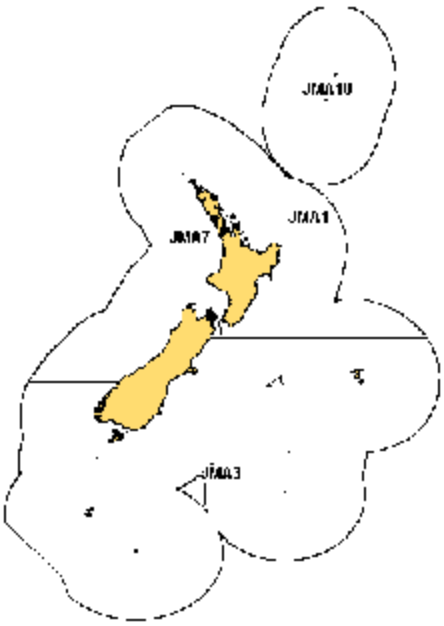
JACK MACKERELS (JMA)

(*Trachurus declivis, Trachurus novaezelandiae, Trachurus murphyi*)



1. FISHERY SUMMARY

The jack mackerel fisheries catch three species; two New Zealand species, *Trachurus declivis* and *T. novaezelandiae*, and the more recently arrived *T.. murphyi* (the Peruvian jack mackerel).

Jack mackerels have been included in the QMS since 1 October 1996, with four QMAs. Previously jack mackerels were considered part of the QMS, although ITQs were issued only in JMA 7. In JMA 1 and JMA 3 quota for the fishery was fully allocated as IQs by regulation with the exception of the 20% allocated to Maori. Before the 1995 jack mackerel regulations were issued, catch in JMA 1 taken in the Muriwhenua area north of 36°S to the limit of the Territorial Sea was not covered by the JMA 1 regulations. Allowances for customary fishers, recreational fishers and an allowance for other sources of mortality have not yet been set.

(a) Commercial fisheries

In JMA 1, the jack mackerel catch is largely taken by the purse-seine fishery operating in the Bay of Plenty and on the east Northland coast, which was, prior to 1992, dominated by *T. novaezelandiae*, but included a small component of *T. declivis*. Between 1991–92 and 1995–96 the proportion of *T. murphyi* in the catch increased considerably, and markets were developed for large jack mackerels, but, by 1996–97, their low value resulted in less targeting of large fish. In 1999–00 and 2000–01, the proportion of *T. novaezelandiae* in the catch had returned to approximately 95%. Some trawl bycatch of jack mackerel is recorded in JMA 1.

Little targeting of jack mackerel occurred in JMA 3 before 1992–93. During the 1990s targeting increased, but has decreased again in recent years. The major component of the catch in this area comes from trawl bycatch on the Chatham Rise and in the Southland/Subantarctic region, which is almost exclusively *T. murphyi*. A small purse-seine fishery operates between the Clarence River mouth and the Kaikoura Peninsula.

Increased availability of jack mackerels caused by the influx of *T. murphyi* resulted in increased quotas in JMA 1 and JMA 3, to 8 000 t and 9 000 t respectively for the 1993–94 fishing year, and a further

increase to 10 000 t and 18 000 t respectively for the 1994–95 year. The latter increases were made under the proviso that they be accounted for by increased catches of *T. murphyi* only; combined landings of *T. declivis* and *T. novaezelandiae* in JMA 1 and JMA 3 must not exceed the original quotas of 5 970 t and 2 700 t respectively. Industry agreed to these limits and voluntarily introduced monitoring programmes to provide the information necessary for them to be met.

The three species occur in each of the Fishstocks, but are not individually distinguished in catch records. Landings and TACs for 1983–84 to 2004–05 are shown for all Fishstocks in Table 1. The landings in 2004-05 are the second highest since 1983-84 and just under 10 000 t greater than in 2003-04.

Table 1: Reported landings (t) of jack mackerel by Fishstock from 1983–84 to 2001–02 and actual TACs (t) for 1986–87 to 2004–05.

QMA	JMA 1		JMA 3		JMA 7		JMA 10		Total	
	Landings	TAC	Landings	TAC	Landings	TAC	Landings	TAC	Landings§	TAC
1983–84*	3 682	–	715	–	12 464	–	0	–	16 880	–
1984–85*	1 857	–	1 223	–	16 013	–	0	–	19 659	–
1985–86*	1 173	–	2 228	–	10 002	–	0	–	14 773	–
1986–87†	4 056	5 970	1 638	2 700	19 815	20 000	0	10	25 509	28 680
1987–88†	3 108	5 970	1 883	2 700	17 827	22 697	0	10	22 818	31 377
1988–89†	2 986	5 970	1 919	2 700	17 402	26 008	0	10	22 308	34 688
1989–90†	4 226	5 970	4 013	2 700	21 776	32 027	0	10	30 102	40 707
1990–91†	6 472	5 970	6 403	2 700	17 786	32 069	0	10	30 661	40 749
1991–92†	7 017	5 970	5 779	2 700	25 880	32 069	0	10	38 676	40 749
1992–93†	7 529	5 970	15 399	2 700	24 767	32 536	83	10	47 778	41 216
1993–94‡	14 256	8 000	9 115	9 000	22 377	32 536	0	10	45 748	49 546
1994–95‡	7 832	10 000	11 519	18 000	18 913	32 536	0	10	38 264	60 546
1995–96†	6 874	10 000	19 803	18 000	12 270	32 536	0	10	38 947	60 546
1996–97†	6 912	10 000	15 687	18 000	12 056	32 536	0	10	34 655	60 546
1997–98†	7 695	10 000	15 452	18 000	14 292	32 536	0	10	37 439	60 546
1998–99†	5 767	10 000	15 111	18 000	13 574	32 536	0	10	37 439	60 546
1999–00†	2 866	10 000	10 306	18 000	7 889	32 536	0	10	21 061	60 546
2000–01†	8 360	10 000	2 744	18 000	15 703	32 536	0	10	26 806	60 546
2001–02†	5 247	10 000	5 000	18 000	22 338	32 536	0	10	32 586	60 546
2002-03†	6 172	10 000	2 225	18 000	26 084	32 536	0	10	34 483	60 546
2003-04†	7 396	10 000	705	18 000	28 883	32 536	0	10	36 989	60 546
2004-05†	9 418	10 000	716	18 000	36 497	32 536	0	10	46 631	60 546

* FSU data.
§ Includes landings from unknown areas before 1986–87.
† QMS data – MHR in recent years.
‡ JMA 1 & 3 landings are totals from CLR & CELR data.

Landings in JMA 1 before 1989–90 were generally well below the quota of 5 970 t, the maximum only slightly above 4 000 t. Landings increased to 7 529 t in 1992–93 followed by a substantial increase to the highest recorded value of 14 256 t in 1993–94, which was more than twice the original quota and exceeded the quota of 8 000 t set for that year. In 1994–95 reported landings (7 832 t) were half those of 1993–94. Landings from 1994–95 to 1997–98 were around 7 000 t. Since 1997–98 landings have fluctuated with no real pattern between a low of 2 866 t in 1999–00 to a high of 8360 t in 2000–01.

Total landings in JMA 3 over the period 1984–85 to 1988–89 were relatively constant, at a level below the quota, at 2700 t. Landings increased over subsequent years to peak in 1992–93 at almost three times that of the preceding year and more than five times the quota (Table 1). Under the first of two consecutive annual increases to the JMA 3 TACC in 1993–94 landings approached the limit set, but fell below the higher TACC level in 1994–95. The lower 1994–95 catch relative to 1992–93 has been

attributed to the delayed implementation of the quota, less targeting of jack mackerel, and low bycatch in the squid trawl fishery. The reduced effort is thought to be a result of marketing difficulties for the relatively low valued *T. murphyi*. Landings in JMA 3 increased markedly in 1995–96 (19 803 t) to a value exceeding the quota, with catches remaining stable around 15 500 t over three subsequent years. More recently, landings have decreased to levels well below the TAC, with only 2 225 t recorded in 2002–03, 705 t in 2003–04 and 716 t in 2004-05.

Landings in JMA 7 represent the greatest proportion of total landings and are mainly taken by chartered trawlers. Landings fluctuated between 17 402 t and 25 880 t from the mid 1980s through the mid 1990s. The marked decrease to 12 270 t in 1995–96 is attributed to changes in fishing strategies (midwater trawling was not allowed under a new code of practice to eliminate dolphin bycatch in JMA 7), a major company withdrew from the fishery for much of the season and marketing was difficult for the relatively low valued *T. murphyi*.

From 1995–96 to 1998–99 landings were in the range 12 056–14 292 t. Recently, landings have increased steadily from 15 703 t in 2000–01 to 28 883 t in 2003–04 and in 2004-05 to 36 497 t. The 2004-05 landings were 3 961 t in excess of the TAC. This increase in JMA 7 landings has been attributed to market demand and a lack of availability of preferred species quota as a result of cuts in quotas for other species.

(b) Recreational fisheries

Jack mackerels do not rate highly as a recreational target species although they are popular as bait.

There is some uncertainty with all recreational harvest estimates for jack mackerels and there is some confusion between blue and jack mackerels in the recreational data. The harvest estimates from the diary surveys should be used only with the following qualifications: a) they may be very inaccurate; b) the 1996 and earlier surveys contain a methodological error; and, c) the 2000 and 2001 estimates are implausibly high for many important fisheries.

Recreational catch in the northern region (JMA 1) was estimated at 333 000 fish (c.v. 0.13) by a diary survey in 1993–94 (Bradford 1996), 79 000 fish (c.v. 0.16) in a national recreational survey in 1996 (Bradford 1998), 349 000 fish (c.v. 0.39%) in the 2000 survey (Boyd & Reilly 2002) and 295 000 fish (c.v. 0.2%) in the 2001 survey (Boyd et al. 2004). The surveys suggest a harvest of 80–110 tonnes per year for JMA 1, insignificant in the context of the commercial catch. Estimates from other areas are very low (between 500 and 47 000 fish) and are likely to be insignificant in the context of the commercial catch.

(c) Maori customary fisheries

Quantitative information on the current level of customary take is not available.

(d) Illegal catch

There is no information on illegal activity or catch but it is considered to be insignificant.

(e) Other sources of mortality

There is no information on other sources of mortality.

2. BIOLOGY

The three species of jack mackerel in New Zealand have different geographical distributions, but their ranges partially overlap. *T. novaezelandiae* predominates in waters shallower than 150 m and warmer than 13°C; it is uncommon south of latitude 42°S. *T. declivis* generally occurs in deeper (<300 m) waters less than 16°C, north of latitude 45°S. *T. murphyi* occurs to depths of least 500 m and has a wide latitudinal range (0°S to 50°S off South America).

T. murphyi was first described in New Zealand waters in 1987. It appears to have established itself off the south and east coasts of the South Island in the mid 1980s, and expanded to the west coast of the South Island and the North and South Taranaki Bights by the late 1980s, reaching the Bay of Plenty in appreciable quantities by 1992 and in June 1994 had become common on the east coast of Northland. The total range of *T. murphyi* now extends along the entire west coast of South America, across the South Pacific, through much of the New Zealand EEZ, and into waters off southeastern Australia.

All species can be caught by bottom trawl, midwater trawl, or by purse seine targeting surface schools.

The vertical and horizontal movement patterns are poorly understood. Jack mackerels are presumed to be generally off the bottom at night, and surface schools can be quite common during the day.

Jack mackerels have a protracted spring-summer spawning season. *T. novaezelandiae* probably mature at about 26–30 cm fork length (FL) at an age of 3–4 years, and *T. declivis* mature when about 26–30 cm FL at an age of 2–4 years. Spawning occurs in the North and South Taranaki Bights, and probably in other areas as well.

The reproductive biology of *T. murphyi* in New Zealand waters is not well understood. Pre- and post-spawning fish have been recorded from the Chatham Rise, Stewart-Snares shelf, Northland east coast and off Kaikoura in summer, but it is unknown whether there has been any resulting recruitment in New Zealand waters. A recent study showed that older size/age groups become increasingly dominant in catches as one moves westward from the South American coast, suggesting that an eastward migration of oceanic spawned fry and young occurs in the South Pacific.

Initial ageing of *T. murphyi* taken in New Zealand waters has been recently completed, but the estimates are yet to be validated. Initial growth is rapid, slowing at 6–7 years, and *T. murphyi* is a moderately long-lived species with a maximum observed age of 32 years. *T. novaezelandiae* and *T. declivis* have moderate initial growth rates that slow after about 6 years. Both species reach a maximum age of 25+ years.

The best available estimate of M for *T. novaezelandiae* and *T. declivis* is 0.18 based on the age-frequency distributions of lightly exploited populations in the Bay of Plenty. Assuming M = 0.18, estimates of Z made in 1989 suggest that F is less than 0.05 for both endemic species off the central west coast (the main jack mackerel fishing ground). Biological parameters relevant to the stock assessment are shown in Table 2.

Table 2: Estimates of biological parameters.

Fishstock	Estimate				Source
1. Natural mortality (M)					
All	M = 0.18 considered best estimate for both endemic species from all areas.				Horn 1991a
2. Weight = a (length)^b (Weight in g, length in cm fork length)					
	Species	**a**		**b**	
All	*T. declivis*	0.023		2.84	Horn 1991a
	T. novaezelandiae	0.028		2.84	Horn 1991a
3. von Bertalanffy growth parameters					
	Species	**K**	**t_0**	**L_∞**	
All	*T. declivis*	0.28	-0.40	46 cm	Horn 1991a
	T. novaezelandiae	0.30	-0.65	36 cm	Horn 1991a
	T. s. murphyi	0.155	-1.4	51.2 cm	Taylor et al. 2002.

3. STOCKS AND AREAS

There are no new data that would alter the stock boundaries given in previous assessment documents. For assessment purposes the three jack mackerel species are treated separately where possible.

There are two possible hypotheses on the stock structure of *T. murphyi* in New Zealand waters: it is either a separate stock established by fish migrating from South America, or part of a single, extensive trans-Pacific stock. While successful recruitment in New Zealand waters would indicate the establishment of a separate stock, current evidence favours the latter hypothesis with an extensive stock between latitudes 35–50° S, linking the coasts of Chile and New Zealand across what has been described as 'the jack mackerel belt'. Few detailed data are available to document the process of range expansion by *T. murphyi* or indicate the relative abundance of the three species in particular areas. Data from jack mackerel catch monitoring, which is a requirement of the increased TACCs introduced in 1994–95, will be useful in quantifying species composition and the relative abundance in JMA 1 and JMA 3.

4. STOCK ASSESSMENT

There are no new data that would alter the yield estimates given in the 1996 Plenary Report. Estimates of MCY for JMA 1 and JMA 3 have not changed since the 1993 Plenary Report. Other yield estimates have not changed since the 1991 Plenary Report. The yield estimates are based on biomass estimates from a stock reduction analysis and aerial sightings data.

(a) Estimates of fishery parameters and abundance

Estimates of fishery parameters are given in Table 3.

Table 3: Estimates of fishery parameters.

Parameter	Fishstock	Estimate	Comments	Source
F	JMA 7	0.05	During 1989	Horn 1991a
Z	JMA 7	0.22	During 1989	Horn 1991a
$F_{0.1}$	JMA 7	0.23	*T. declivis*	Horn 1991a
		0.33	*T. novaezelandiae*	Horn 1991a

(b) Biomass estimates

Biomass estimates are discussed in the section on estimation of MCY. Estimates of current biomass are not available.

(c) Estimation of Maximum Constant Yield (MCY)

(i) Challenger, Central (West) and part of Auckland (West) (QMAs 7, 8, and part of 9)

MCY was estimated in the early 1990s for the two endemic jack mackerel species separately using the equation MCY = 2/3 MSY (Method 3). The deterministic MSY values (8.8% and 14.7% of B_0 for *T. declivis* and *T. novaezelandiae* respectively) were calculated using a yield per recruit analysis and a Beverton and Holt stock-recruitment relationship with an assumed steepness of 0.95. B_0 was estimated using a backward projection of a stock reduction analysis that produced biomass trajectories over the period 1970–1990.

For *Trachurus declivis*, B_0 = 200 000 t,
MCY = 2/3 * (0.088 * 200 000 t) = 11 800 t

For *Trachurus novaezelandiae*, B_0 = 100 000 t,
MCY = 2/3 * (0.147 * 100 000 t) = 9800 t

Because these yield estimates are based on an assumed stock-recruitment relationship, they are highly uncertain.

(ii) Northland, Bay of Plenty, east coast North Island (QMAs 1 and 2)

Annual landings before 1990–91 ranged between a little more than 1000 t to less than 5000 t. Since then, landings have increased markedly as a result of the increased availability of *T. murphyi* to a maximum in excess of 14 000 t in 1993–94. Concerns about the assumptions used to produce the original yield estimate and the production of time series abundance indices from aerial sightings data resulted in a revised yield estimate in the mid 1990s. The aerial sightings indices showed little change in jack mackerel abundance estimates in JMA 1 between 1976 and 1990.

MCY was estimated in 1993 using the equation MCY = cY_{av} (method 4) incorporating the mean of removals from 1983–84 to 1989–90, before the *T. murphyi* invasion influenced total catches. It is assumed that this represents a period when fishing effort was relatively stable, thus satisfying the criterion for the use of method 4. The calculated MCY applies only to *T. declivis* and *T. novaezelandiae*.

Using M = 0.18 and therefore c = 0.8, MCY = 0.8 * 3013 = 2410 t (rounded to 2400 t).

(iii) Rest of the EEZ (QMAs 3–6)

Trawl surveys in QMAs 3–6 are not considered to be a suitable means to estimate biomass of jack mackerels, due primarily to the slow towing speed. Landings from JMA 3 have fluctuated widely since 1983–84, and were relatively high in the 1990s due probably to an increased abundance of *T. murphyi*.

For JMA 3 there are no available estimates of biomass and no series of catch data from a period of relatively constant fishing mortality. Therefore, it is not possible to estimate MCY for this Fishstock.

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

(d) Estimation of Current Annual Yield (CAY)

Estimates of current biomass are not available for any jack mackerel stock, so CAY cannot be estimated.

Yield estimates for *T. declivis* and *T. novaezelandiae* are shown in Table 4.

Table 4: Yield estimates for *T. declivis* and *T. novaezelandiae* (t).

Parameter	Fishstock	Estimate
MCY	JMA 1	2400
	JMA 3	Cannot be determined
	JMA 7	21 600
CAY	All	Cannot be determined

(e) Other yield estimates and stock assessment results

No other information is available for jack mackerels.

(f) Other factors

The estimates of MCY given above are likely to be conservative as they do not take into account the presence of the third species, *T. murphyi*, which is known to at times comprise a substantial proportion of the purse seine catches in the area between Cook Strait and Kaikoura, in the Bay of Plenty and on the east Northland coast. It is also the main trawl-caught mackerel on the Chatham Rise and the Stewart Island-Snares shelf region, is an important component of the west coast North Island jack mackerel trawl fishery, and has become an increasing proportion of jack mackerel catches on the west coast South Island. The increasing abundance of this species appears to have slowed. The effect of in *T. murphyi* on the range and abundance of the other two species are unknown.

Aerial sightings data were used to produce a time series of relative abundance indices for jack mackerel. The time series covered the period from the beginning of the purse-seine fishery in 1976, to 1993. They indicated increases in abundance in JMA 1 from the early 1990s, and, although the result is not as clear, similar trends in JMA 3 and JMA 7. These increases were attributed to the invasion of *T. murphyi*.

The stipulation that catches in JMA 1 and JMA 3 above the original TACs (5970 t and 2700 t, respectively) be accounted for by increases in *T. murphyi* only, is a method of managing this species independently of the other two. This approach was introduced as a means of maintaining stocks of the endemic species while allowing exploitation of increased stocks of *T. murphyi* resulting from its invasion.

5. STATUS OF THE STOCKS

Estimates of B_0 are available for *T. declivis* and *T. novaezelandiae* in JMA 7. Estimates of reference biomass are unavailable for all other Fishstocks and no estimate of current biomass is available for any Fishstock.

JMA 7

Jack mackerel landings for JMA 7 were relatively constant from 1986–87 to 1990–91, but there was a marked increase in 1991–92 which was largely sustained through to 1993–94. Estimates of B_{1991} were 76% and 79% of B_0 for *T. declivis* and *T. novaezelandiae*, respectively, so the stock was above B_{msy}. For JMA 7, recent landings are considered to be sustainable and at levels which will allow the stock to move towards a size that will support the MSY. The current TACC is approximately equal to the MSY for *T. declivis* and *T. novaezelandiae* combined and is considered sustainable and at a level that will allow the stock to move towards a size that will support the MSY. The estimates of B_O and yield do not include *T. murphyi*.

JMA 1 and JMA 3

Landings for JMA 1 and JMA 3 have fluctuated widely since 1983–84 but the general trend is for increased catches, probably caused by the increased availability of *T. murphyi*. The size of the jack mackerel resource in JMA 1 is unknown, although aerial sightings data from 1976 to 1993 suggest no change in abundance until the early 1990s when an increase occurred. The resource in JMA 3 has increased in recent years but few stock assessment data are available. However, for JMA 1 and 3 it is not known whether catches at the level of the current TACCs or recent catch levels are sustainable in the long term, or whether they will allow the stock to move towards a size that will support the MSY.

The effect of the *T. murphyi* invasion on stocks of the New Zealand jack mackerels is unknown.

Summary of yields estimates (t) for *T. declivis* and *T. novaezelandiae* only, TACCs (t), and reported landings (t) for all three species in the most recent fishing year.

Fishstock	QMA		MCY	2004-05 Actual TAC	2004-05 Reported landings
JMA 1	Auckland (East)/ Central (East)	1, 2	2400	10 000	9 418
JMA 3	South–East/Southland/Sub–Antarctic	3, 4, 5, 6	–	18 000	716
JMA 7	Challenger/Central (West)/Auckland (West)	7, 8, 9	21 600	32 536	36 497
JMA 10	Kermadec	10	–	10	0
Total				60 546	46 631

6. FOR FURTHER INFORMATION

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