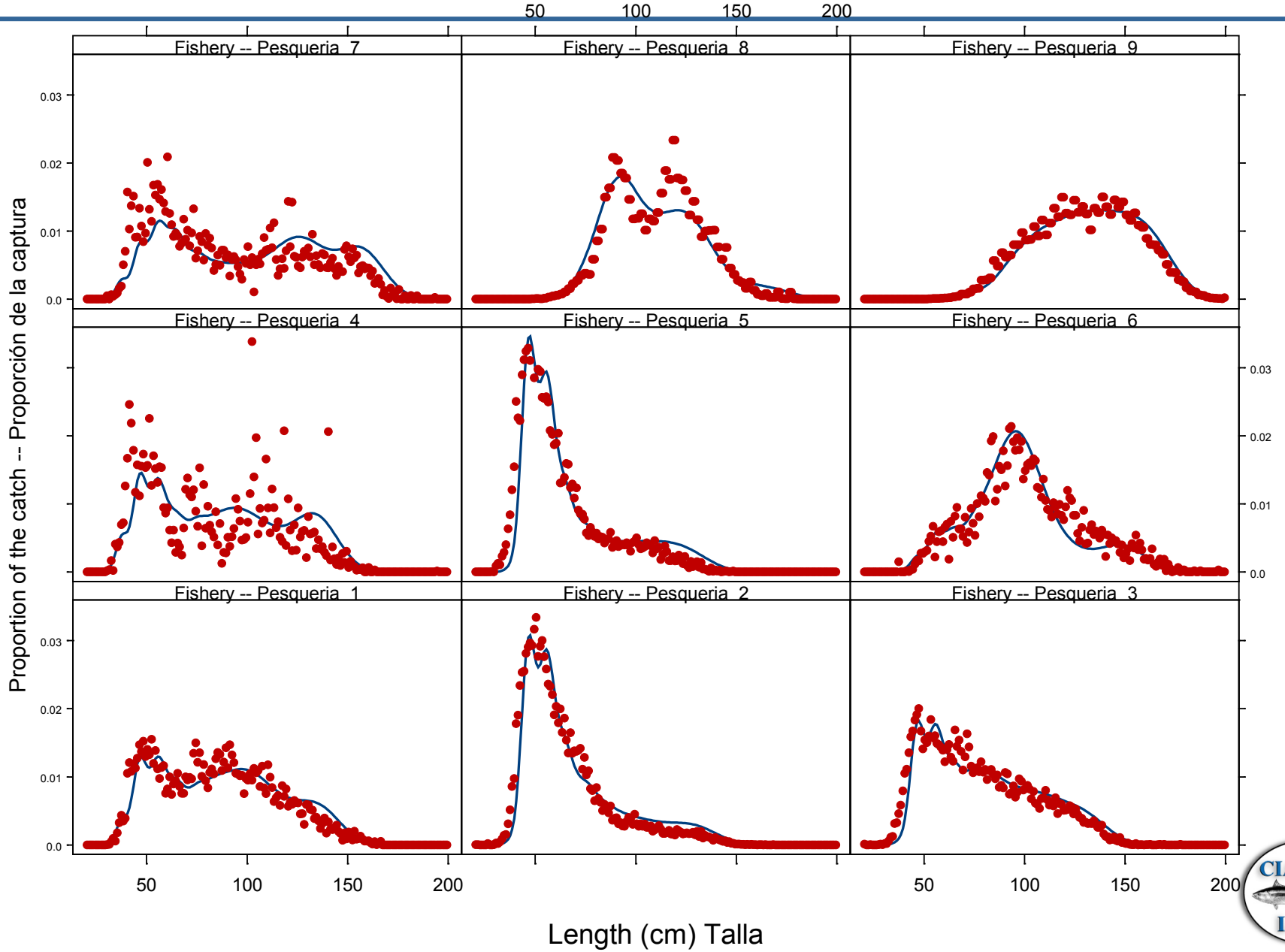




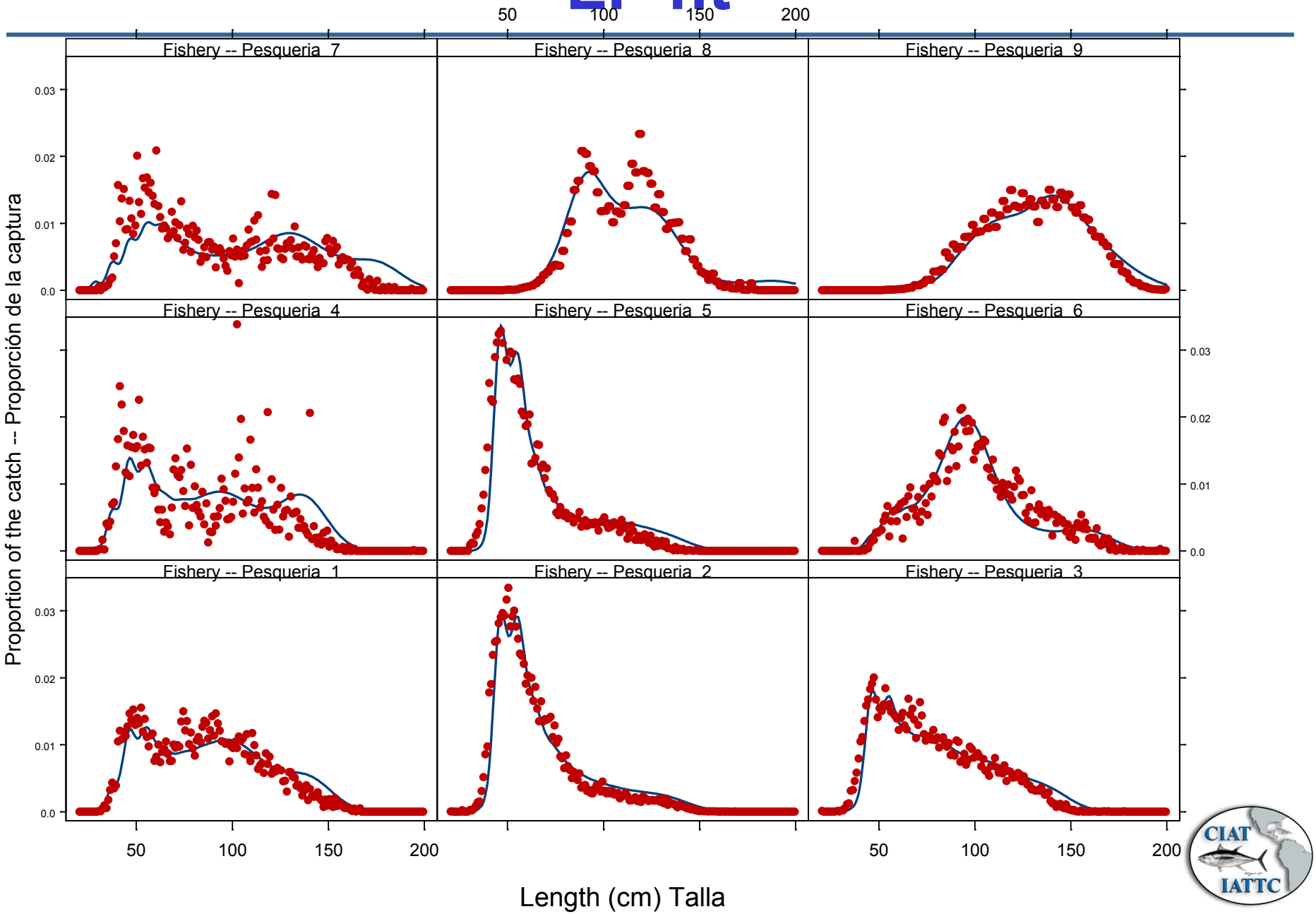
Likelihoods

	Linf = 171.5	Ling = 201.5
Total	11.32	-14.03
Length-frequency	-13.19	0.34
Growth	27.33	-25.37
Selectivity	0.50	-0.75
Catch	-0.21	0.14
Effort	-0.10	4.43
Recruitment	-7.16	9.41

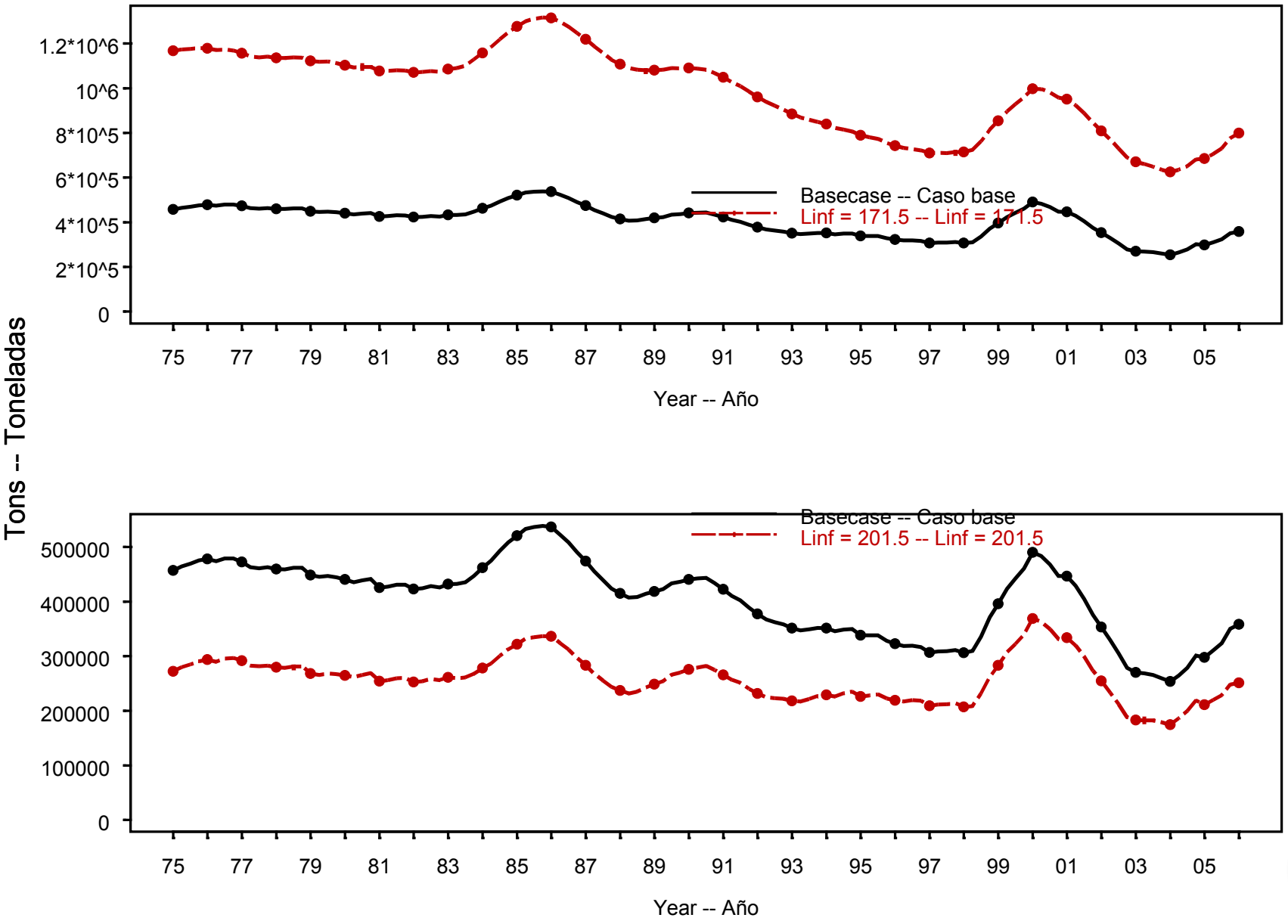
LF fit


Fishery -- Pesqueria_7
Fishery -- Pesqueria_8
Fishery -- Pesqueria_9
Fishery -- Pesqueria_4
Fishery -- Pesqueria_5
Fishery -- Pesqueria_6
Fishery -- Pesqueria_1
Fishery -- Pesqueria_2
Fishery -- Pesqueria_3
Proportion of the catch -- Proporción de la captura
Length (cm) Talla
0.0
0.01
0.02
0.03
50
100
150
200

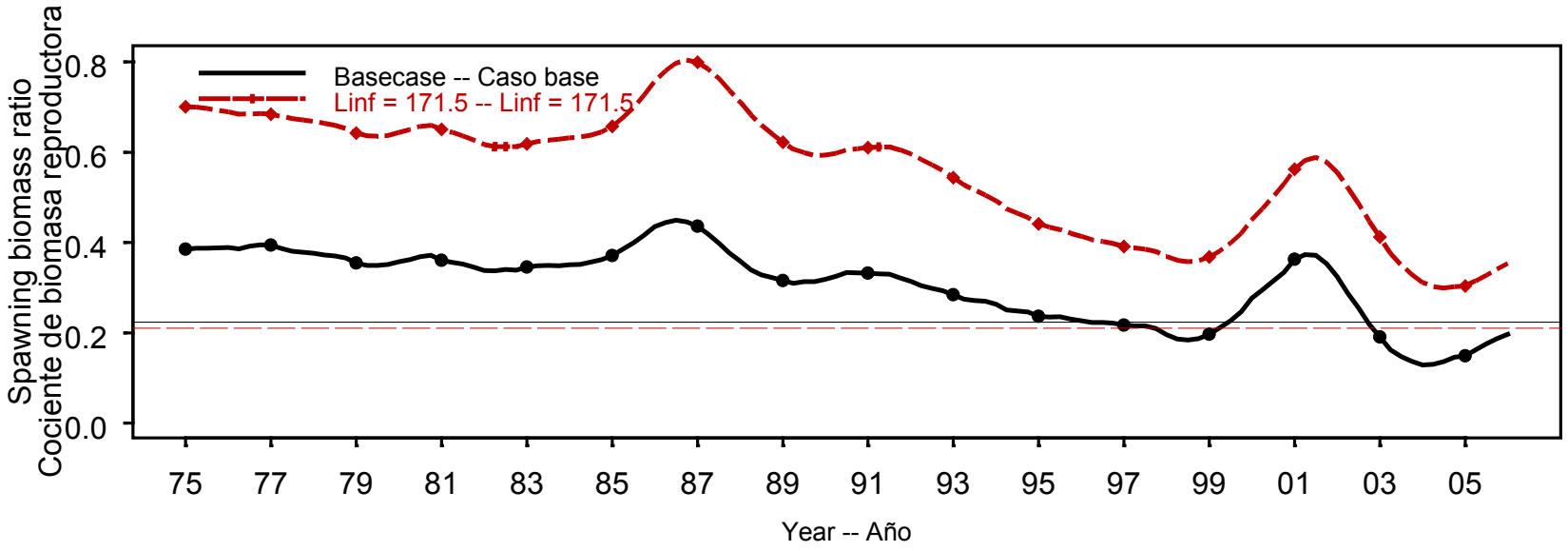
LF fit

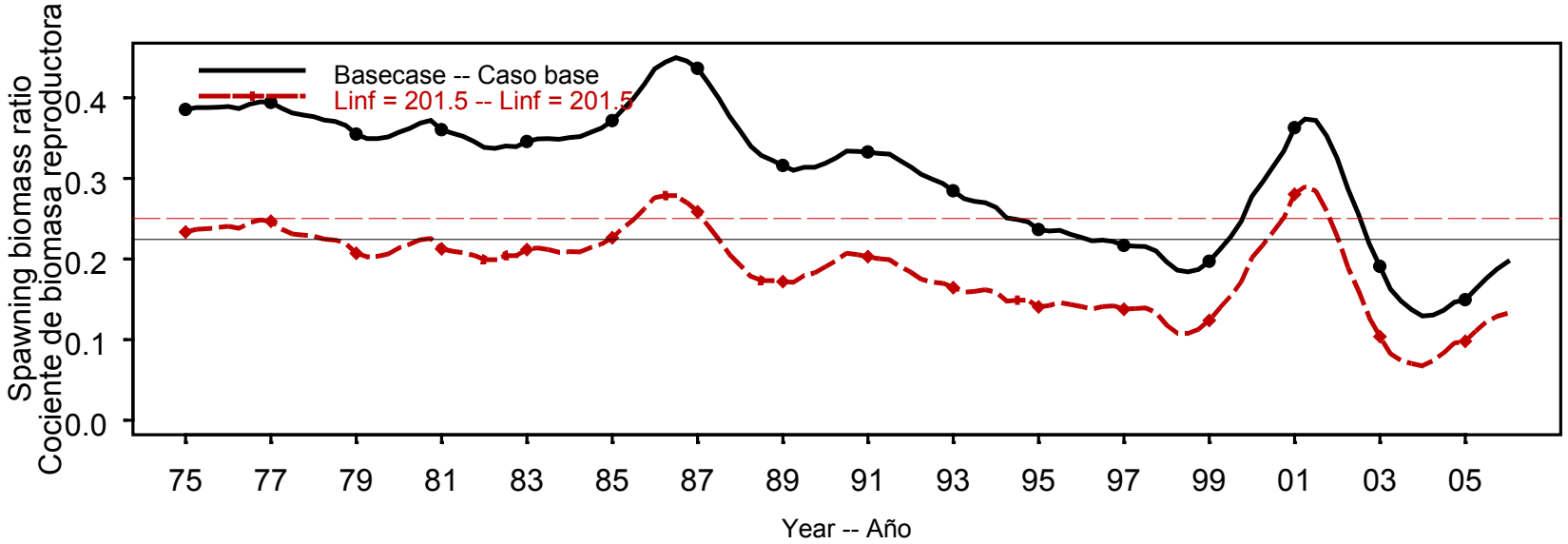

Fishery -- Pesqueria_7
Fishery -- Pesqueria_8
Fishery -- Pesqueria_9
Fishery -- Pesqueria_4
Fishery -- Pesqueria_5
Fishery -- Pesqueria_6
Fishery -- Pesqueria_1
Fishery -- Pesqueria_2
Fishery -- Pesqueria_3
Proportion of the catch -- Proporción de la captura
Length (cm) Talla
0.0
0.01
0.02
0.03
50
100
150
200
CIAT
IATTC

Biomass


1.2*10^6
10^6
8*10^5
6*10^5
4*10^5
2*10^5
0
Tons -- Toneladas
75 77 79 81 83 85 87 89 91 93 95 97 99 01 03 05
Year -- Año
Basecase -- Caso base
Linf = 171.5 -- Linf = 171.5
500000
400000
300000
200000
100000
0
Basecase -- Caso base
Linf = 201.5 -- Linf = 201.5
75 77 79 81 83 85 87 89 91 93 95 97 99 01 03 05
Year -- Año

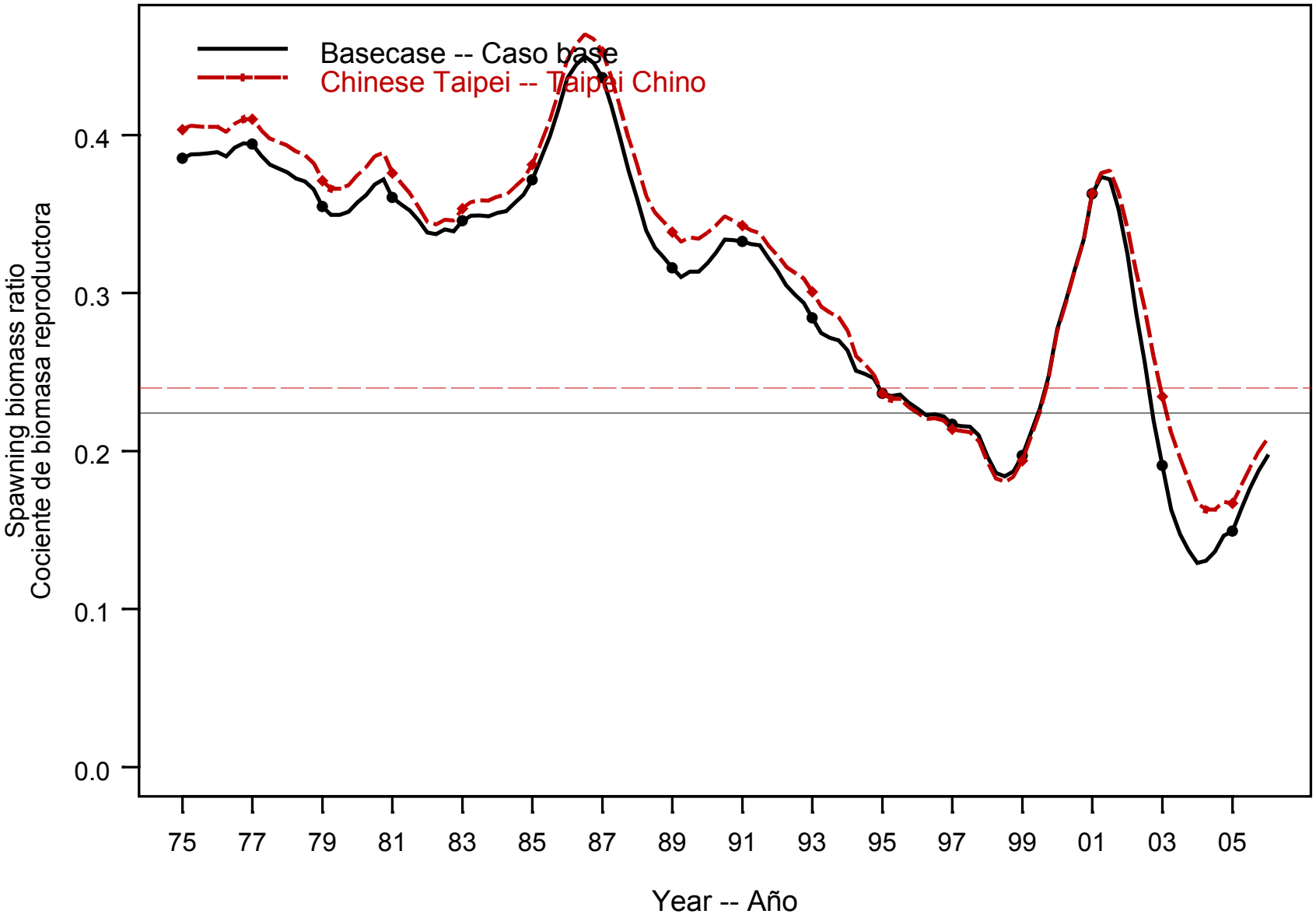
SBR


Spawning biomass ratio
Cociente de biomasa reproductora
Basecase -- Caso base
Linf = 171.5 -- Linf = 171.5
0.0
0.2
0.4
0.6
0.8
75 77 79 81 83 85 87 89 91 93 95 97 99 01 03 05
Year -- Año

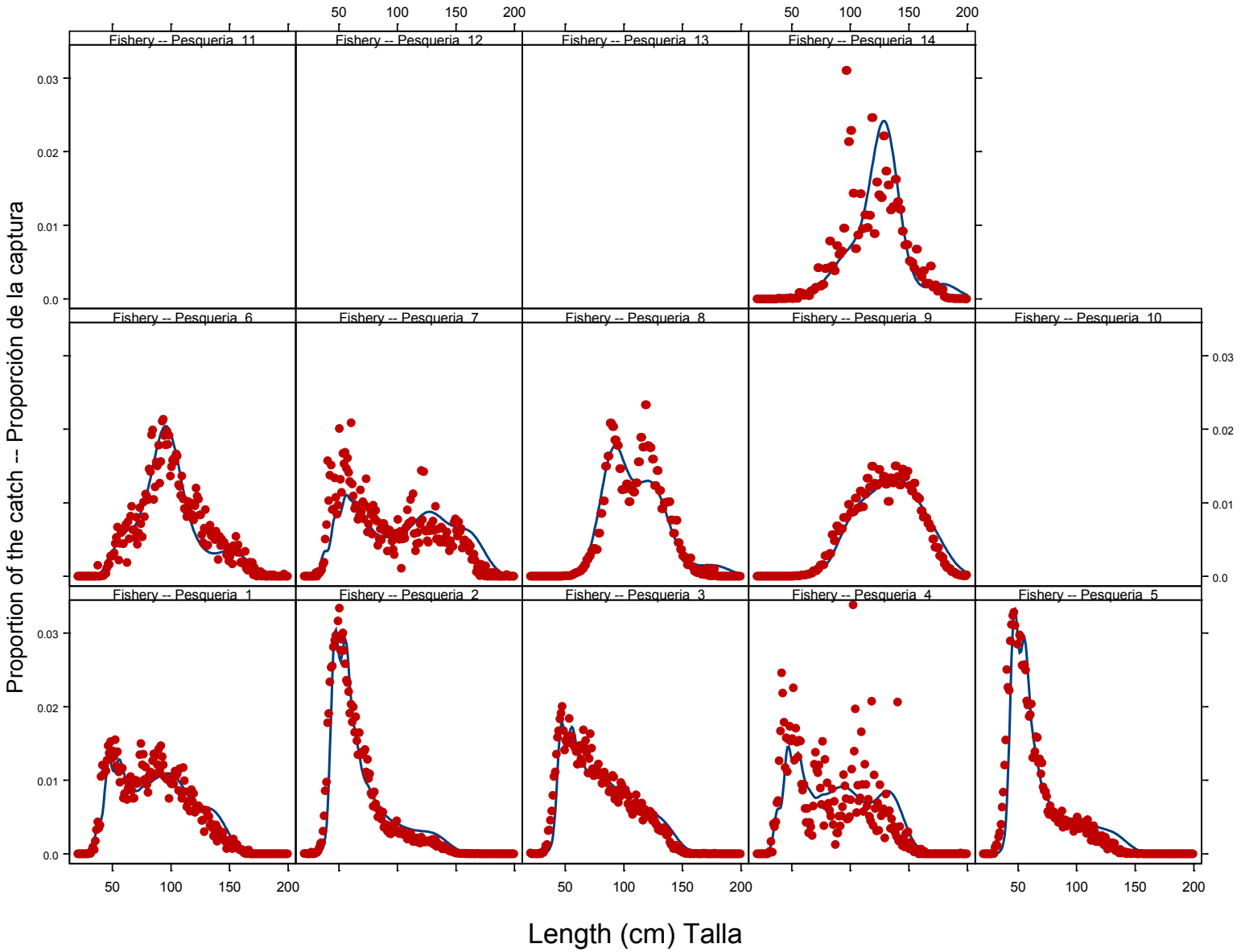

Spawning biomass ratio
Cociente de biomasa reproductora
Basecase -- Caso base
Linf = 201.5 -- Linf = 201.5
0.0
0.1
0.2
0.3
0.4
75 77 79 81 83 85 87 89 91 93 95 97 99 01 03 05
Year -- Año

Inclusion of the Chinese Taipei longline length-frequcy dat

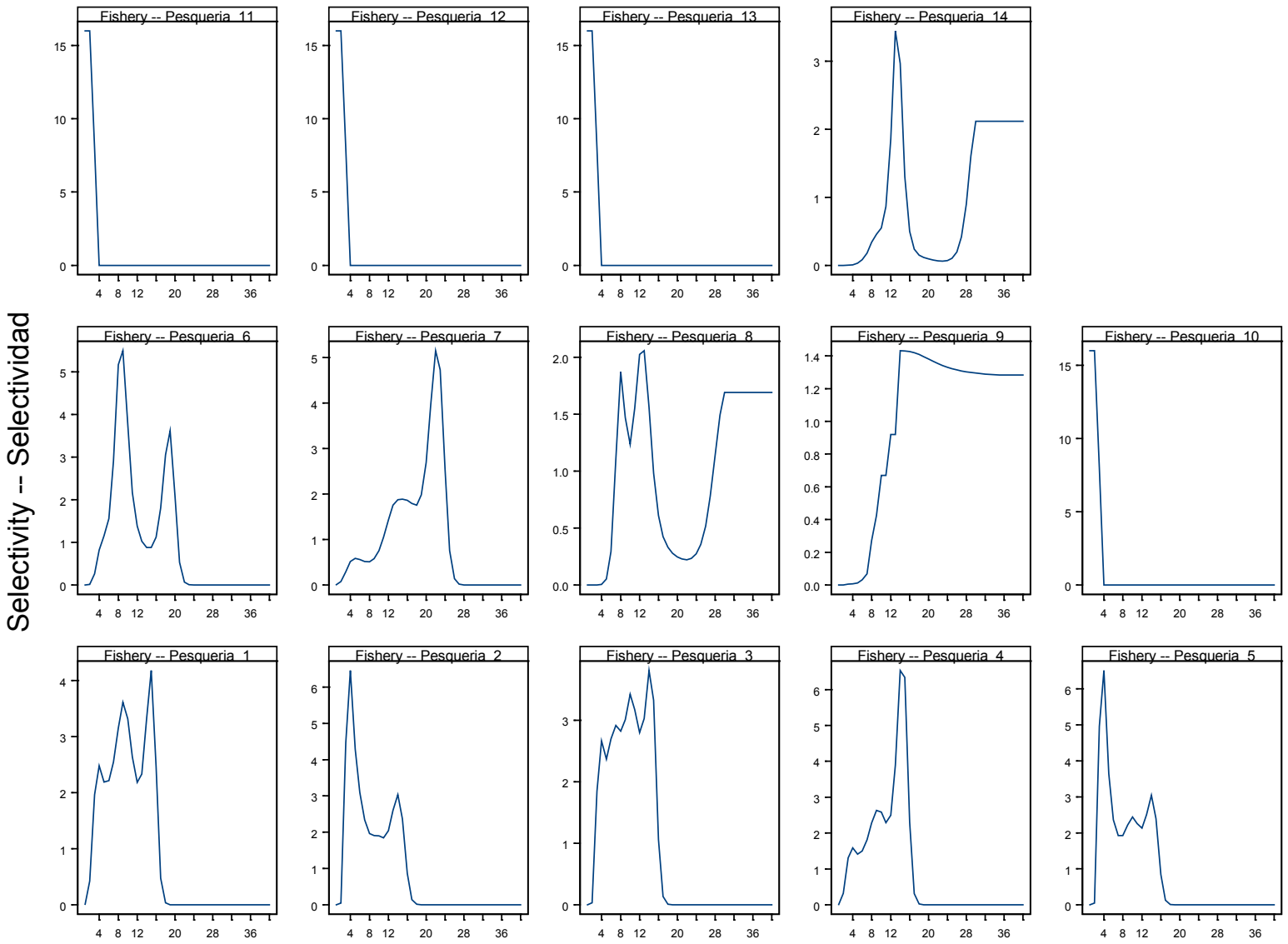
SBR


Basecase -- Caso base
Chinese Taipei -- Taipei Chino
Spawning biomass ratio
Cociente de biomasa reproductora
0.0
0.1
0.2
0.3
0.4
75
77
79
81
83
85
87
89
91
93
95
97
99
01
03
05
Year -- Año

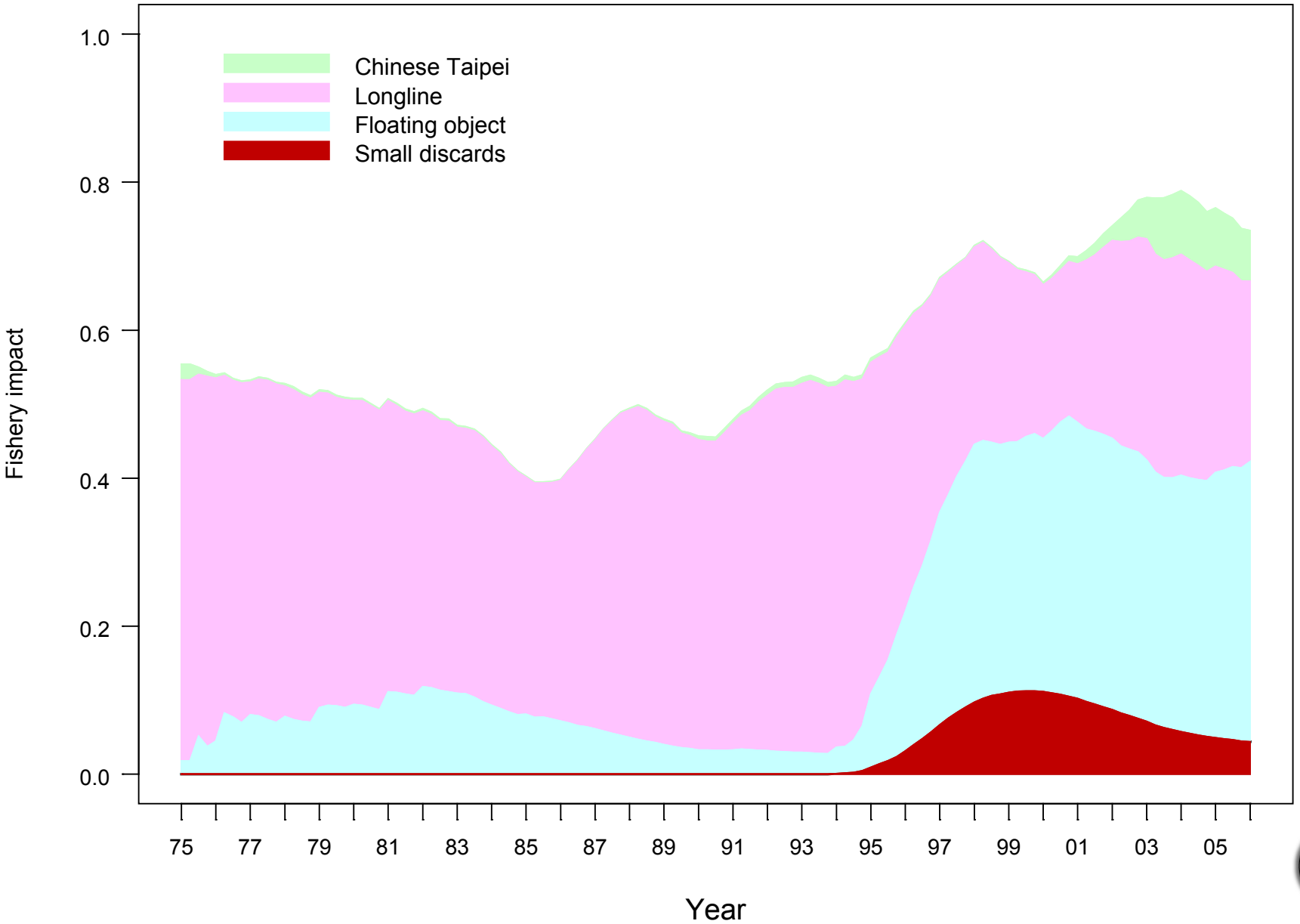
LF fit


Fishery -- Pesqueria_11
Fishery -- Pesqueria_12
Fishery -- Pesqueria_13
Fishery -- Pesqueria_14
Fishery -- Pesqueria_6
Fishery -- Pesqueria_7
Fishery -- Pesqueria_8
Fishery -- Pesqueria_9
Fishery -- Pesqueria_10
Fishery -- Pesqueria_1
Fishery -- Pesqueria_2
Fishery -- Pesqueria_3
Fishery -- Pesqueria_4
Fishery -- Pesqueria_5
Proportion of the catch -- Proporción de la captura
Length (cm) Talla
0.0
0.01
0.02
0.03
50
100
150
200

Selectivity

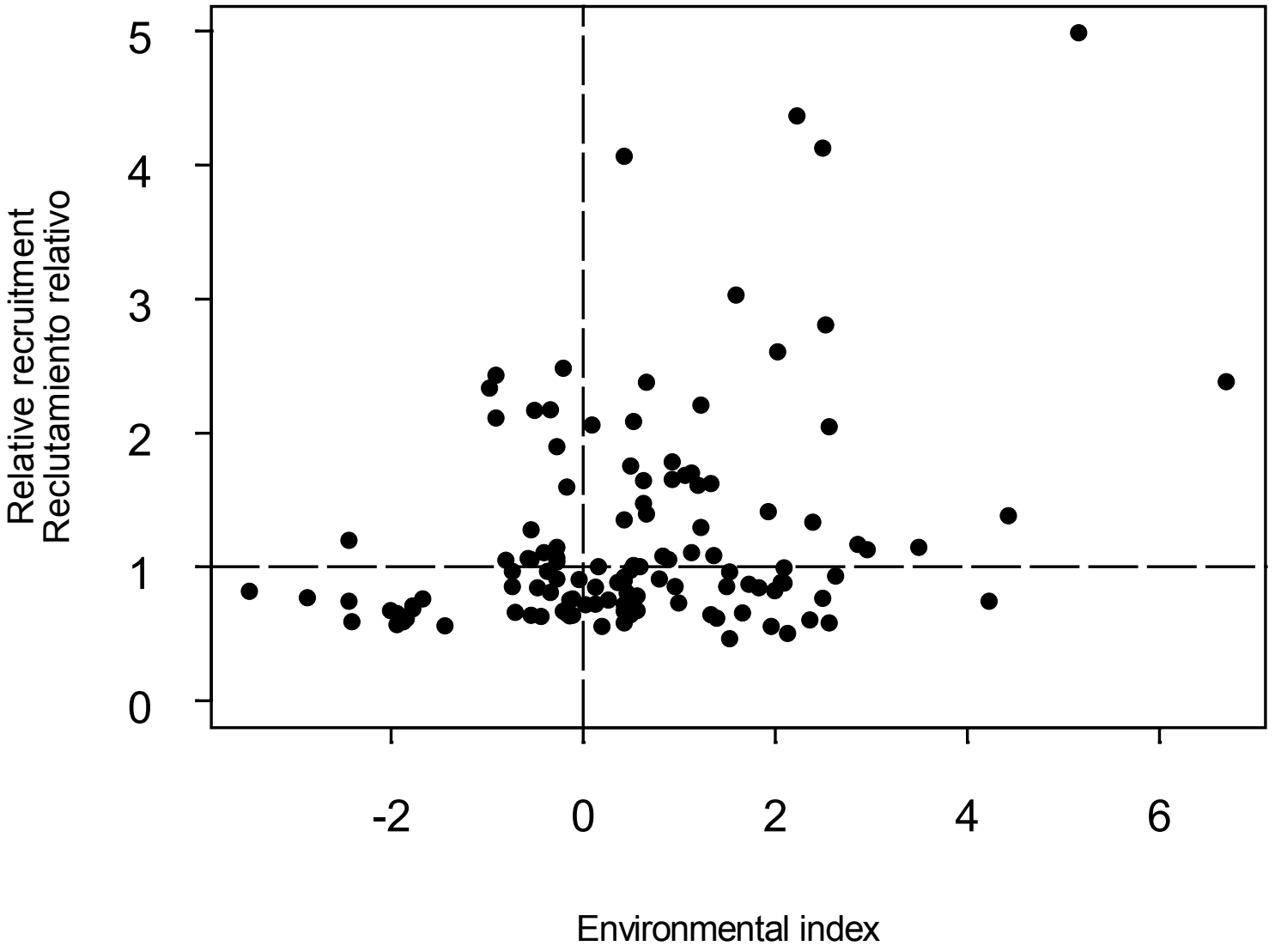


Fishery impact

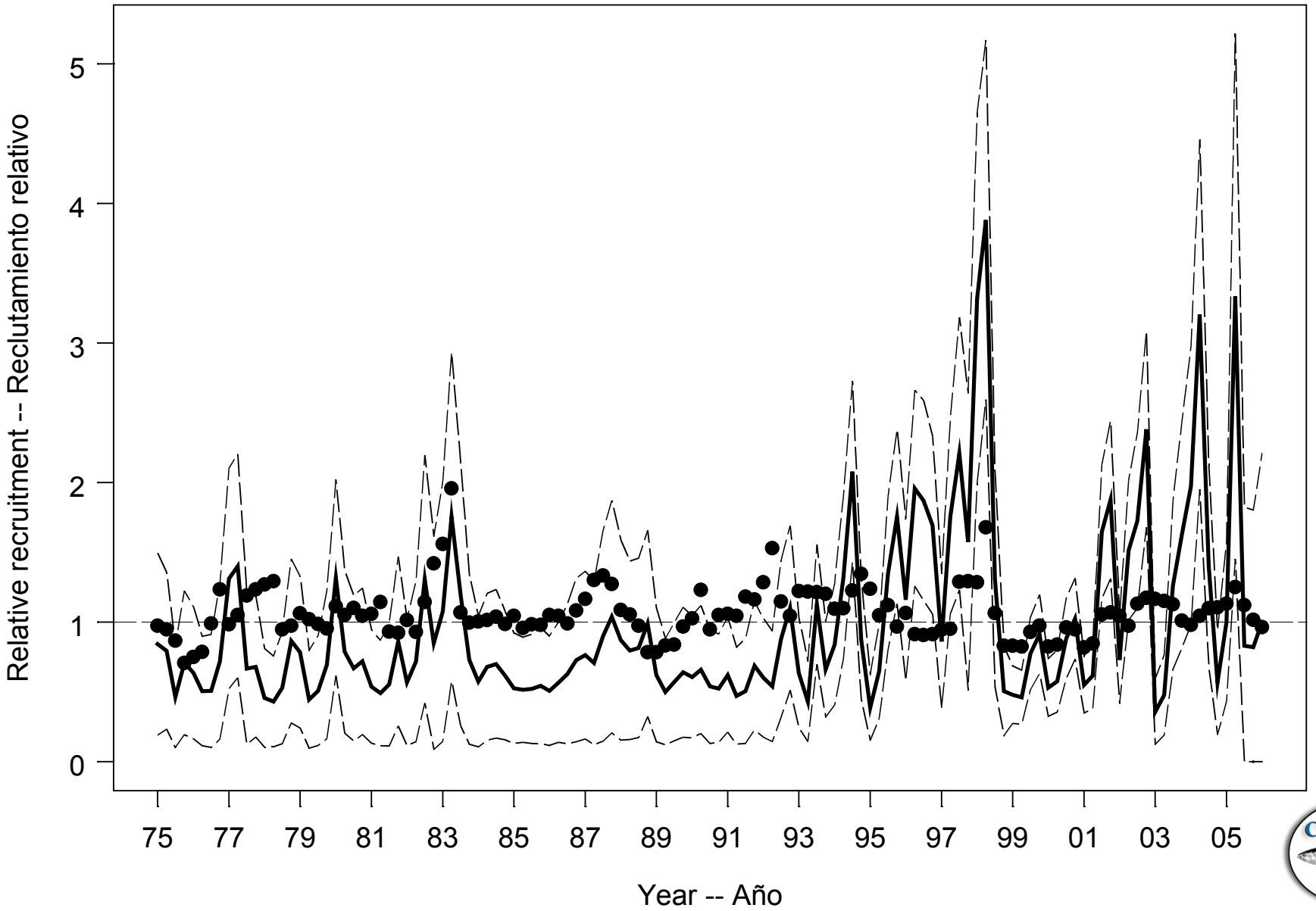


Relationship between recruitment an the el Nino index

El Nino relationship



El Nino relationship



	Base case	Steepness = 0.75	Linf = 171.5	Linf = 201.5	Taiwan
AMSY—RMSP	106,722	102,263	140,329	107,812	107,973
B_{AMSY}—B_{RMSP}	326,329	503,221	458,837	320,374	352,783
S_{AMSY}—S_{RMSP}	541	956	905	480	593
B_{AMSY}/B_0—B_{RMSP}/B_0	0.30	0.36	0.28	0.32	0.32
S_{AMSY}/S_0—S_{RMSP}/S_0	0.22	0.31	0.21	0.25	0.24
C_{recent}/AMSY— C_{recent}/RMSP	1.00	1.06	0.77	0.99	1.00
B_{recent}/B_{AMSY}— B_{recent}/B_{RMSP}	1.10	0.78	1.74	0.78	1.09
S_{recent}/S_{AMSY}— S_{recent}/S_{RMSP}	0.88	0.61	1.68	0.53	0.87
F multiplier— Multiplicador de *F*	0.68	0.51	1.44	0.41	0.65

Summary: Main results

- Biomass trends are similar to those estimated (and predicted) in previous assessments
- Both total and spawning biomass is estimated to have substantially declined since 2000, but there has been a slight increase recently
- Current biomass level is low compared to average unexploited conditions
- The current effort restrictions are not enough to maintain the population a level that will support AMSY

What is robust

- Fishing mortality levels are greater than that necessary to achieve the maximum sustainable yield.

Plausible Sensitivities and Uncertainties

- Results are more pessimistic with the inclusion of a stock-recruitment relationship
- Biomass trends are strongly related to longline CPUE

Conclusions

- Current spawning biomass is unlikely to remain at or above the level required to produce AMSY.
- In the most recent years the fishing mortality is greater than that required to produce AMSY.
- Under average recruitment, the stock is predicted to be below the level that would support AMSY unless fishing mortality levels are reduced further than the current restrictions.