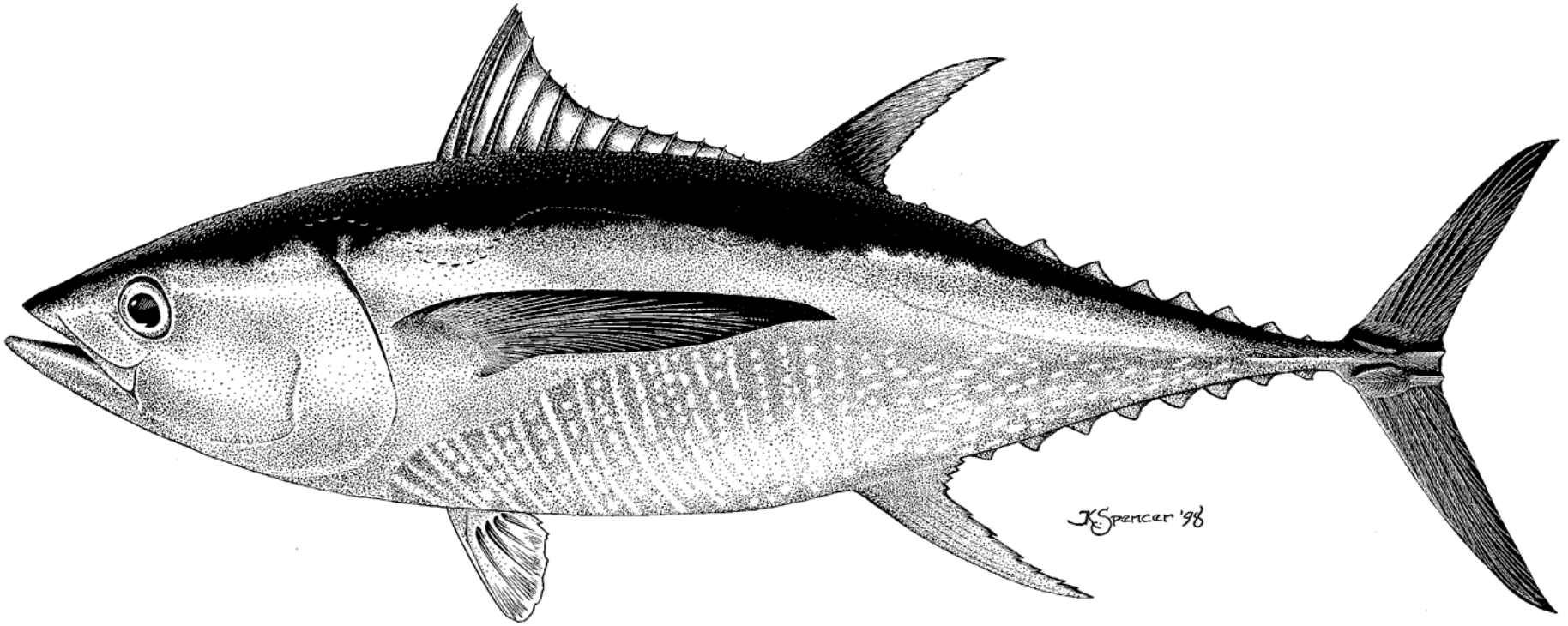
Yellowfin Tuna 1975-2004



Major Changes

- Catch and length-frequency data for the surface fisheries have been updated to include new data for 2004 and revised data for 2000-2003.
- Effort data for the surface fisheries have been updated to include new data for 2004 and revised data for 1975-2003.
- Catch data for the Japanese longline fisheries have been updated for 1999-2002 and to include new data for 2003.
- Catch data for the longline fisheries of Chinese Taipei have been updated to include new data for 2002.
- Catch data for the longline fisheries of the Peoples Republic of China have been updated to include new data for 2003 and revised data for 2001-2002.
- Longline catch-at-length data for 2001-2002 have been updated and new data for 2003 added.
- Longline catch per unit effort data have been standardized using a mixed model, made up of 2 generalized linear models, the 1st using a binomial likelihood and the 2nd using a gamma likelihood.
- Longline effort data based on standardization of catch per unit effort have been updated to include data for 2002-2003.
- Growth model has been changed

Sensitivity Analyses

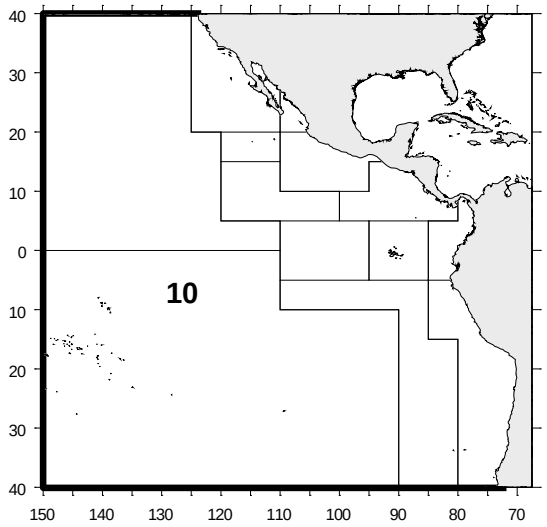
- Stock recruitment relationship (steepness = 0.75)

Data

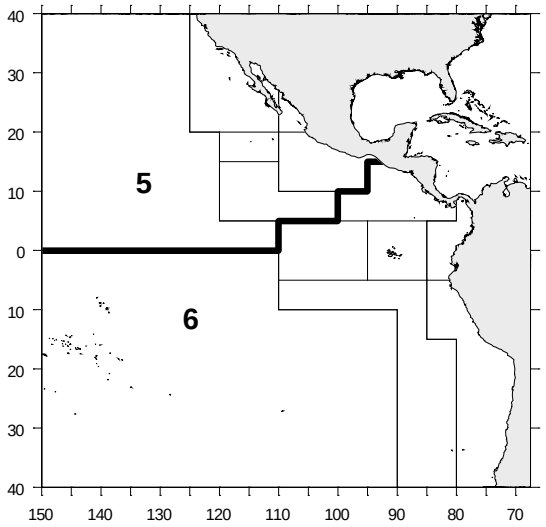
- Fishery definitions
- Catch
- Effort
- Length frequency

Yellowfin Fishery Definitions

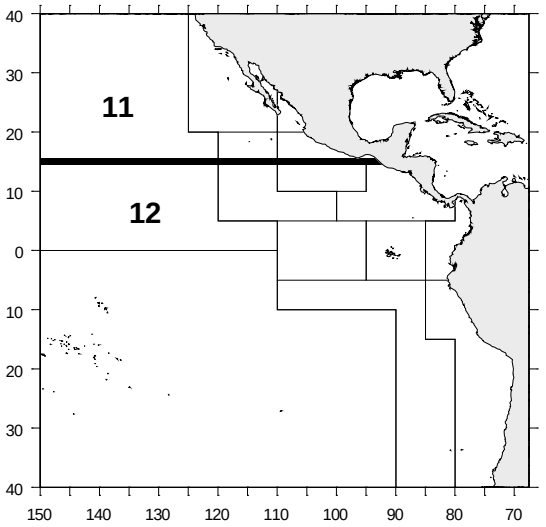
Baitboat



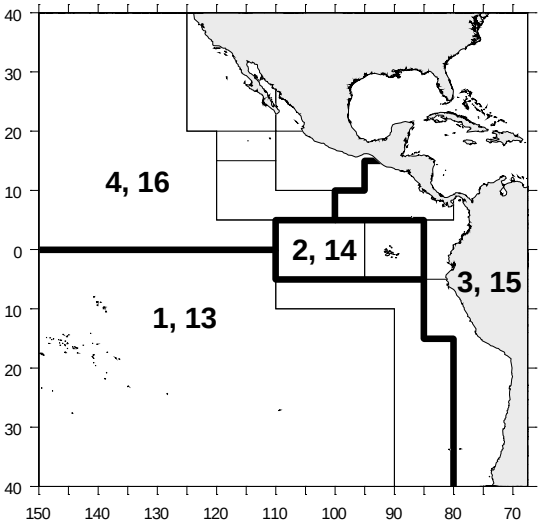
Unassociated



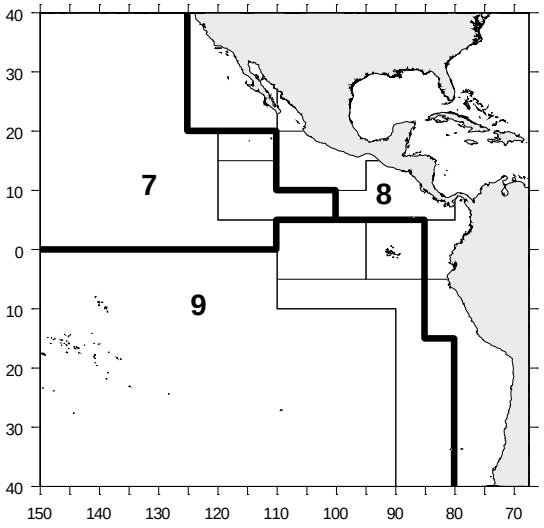
Longline



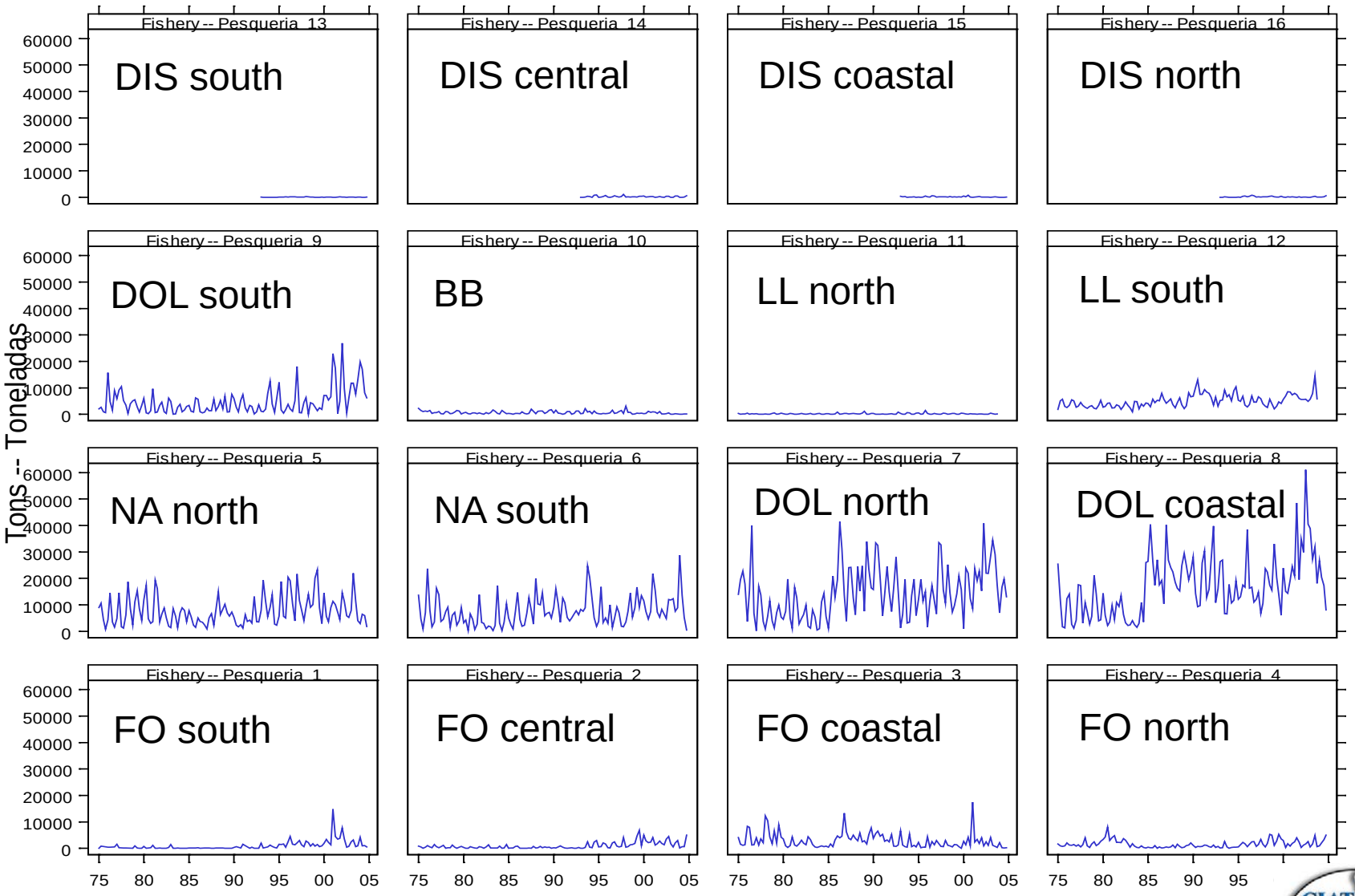
Floating Objects



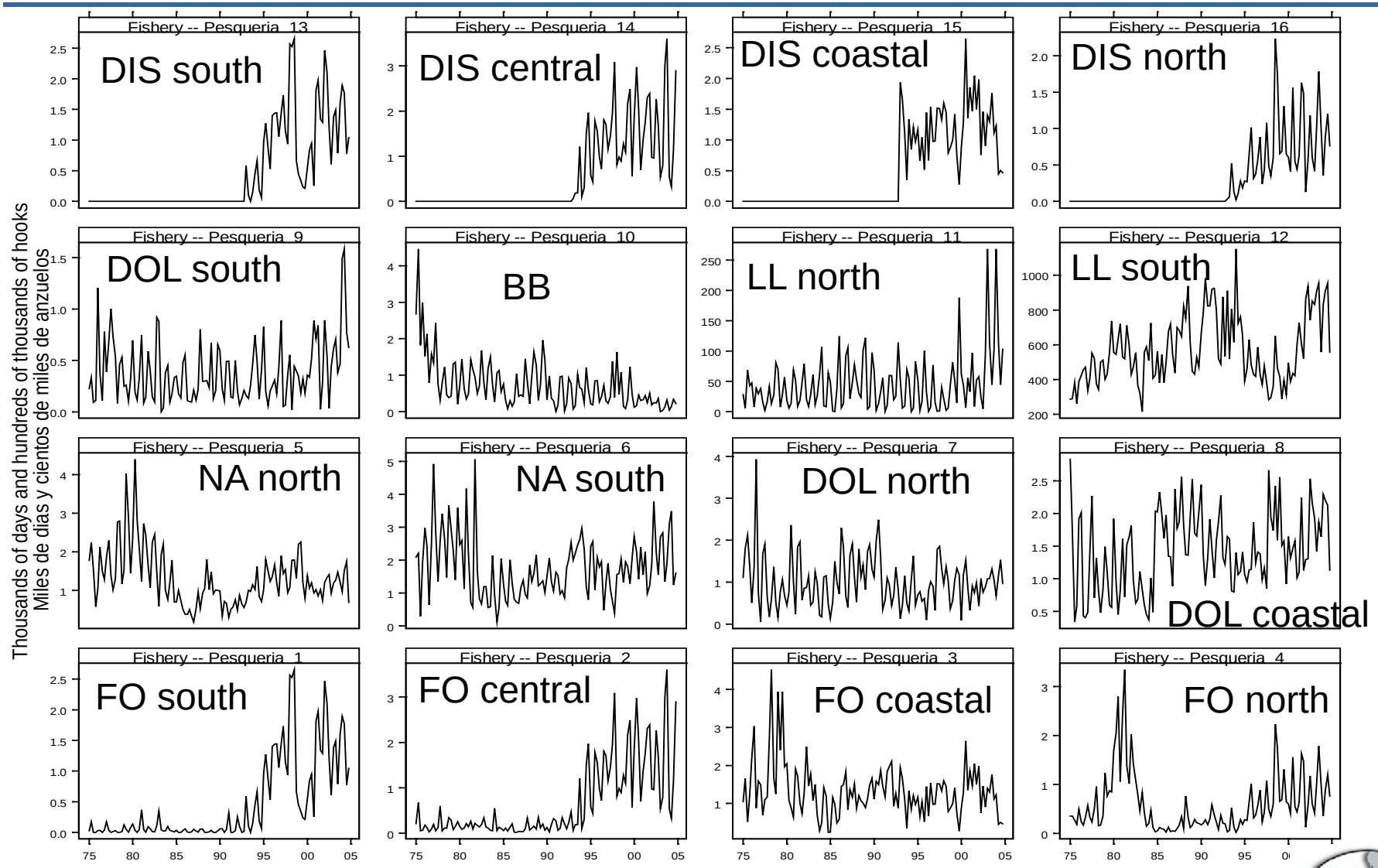
Dolphin



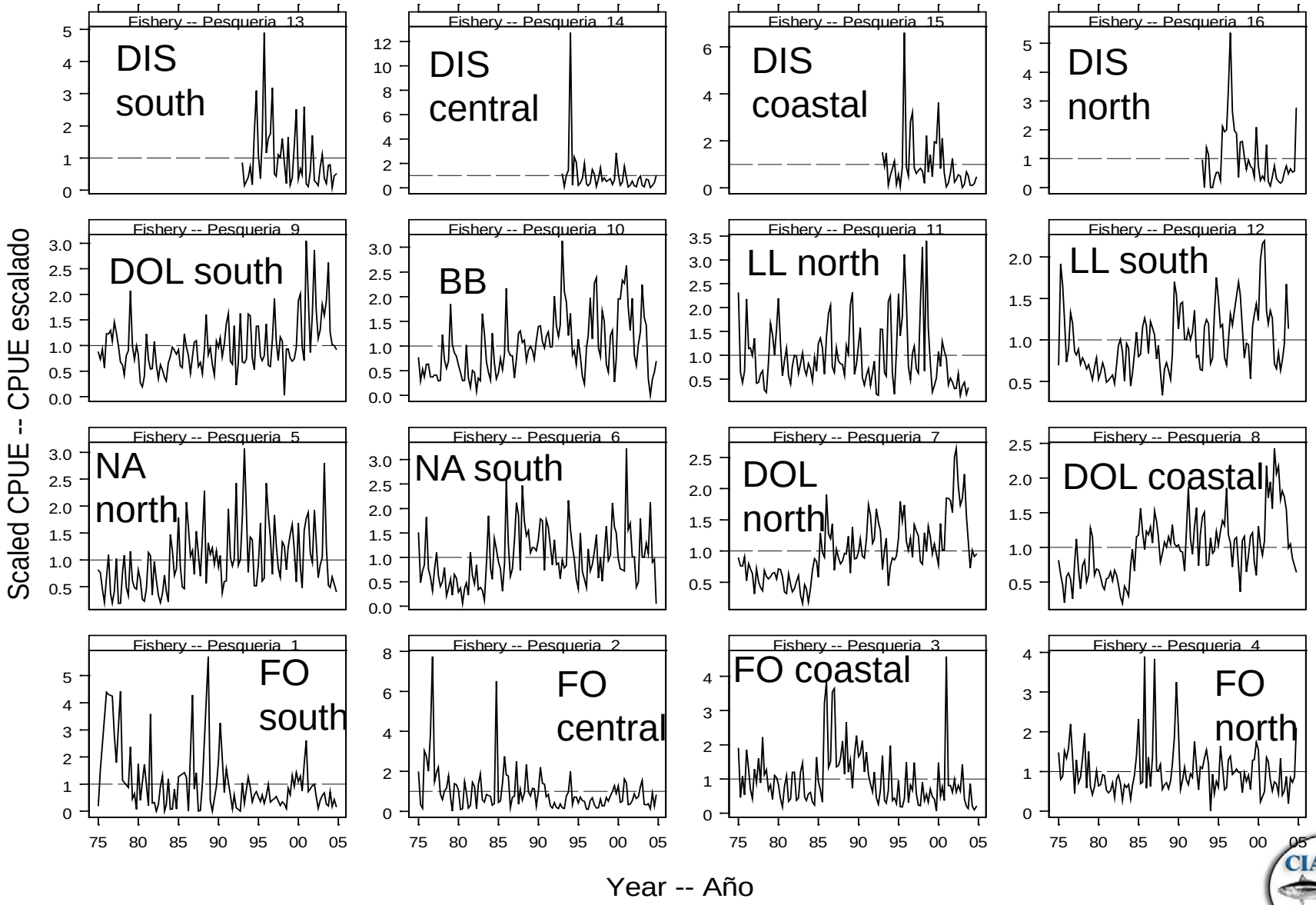
Catch


Fishery -- Pesqueria 13
DIS south
Fishery -- Pesqueria 14
DIS central
Fishery -- Pesqueria 15
DIS coastal
Fishery -- Pesqueria 16
DIS north
Fishery -- Pesqueria 9
DOL south
Fishery -- Pesqueria 10
BB
Fishery -- Pesqueria 11
LL north
Fishery -- Pesqueria 12
LL south
Fishery -- Pesqueria 5
NA north
Fishery -- Pesqueria 6
NA south
Fishery -- Pesqueria 7
DOL north
Fishery -- Pesqueria 8
DOL coastal
Fishery -- Pesqueria 1
FO south
Fishery -- Pesqueria 2
FO central
Fishery -- Pesqueria 3
FO coastal
Fishery -- Pesqueria 4
FO north
Tons -- Toneladas
0
10000
20000
30000
40000
50000
60000
75
80
85
90
95
00
05
Year -- Año

Effort


Fishery -- Pesqueria 13
DIS south
Fishery -- Pesqueria 14
DIS central
Fishery -- Pesqueria 15
DIS coastal
Fishery -- Pesqueria 16
DIS north
Fishery -- Pesqueria 9
DOL south
Fishery -- Pesqueria 10
BB
Fishery -- Pesqueria 11
LL north
Fishery -- Pesqueria 12
LL south
Fishery -- Pesqueria 5
NA north
Fishery -- Pesqueria 6
NA south
Fishery -- Pesqueria 7
DOL north
Fishery -- Pesqueria 8
DOL coastal
Fishery -- Pesqueria 1
FO south
Fishery -- Pesqueria 2
FO central
Fishery -- Pesqueria 3
FO coastal
Fishery -- Pesqueria 4
FO north
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

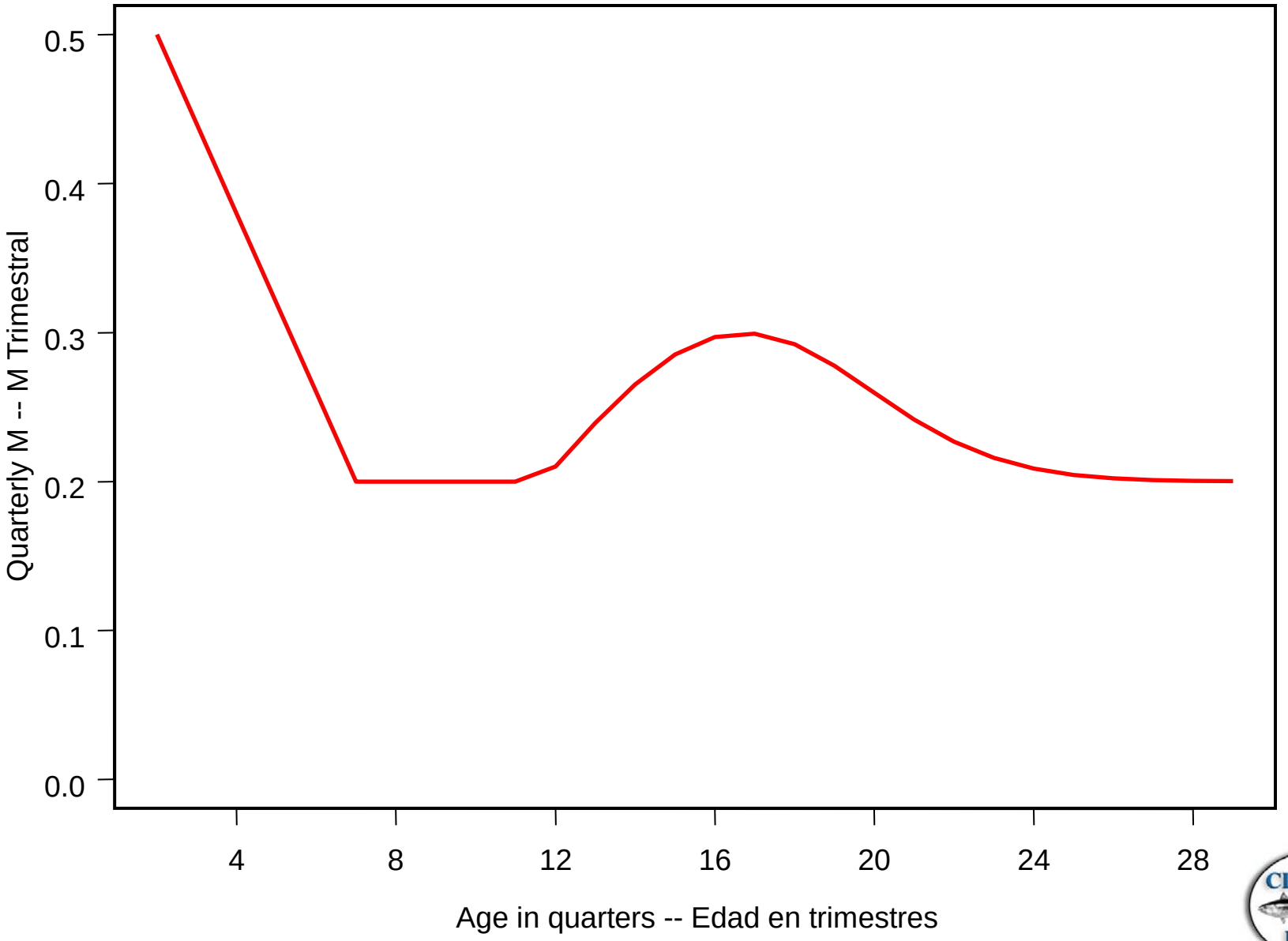
CPUE


Fishery -- Pesqueria 13
DIS south
Fishery -- Pesqueria 14
DIS central
Fishery -- Pesqueria 15
DIS coastal
Fishery -- Pesqueria 16
DIS north
Fishery -- Pesqueria 9
DOL south
Fishery -- Pesqueria 10
BB
Fishery -- Pesqueria 11
LL north
Fishery -- Pesqueria 12
LL south
Fishery -- Pesqueria 5
NA north
Fishery -- Pesqueria 6
NA south
Fishery -- Pesqueria 7
DOL north
Fishery -- Pesqueria 8
DOL coastal
Fishery -- Pesqueria 1
FO south
Fishery -- Pesqueria 2
FO central
Fishery -- Pesqueria 3
FO coastal
Fishery -- Pesqueria 4
FO north
Scaled CPUE -- CPUE escalado
75 80 85 90 95 00 05
Year -- Año

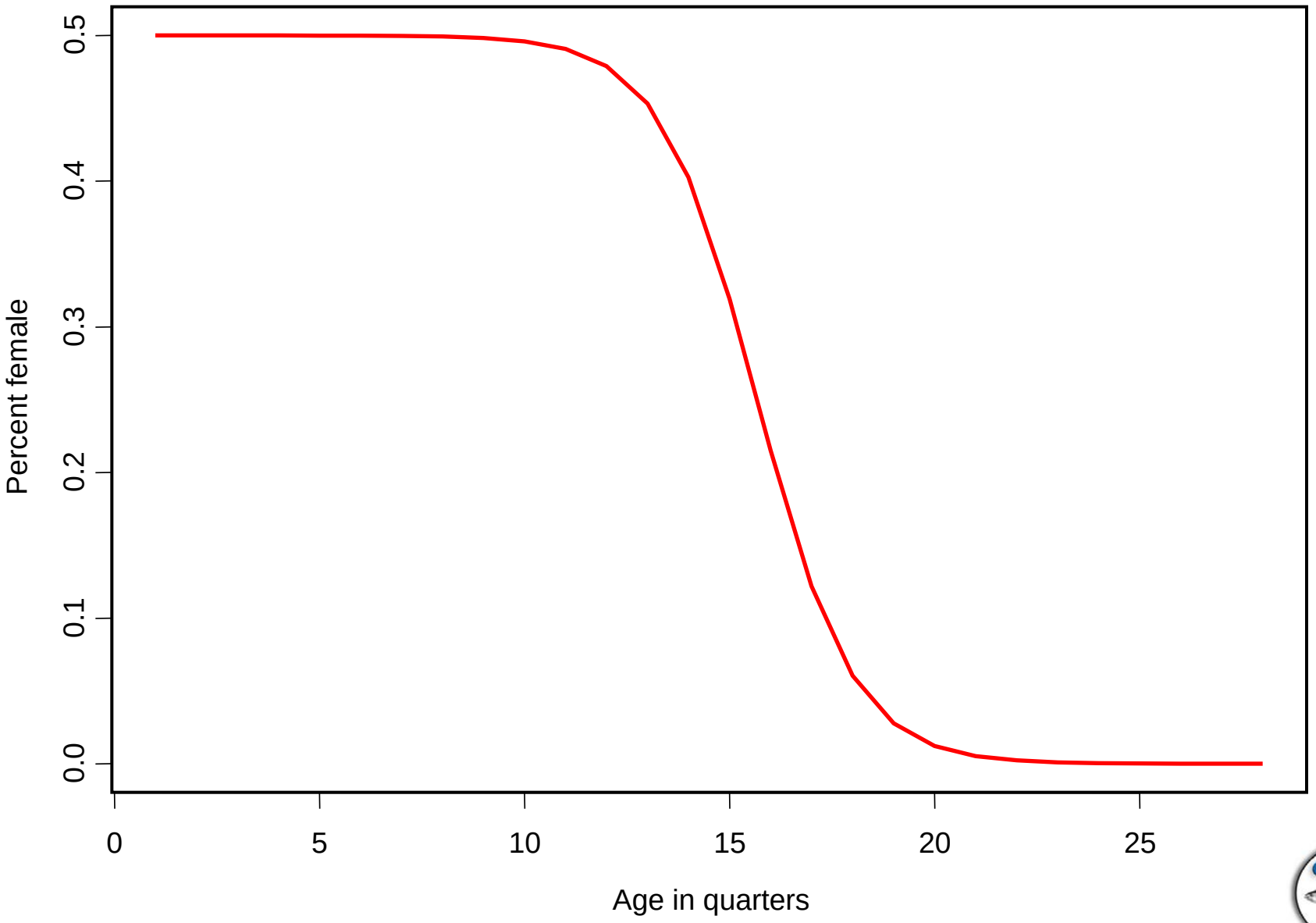
Fixed Parameters

- Natural Mortality
- Fecundity at age
- Sex ratio at age
- Selectivity curves for the discard fisheries
- The steepness of the stock recruitment relationship = 1 (no relationship)

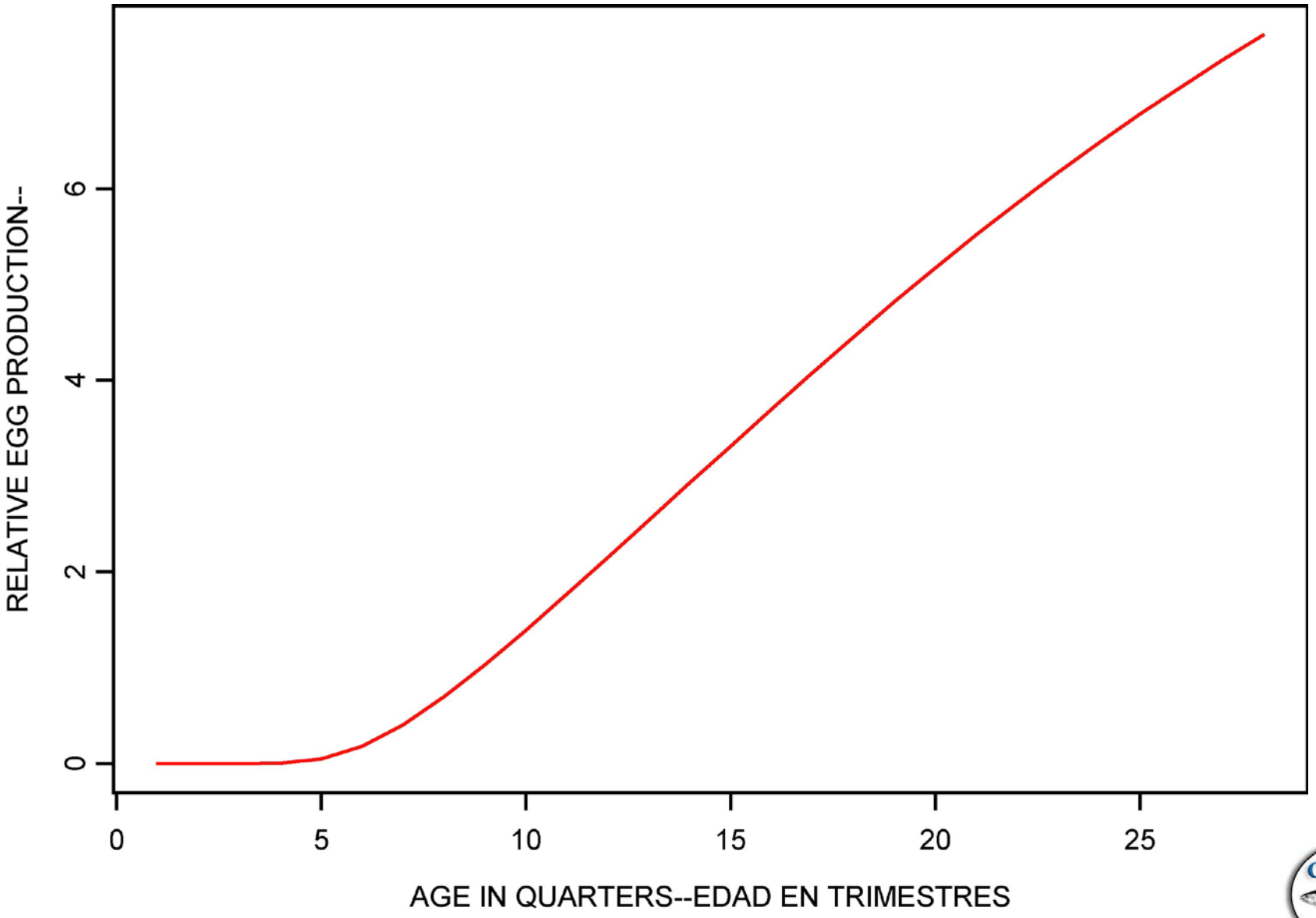
Natural Mortality



Sex Ratio



Relative Fecundity



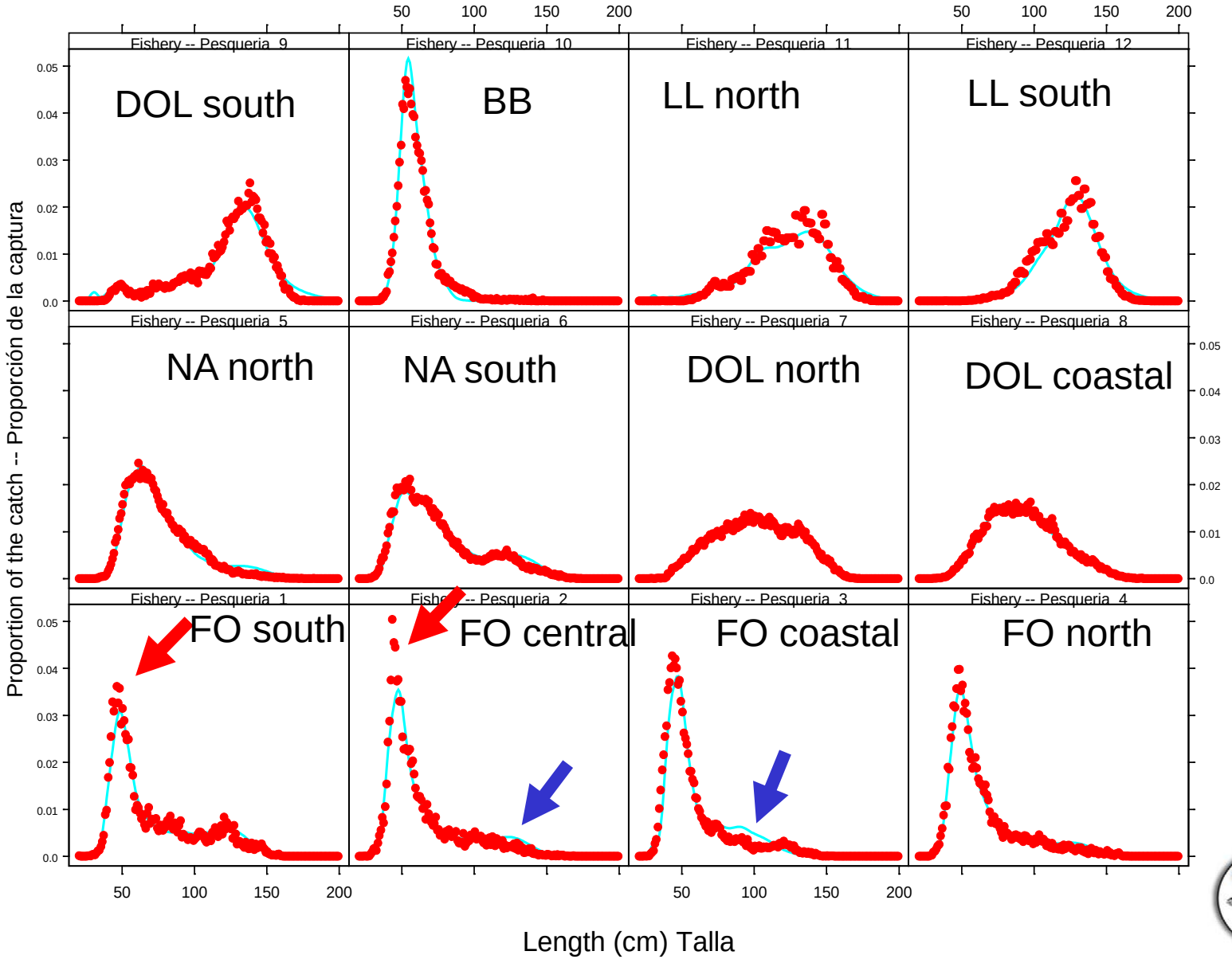
Estimated parameters

- **Recruitment**
  - Temporal anomalies, (no Seasonal component)
- **Catchability**
  - Temporal anomalies
- **Selectivity**
- **Initial population size and age-structure**
- **Mean length at age**
- **Variation of length at age**

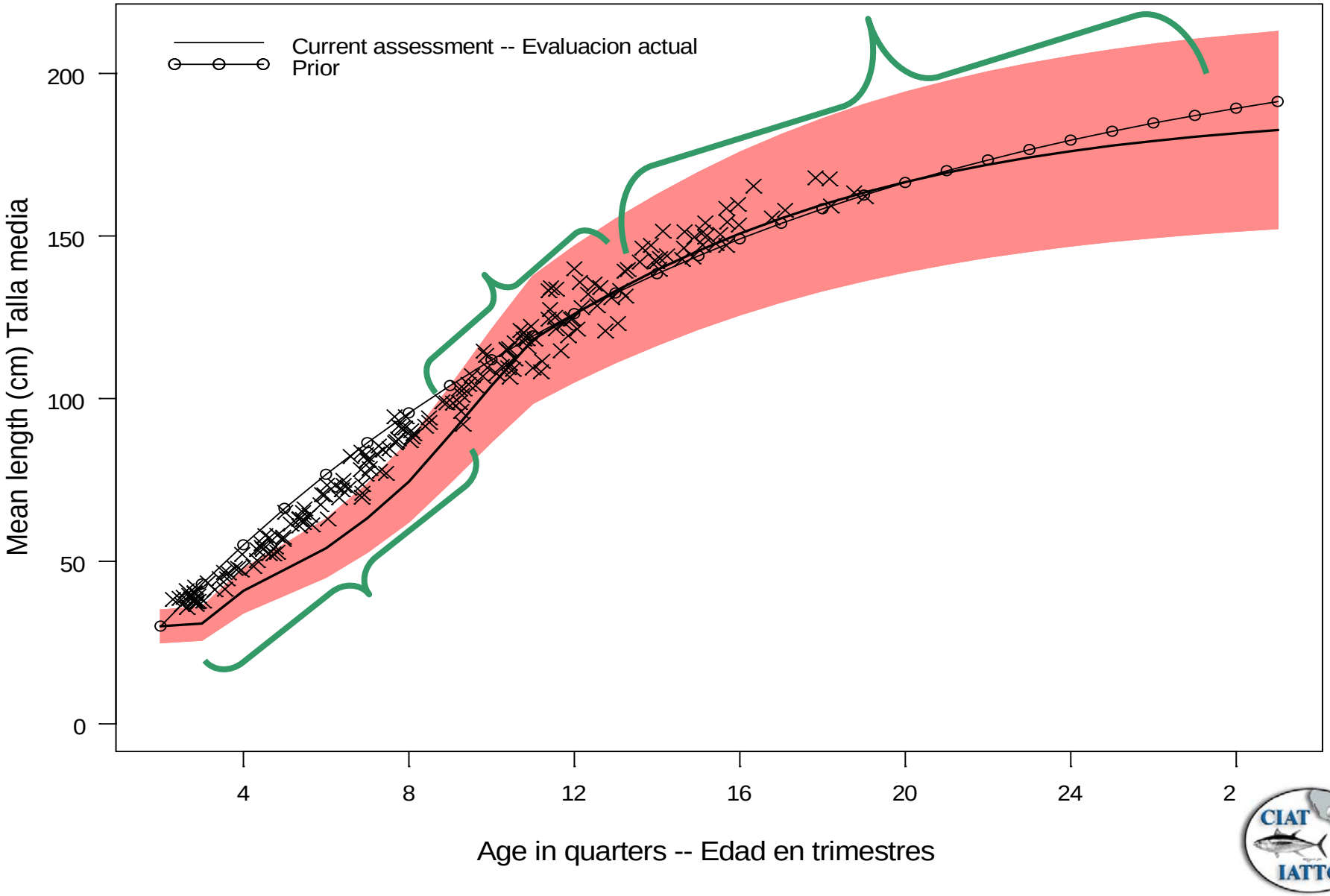
Results

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

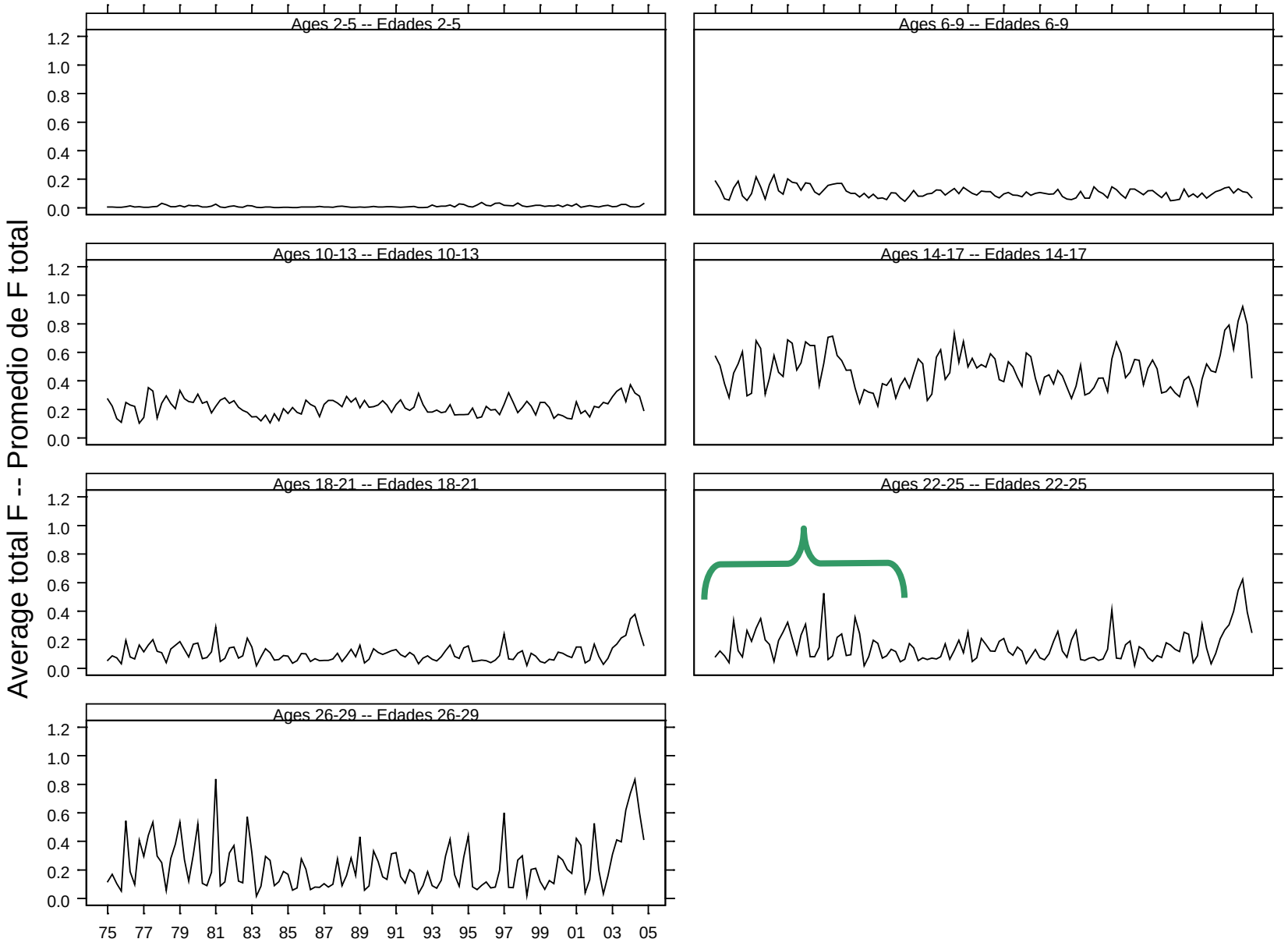
Fit to the length-frequency



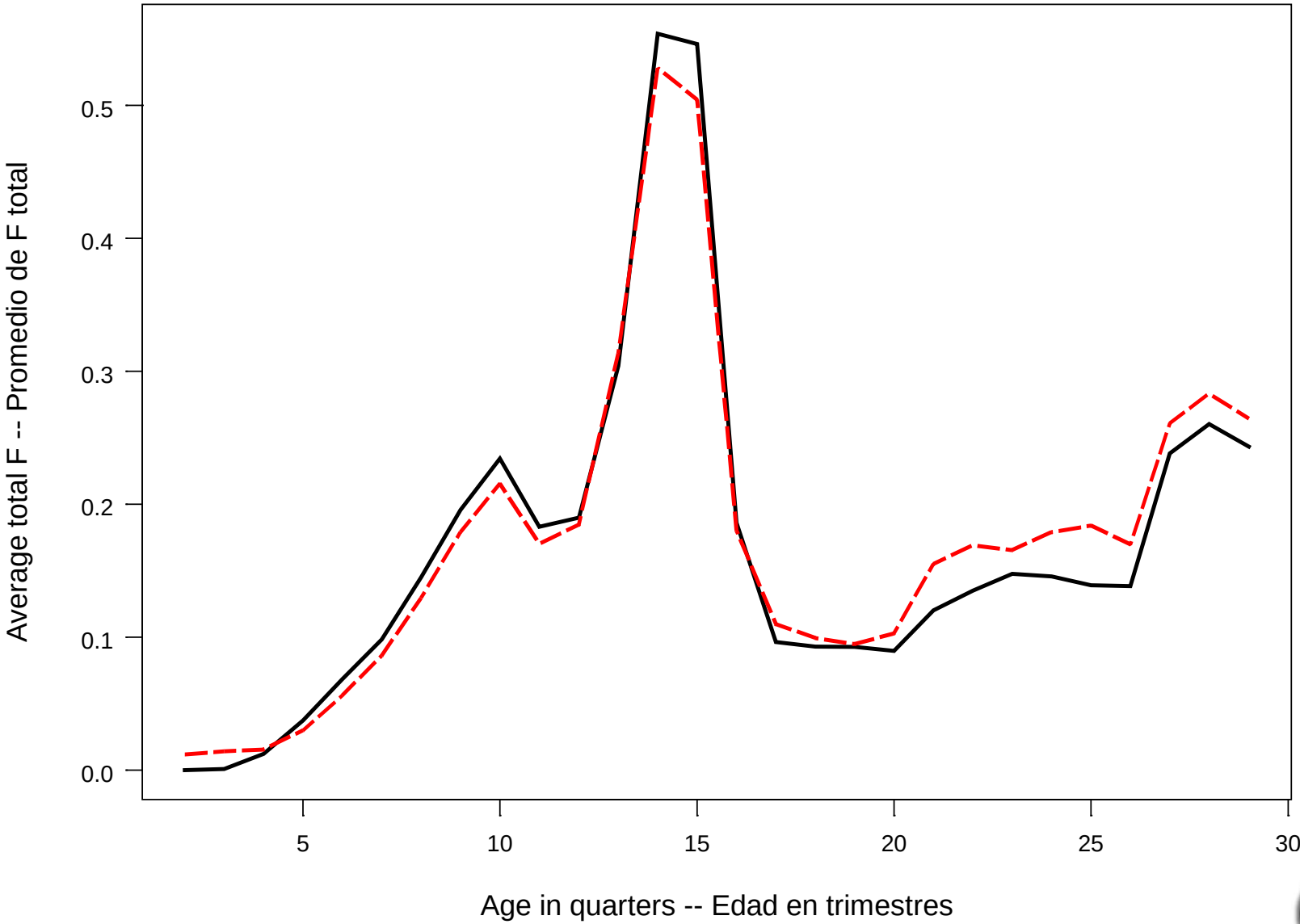
Growth


Current assessment -- Evaluacion actual
Prior
Mean length (cm) Talla media
0
50
100
150
200
4
8
12
16
20
24
2
Age in quarters -- Edad en trimestres

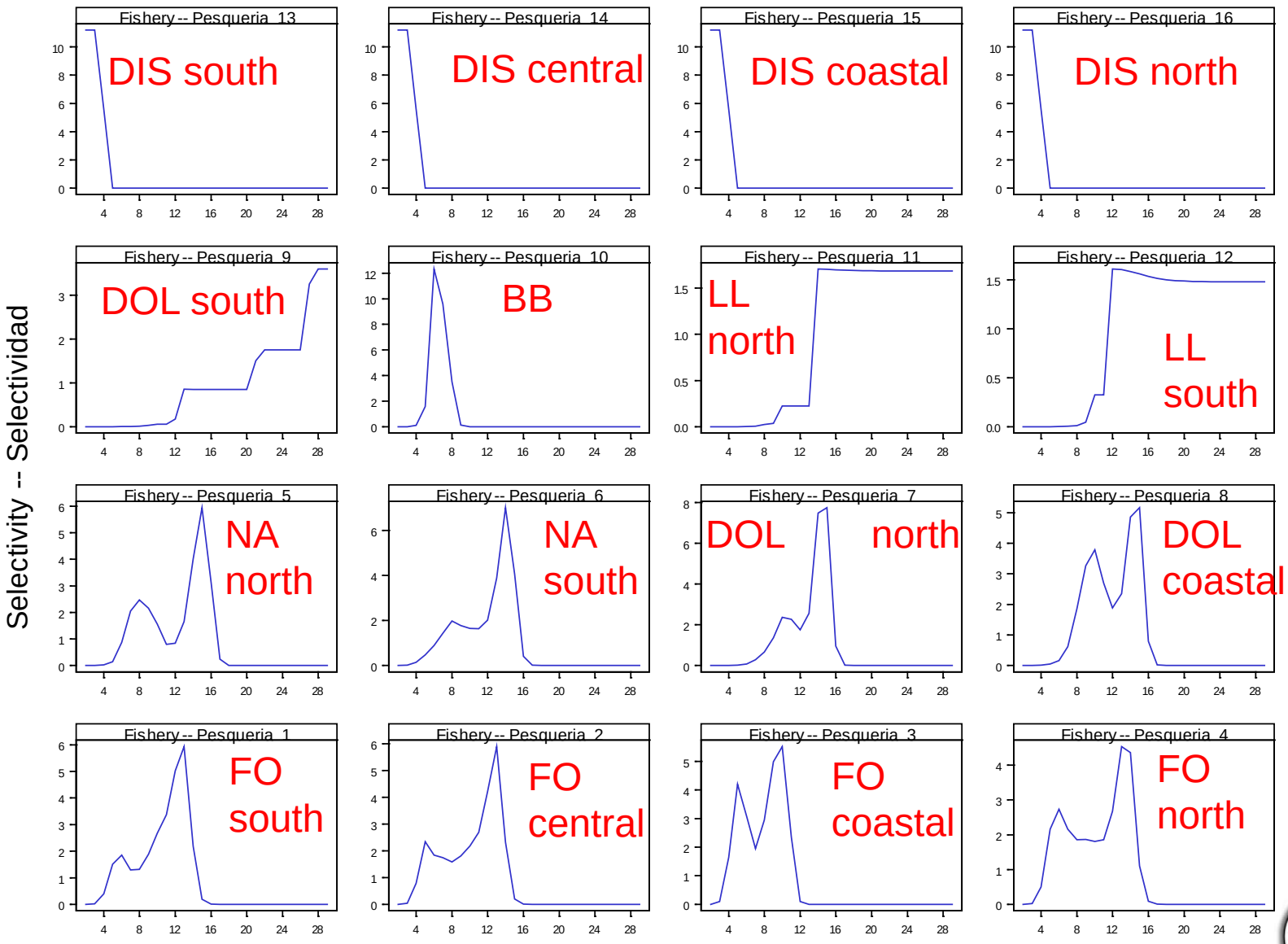
Fishing mortality



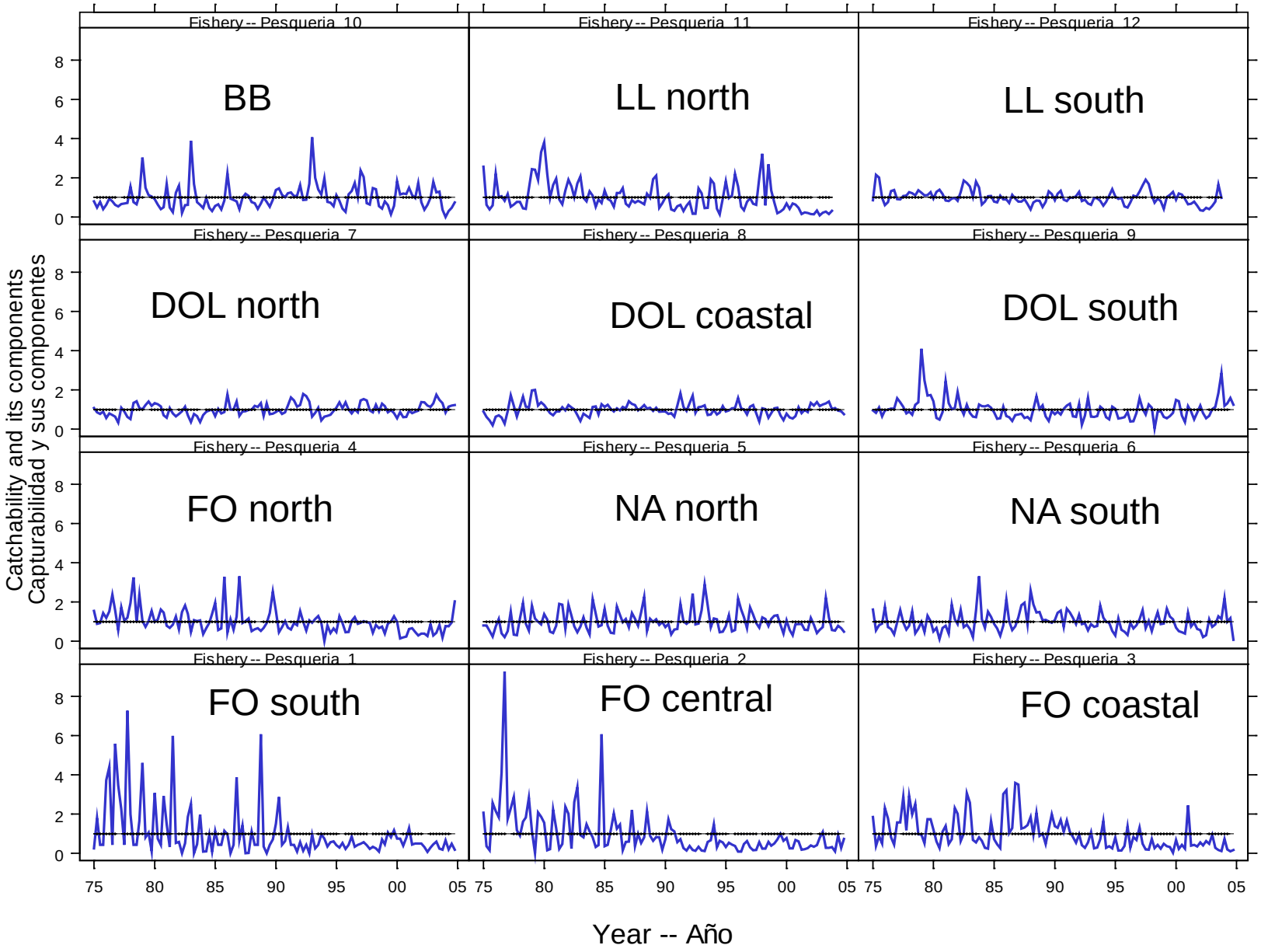
Age Specific Fishing Mortality



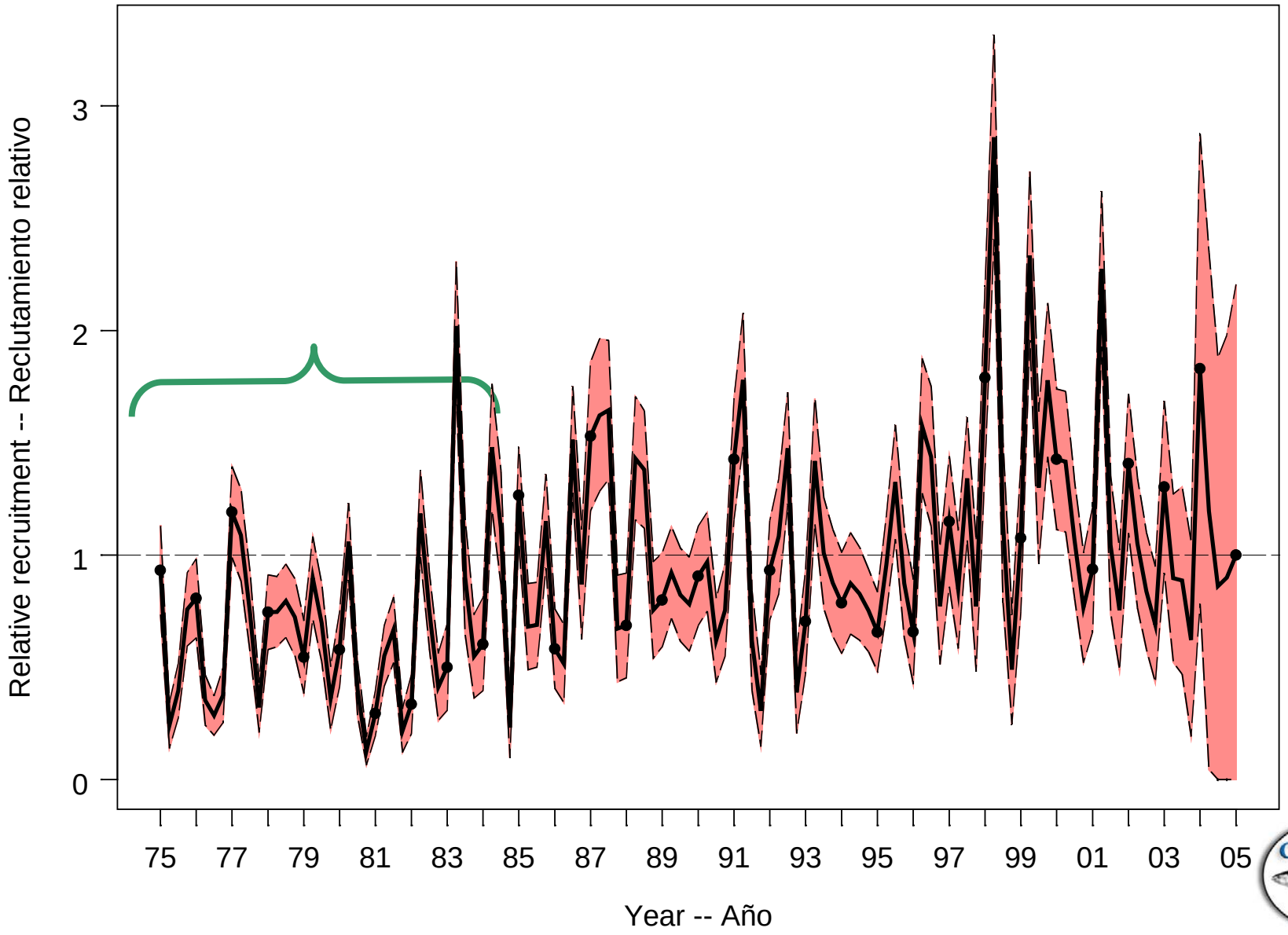
Selectivity



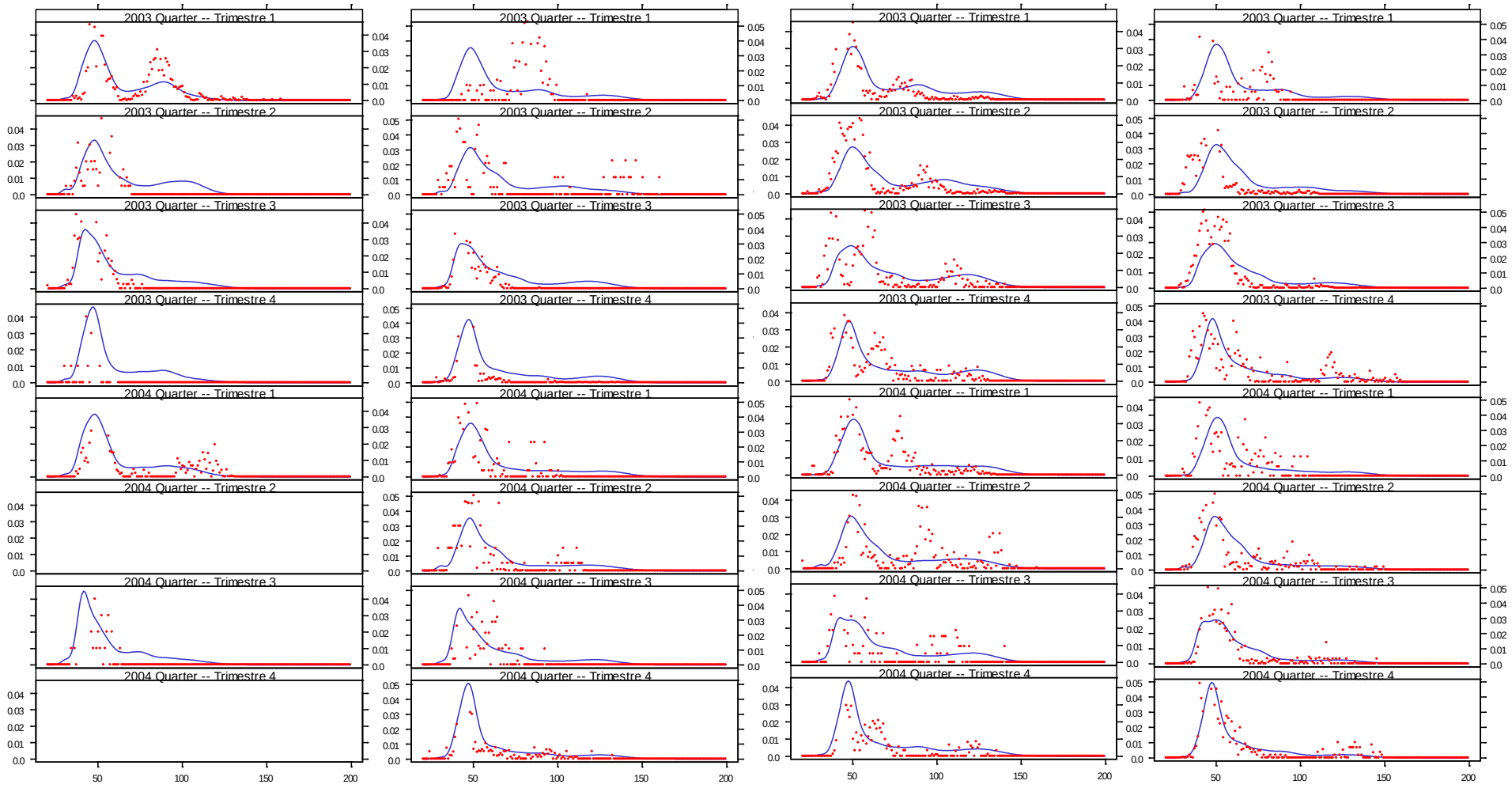
Catchability



Recruitment



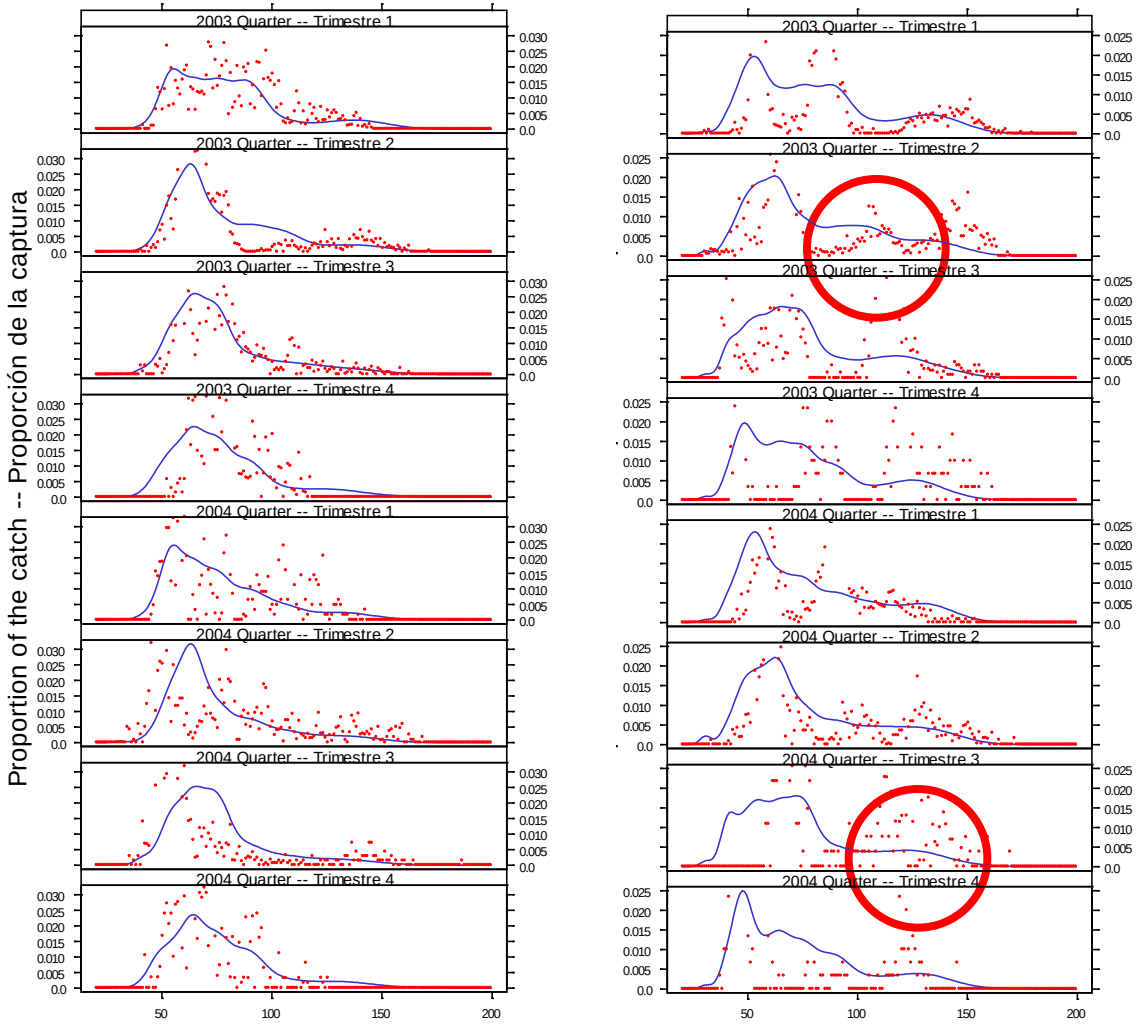
Recent length-frequency data (FO)



FO south FO central FO coastal FO north

Length(cm)–Talla(cm)

Recent length-frequency data (Unassociated)

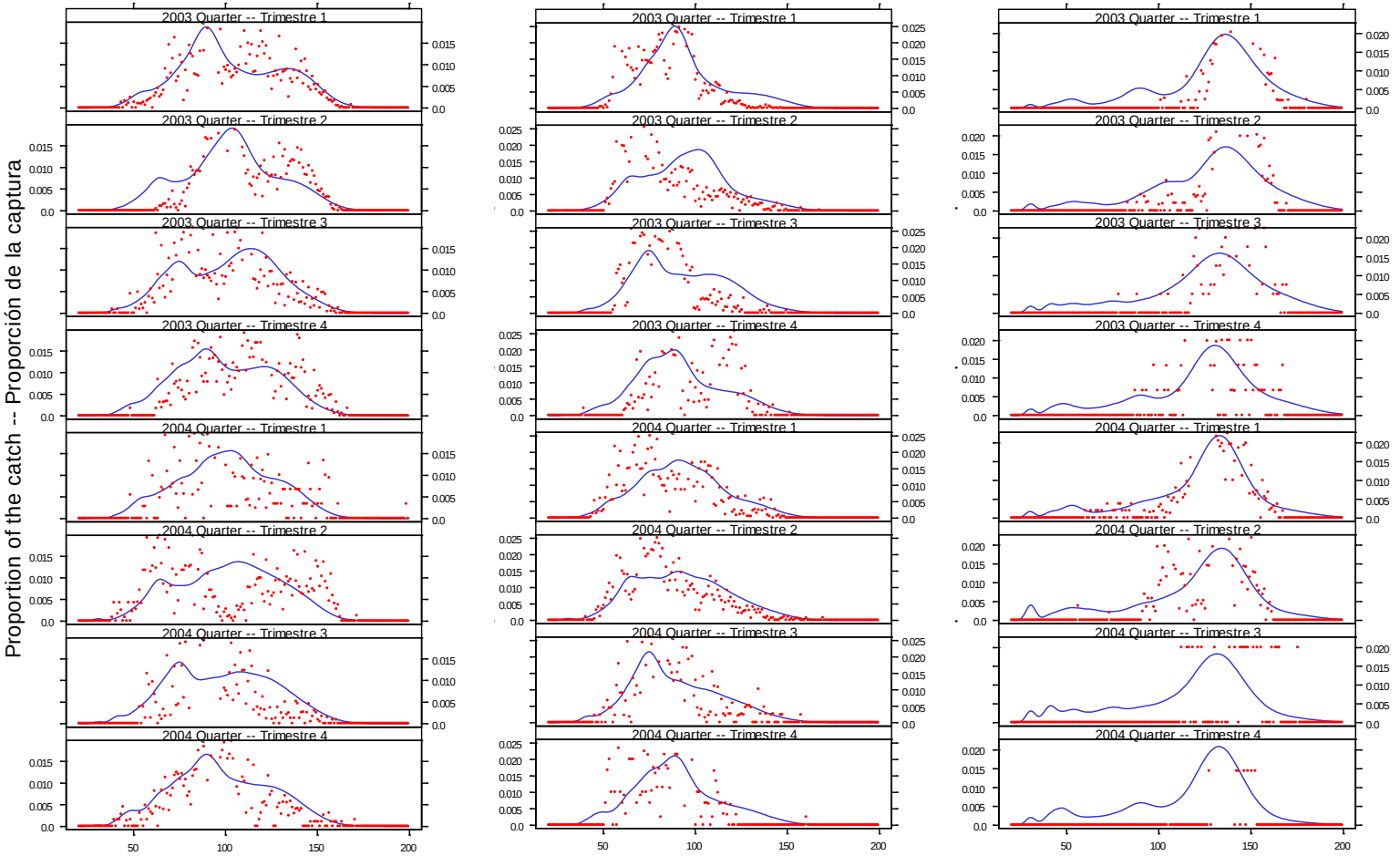


NA north

NA south

Length(cm)–Talla(cm)

Recent length-frequency data (Dolphin associated)



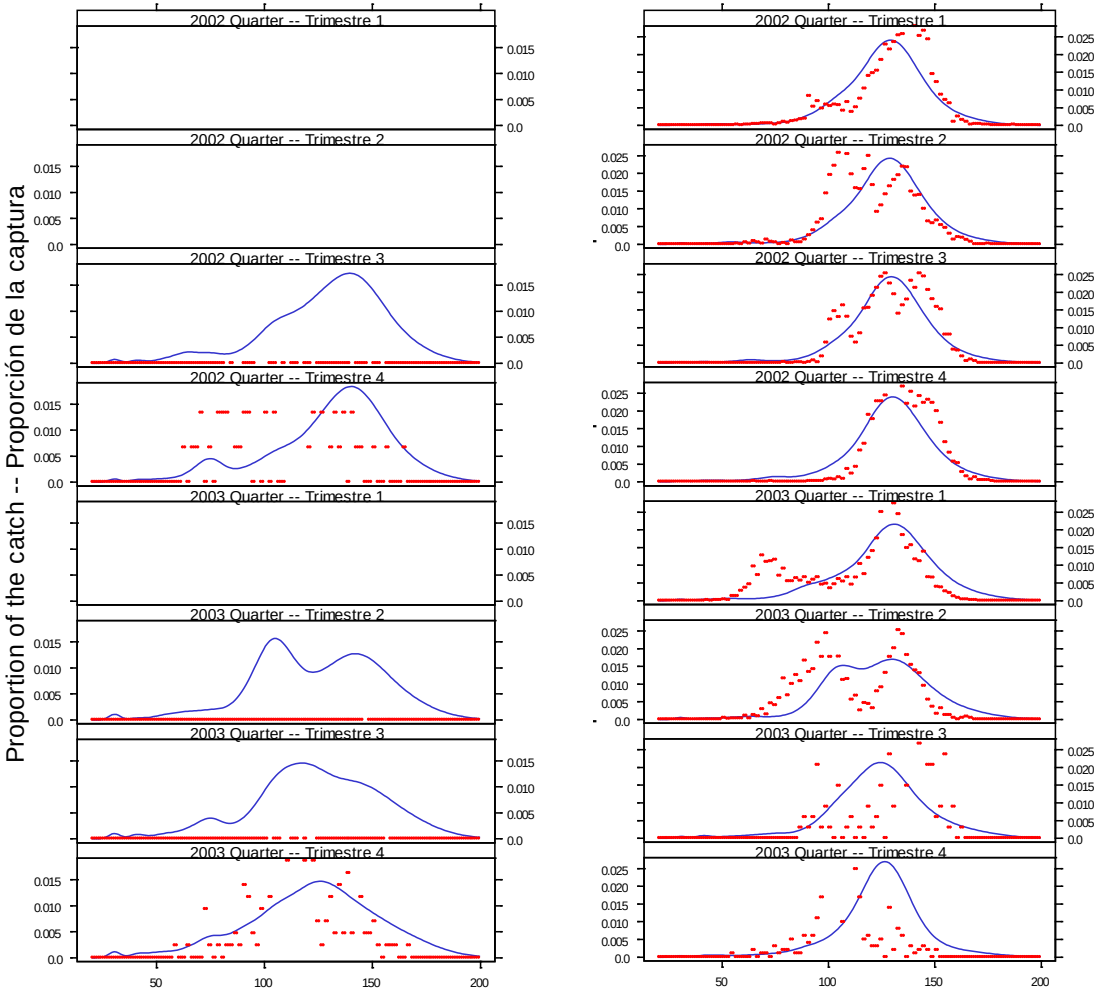
DOL north

DOL coastal

DOL south

Length(cm)–Talla(cm)

Recent length-frequency data (longline)

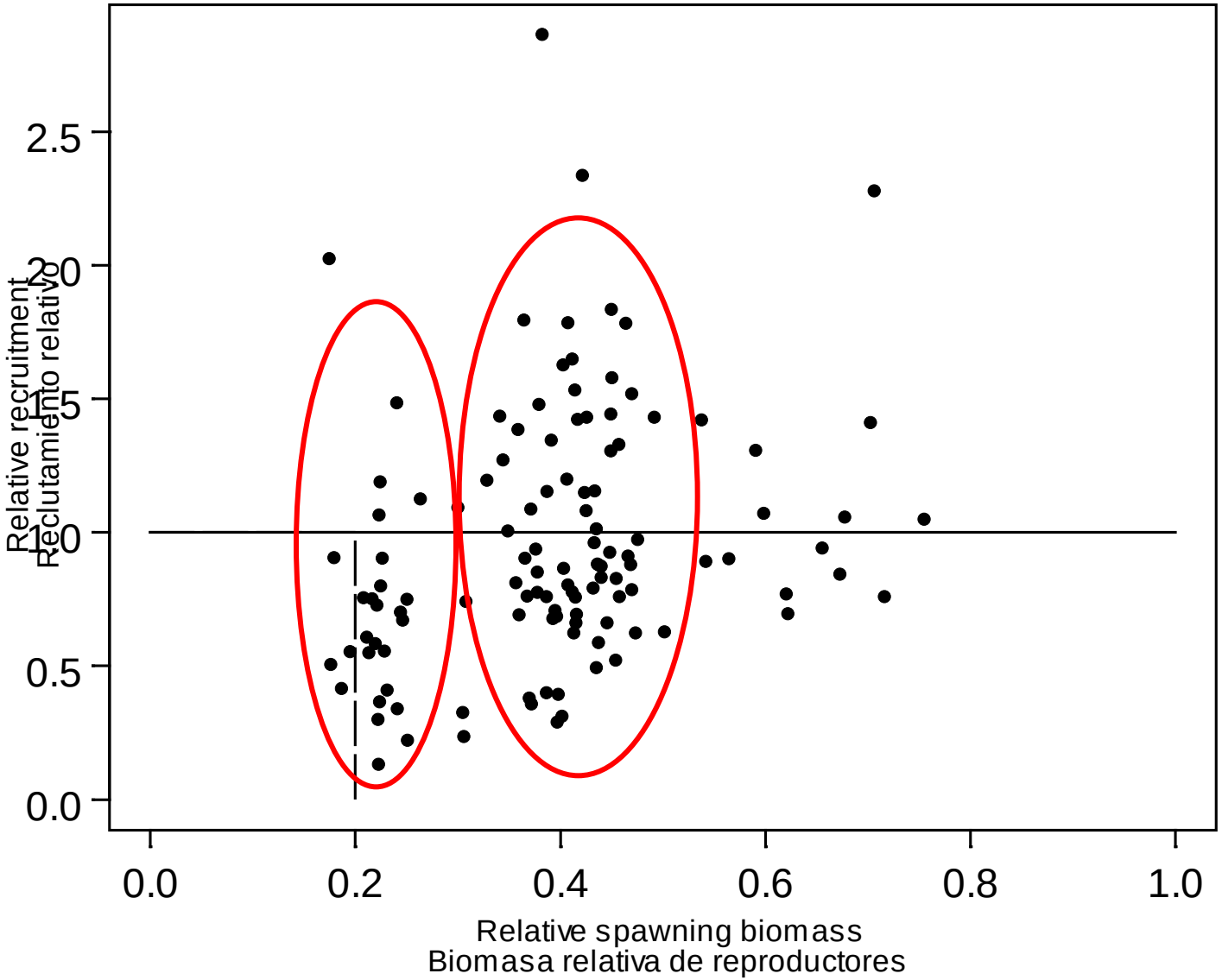


LL north

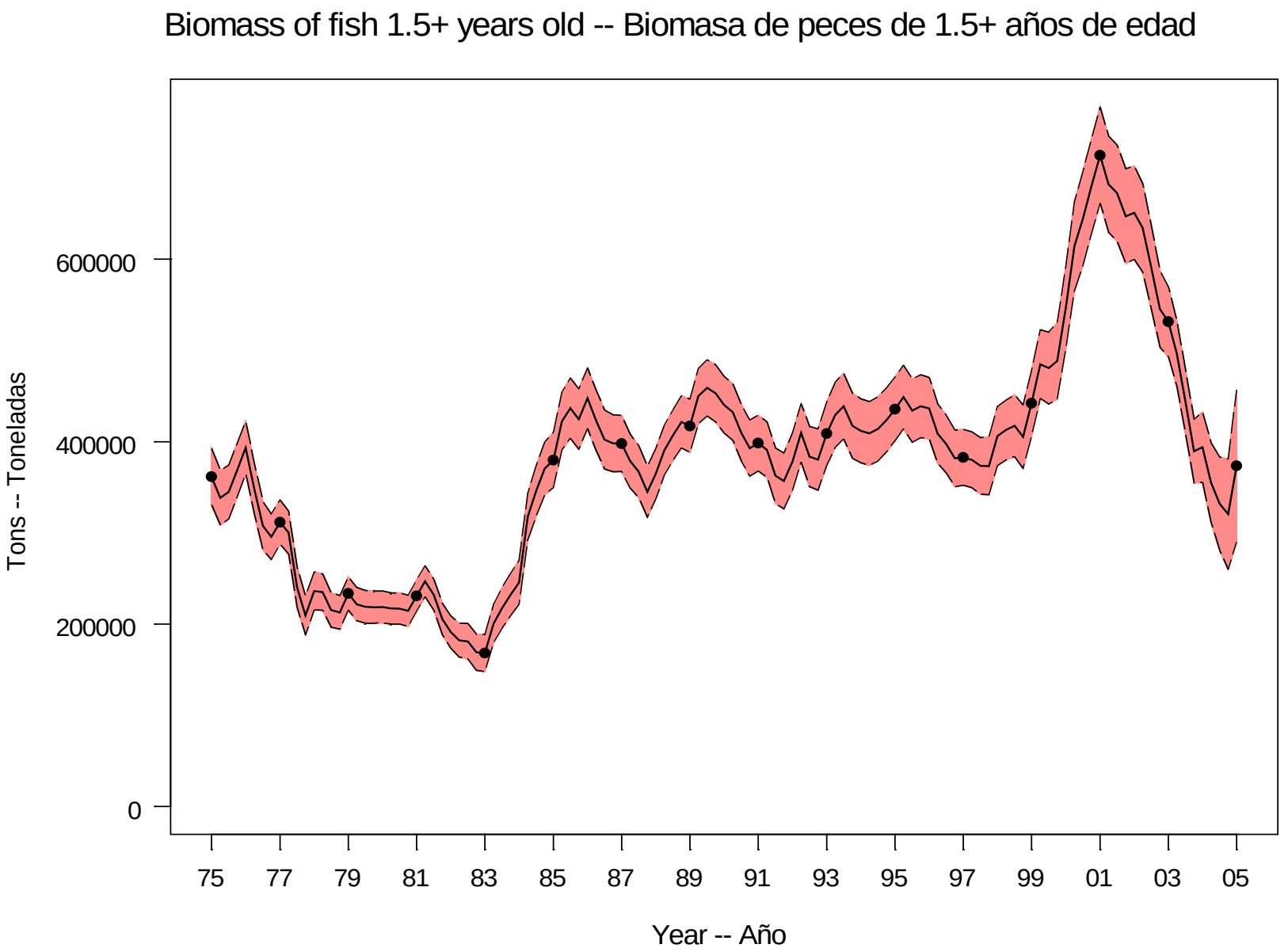
LL south

Length(cm)–Talla(cm)

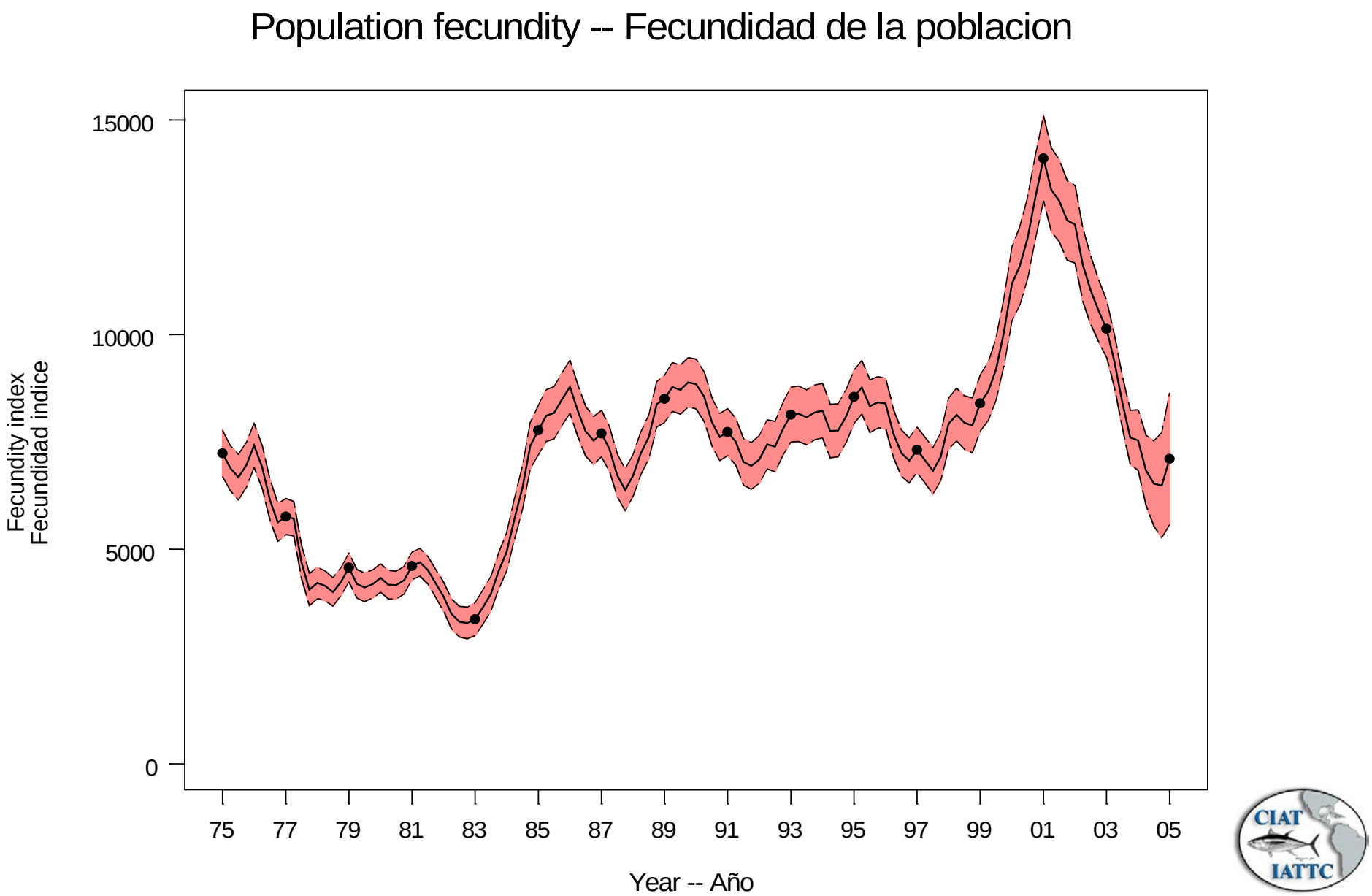
Stock - recruitment



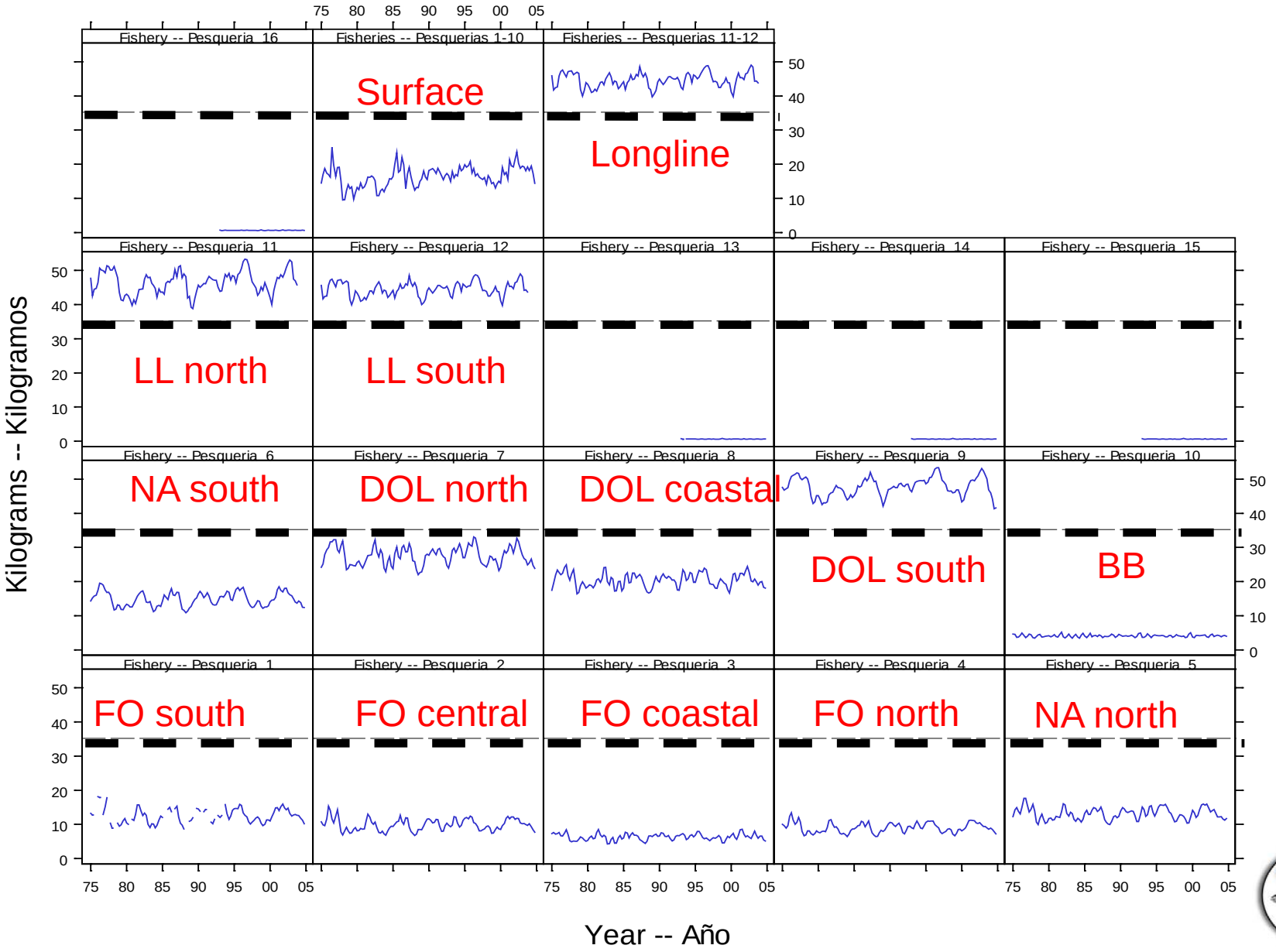
Biomass


Biomass of fish 1.5+ years old -- Biomasa de peces de 1.5+ años de edad
Tons -- Toneladas
600000
400000
200000
0
75
77
79
81
83
85
87
89
91
93
95
97
99
01
03
05
Year -- Año

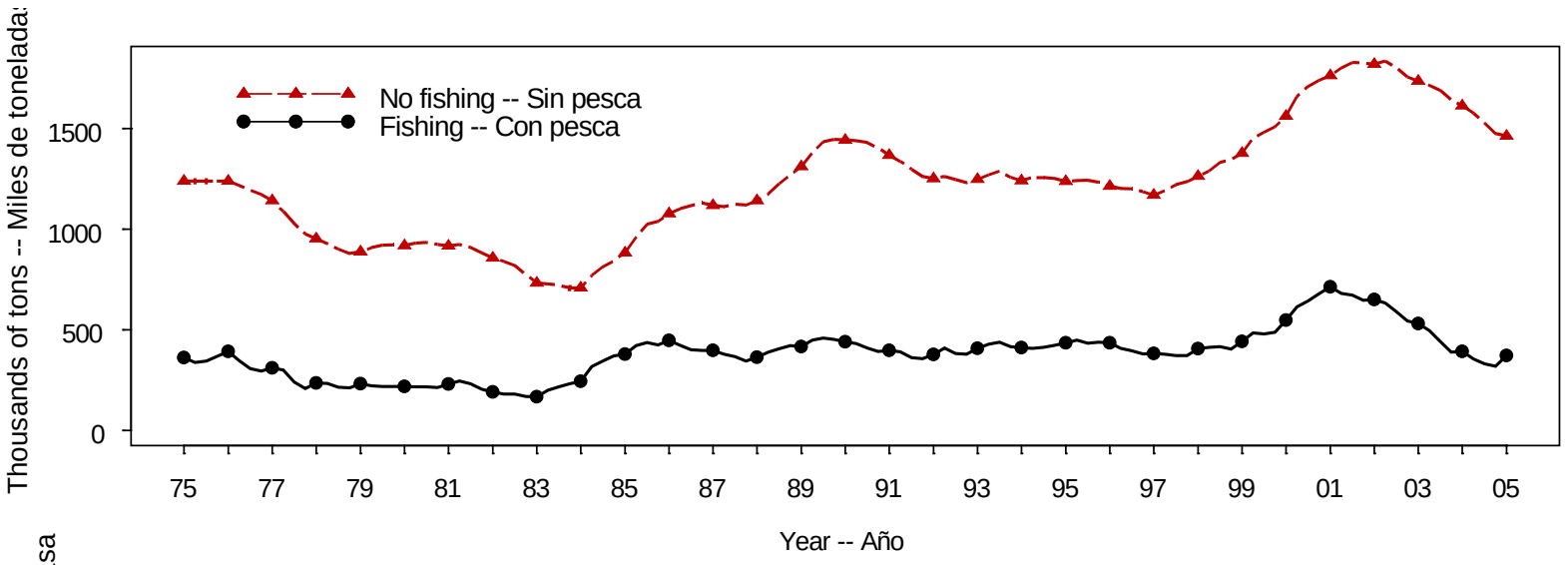
Spawning Biomass

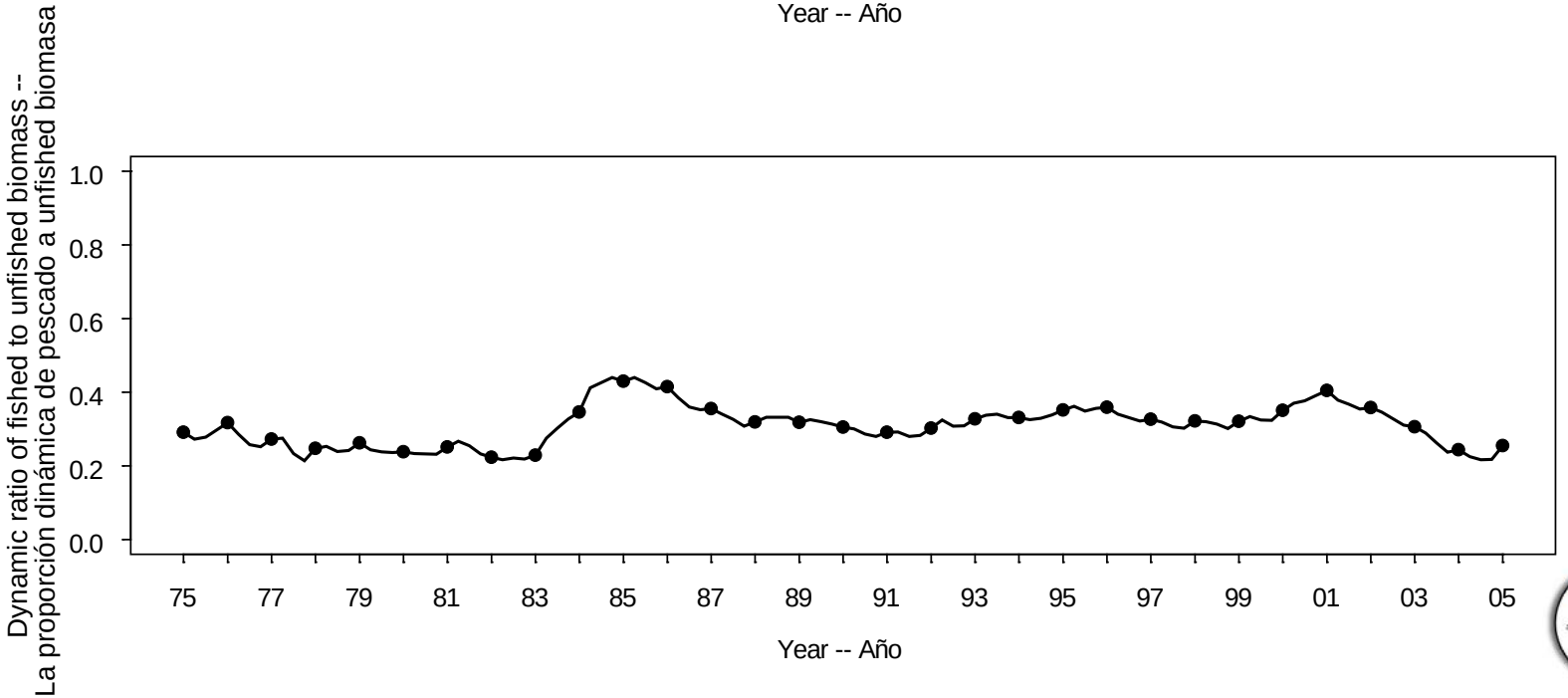


Average weight

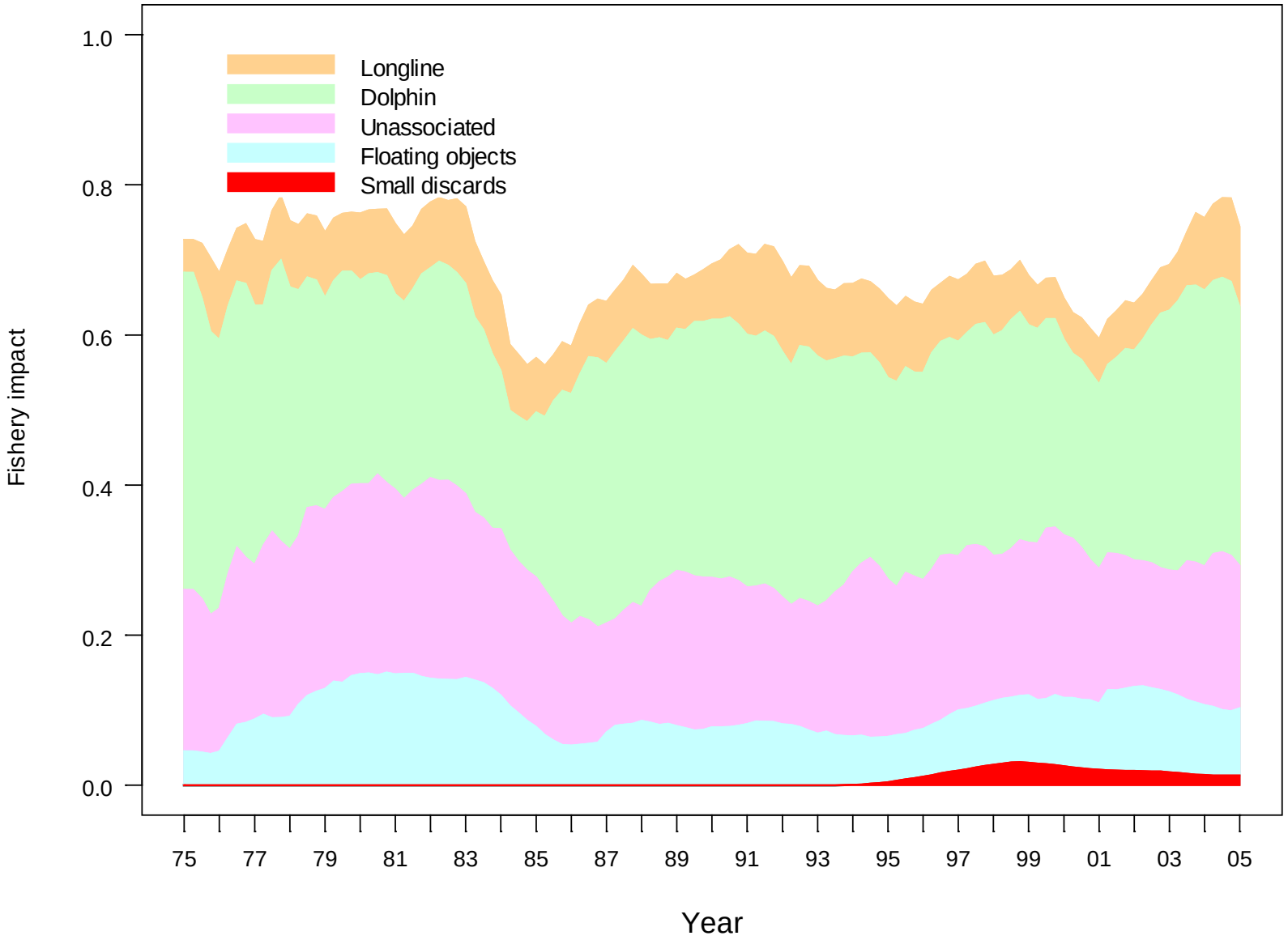


No Fishing

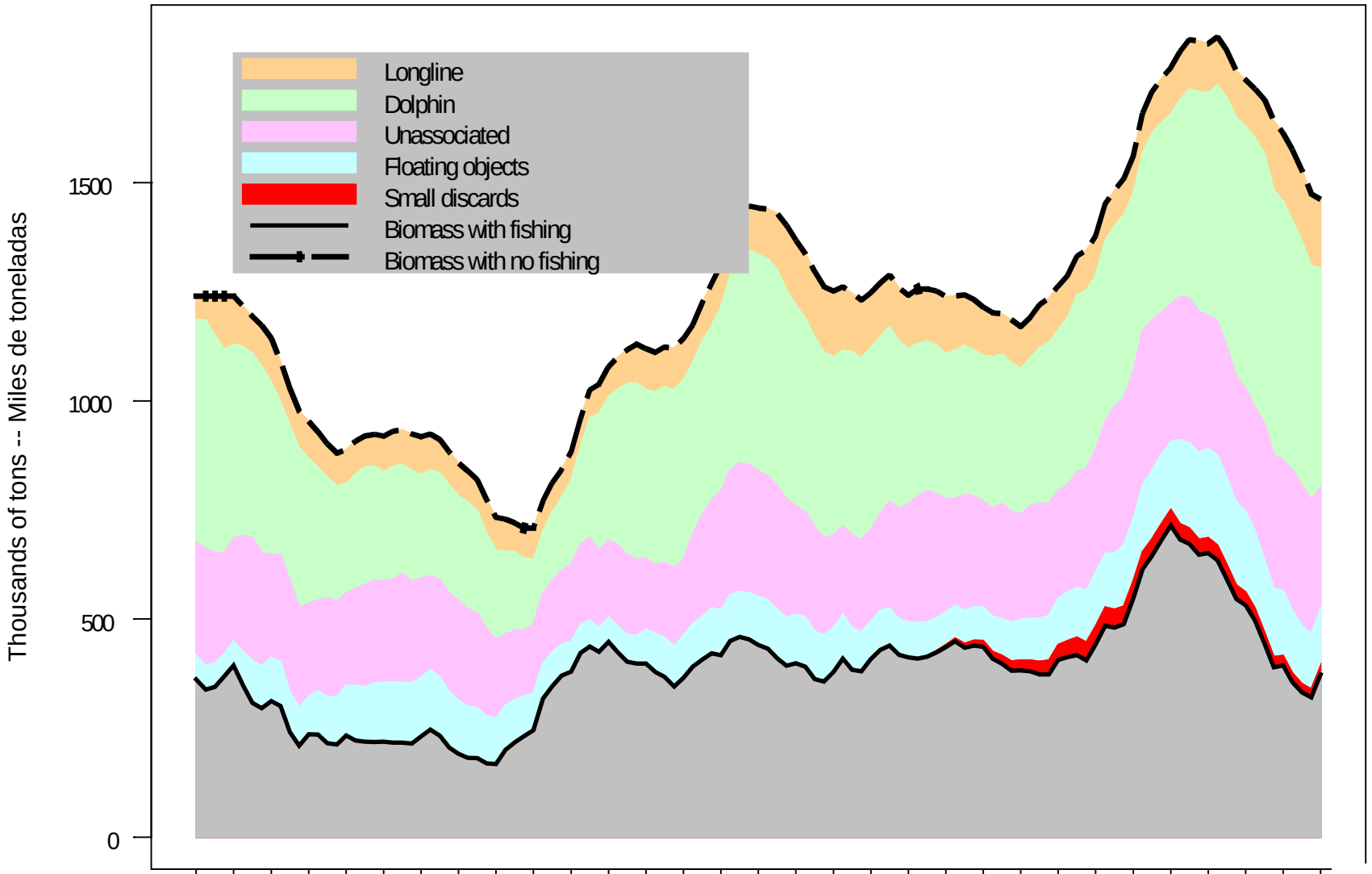

Thousands of tons -- Miles de toneladas
No fishing -- Sin pesca
Fishing -- Con pesca
0
500
1000
1500
75
77
79
81
83
85
87
89
91
93
95
97
99
01
03
05
Year -- Año


Dynamic ratio of fished to unfished biomass --
La proporción dinámica de pescado a unfished biomasa
0.0
0.2
0.4
0.6
0.8
1.0
75
77
79
81
83
85
87
89
91
93
95
97
99
01
03
05
Year -- Año

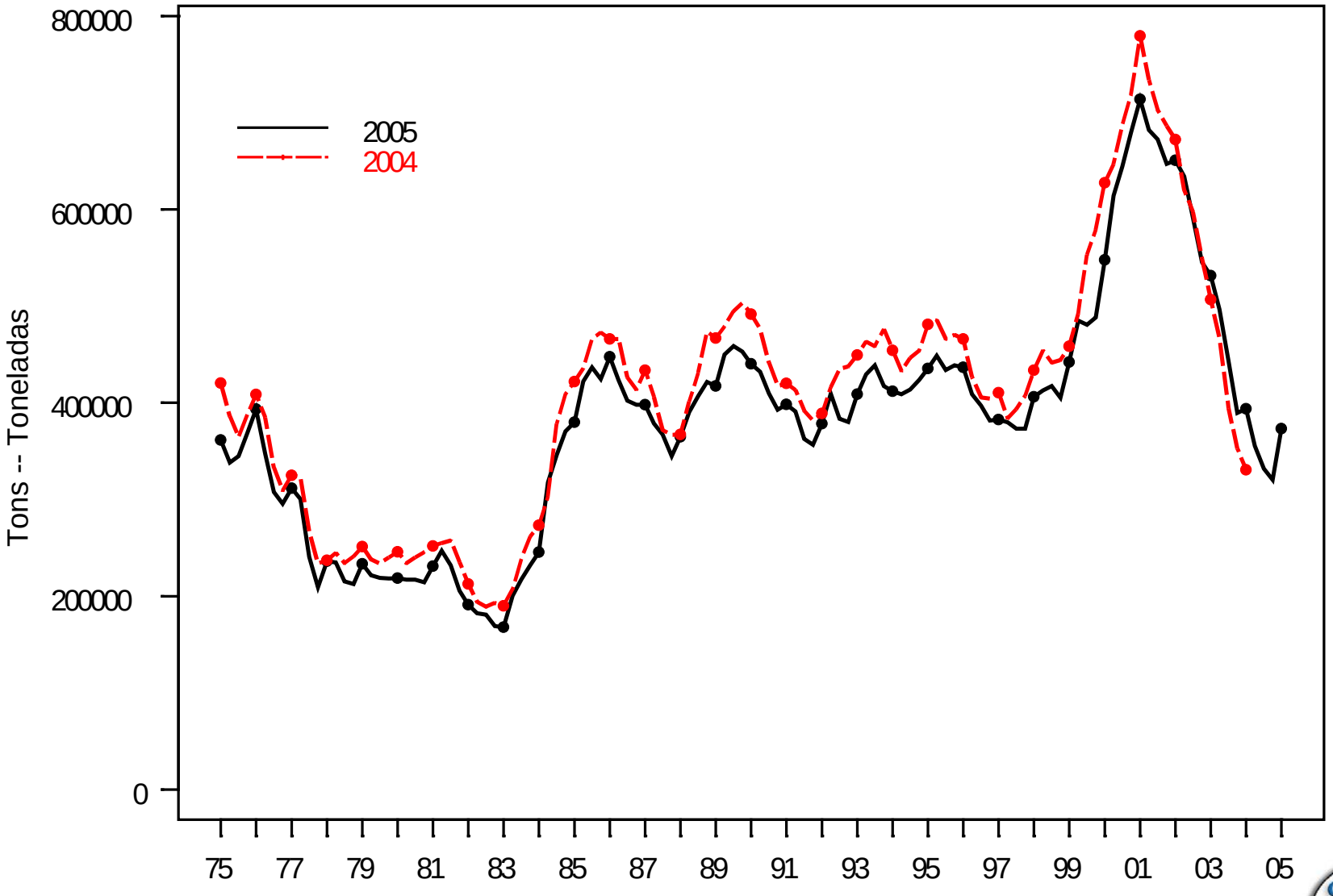
Fishery impact



No Fishing and Fishery Impact



Biomass Comparisons



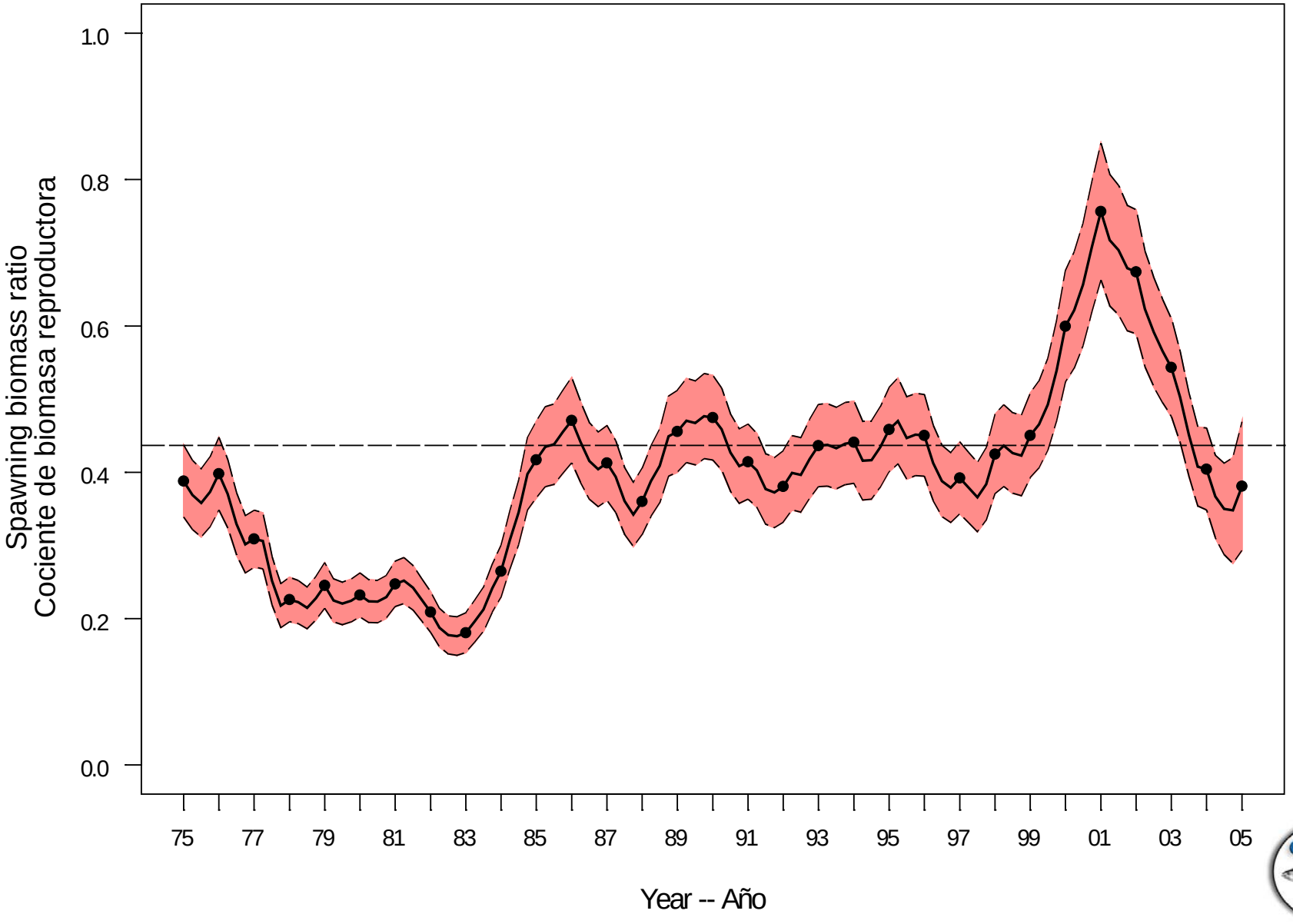
Comparisons to reference points

- SBR
- Critical weight
- Lifetime fecundity
- MSY_{ref} and SBR_{ref}

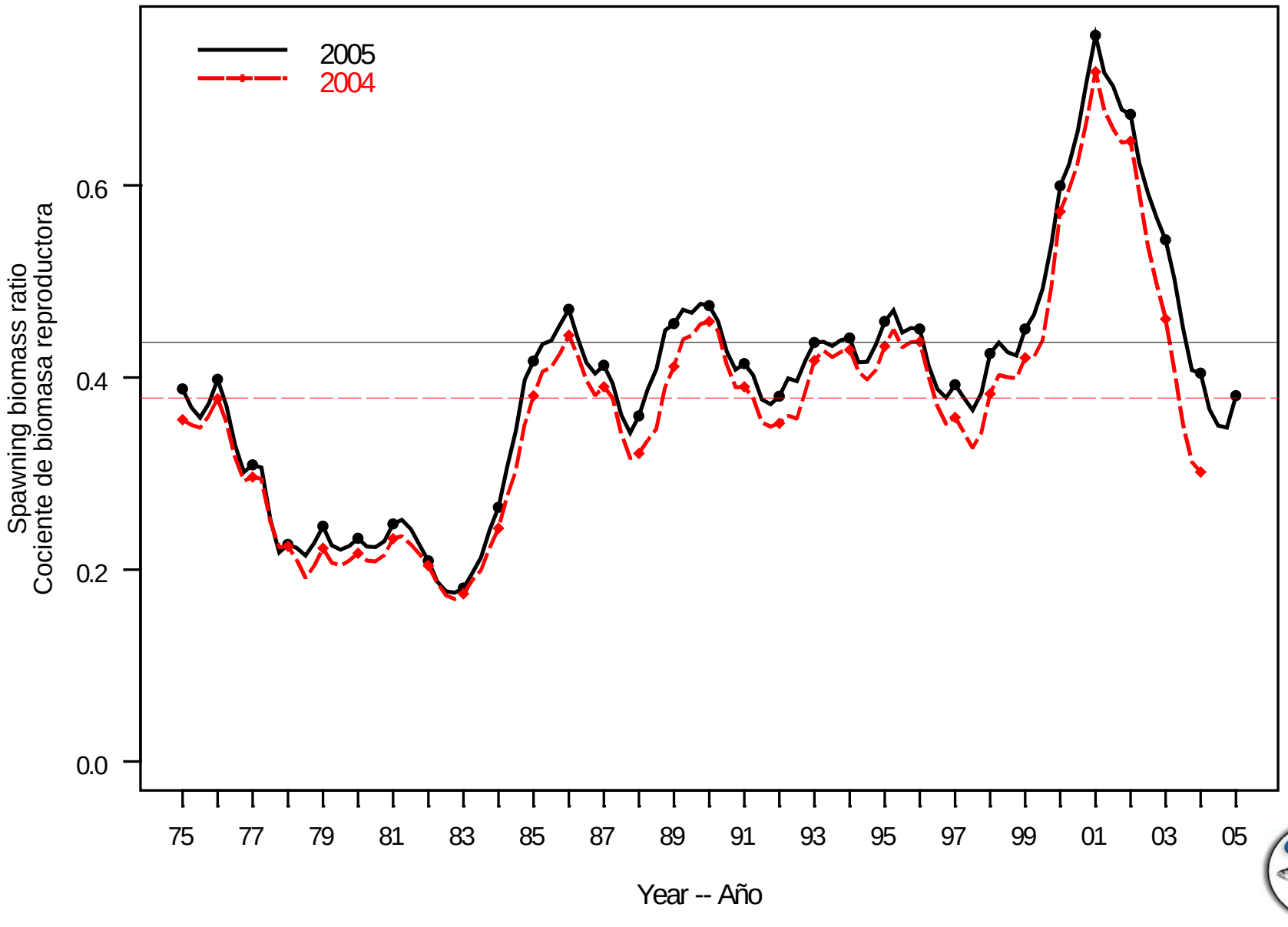
Ref pts & projections - assumptions

- For MSY calculations
  - Average of 2002-2003 for fishing mortality
- For forward projections
  - Average of 2002-2003 for catchability
  - 2004 effort

SBR


Spawning biomass ratio
Cociente de biomasa reproductora
1.0
0.8
0.6
0.4
0.2
0.0
75
77
79
81
83
85
87
89
91
93
95
97
99
01
03
05
Year -- Año

SBR


2005
2004
Spawning biomass ratio
Cociente de biomasa reproductora
0.0
0.2
0.4
0.6
75
77
79
81
83
85
87
89
91
93
95
97
99
01
03
05
Year -- Año

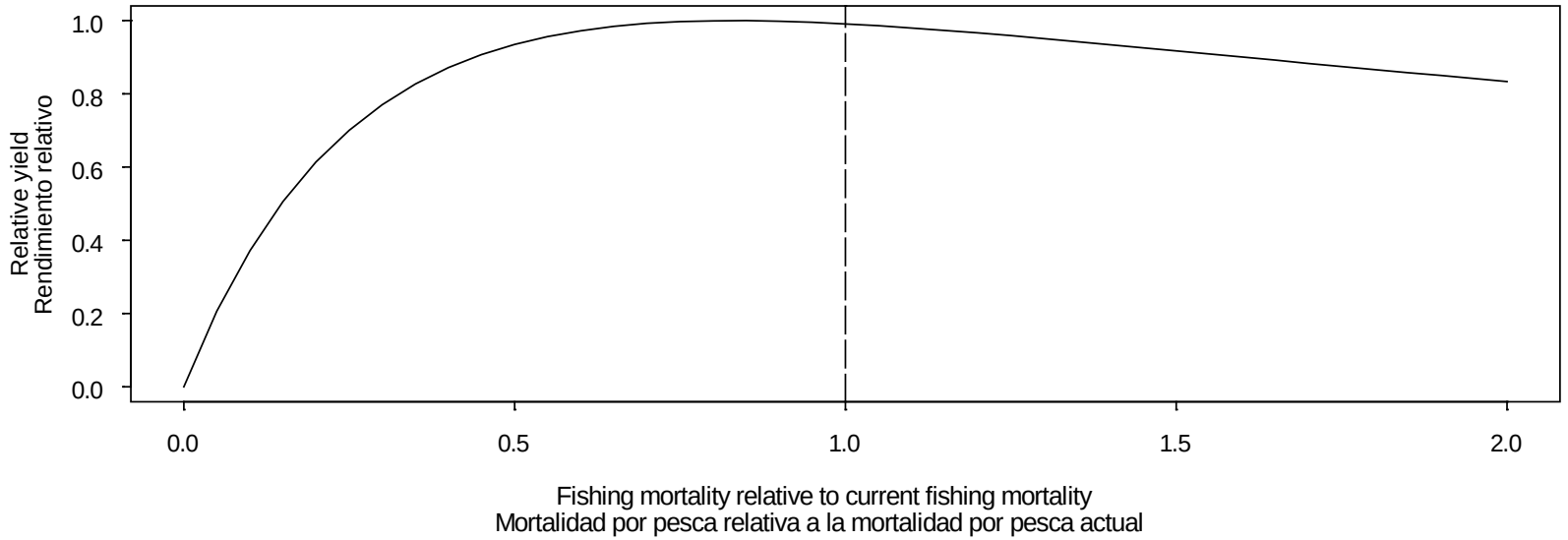
AMSY by method

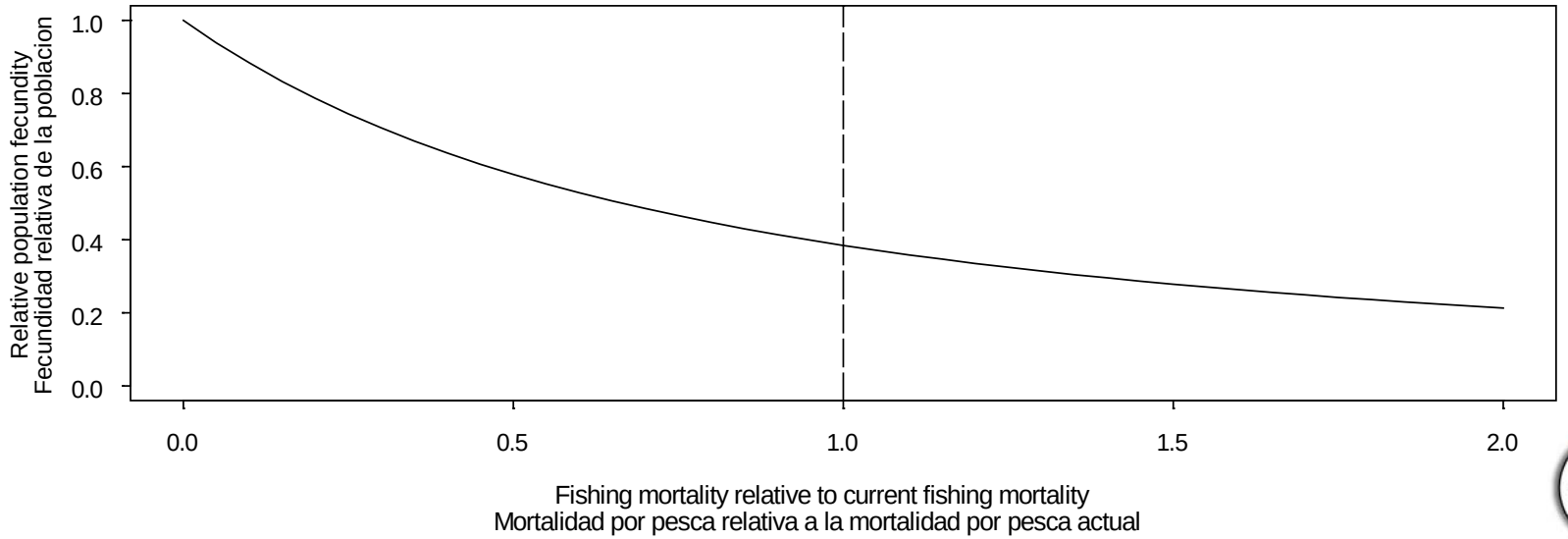
Fishery	AMSY	B_{AMSY}	S_{AMSY}	$B_{AMSY}/B_{F=0}$	$S_{AMSY}/S_{F=0}$	*F* multiplier
Pesquería	**RMSP**	B_{RMSP}	S_{RMSP}	$B_{RMSP}/B_{F=0}$	$S_{RMSP}/S_{F=0}$	**Multiplicador de *F***
All—Todos	284,707	419,598	8,144	0.34	0.44	0.83
OBJ	167,534	321,446	5,513	0.26	0.30	8.35
NOA	241,677	386,264	7,203	0.31	0.39	4.08
DEL	312,582	420,757	8,299	0.34	0.45	1.47
LL	397,336	467,831	9,495	0.38	0.51	25.37

AMSY with method removed

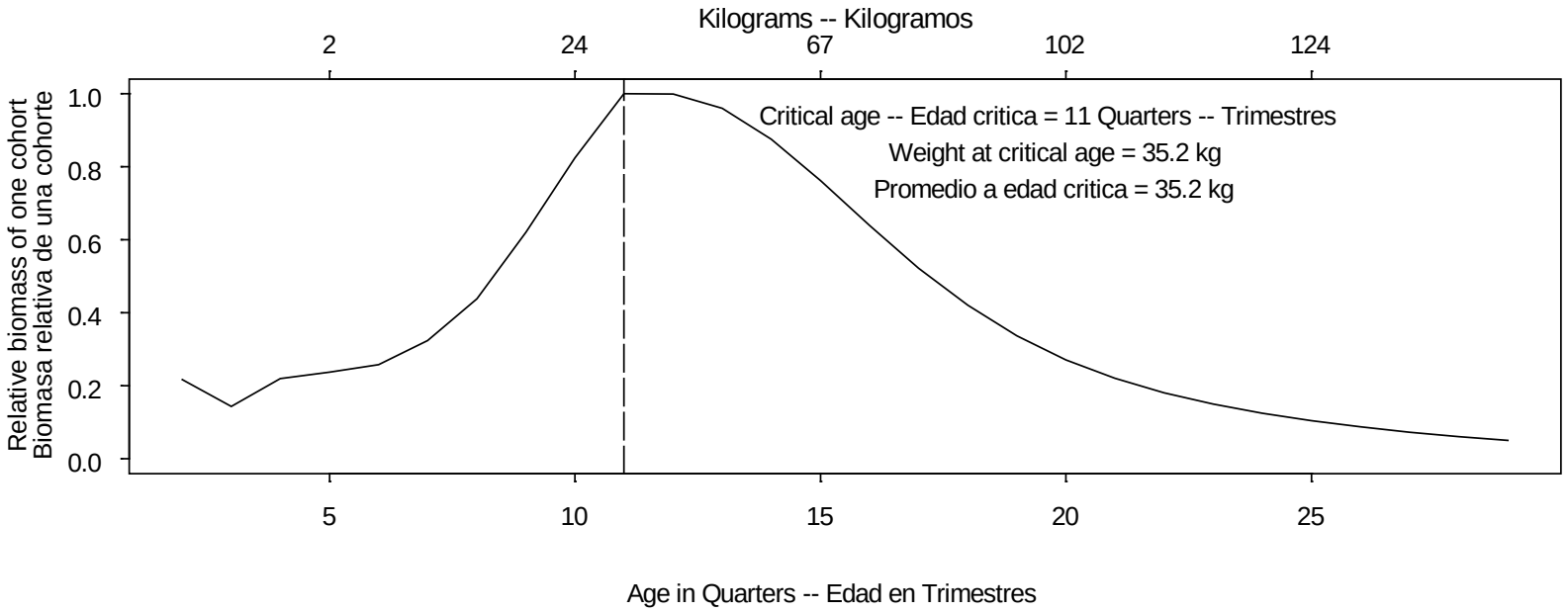
Fishery	AMSY	B_{AMSY}	S_{AMSY}	$B_{AMSY}/B_{F=0}$	$S_{AMSY}/S_{F=0}$	*F* multiplier
Pesquería	**RMSP**	B_{RMSP}	S_{RMSP}	$B_{RMSP}/B_{F=0}$	$S_{RMSP}/S_{F=0}$	**Multiplicador de *F***
All—Todos	284,707	419,598	8,144	0.34	0.44	0.83
No FLT	294,097	420,315	8,195	0.34	0.44	1.32
No UNA	281,202	412,575	7,993	0.33	0.43	1.32
No DOL	229,561	385,841	7,171	0.31	0.38	2.43
No LL	268,528	403,271	7,730	0.33	0.41	1.12

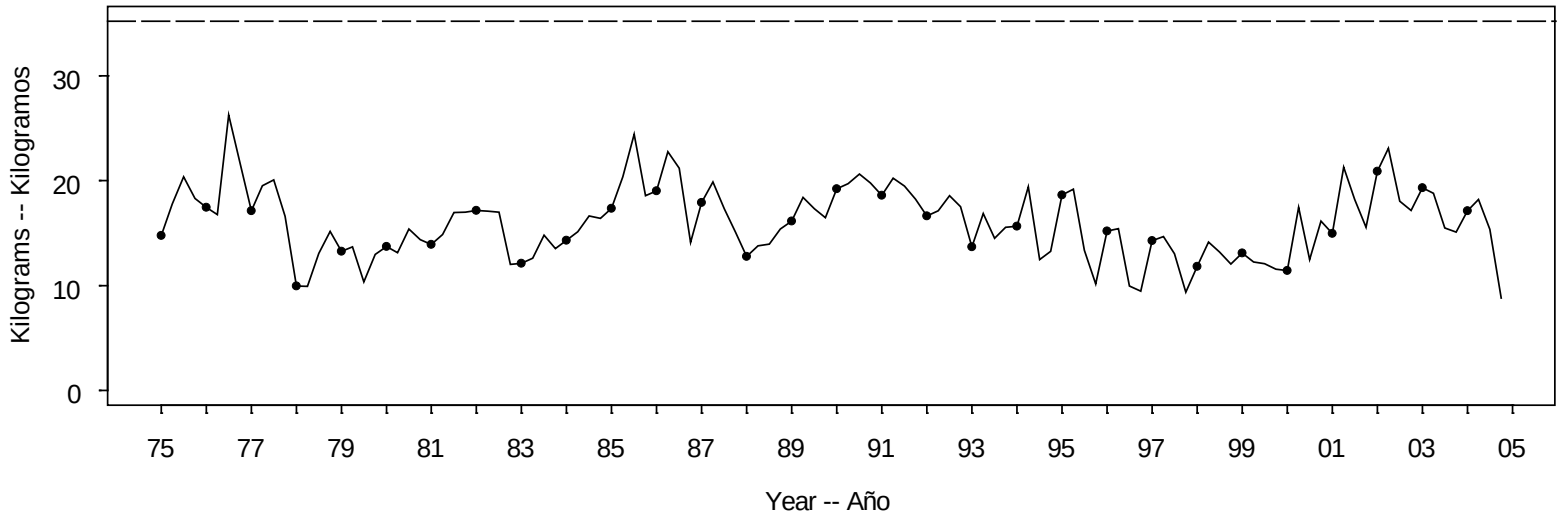
Yield


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

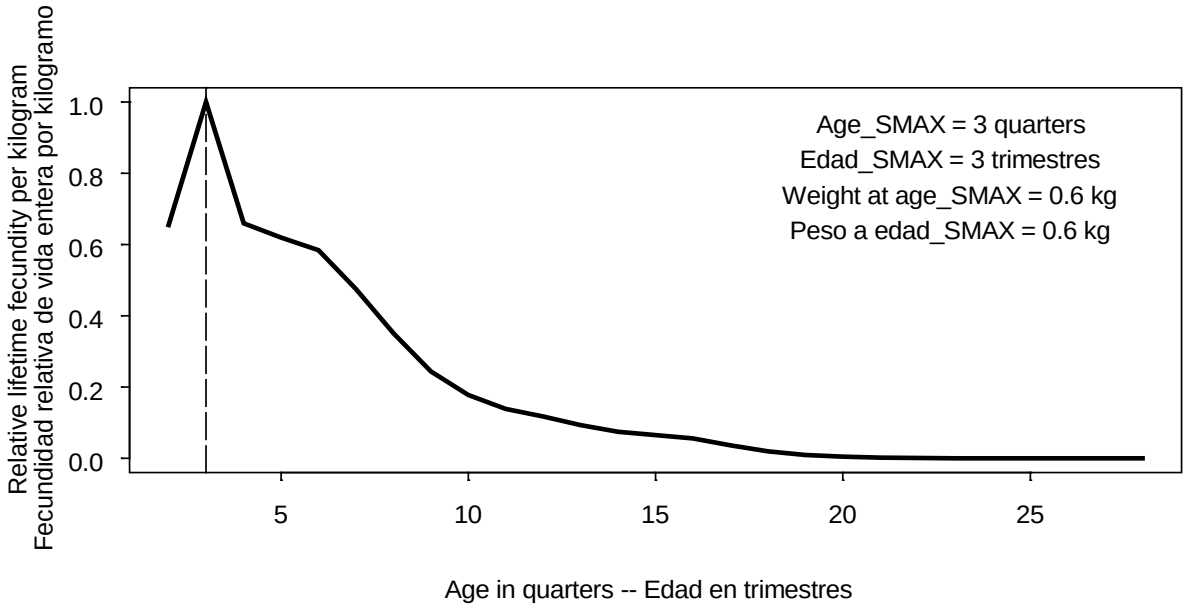

Relative population fecundity
Fecundidad relativa de la poblacion
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
Fishing mortality relative to current fishing mortality
Mortalidad por pesca relativa a la mortalidad por pesca actual

Critical Weight

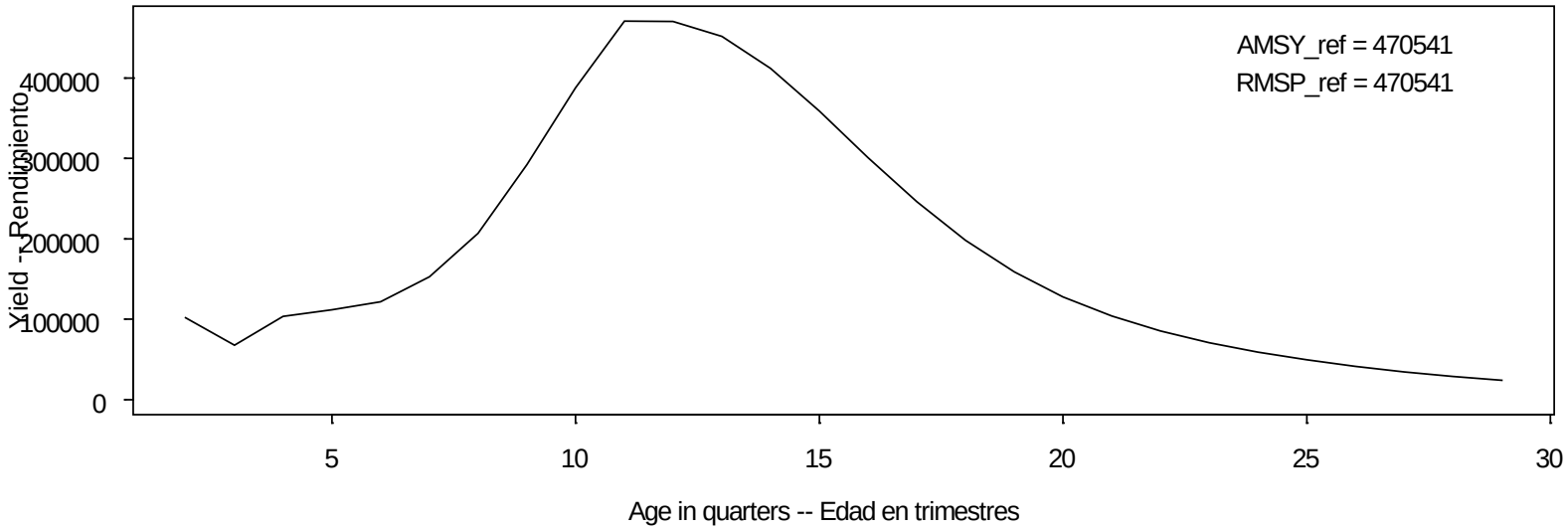


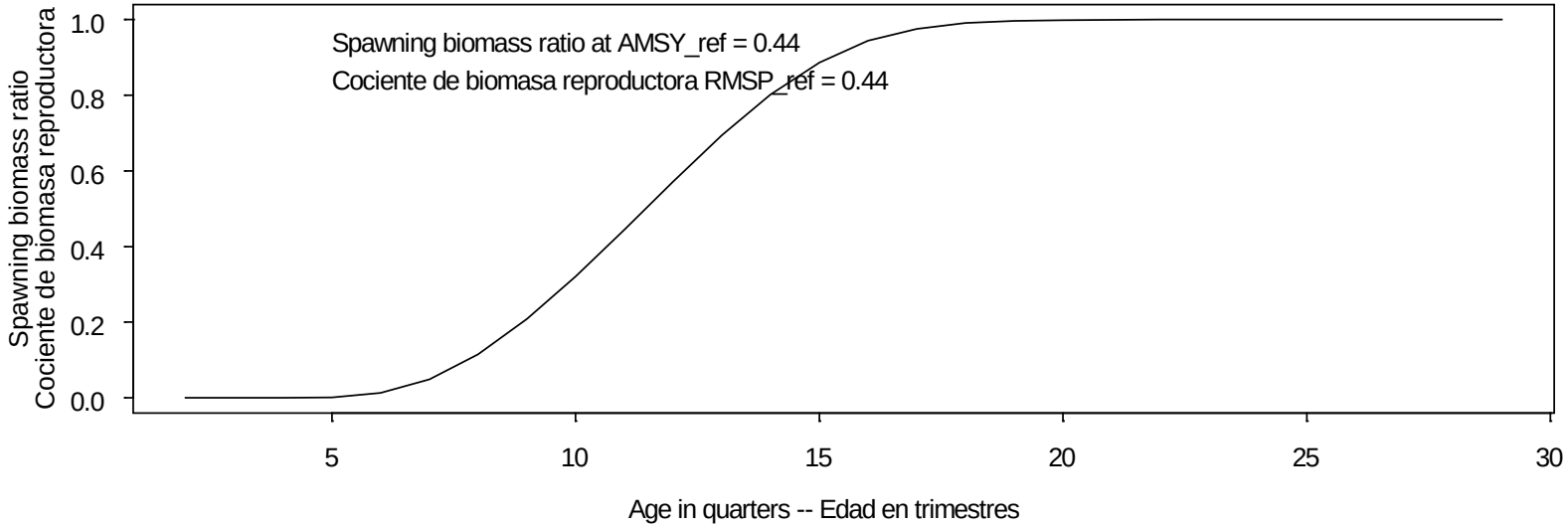


Lifetime Fecundity

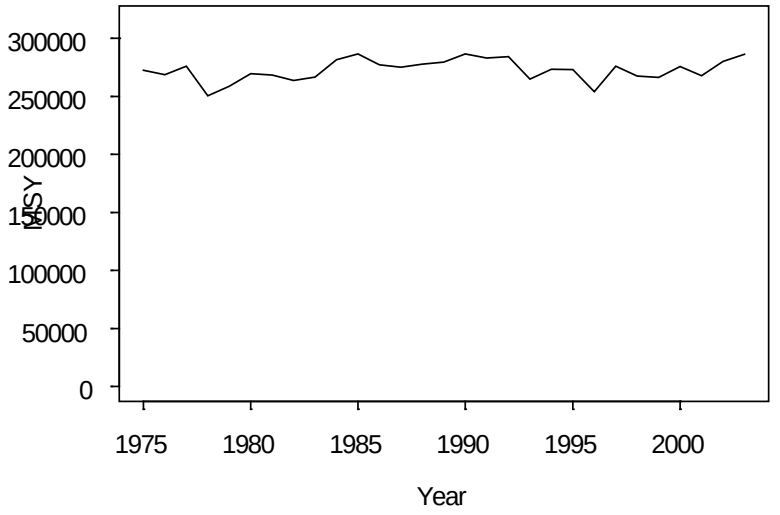


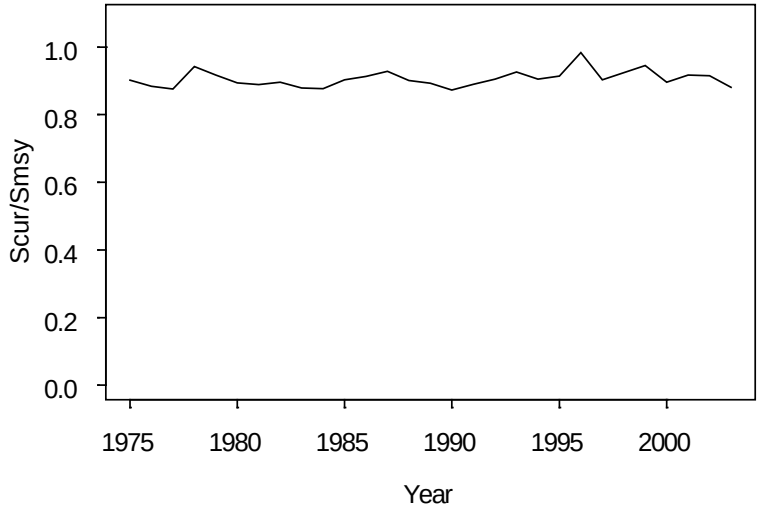
MSY_{ref} and SBR_{ref}

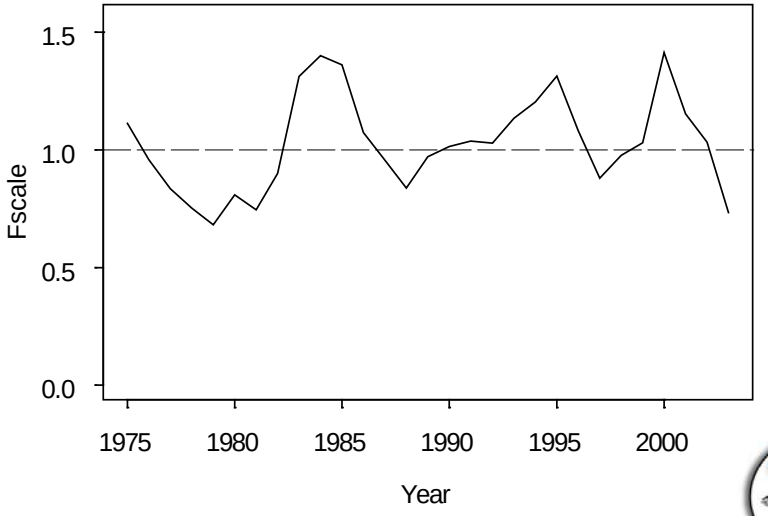




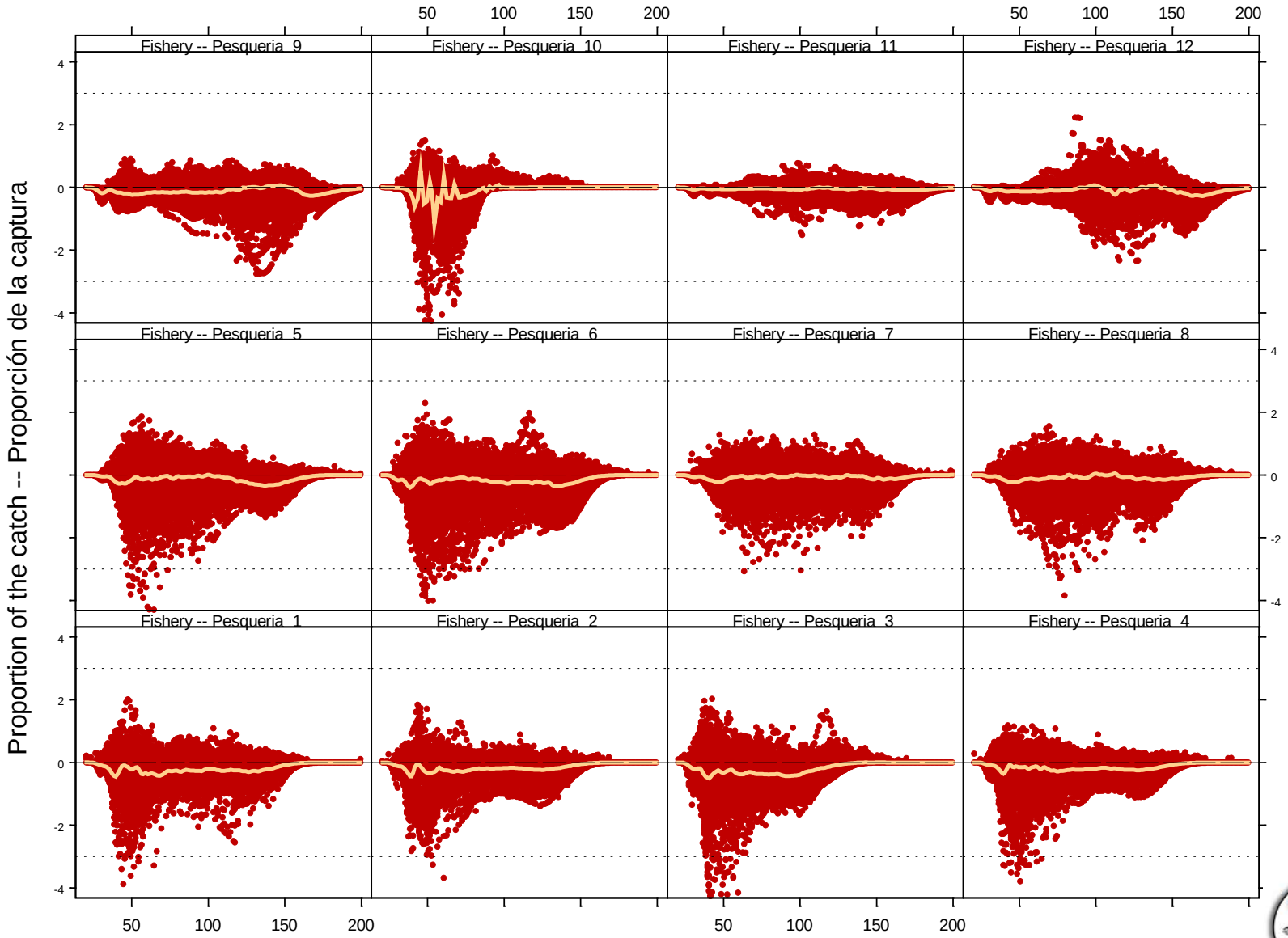
AMSY quantities using F(y)



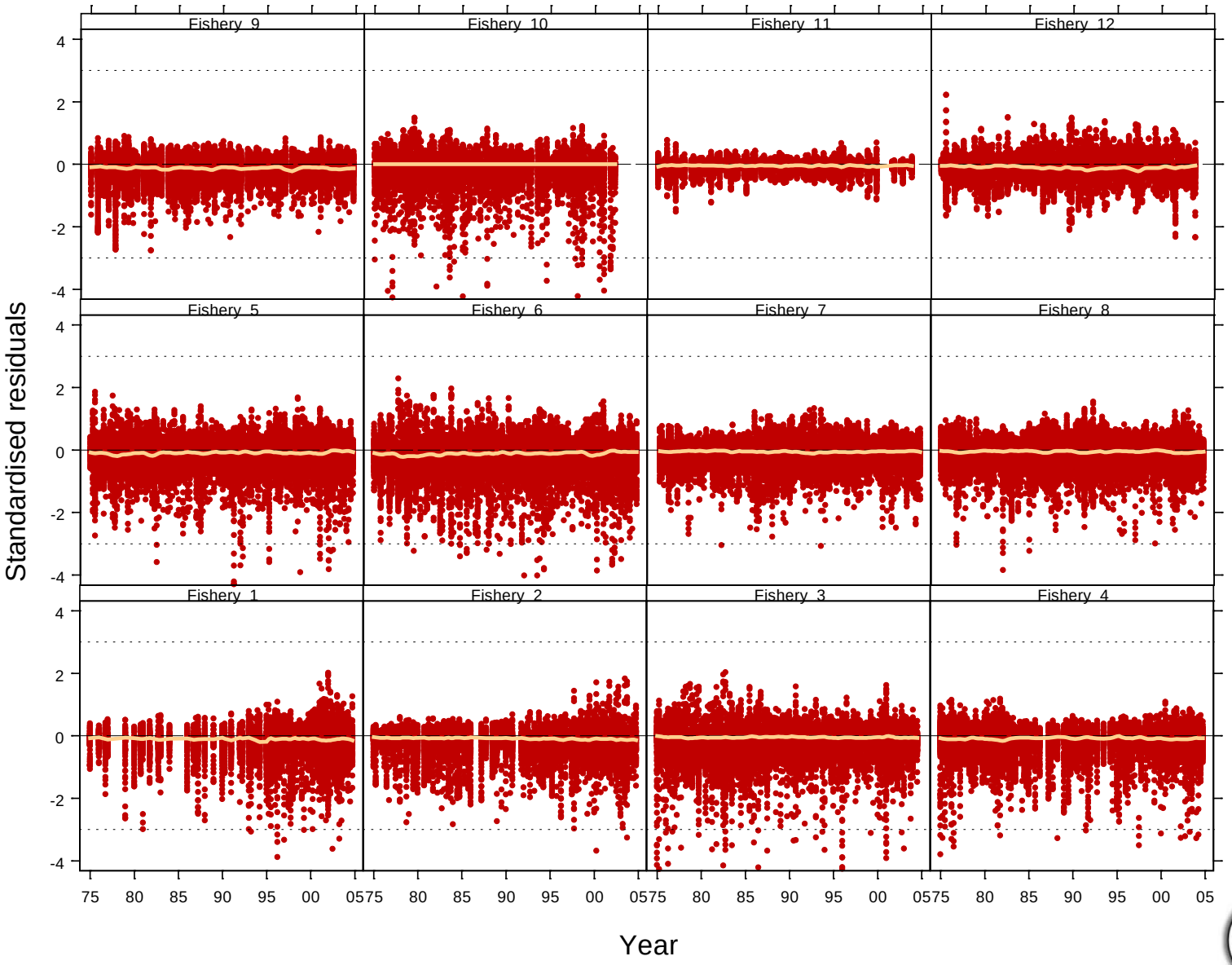




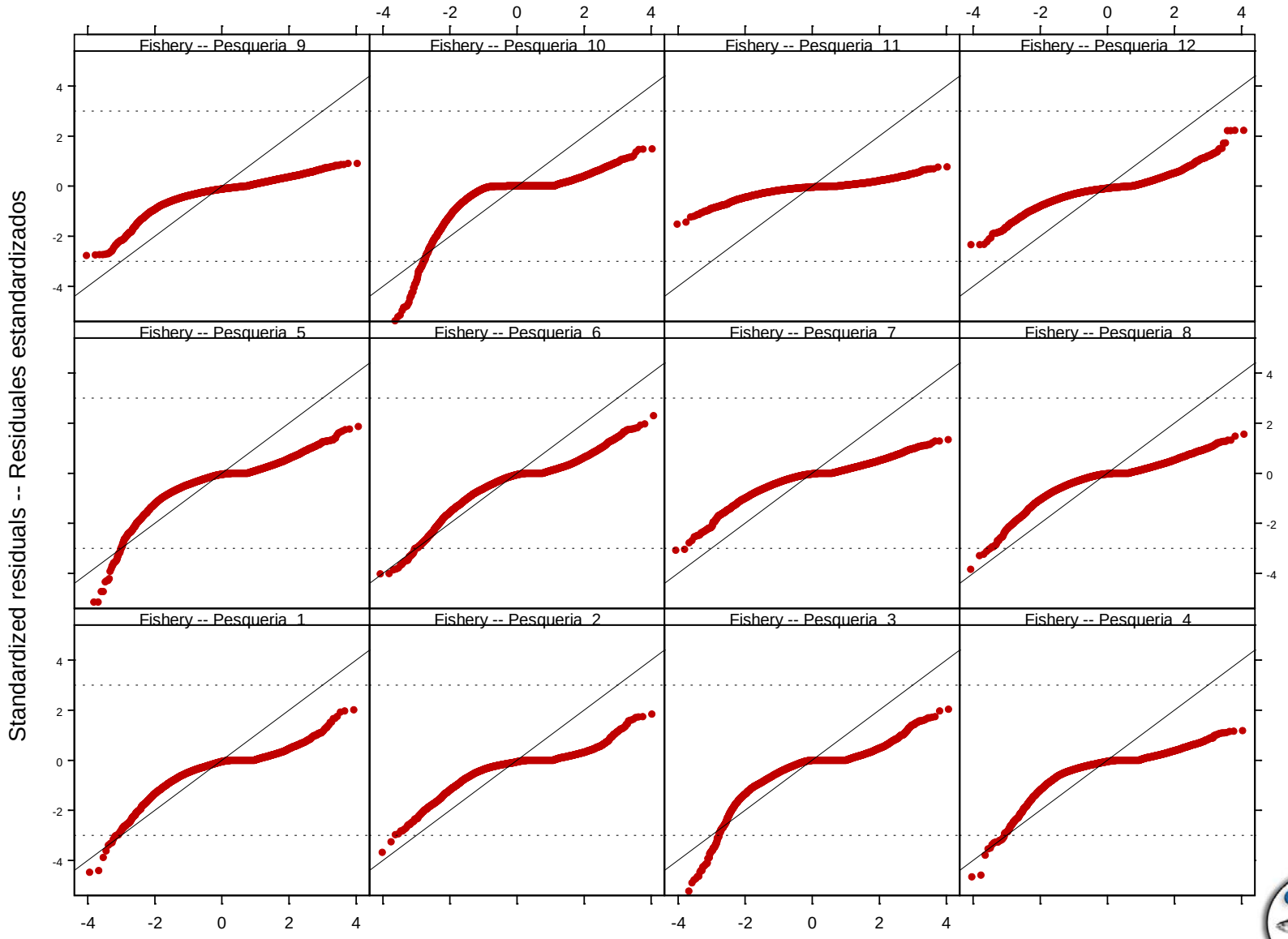
Length-frequency residuals - length



Length-frequency residuals - time



Length-frequency residuals - qqnorm

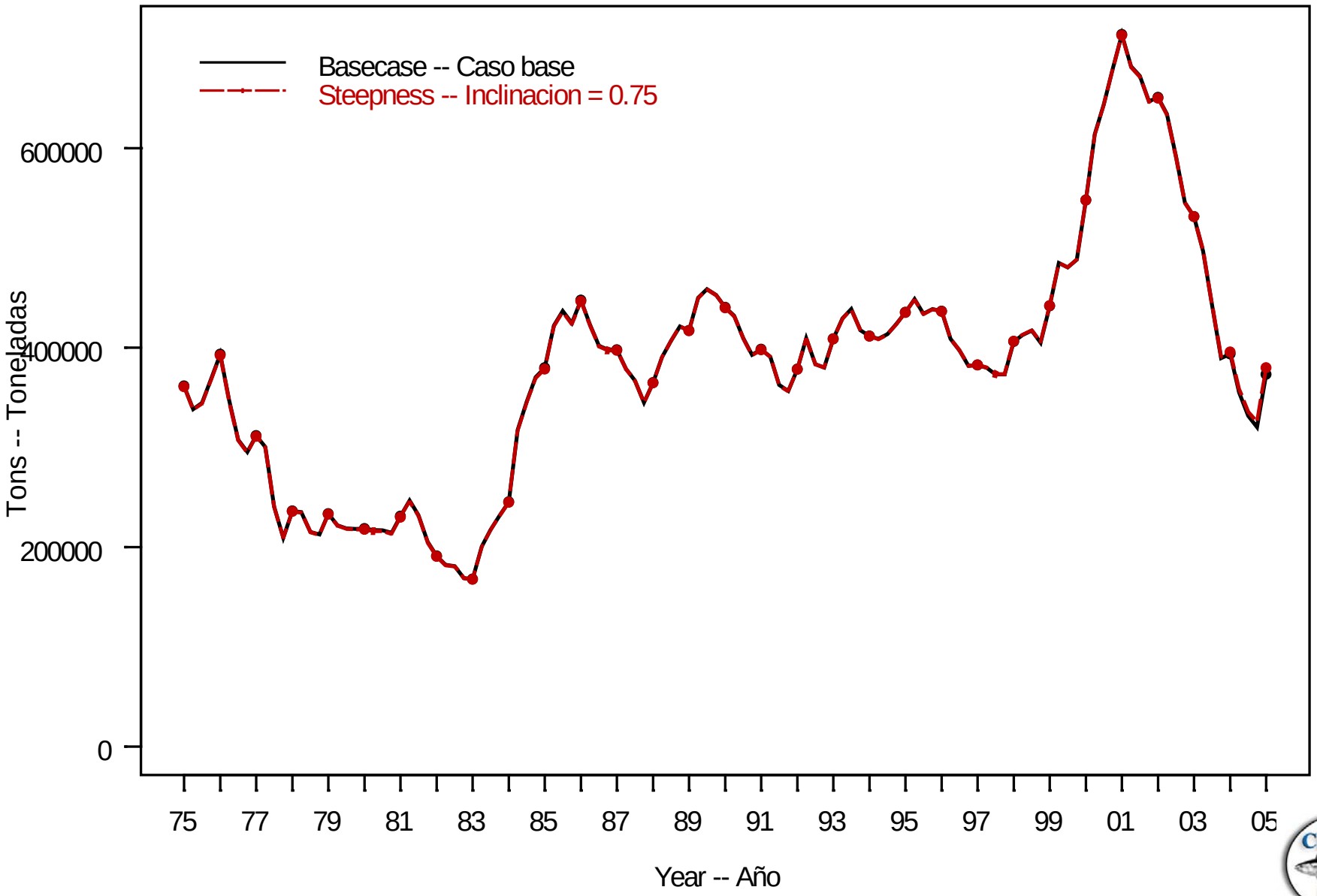


Sensitivity: h = 0.75

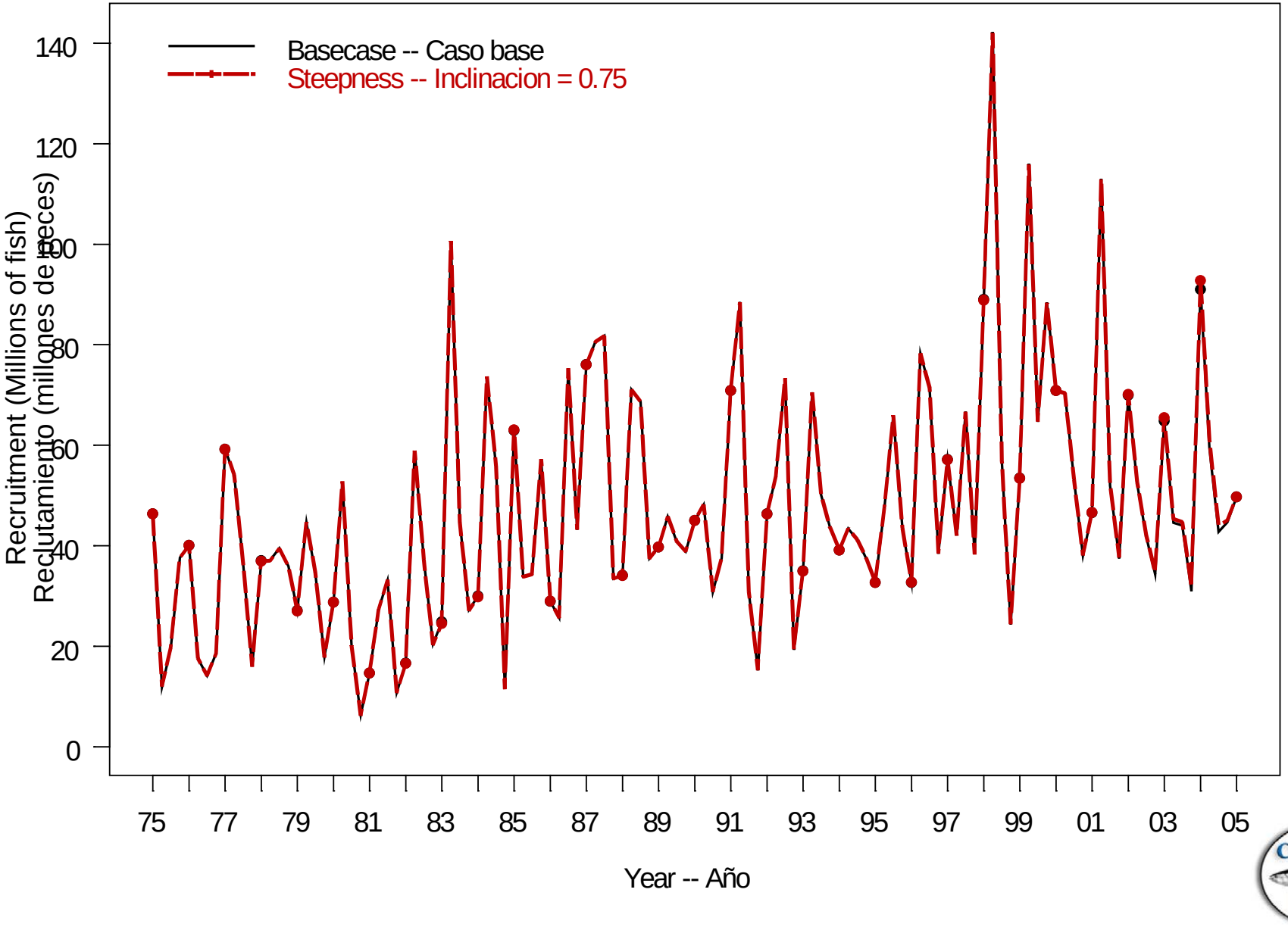
- When the spawning population is 20% of its unexploited level the recruitment is 75% of its unexploited level

- Biomass
- Recruitment
- SBR
- Yield Curve
- AMSY

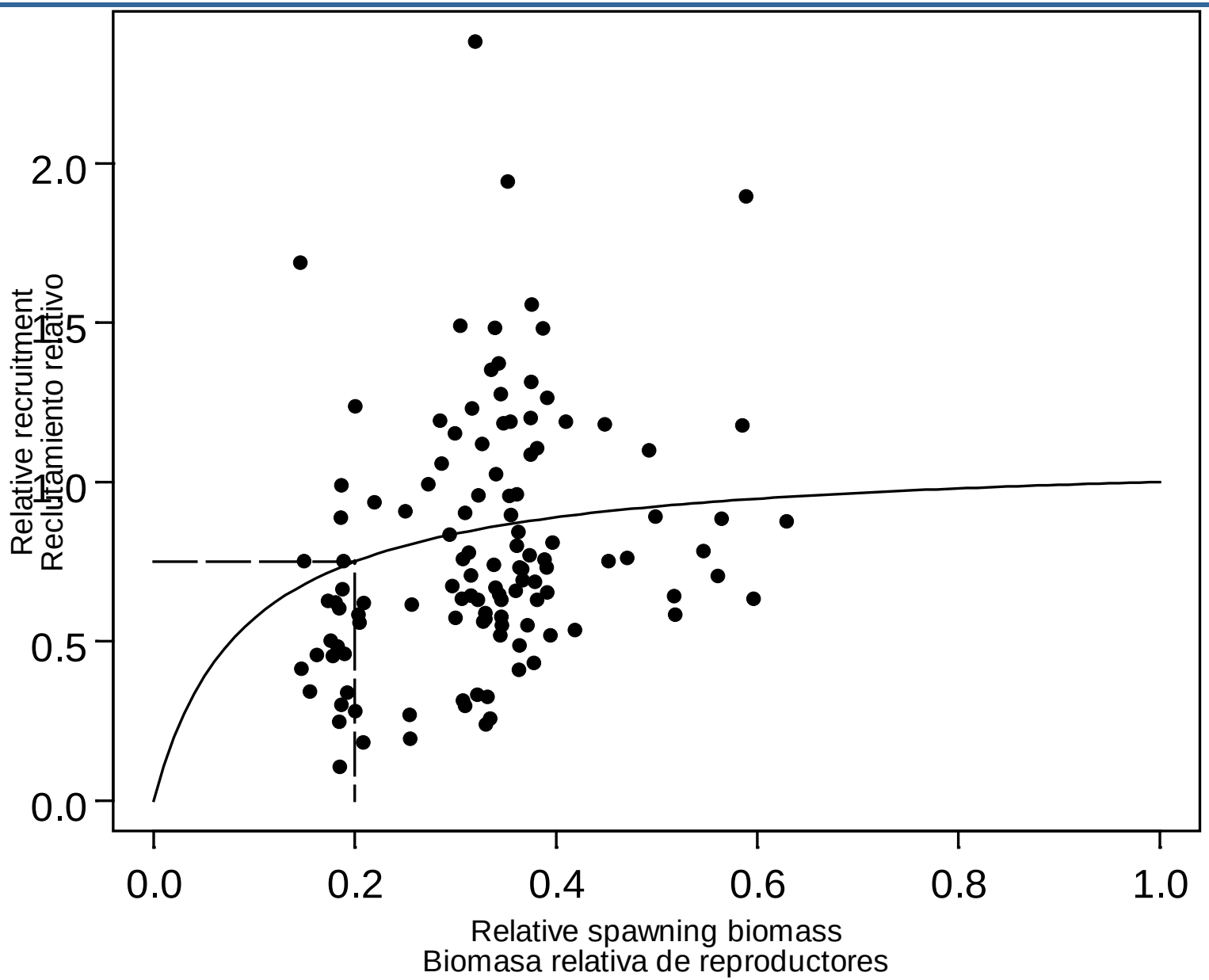
Biomass Comparison



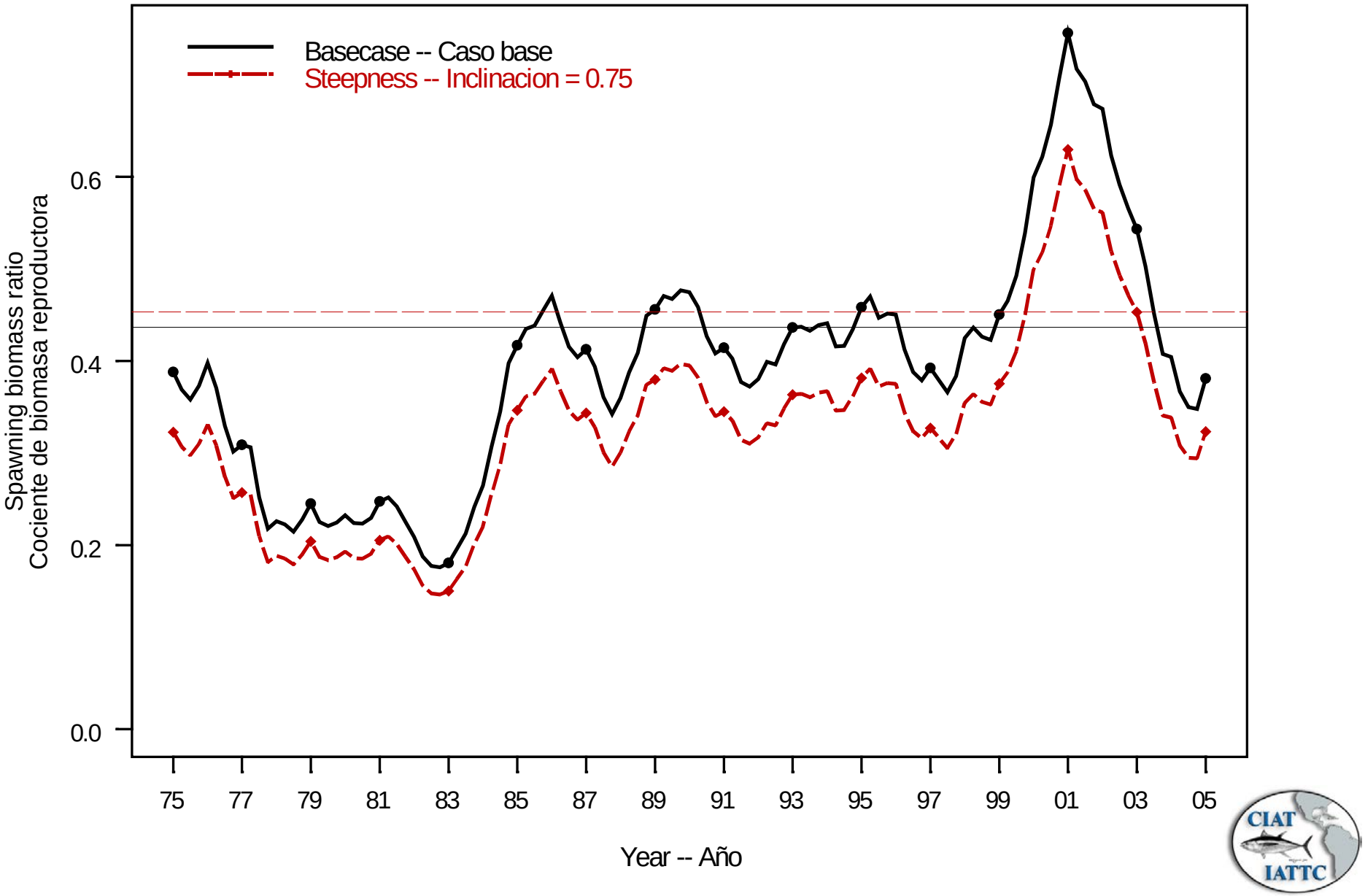
Recruitment



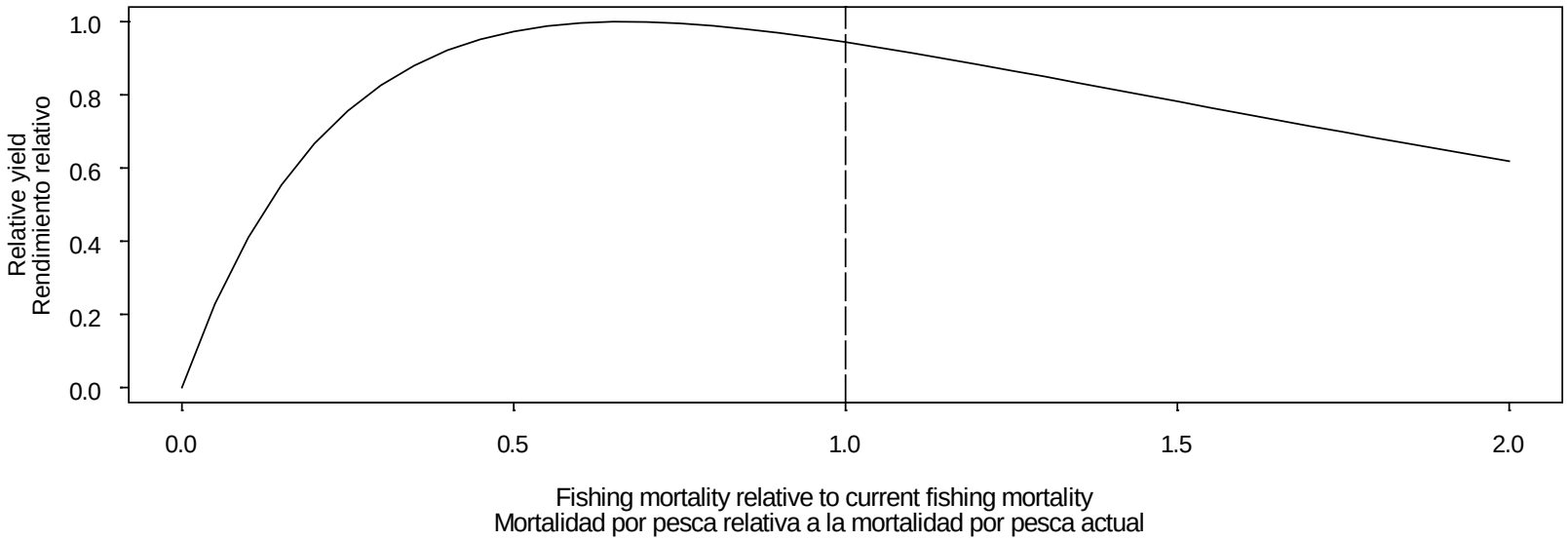
Recruitment

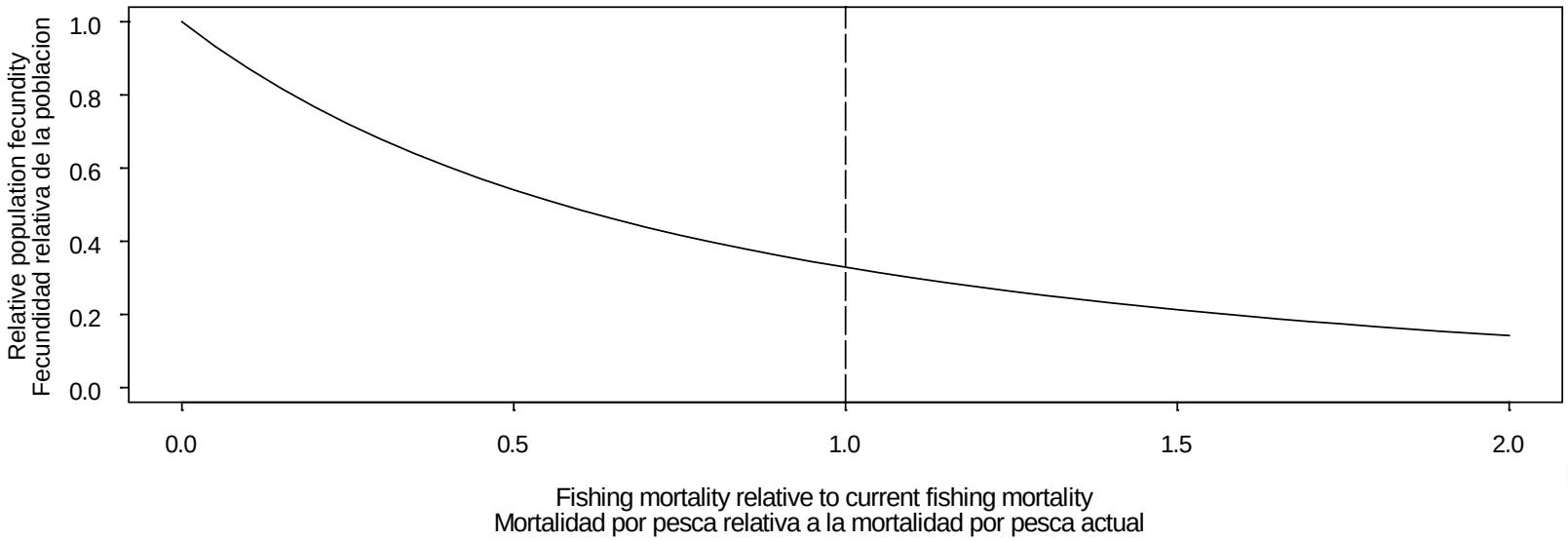


SBR


Basecase -- Caso base
Steepness -- Inclinacion = 0.75
Spawning biomass ratio
Cociente de biomasa reproductora
0.0
0.2
0.4
0.6
75
77
79
81
83
85
87
89
91
93
95
97
99
01
03
05
Year -- Año

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

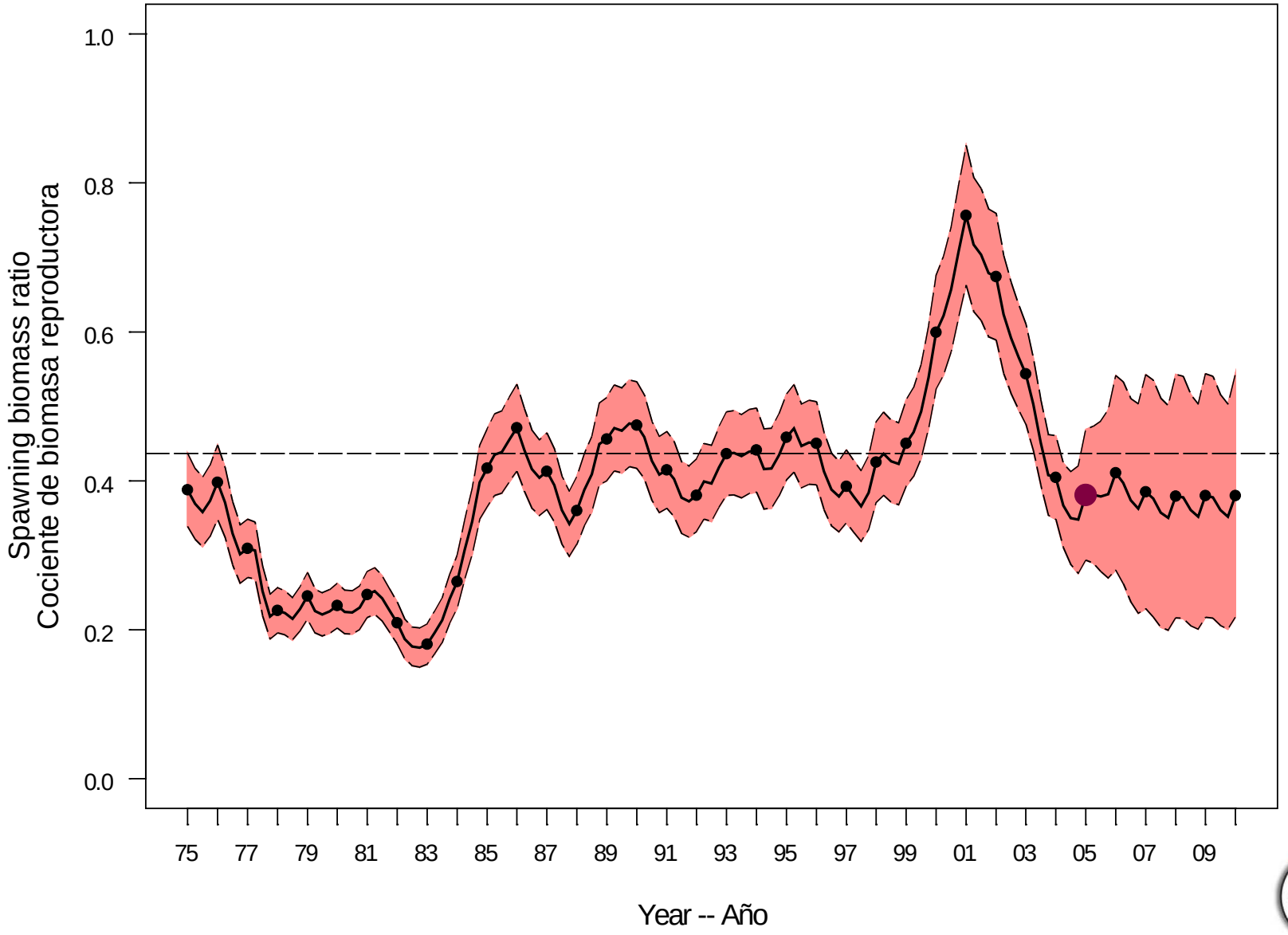
AMSY table

	Base case Caso base	h = 0.75 h = 0.75
AMSY–RMSP	284,707	306,775
B_{AMSY} –B_{rm2}	419,598	531,276
S_{AMSY} —S_{rm2}	8,144	10,141
C_{RECENT}/AMSY—C_{2002}/RMSP	1.04	0.97
B_{RECENT}/B_{AMSY} –B_{2003}/B_{RMSP}	0.89	0.72
S_{RECENT}/S_{AMSY} –S_{2003}/S_{RMSP}	0.87	0.71
$S_{AMSY}/S_{F=0}$ –$S_{RMSP}/S_{F=0}$	0.44	0.45
F multiplier—Multiplicador de *F*	0.83	0.67

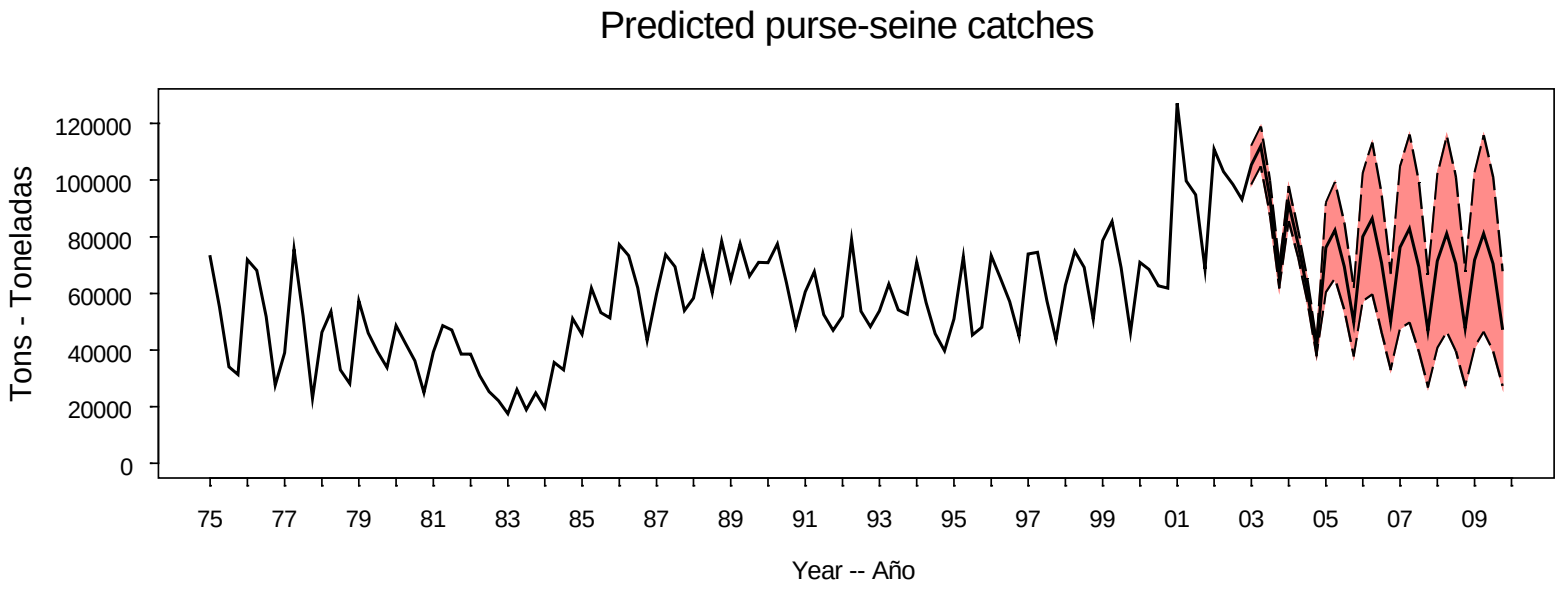
Forward Simulations

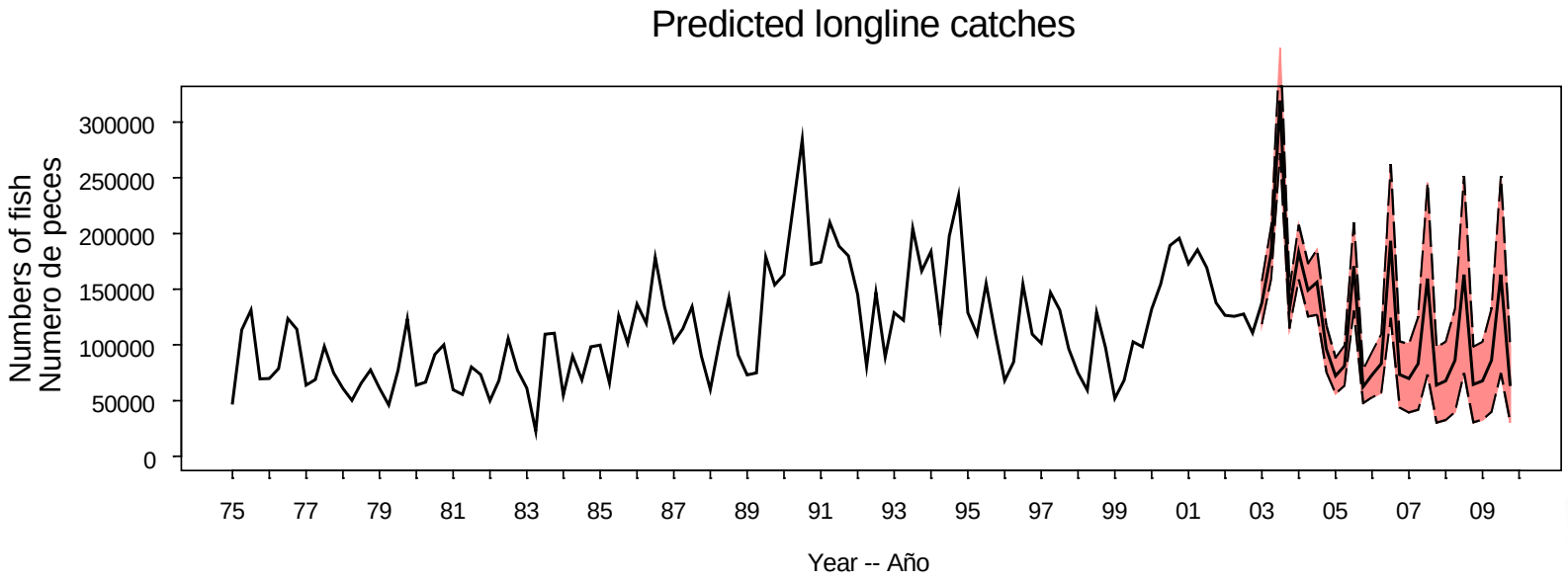
- Spawning biomass ratio
- Surface fishery catch
- Longline catch
- Effects of restrictions

SBR

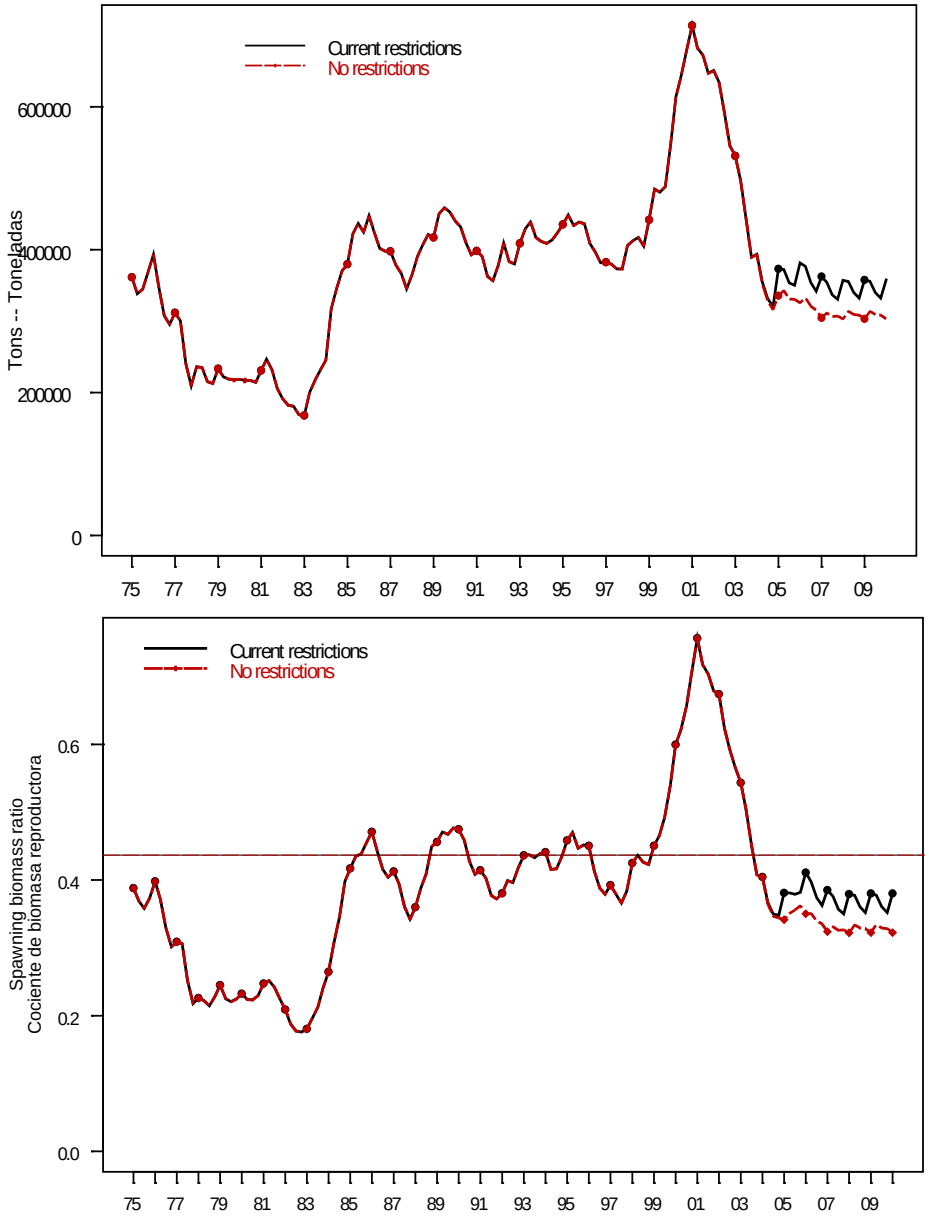

Spawning biomass ratio
Cociente de biomasa reproductora
1.0
0.8
0.6
0.4
0.2
0.0
75
77
79
81
83
85
87
89
91
93
95
97
99
01
03
05
07
09
Year -- Año

Catch


Predicted purse-seine catches
Tons - Toneladas
120000
100000
80000
60000
40000
20000
0
75 77 79 81 83 85 87 89 91 93 95 97 99 01 03 05 07 09
Year -- Año


Predicted longline catches
Numbers of fish
Numero de peces
300000
250000
200000
150000
100000
50000
0
75 77 79 81 83 85 87 89 91 93 95 97 99 01 03 05 07 09
Year -- Año

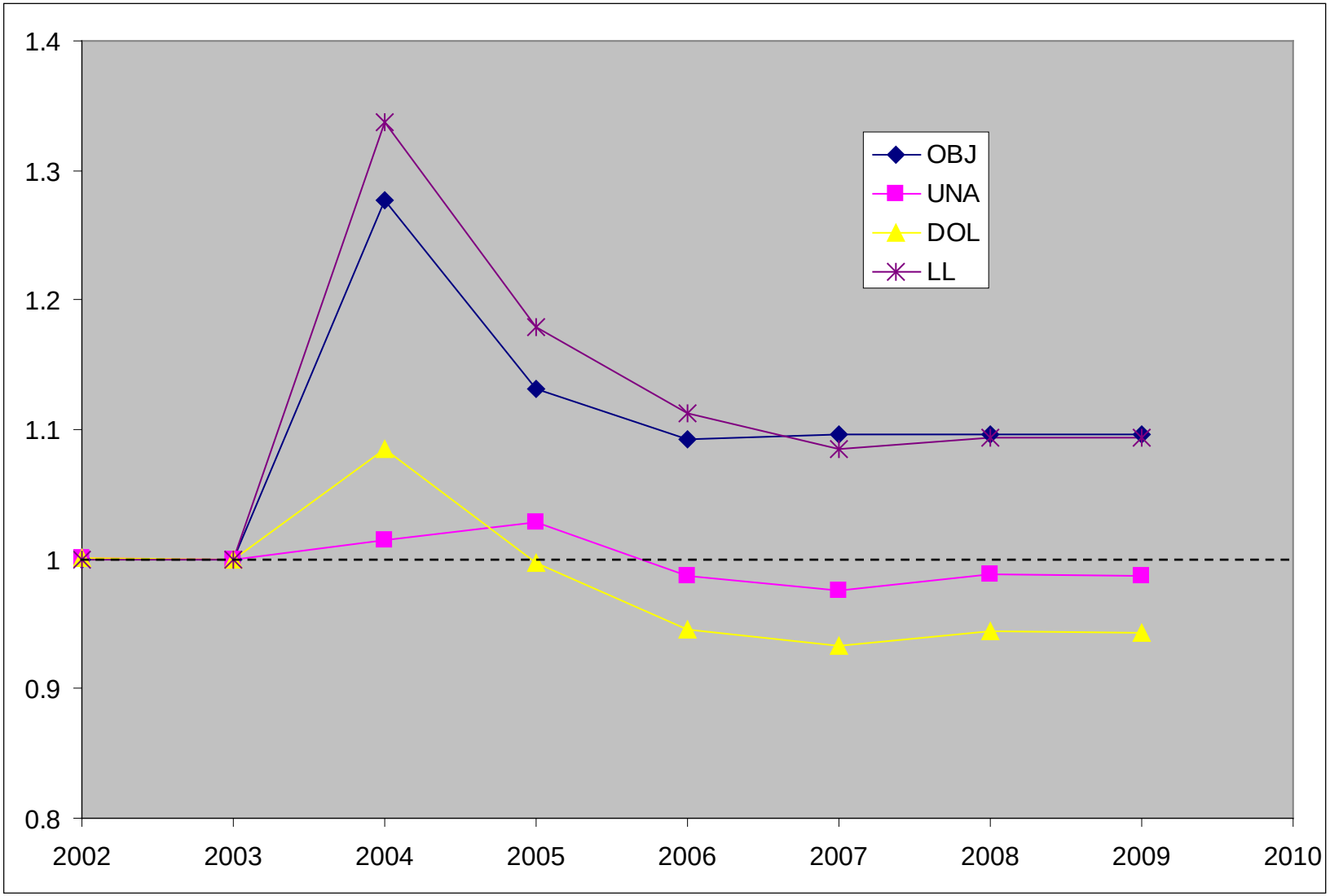
With & w/o closure (Biomass & SBR)



Spawning biomass and catch with and without current restrictions

	End of year spawning biomass		Basecase catch		No restrictions catch	
Year	**Basecase**	**No restrictions**	**Purse seine**	**Longline**	**Purse seine**	**Longline**
2004	7104	6369	270477	24499	293845	33329
2005	7659	6532	276478	15621	279732	18734
2006	7183	6038	286070	16820	275465	19028
2007	7073	6007	274225	15148	260963	16722
2008	7087	6013	269458	15253	259468	16977
2009	7087	6014	269882	15271	259655	16984

Ratio of predicted ‘catch with restrictions’ to ‘catch without restrictions’, by gear type



Summary: Main Results

- The results are similar to the previous four assessments, except that SBR at SBR_{AMSY} is higher than in the last assessment
- The biomass is estimated to have declined very slightly in 2004
- There is uncertainty about recent and future recruitment and biomass levels

What is robust

- The trend in biomass
- The regime shift in recruitment

Plausible Sensitivities and Uncertainties

- The stock recruitment relationship
- Uncertainty in current biomass and recruitment

Conclusions

1. The current SBR may be slightly below the SBR required to produce AMSY
2. The current fishing mortality rates are higher than those required to produce AMSY
3. The average weight of a yellowfin in the catch is much less than the critical weight and increasing the average weight could increase AMSY
4. There have been two different productivity regimes and the levels of AMSY and the biomass required to produce AMSY may differ between the regimes

The END