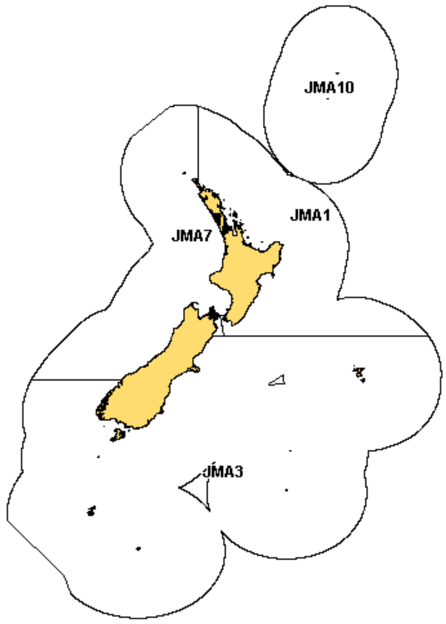
JACK MACKERELS (JMA)

(*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 (about 96% of annual landings) 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 recent years the proportion of *T. novaezelandiae* has been variable with an initial return to more than 95% in 1999–00 and 2000–01, a decline to 46% in 2003–04, and an increase to 81% in 2004–05. Some trawl bycatch of jack mackerel has been recorded in JMA 1.

Since 1991–92, jack mackerel targeted landings in JMA 1 have represented more than 80% of total catch. The highest rates of bycatch are from kahawai and blue mackerel targeted operations which each accounting for about 7% of the total jack mackerel catch. The majority of JMA 1 catch over these years has been taken from statistical areas 008 and 009 (Bay of Plenty) between June and November; considerably less has been taken in statistical areas 002 and 003, although high catches were recorded from these areas in 1993–94 and 1994–95.

Jack mackerel catch in JMA 3 is almost exclusively *T. murphyi* and little targeting occurred before 1992–93. During the 1990s targeting increased and accounted for the majority of catch (about 50%

between 1991–92 and 1996–97), but, after a peak of more than 80% in 1997–98 and 1998–99, has decreased again to about 50–60% in recent years. The balance of the catch in this area comes from trawl bycatch (squid 15–30%; barracouta 15–20%) on the Chatham Rise and in the Southland/Subantarctic region. A purse seine fishery has operated between the Clarence River mouth and the Kaikoura Peninsula, which peaked at 4400 t in 1992–93 and averaged more than 3000 t between 1989–90 and 1993–94. Purse seine catches have shown a steady decline since, dropping from 1000 t in 1994–95, to 100 t in 2001–02 and 2002–03; no catch was recorded for 2003–04.

Increased availability of jack mackerels caused by the influx of *T. murphyi* resulted in increased quotas in JMA 1 and JMA 3, to 8000 t and 9000 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 5970 t and 2700 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 2005–06 are shown for all Fishstocks in Table 1. Total landings in 2004–05 were the second highest since 1983–84 and almost 10 000 t greater than in 2003–04. In 2005–06 the total declined by about 4000 t to 42 700 t.

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*	3682	–	715	–	12 464	–	0	–	16 880	–
1984–85*	1857	–	1223	–	16 013	–	0	–	19 659	–
1985–86*	1173	–	2228	–	10 002	–	0	–	14 773	–
1986–87†	4056	5970	1638	2700	19 815	20 000	0	10	25 509	28 680
1987–88†	3108	5970	1883	2700	17 827	22 697	0	10	22 818	31 377
1988–89†	2986	5970	1919	2700	17 402	26 008	0	10	22 308	34 688
1989–90†	4226	5970	4013	2700	21 776	32 027	0	10	30 102	40 707
1990–91†	6472	5970	6403	2700	17 786	32 069	0	10	30 661	40 749
1991–92†	7017	5970	5779	2700	25 880	32 069	0	10	38 676	40 749
1992–93†	7529	5970	15 399	2700	24 767	32 536	83	10	47 778	41 216
1993–94‡	14 256	8000	9115	9000	22 377	32 536	0	10	45 748	49 546
1994–95‡	7832	10 000	11 519	18 000	18 913	32 536	0	10	38 264	60 546
1995–96†	6874	10 000	19 803	18 000	12 270	32 536	0	10	38 947	60 546
1996–97†	6912	10 000	15 687	18 000	12 056	32 536	0	10	34 655	60 546
1997–98†	7695	10 000	15 452	18 000	14 292	32 536	0	10	37 439	60 546
1998–99†	5767	10 000	15 111	18 000	13 574	32 536	0	10	37 439	60 546
1999–00†	2866	10 000	10 306	18 000	7 889	32 536	0	10	21 061	60 546
2000–01†	8360	10 000	2744	18 000	15 703	32 536	0	10	26 806	60 546
2001–02†	5247	10 000	5000	18 000	22 338	32 536	0	10	32 586	60 546
2002–03†	6172	10 000	2225	18 000	26 084	32 536	0	10	34 483	60 546
2003–04†	7396	10 000	705	18 000	28 883	32 536	0	10	36 989	60 546
2004–05†	9418	10 000	716	18 000	36 507	32 536	0	10	46 641	60 546
2005–06†	9924	10 000	5000	18 000	27 782	32 536	0	10	42 706	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 5970 t (Table 1), with the maximum in 1986–87 only slightly above 4000 t. Landings increased to 7529 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 8000 t set for that year. In 1994–95 reported landings (7832 t) were half those of 1993–94. Landings from 1994–95 to 1997–98 were around 7000 t. Since 1997–98 landings have fluctuated with no real pattern between a low of 2866 t in 1999–00 to the high of 9418 t in 2004–05.

Total landings in JMA 3 over the period 1984–85 to 1988–89 were relatively constant, at a level below the quota of 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. Under the first of two consecutive annual increases to the JMA 3 TACC in 1993–94, landings were slightly above the limit set, but fell below the higher TACC level in 1994–95. The lower 1994–95 catch relative to that in 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 lower 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 2225 t recorded in 2002–03, 705 t in 2003–04 and 716 t in 2004-05. The 5000 t taken in 2005–06 is unexpected in light of the declining trend from this fishery in recent years, the fact that the majority of catch is of *T. murphyi*, and the general observation of declining trends for *T. murphyi* in other areas.

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 (mid-water trawling between 2 a.m. and 4 a.m. is banned under a code of practice to eliminate dolphin bycatch in JMA 7 that has been operational since 1995–96), the withdrawal of a major company from the fishery for much of the season, and difficulty marketing 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 to 36 497 t in 2004–05. The 2004–05 landings were 3961 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.

A number of factors have been identified that can influence landing volumes in the jack mackerel fisheries. In the purse seine fishery, jack mackerel is often mixed with kahawai. Fishing companies will avoid these mixed schools to conserve kahawai quota, particularly at the beginning of the fishing year. When mixing of the two species is prevalent, low kahawai TACC can result in the targeting of jack mackerel being inhibited. Both skipjack tuna and blue mackerel are fished in preference to jack mackerel in the purse seine fishery, and the length of the jack mackerel season is influenced by the availability of these species.

A number of bycatch issues exist in the JMA 7 TCEPR fishery. A large bycatch fishery for blue mackerel operates for many months of the year and other bycatch species taken in this fishery include barracouta, gurnard, John dory, kingfish, and snapper. Although non-availability of ACE is unlikely to be constraining in the first three of these additional species, the same is not true of kingfish, blue mackerel, and snapper. Fishing company spokespersons have stated that known hotspots of snapper are avoided.

(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 (CV 0.13) by a diary survey in 1993–94 (Bradford, 1996), 79 000 fish (CV 0.16) in a national recreational survey in 1996 (Bradford, 1998), 349 000 fish (CV 0.39%) in the 2000 survey (Boyd & Reilly, 2002) and 295 000 fish (CV 0.2%) in the 2001 survey (Boyd et al., 2004). The surveys suggest a harvest of 80–110 t 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 at the Galapagos Islands and coastal Ecuador, to south of 40°S off the Chilean coast).

T. murphyi was first described in New Zealand waters in 1987. Its presence was recorded off the south and east coasts of the South Island in the mid 1980s. It expanded onto 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 becoming common on the east coast of Northland by June 1994. However this extensive distribution has decreased in more recent years and, since the late 1990s, its presence north of Cook Strait has been spasmodic with occasional landings in the JMA 1 purse seine fishery north of East Cape and from the JMA 1 inshore trawl fishery south of East Cape. The total range of *T. murphyi* now extends along the 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, mid-water 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 matures at about 26–30 cm fork length (FL) at an age of 3–4 years, and *T. declivis* matures 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.

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.

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)

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

Stock assessments for jack mackerel are complicated by the reporting and management of three species under a single code. Preliminary stock assessments for *T. declivis* and *T. novaezealandiae* in JMA 7 were undertaken in 2007 based on data from a new Bayesian analysis for splitting the recorded commercial catch into *T. declivis*, *T. novaezealandiae*, and *T. murphyi* components. This analysis was used to derive a catch history and CPUE indices for the *T. declivis* fishery in JMA 7, which were incorporated along with a proportions-at-age series into the assessments.

The assessment for *T. declivis* is described below, but the assessment for *T. novaezealandiae* is not included because of convergence problems with the assessment model which led to its rejection by the working group.

Otherwise, 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.

4.1 *T. declivis* in Challenger, Central West and Auckland West (JMA 7)

4.1.1 Species Proportion Estimates

A Bayesian species proportions model was used to estimate the proportion of *T. declivis* in the catch for the JMA 7 TCEPR fishery from 1989–09 through to 2004–05. Six spatial-temporal strata were used in the model: three spatial strata in combination with two temporal strata. The three spatial strata consisted of three regions with differing patterns in the relative proportions of the three jack mackerel species. The two temporal strata are a summer fishery (October-March) and a winter fishery (April-September). In the model the species proportions are estimated for each year (1989–90 to 2004–05), and the six strata for that year.

4.1.2 CPUE

The Bayesian species proportions model was used to estimate the *T. declivis* catch for each TCEPR tow, and the derived catch-effort data used in a standardised CPUE analysis. Based on changes in jack mackerel fishery practice, and changes in vessel composition over time, the CPUE analysis was split into two time periods: into an early period covering the years 1989-90 to 1995–96, and a late period covering 1996–97 to 2004–05 (Table 3).

Table 3: Standardised CPUE indices (relative year effects) with number of tows from 1989–90 to 2004–05.

	Year	CPUE index	CV	Number of tows
1989-90	1990	2.07	0.1	716
1990-91	1991	2.05	0.1	688
1991-92	1992	1.9	0.1	947
1992-93	1993	1.56	0.09	1088
1993-94	1994	1.37	0.09	1444
1994-95	1995	1.28	0.09	597
1995-96	1996	0.89	0.1	502
1996-97	1997	1.69	0.13	160
1997-98	1998	0.92	0.11	252
1998-99	1999	2.7	0.08	712
1999-00	2000	2.15	0.08	717
2000-01	2001	2.67	0.07	1240
2001-02	2002	2.85	0.07	1760
2002-03	2003	2.38	0.06	2272
2003-04	2004	2.59	0.07	2055
2004-05	2005	3.23	0.07	2002

4.1.3 Catch History

Catch records for jack mackerel extend back to 1946, though landings are small until the mid 1960s. The Bayesian model annual species proportions were used to estimate the *T. declivis* landings from 1991–92 to 2004–05, while previous species proportions were used to estimate landings for the earlier years (Table 4)

Recreational catch, illegal catch, and Maori customary catch are not well known, though are thought to be small relative to the commercial catch, so no components are included for these in the catch history.

Table 4: Catch history (t) for *T. declivis* in the JMA 7 fishery. The year denotes the year at the end of the fishing year.

Year	Estimated catch	Year	Estimated catch	Year	Estimated catch
1946	3	1967	3326	1988	10 340
1947	1	1968	3326	1989	10 963
1948	2	1969	3326	1990	6315
1949	8	1970	2787	1991	6759
1950	0	1971	4634	1992	12 422
1951	0	1972	6405	1993	7925
1952	3	1973	5284	1994	10 741
1953	4	1974	6423	1995	6809
1954	0	1975	4591	1996	5276
1955	5	1976	5518	1997	4702
1956	1	1977	6151	1998	5002
1957	3	1978	2197	1999	10 045
1958	4	1979	2524	2000	4339
1959	0	1980	1522	2001	6595
1960	2	1981	3547	2002	13 403
1961	2	1982	3372	2003	12 781
1962	2	1983	5540	2004	16 752
1963	5	1984	6980	2005	17 154
1964	4	1985	8967		
1965	3	1986	6801		
1966	23	1987	11 493		

4.1.4 Catch at Age

Catch-at-age data were used from the commercial fishery in the years 1989–90, 1990–91, 1995–96, and 2004–05.

4.1.5 Model Structure

In 2007 the observational data were incorporated into an age-based Bayesian stock assessment to estimate stock size. The stock was considered to reside in a single area, with no partition by sex or maturity. In the model age groups were 1-25 years, with a plus group of 25+. The model covers the period 1965–2005 (estimated catch is insignificant before 1965).

There is a single time step in the model, in which the order of processes is ageing, recruitment, and mortality (natural and fishing). Recruitment numbers followed a Beverton-Holt relationship with steepness of 0.924 derived from a mean value over a number of species similar to jack mackerel. Maturation is not explicitly modeled; instead a maturity-at-age logistic ogive is used with an a_{50} of 3 and an a_{to95} of 9 years. Growth follows a von Bertalanffy curve.

The model was fitted to: (a) an early CPUE series covering the years 1990 to 1996, (b) a late CPUE series covering the years 1997 through to 2005, (c) and a commercial proportions-at-age series for 1990, 1991, 1996, and 2005. A research trawl proportions-at-age for 1981 was not entered into the model, but the fit to it was evaluated outside the model assuming that the research trawl selectivity is the same as the commercial trawl selectivity.

A double half normal curve was used to model the commercial trawl selectivity.

The relative influence of the different data series in the model were evaluated by dropping the early CPUE series, dropping the late CPUE series, and putting more weight on the proportions-at-age data by increasing their effective sample size.

4.1.6 Results

For the base model in this preliminary assessment it is estimated that current biomass is 53% of virgin biomass. The biomass trajectory indicates a decline in biomass until the mid 1990s, followed by an increase in biomass until 2002, subsequently followed by a slight decline (Figure 1).

Dropping the early CPUE series gave a current biomass of 76% of virgin biomass, whereas in contrast dropping the late CPUE series gave a current biomass of 30%. Doubling the effective sample sizes for all the proportions-at-age data gave a current biomass of 66% of virgin biomass.

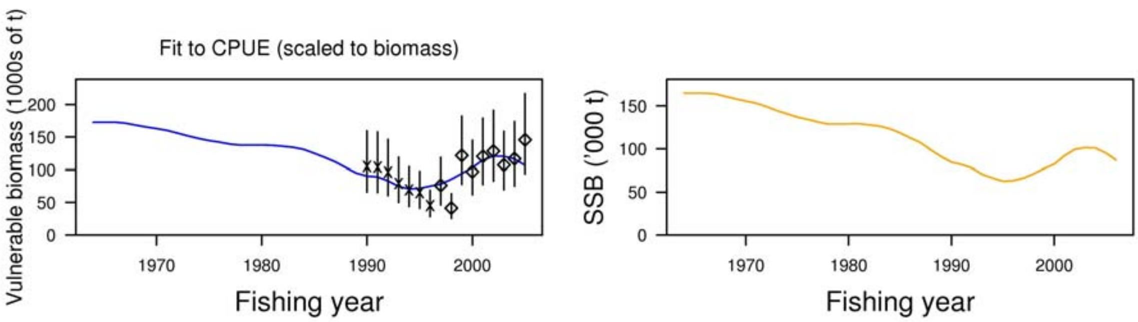


Figure 1: Biomass trajectories for the base case. The left-hand graph shows the fit of the CPUE indices to the vulnerable biomass; the right-hand graph the mature biomass trajectory. The year denotes the year at the end of the fishing year.

(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)

The 2007 assessment for *T. declivis* did not include yield estimates so there is no information to update the historical estimates described below.

(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*. In the two most recent years, catches were equivalent to the lowest on record, which was last experienced in 1984–85.

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 has been known at times to 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, although the proportion of this component seems to have declined considerably since the late 1990s. It is also the main trawl-caught mackerel on the Chatham Rise and the Stewart Island-Snares shelf region and has been a major proportion of jack mackerel catches on the west coast South Island. *T. murphyi* has also been an important component of the west coast North Island jack mackerel trawl fishery, but its presence appears to have declined in recent years with a very low representation in the TCEPR fishery in 2004–05. Thus, there has been a contraction in the range of this species in New Zealand waters, although it is unknown yet whether this represents a decrease in its overall abundance here. The effect of in *T. murphyi* on the range and abundance of the other two species is 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

Assessment of the status of JMA is complicated by the reporting and management of three species under a single code. This is further complicated by the uncertain 'status' of *T. murphyi*. The effect of the *T. murphyi* invasion on stocks of the New Zealand jack mackerels is unknown.

JMA 1 and JMA 3

Little is known about the resource in JMA 3, though estimated species proportions indicate a catch dominated by *T. murphyi*. 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.

JMA 7

Of the three jack mackerel species taken in JMA 7, recent information on stock status is only available for *T. declivis*. The current TACC is approximately 50% greater than the historical MCY-based yield estimates for *T. declivis* and *T. novaezelandiae* combined. These estimates of yield do not include *T. murphyi* which comprise an important part of the catches from JMA 7 in some years.

The 2007 preliminary assessment for *T. declivis* does not indicate sustainability concerns with this component of JMA 7 at this time though there are uncertainties in the assessment relating to the catch histories and abundance indices. The preliminary stock assessment indicates that current biomass is 53% of B_0, so the stock is probably above B_{MSY}. The historical estimate of B_0 (see MCY section) is similar to that from the 2007 assessment.

The status of *T. novaezelandiae* and *T. murphyi* in JMA 7 is not known, nor is the sustainability of current removals of these species.

Overall it can not be determined if the TAC or current removals are sustainable for JMA 7, but it is likely that the removals from one component of the fishery (*T. declivis*) are sustainable at this time. Given increased catches in recent years continued monitoring of the catch composition is strongly recommended as is further work on potential abundance indices.

Yield estimates, TACCs and reported landings for the 2005/06 fishing year are summarised in Table 5.

Table 5: 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	2005–06 Actual TAC	2005–06 Reported landings
JMA 1	Auckland (East)/ Central (East)	1, 2	2400	10 000	9924
JMA 3	South–East/Southland/Sub–Antarctic	3, 4, 5, 6	–	18 000	5000
JMA 7	Challenger/Central (West)/Auckland (West)	7, 8, 9	21 600	32 536	27 782
JMA 10	Kermadec	10	–	10	0
Total				60 546	42 706

6. FOR FURTHER INFORMATION

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