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Biomass and yield estimates for alfonsino in BYX 2 for the 1991–92 fishing year

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BIOMASS AND YIELD ESTIMATES FOR ALFONSINO IN BYX 2 FOR THE 1991–92 FISHING YEAR

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1. INTRODUCTION

1.1 Overview

This document provides a stock assessment and yield estimates for alfonsino in BYX 2. Biomass is estimated using an age and sex structured model.

1.2 Description of the fishery

Alfonsino are commonly found along the East Coast from Tuaheni Rise (Gisborne) to Campbell Bank (Kaikoura) in depths of 200-400 m. Most fish reported as BYX is alfonsino Beryx splendens, although a minor proportion of the landings is red bream Beryx decadactylus.

The first domestic landings were recorded in 1981. Domestic target trawl fishing for alfonsino, with traditional bottom trawl gear, began in 1983. Catches rose rapidly with the introduction of a semipelagic trawl enabling fishing over foul ground (Horn and Massey 1989). Grounds fished during the early part of the fishery were the Palliser Bank and the Motukura Ridge (Fig. 1). From 1984/85, effort extended to other grounds including the Kaiwhata Ridge, Madden Canyon, Paoanui Ridge and the Tuaheni Rise. Since 1986/87 most target fishing, primarily by midwater trawl, has occurred at night when alfonsino form dense feeding schools.

1.3 Recent papers

Horn (1989) reviewed the history of the alfonsino fishery and the biological data on alfonsino. The literature relevant to New Zealand alfonsino is also summarised in Horn (1989). Massey and Horn (1990) described growth and age structure of alfonsino from the North Island from catch sampling data.

2.0 REVIEW OF THE FISHERY

2.1 TACs, catch, landings and effort data

Alfonsino has supported a major mid-water trawl fishery in QMA 2 since 1983. Major grounds are Palliser Bank, Tuaheni Rise, Ritchie Banks and Paoanui Ridge.

The original gazetted TAC for BYX 2 of 1,510 t was based on 1983/84 landings. The TAC for BYX 2 was reduced from 1,630 t to 1,274 t during the 1989/90 fishing year.

(a) TACs and landings

Reported landings are given in Table 1. Landings are also compared to actual TACs since the introduction of the Quota Management System in Table 1. Landings since 1982/83 have fluctuated considerably, peaking in 1985/86 at 1,880 t. Since then landings have declined to around 1,500 t in 1989/90 (Fig. 2).

Table 1. Alfonsino landings and TACs in BYX 2.

Fishing year	Landings (t)	Actual TAC (t)
1982/83	658	
1983/84	1,483	
1984/85	1,608	
1985/86	1,880	
1986/87	1,387	1,510
1987/88	1,252	1,511
1988/89	1,598	1,630
1989/90	1,496	1,274

Sources of landing data:

1982/83-1984/85; FSU computer extracts.
1985/86-1989/90; MAFFish Quota Monitoring System.

(b) CPUE data

CPUE data have been used to monitor the QMA 2 alfonsino/bluenose trawl fishery (Horn 1988, Horn and Massey 1989, Ryan and Stocker 1991). Methods and assumptions are found in those documents. The unit of fishing effort for the trawl fishery is a 24 hour day spent targeting alfonsino, for one trawler.

The earlier data was summarised by calendar year. In this document the data has been converted to fishing years (i.e. October-September) and more recent data included. Catch and effort is presented by fishing ground for alfonsino and bluenose (Table 2). The CPUE values and corresponding coefficients of variation (C.V.) are used in the following analysis.

The decline in commercial CPUE (Fig. 3) for BYX 2 in this assessment is considerably less than that estimated in the 1990 assessment. There are two reasons for the difference in the estimated rate of decline: (1) The 1990 assessment estimated the rate of decline for each individual ground and then averaged the decline across all grounds, while the current assessment uses the rate of decline for all grounds combined. (2) Differences in the data sets and time periods used.

Table 2. Alfonsino/bluenose QMA 2 trawl catch (t), effort (days), and catch per unit effort (CPUE) data by fishing ground. c.v. = coefficient of variation

Fishing Year	Catch effort	Fishing Ground							Total	CPUE	c.v. (%)
		Palliser	Motukura	Kaiwhata	Other	Tuaheni	Paoanui	Madden			
1982–83	BYX	611.9			45.7				657.6	9.26	11.9
	BNS	24.6			0.8				25.4		
	days	60			11				71		
1983–84	BYX	639.8	84.5		428.2				1152.5	6.82	7.3
	BNS	298.4	36.3		87.6				422.3		
	days	93	10		66				169		
1984–85	BYX	30.2	283.7	26.3	331.2	307	37.2		1015.6	5.90	8.1
	BNS	19.9	125.5	2.3	97.4	86.5	69.5		401.1		
	days	9	39	5	84	26	9		172		
1985–86	BYX	448.6	184.3	3.3	452.9	237.8	148.3	3.7	1478.9	6.09	6.2
	BNS	199.6	82.4	7.4	75.4	92.0	176.7	0.3	633.8		
	days	91	47	5	43	35	20	2	243		
1986–87	BYX	291.7	62.9	67.6	387.6	139.6	277.9	1.7	1229.0	3.88	7.7
	BNS	112.1	37.0	83.7	265.5	20.3	481.0	0.9	1000.5		
	days	105	23	23	49	37	75	5	317		
1987–88	BYX	328.4	3.3	5.4	319.3	127.3	367.3	0	1151.0	4.43	10.4
	BNS	139.0	2.4	5.9	124.5	15.0	179.8	0.1	466.7		
	days	107	7	8	58	35	44	1	260		
1988–89	BYX	86.1	51.3		986.7	46.9	47.5		1218.5	5.56	8.6
	BNS	46.4	15.6		342.7	10.8	2.2		414.7		
	days	31	19		152	9	8		219		
1989–90	BYX	375.7	479.2	4.2	301.9	31.2	259.2		1451.4	4.76	6.5
	BNS	102.3	292.7	7.0	58.0	9.5	87.7		557.2		
	days	87	117	8	36	16	41		305		

Notes (1) 1983–1988 FSU data; 1987–1990 QMS data.
(2) Catch given in tonnes greenweight.
(3) Effort is the no. of 24 hr vessel-days of target fishing on alfonsino.

3.0 RESEARCH

3.1 Stock structure

It is not known whether there is more than one stock of alfonsino in New Zealand (Horn 1988).

3.2 Resource surveys

No surveys for measuring the biomass of alfonsino in QMA 2 have been successful (Horn and Massey 1989)

3.3 Other studies

The effect on the CPUE index of recent changes in fishing patterns is being examined.

3.4 Biomass estimates

An age and sex-structured model (Hilborn et al. 1991) was used to estimate the virgin biomass (B_0) and current biomass for alfonsino in BYX 2. The modelling procedure is very similar to the stock reduction method described by Francis (1990).

The dynamics of the population are described by a standard discrete age-time structured model (Walters 1969). Given a known catch history, some indices of abundance and life history parameters of the fish stock, a deterministic trajectory of stock biomass is estimated. The objective is to search over biological parameters that not only give the best fit between the model trajectory and the observed indices of abundance, but also give a posterior distribution of alternative hypothesis about the virgin biomass and current stock size. Two formulations of the catchability coefficient (q) were used (ln q and q) for calculating the posterior distributions of B_0.

The parameter values for growth, survival and recruitment are given in Table 3. Recruitment "steepness" refers to a parameter of the standard Beverton-Holt stock recruitment curve. It is the proportion of mean recruitment at virgin biomass that recruits when spawning biomass is reduced to 20% of virgin biomass.

Table 3.
Alfonsino life history parameters used in age and sex-structured stock reduction analysis. L_{inf}, k and t_0 are parameters of the von Bertalanffy growth equation; a and b are parameters of the length-weight relationship, $W = aL^b$.

Parameters	Females	Males
Estimate of natural mortality (M)	0.20	0.20
	0.23	0.23
age of recruitment (A_r)	5 yr	5 yr
age of maturity (A_m)	4 yr	4 yr
L_{inf} (cm)	57.5	51.1
k (yr^{-1})	0.08	0.11
t_0 (year)	-4.10	-3.56
a = 0.0226 b = 3.018		
recruitment "steepness" = 0.95		

Estimates of B_0 and biomass in October 1990 (B_{1990}) for each of the catchability assumptions, and alternative assumptions about M (M = 0.2 and M = 0.23) are given in Table 4. The two catchability assumptions and alternative natural mortality assumptions produced similar results.

Table 4. Results of stock reduction analysis for alfonsino BYX 2 for two assumptions about catchability (ln q and q), and alternative assumptions about natural mortality (M).

	ln q	q
a) M = 0.2		
B_0	18,800 t	19,000 t
B_{1990}	11,600 t	11,800 t
B_0/B_{1990}	0.62	0.62
b) M = 0.23		
B_0	17,500 t	17,500 t
B_{1990}	10,800 t	10,800 t
B_0/B_{1990}	0.62	0.62

The posterior distributions show the uncertainty about the true values of B_0 and B_{1990} (Figs. 4 and 5). Also shown are the equilibrium biomass values at the long-term sustainable yield using an $F_{0.1}$ fishing strategy (see section 3.5.1 below).

3.5 Yield estimates

3.5.1 Yield per recruit analysis

A yield per recruit analysis was carried out for alfonsino with the above growth, recruitment and mortality parameters to determine $F_{0.1}$. The method of Hilborn et al. (1991) with a Beverton and Holt stock-recruit model was used for the computations. The resulting estimates of $F_{0.1}$ for both sexes combined were 0.25 and 0.32 for M = 0.2 and M = 0.23 respectively.

3.5.1 Estimation of Maximum Constant Yield (MCY)

MCY was estimated using the equation MCY = 2/3*MSY (Method 3 of the "Guide"). MSY was estimated using the above age structured model with a Beverton and Holt stock recruitment relationship with an assumed "steepness" of 0.95. Two values of M were used (0.20 and 0.23). Two formulations of the catchability coefficient (q) were used (ln q and q). The results using the two formulations were either identical or very similar, so only the

results using q are shown here. The estimates of MCY (with corresponding 50% confidence intervals) are as follows:

M = 0.20

B_0	19,000 t	17,000-21,000 t
MSY	1,640 t	1,460- 1,800 t
MCY	1,110 t	980- 1,200 t

M = 0.23

B_0	17,500 t	15,500-19,500 t
MSY	1,790 t	1,580- 1,990 t
MCY	1,200 t	1,050- 1,330 t

The level of risk to the stock by harvesting the population at the estimated MCY value cannot be determined.

3.5.2 Estimation of Current Annual Yield (CAY)

CAY was calculated using the Baranov catch equation (Method 1 of the "Guide") with estimates of $B_{1991\text{-}92}$ and assuming F_{ref} is equal to $F_{0.1}$. The beginning-of-season biomass for 1991/92 ($B_{1991\text{-}92}$) was estimated by running the model forward from the estimate of B_0 using the reported landing history. The 1990/91 catch was assumed to be the TAC of 1,274 t. The fishing mortality rates of $F_{0.1}$ = 0.25 (for M = 0.20) and 0.32 (for M = 0.23) were applied to the beginning-of-season biomass estimates for 1991/92 to estimate CAY for 1991/92. Estimates of B_0, $B_{1991\text{-}92}$, $CAY_{1991\text{-}91}$, long-term equilibrium biomass using an $F_{0.1}$ strategy, B_{equil} and Yield @ $F_{0.1}$ with corresponding 50% confidence intervals for the two natural mortality assumptions are as follows:

M = 0.20

B_0	19,000 t	17,000-21,000 t
$B_{1991\text{-}92}$	11,400 t	9,400-13,500 t
$CAY_{1991\text{-}92}$	2,050 t	1,690- 2,430 t
B_{equil}	6,600 t	5,900- 7,300 t
Yield @ $F_{0.1}$	1,480 t	1,320- 1,640 t

M = 0.23

B_0	17,500 t	15,500-19,500 t
$B_{1991\text{-}92}$	10,600 t	8,600-12,600 t
$CAY_{1991\text{-}92}$	2,280 t	1,850- 2,700 t
B_{equil}	6,000 t	5,310- 6,680 t
Yield @ $F_{0.1}$	1,610 t	1,430- 1,800 t

3.5.3 Other yield estimates

$F_{0.1}$ for the combined sexes, together with an assumed Beverton and Holt stock-recruitment model without recruitment variability, was used to calculate the $F_{0.1}$ yield. This long-term stable yield is 9% of B_0 and occurs at a biomass of 35% of B_0. The estimate of $B_{1991\text{-}92}$ is greater than the equilibrium biomass and the estimate of $CAY_{1991\text{-}92}$ is substantially greater than the $F_{0.1}$ yield.

4. MANAGEMENT IMPLICATIONS

The fishery for alfonsino in QMA 2 is relatively new. For both estimates of M, $CAY_{1991\text{-}92}$ is substantially greater than the $F_{0.1}$ yield, and the fishery is still in the fishing down phase. The current TAC of 1,274 t is less than the two estimates of $F_{0.1}$ yield and is considered sustainable. Current landings (1,478 t reported in 1989/90) are closer to the $F_{0.1}$ yield and are considered sustainable.

Management strategies for alfonsino in QMA 2 should also consider implications for the bluenose fishery in QMA 2. Bluenose is a major by-catch of alfonsino and the fisheries are linked.

The decline in commercial cpue for BYX 2 in this assessment is considerably less than that estimated in the 1990 assessment. There are two reasons for the difference in the estimated rate of decline: (1) The 1990 assessment estimated the rate of decline for each individual ground and then averaged the decline across all grounds, while the current assessment uses the rate of decline for all grounds combined. (2) Differences in the data sets and time periods used. This has consequently resulted in a higher estimate of CAY from the current assessment than from the 1990 assessment. The large difference in the rate of decline of the cpue data as estimated by the 1990 and 1991 assessments highlights the great sensitivity of the results to the assumptions made in the analysis and suggests a degree of uncertainty in the resulting yield estimates.

5. REFERENCES

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FIGURE CAPTIONS

Figure 1. Lower east coast North Island, showing the major commercial grounds for alfonsino and bluenose and the fishing return areas 011-016 (After Horn and Massey 1989).

Figure 2. Catch (tonnes) and effort (days) for alfonsino BYX 2, 1983-90. The unit of fishing effort, for one trawler, is a 24 hour day spent targeting alfonsino.

Figure 3. CPUE (tonnes/day) and coefficient of variation (%) for alfonsino BYX 2, 1983-90.

Figure 4. Posterior distributions of probable values of B_0, corresponding to results of the stock reduction analysis (with M = 0.2) presented in Table 4. Comparing the effect of two formulations of the catchability coefficient (q) and (ln q), and showing corresponding values of $B_{1991\text{-}92}$ and B_{equil}.

Figure 5. Posterior distributions of probable values of B_0, corresponding to results of the stock reduction analysis (with M = 0.23) presented in Table 4. Comparing the effect of two formulations of the catchability coefficient (q) and (ln q), and showing corresponding values of $B_{1991\text{-}92}$ and B_{equil}.

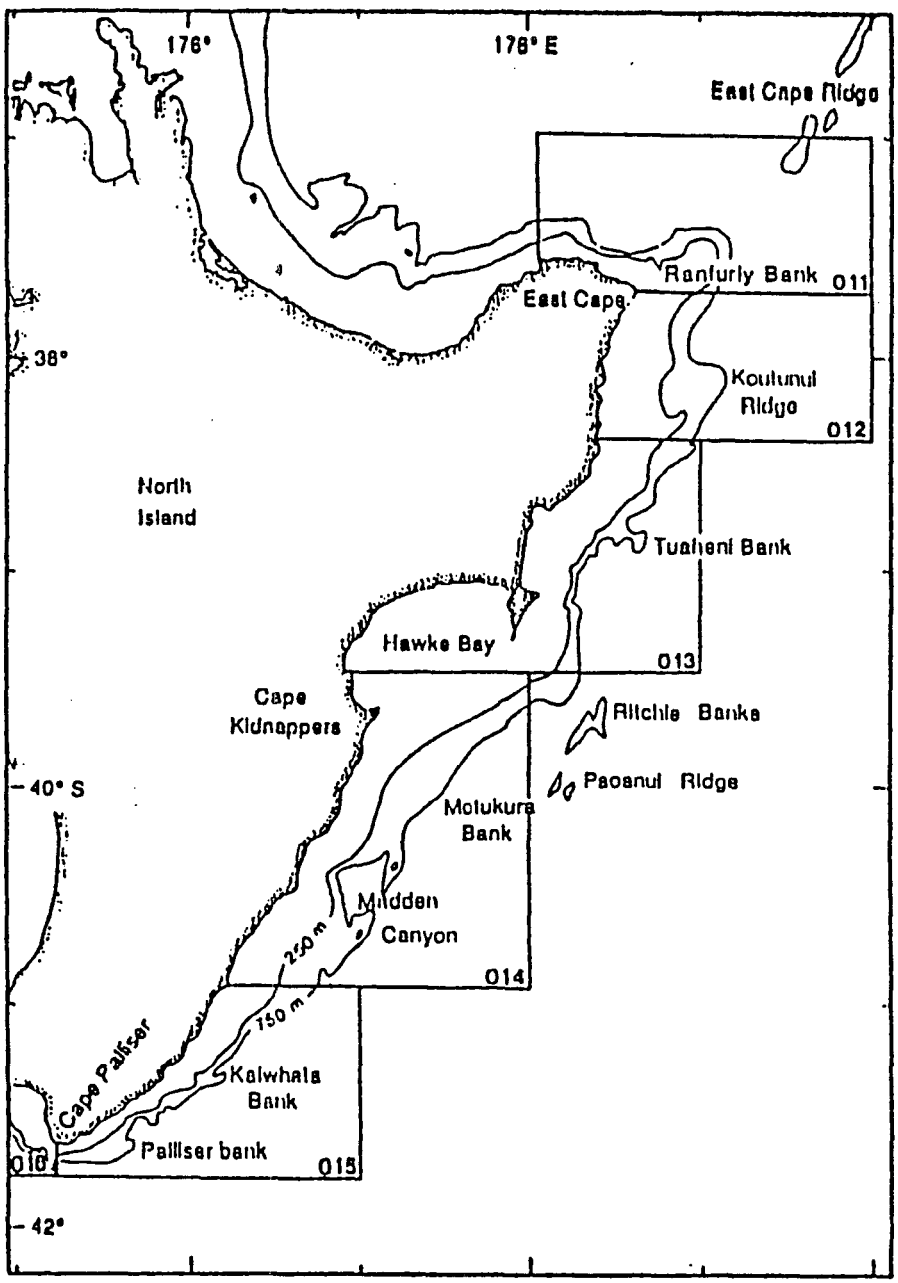
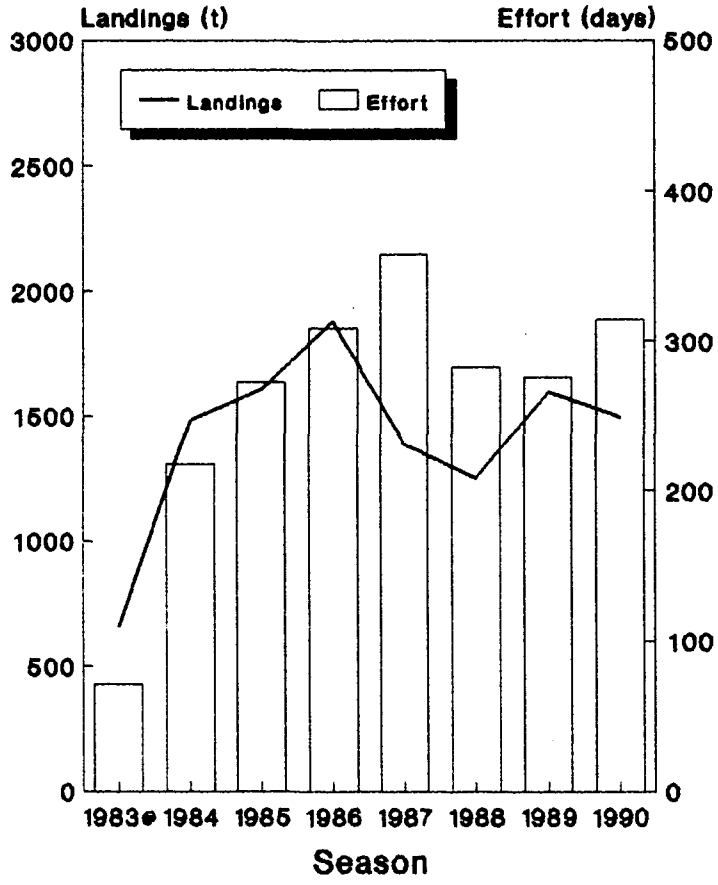

176°
178° E
East Cape Ridge
Ranfurly Bank
011
East Cape
38°
Koutunui
Ridge
012
North
Island
Tuahenl Bank
Hawke Bay
013
Cape
Kidnappers
Ritchie Banks
Paoanui Ridge
40° S
Motukura
Bank
Madden
Canyon
250 m
014
750 m
Cape Palliser
Kaiwhata
Bank
Palliser bank
016
015
42°

Figure 1:

Figure 2

Alfonsino (QMA2)



*Fishing Season Sept. 1 '82- Oct. 31 '83

Figure 3

Alfonsino (QMA2)

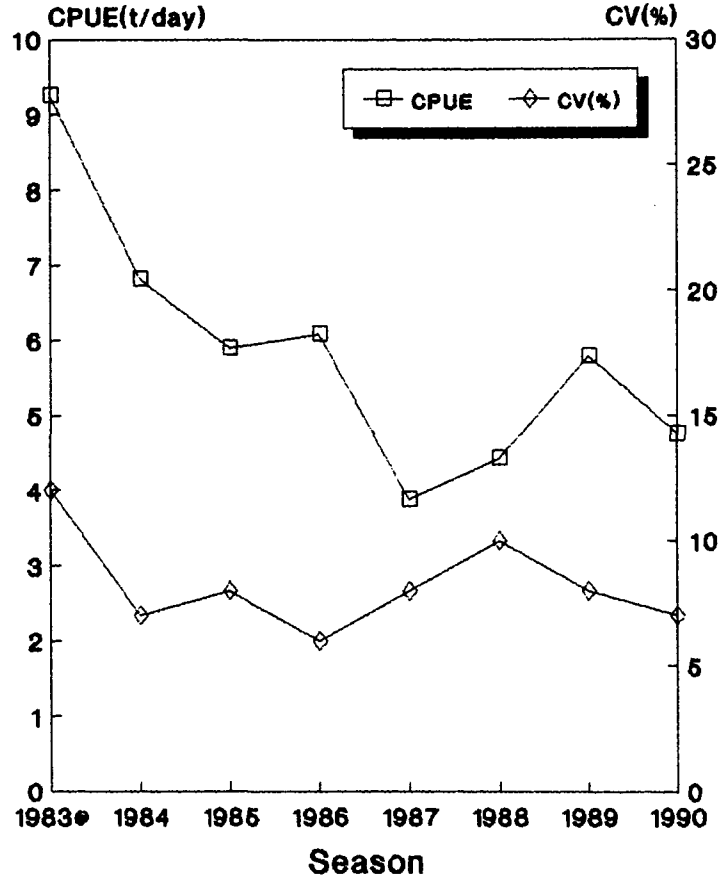


Figure 4

Alfonsino (QMA2): M = 0.2

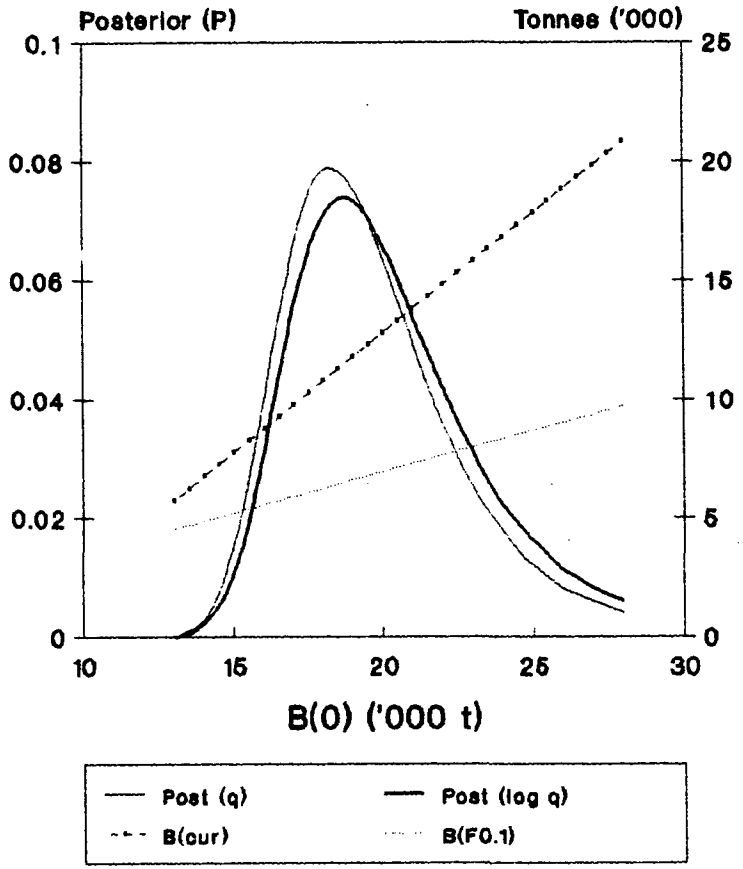


Figure 5

Alfonsino (QMA2): M = 0.23