FLATFISH (FLA)
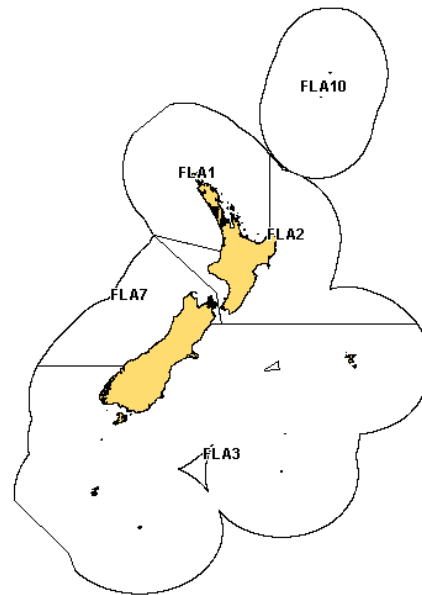
(*Colistium nudipinnis, Peltorhamphus novaezelandiae, Colistium guntheri, Rhombosolea retiaria, Rhombosolea plebeoa, Rhombosolea leporina, Rhombosolea tapirina, Pelotretis flavilatus*)

Patiki

1. FISHERY SUMMARY

1.1 Commercial fisheries

Flatfish ITQ provides for the landing of eight species of flatfish. These are: the yellow-belly flounder, *Rhombosolea leporina*; sand flounder, *Rhombosolea plebeia*; black flounder, *Rhombosolea retiaria*; greenback flounder, *Rhombosolea tapirina*; lemon sole, *Pelotretis flavilatus*; New Zealand sole, *Peltorhamphus novaezeelandiae*; brill, *Colistium guntheri*; and turbot, *Colistium nudipinnis*. For management purposes landings of these species are combined.

Flatfish are shallow water species, taken mainly by the inshore trawl fleet. Set and drag net fishing are important in the northern harbours and the Firth of Thames. Important fishing areas are:

Yellow-belly flounder	–	Firth of Thames, Kaipara and Manukau harbours;
Sand flounder	–	Hauraki Gulf, Tasman/Golden Bay, Bay of Plenty, and Canterbury Bight;
Greenback flounder	–	Canterbury Bight, Southland;
Black flounder	–	Canterbury Bight;
Lemon sole	–	west coast South Island, Otago and Southland;
New Zealand sole	–	west coast South Island, Otago and Canterbury Bight;
Brill and turbot	–	west coast South Island.

The current TACC of 6 670 t was introduced in the 1990–91 fishing year. TACCs were originally set at the level of the sum of the provisional ITQs for each fishery. Between 1983–84 and 1992–93 total flatfish landings fluctuated between 5160 t and 2750 t; from 1992–93 to 1997–98, landings were relatively consistent, between about 4500 t and 5000 t per year. Landings declined to 2963 t 1999–00, the lowest recorded since 1986–87. However, catches have increased over the past few years with 4051 t reported for the 2006–07 fishing year. Landings and TACCs are given in Table 1. From 1 October 2007 a TAC and allowances were set for the first time in FLA 3. The TACC was reduced by 47% to 1430 t, customary, recreational and other sources of mortality were allocated 5, 150 and 32 t respectively.

The fishery is mainly confined to the inshore domestic trawl fleet except for small incidental bycatch of soles, brill and turbot by deepwater trawlers, and some localised setnetting, particularly in the north.

FLATFISH (FLA)

Table 1: Reported landings (t) of flatfish by Fishstock from 1983–84 to 2006–07 and actual TACCs (t) from 1986–87 to 2006–07.

Fishstock FMA (s)	FLA 1 1 & 9		FLA 2 2 & 8		FLA 3 3, 4, 5 & 6		FLA 7 7		FLA 10 10	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1983–84*	1 215	–	378	–	1 564	–	1 486	–	0	–
1984–85*	1 050	–	285	–	1 803	–	951	–	0	–
1985–86*	722	–	261	–	1 537	–	385	–	0	–
1986–87†	629	1 100	323	670	1 235	2 430	563	1 840	0	10
1987–88†	688	1 145	374	677	2 010	2 535	1 000	1 899	0	10
1988–89†	787	1 153	297	717	2 458	2 552	757	2 045	0	10
1989–90†	791	1 184	308	723	1 637	2 585	745	2 066	0	10
1990–91†	849	1 187	292	726	1 340	2 681	502	2 066	0	10
1991–92†	940	1 187	288	726	1 229	2 681	745	2 066	0	10
1992–93†	1 106	1 187	460	726	1 954	2 681	1 566	2066	0	10
1993–94†	1 136	1 187	435	726	1 926	2 681	1 108	2 066	0	10
1994–95†	964	1 187	543	726	1 966	2 681	1 107	2 066	0	10
1995–96†	628	1 187	481	726	2 298	2 681	1 163	2 066	1	10
1996–97†	741	1 187	363	726	2 573	2 681	1 117	2 066	0	10
1997–98†	728	1 187	559	726	2 351	2 681	1 020	2 066	0	10
1998–99†	690	1 187	274	726	1 882	2 681	868	2 066	0	10
1999–00†	751	1 187	212	726	1 583	2 681	417	2 066	0	10
2000–01†	792	1 187	186	726	1 702	2 681	447	2 066	0	10
2001–02†	596	1 187	177	726	1 693	2681	614	2 066	0	10
2002–03†	686	1 187	144	726	1 650	2 681	819	2 066	0	10
2003–04†	784	1 187	218	726	1 286	2 681	918	2 066	0	10
2004–05†	1 038	1 187	254	726	1 353	2 681	1 231	2 066	0	10
2005–06†	964	1 187	296	726	1 177	2 681	1 283	2 066	0	10
2006–07†	920	1 187	296	726	1 425	2 681	1 411	2 066	0	10

Fishstock FMA (s)	Total	
	Landings§	TACC
1983–84*	5 160	–
1984–85*	4 467	–
1985–86*	3 215‡	-
1986–87†	2 750‡	6 050
1987–88†	4 072‡	6 266
1988–89†	4 299	6 477
1989–90†	3 482	6 568
1990–91†	2 983	6 670
1991–92†	3 202	6 670
1992–93†	5 086	6 670
1993–94†	4 605	6 670
1994–95†	4 580	6 670
1995–96†	4 571	6 670
1996–97†	4 794	6 670
1997–98†	4 657	6 670
1998–99†	3 714	6 670
1999–00†	2 963	6 670
2000–01†	3 127	6 670
2001–02†	3 080	6 670
2002–03†	3 299	6 670
2003–04†	3 206	6 670
2004–05†	3 876	6 670
2005–06†	3 720	6 670
2006–07†	4 051	6 660

* FSU data.
† QMS data.
‡ Includes 11 t Turbot, area unknown but allocated to QMA 7.
§ Includes landings from unknown areas before 1986–87.

Fishers and processors often use a generic flatfish (FLA) code to report estimated catches of flatfish species rather than using the individual species codes to separately identify their catch. Beentjes (2003) showed that, for all QMAs combined between 1989–90 and 2001–02, about half of the estimated catch of flatfish was recorded using the generic species code FLA, and the remainder was reported using a combination of 12 other species codes (Table 2). Flatfish species that comprised a large proportion of the total estimated catch over the 13 year period included ESO (16%), LSO (12%), SFL (12%) and YBF (6%). Species that are important contributors to catch in each QMA are FLA 1: YBF, SFL, GFL; FLA 2: ESO, SFL; FLA 3: ESO, LSO, SFL, BFL, BRI; FLA 7: GFL, SFL, TUR (Table 3; codes provided in the caption to Table 2).

Table 2: Total estimated flatfish catch (t) by species and fishing year for all flatfish QMAs combined. Codes: black flounder (BFL), brill (BRI), New Zealand sole (ESO), flatfish not species (FLA, FLO, SOL), greenback flounder (GFL), lemon sole (LSO), sand flounder (SFL), Turbot (TUR), witch (WIT), yellow belly flounder (YBF) (Beentjes 2003).

Year	BFL	BRI	ESO	FLA	FLO	GFL	LSO	SFL	SOL	TUR	WIT	YBF	Total (t)
1989–90	0	0	0	2 750	0	0	0	<1	0	0	<1	<1	2 750
1990–91	114	44	238	1 566	0	75	103	284	0	24	1	182	2 629
1991–92	23	45	384	1 530	0	64	151	336	<1	64	2	209	2 809
1992–93	40	74	904	1 948	0	119	521	688	0	87	3	235	4 619
1993–94	24	54	836	1 457	0	94	446	755	0	63	2	249	3 980
1994–95	66	54	742	1 546	<1	92	466	689	3	69	19	277	4 024
1995–96	95	48	730	1 523	12	50	607	515	15	61	0	154	3 810
1996–97	39	43	731	1 714	32	61	561	477	4	42	5	153	3 863
1997–98	14	33	550	1 718	29	59	714	452	4	39	1	162	3 775
1998–99	24	41	418	1 294	28	45	667	297	4	37	3	202	3 060
1999–00	61	44	355	1 075	7	36	408	247	2	30	1	267	2 534
2000–01	42	42	479	1 086	13	29	392	245	3	40	45	316	2 733
2001–02	85	27	495	1 098	9	35	271	199	1	41	28	210	*2 498
Total	627	550	6 864	20 305	130	759	5 306	5 184	36	595	110	2617	43 084
Percent	1.4	1.3	15.9	47.1	0.3	1.8	12.3	12.0	0.1	1.4	0.3	6.1	

* October 2001 to August 2002

Table 3: Distribution (%) of the total estimated catch of 13 flatfish species by QMA for the period 1989–90 and 2001 02 (Beentjes, 2003). Species codes are provided in the caption to Table 1. Catches were allocated to specific QMAs based on the reported statistical area of catch.

QMA	BFL	BLF	BRI	ESO	FLA	FLO	GFL	LSO	SFL	SOL	TUR	WIT	YBF	All species
FLA 1	6		3	2	27	1	26	2	23	8	2	0	83	22
FLA 2	15		0	8	13	5	12	1	13	79	4	2	2	10
FLA 3	74	99	62	64	41	94	28	92	29	12	26	87	11	48
FLA 7	5	1	34	27	19	1	34	5	36	1	69	11	3	20
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100

1.2 Recreational fisheries

There are important recreational fisheries, mainly for the four flounder species, in most harbours, estuaries, coastal lakes and coastal inlets throughout New Zealand. The main methods are setnetting, drag netting and spearing. In the northern region, important areas include the west coast harbours, the lower Waikato, the Hauraki Gulf and the Firth of Thames. In the Bay of Plenty, Ohiwa and Tauranga Harbours are important. In the Challenger FMA, there is a moderate fishery in Tasman and Golden Bays and in areas of the Mahau-Kenepuru Sound and in Cloudy Bay. In the South-East and Southland FMAs, flatfish are taken in areas such as Lake Ellesmere, inlets around Banks Peninsula and the Otago Peninsula, the Oreti and Riverton estuaries, Bluff Harbour and the inlets and lagoons of the Chatham Islands (for further details see the 1995 Plenary Report). Harvest estimates from recreational surveys are given in Table 4.

Table 4: Estimated number and weight of flatfish, by Fishstock and survey, harvested by recreational fishers. Surveys were carried out in different years in the Ministry of Fisheries regions: South in 1991–92, Central 1992–93, North 1993–94 (Teirney *et al.* 1997) and nationally in 1996 (Bradford 1998) and 1999–00 (Boyd & Reilly 2005). (– Data not available.)

Fishstock	Survey	Number	CV%	Harvest range (t)	Point estimate (t)
1991–92					
FLA 1	South	3 000	–	–	–
FLA 3	South	15 200	31	50–90	–
FLA 7	South	3 000	–	–	–
1992–93					
FLA 1	Central	6 100	–	–	–
FLA 2	Central	73 000	26	20–40	–
FLA 7	Central	37 100	59	10–30	–
1993–94					
FLA 1	North	520 000	19	225–275	–
FLA 2	North	3 000	–	0–5	–
1996					
FLA 1	National	308 000	11	95–125	110
FLA 2	National	67 000	19	13–35	24
FLA 3	National	113 000	14	30–50	40
FLA 7	National	44 000	18	10–20	16
1999–00					
FLA 1	National	702 000	25	203–336	–
FLA 2	National	380 000	49	82–238	–
FLA 3	National	395 000	33	128–252	–
FLA 7	National	114 000	53	23–73	–

A key component of the estimating recreational harvest from diary surveys is determining the proportion of the population that fish. The Recreational Working Group has concluded that the methodological framework used for telephone interviews produced incorrect eligibility figures for the 1996 and previous surveys. Consequently the harvest estimates derived from these surveys are considered to be unreliable. However, relative comparisons can be made between stocks within these surveys. The Recreational Working Group considered that the 2000 survey using face-to-face interviews better estimated eligibility and that the derived recreational harvest estimates are believed to be more accurate. FMA2 catches are nevertheless considered to be over-estimates, probably because of an unrepresentative diarist sample. The 1999–00 Harvest estimates for each Fishstock should be evaluated with reference to the coefficient of variation.

1.3 Customary non-commercial fisheries
Quantitative information on the current level of customary non-commercial catch is not available.

1.4 Illegal catch
There is no quantitative information on the current level of illegal catch available.

1.5 Other sources of mortality
Flatfish have always been subject to 'high-grading', and market preference has led to the establishment of 'processor' grading and size limits. Fishers often have no market for lower grade flatfish, and although greater than the minimum size limit, this fish is discarded. The extent of this unrecorded fishing mortality is unknown.

2. BIOLOGY

Some New Zealand flatfish species are fast-growing and short-lived, generally only surviving to 3–4 years of age, with very few reaching 5–6 years, others such as brill and turbot are longer lived, reaching a maximum age of 21 years and 16 years, respectively (Steven *et al.* 2001). However, these estimates have yet to be fully validated. Size limits (set at 25 cm for most species) are generally at or above the size at which the fish reach maturity and confer adequate protection to the juveniles.

Juveniles congregate in sheltered inshore waters, e.g. estuarine areas, shallow mudflats and sandflats, where they remain for up to two years. Juvenile survival is highly variable. Flatfish move offshore for first spawning at 2–3 years of age during winter and spring. Adult mortality is high, with many flatfish spawning only once and few spawning more than two or three times. However, fecundity is high, e.g., from 0.2 million eggs to over 1 million eggs in sand flounders.

Available biological parameters relevant to stock assessment are shown in Table 5. The estimated parameters in sections 1 & 3 apply only to sand flounder in Canterbury and brill and turbot in west coast South island – growth patterns are likely to be different for these species in other areas and for other species of flatfish.

Table 5: Estimates of biological parameters of flat fish.

Fishstock			Estimate			Source
1. Natural mortality (M)						
Brill - West coast South Island (FLA 7)			0.20			Stevens *et al*. (2001)
Turbot - West coast South island (FLA 7)			0.26			Stevens *et al*. (2001)
Sand flounder - Canterbury (FLA 3)			1.1–1.3			Colman (1978)
Lemon sole - West coast South island (FLA 7)			0.62–0.96			Gowing *et al*. (2006)

2. Weight = a(length)^b (Weight in g, length in cm total length).

	Females		Males		Source
	a	b	a	b	
Brill (FLA 7)	0.01443	2.9749	0.02470	2.8080	Hickman & Tait (unpub.)
Turbot (FLA 7)	0.00436	3.3188	0.00571	3.1389	Hickman & Tait (unpub.)
Sand flounder (FLA 1)	0.03846	2.6584	–	–	McGregor (unpub.)
Yellow-belly flounder (FLA 1)	0.07189	2.5117	0.00354	3.3268	McGregor (unpub.)
New Zealand sole (FLA 3)	0.03578	2.6753	0.007608	3.0728	McGregor (unpub.)

3. von Bertalanffy growth parameters

	Females			Males			Source
	L_∞	k	t_0	L_∞	k	t_0	
Brill							
West coast South Island (FLA 7)	43.8	0.10	-15.87	38.4	0.37	38.4	Stevens *et al*. (2001)
Turbot							
West coast South island (FLA 7)	57.1	0.39	0.30	49.2	0.34	49.2	Stevens *et al*. (2001)
Sand flounder							
Canterbury (FLA 3)	59.9	0.235	-0.083	37.4	0.781	37.4	Mundy (1968), Colman (1978)
Lemon sole							
West coast South island (FLA 7)	26.1	1.29	-0.088	25.6	1.85	25.6	Gowing *et al*. (2006)

3.   STOCKS AND AREAS

Flatfish are shallow-water species, generally found in waters less than 50 m in depth. There is evidence of many fairly localised stocks. However, the inter-relationships of neighbouring populations have not been thoroughly studied. The best information is available from studies of the variation in morphological characteristics of sand flounders and from the results of tagging studies, conducted mainly on sand and yellow-belly flounders. Variation in morphological characteristics indicate that sand flounder stocks off the east and south coasts of the South Island are clearly different from stocks in central New Zealand waters and from those off the west coast of the South Island. There also appear to be differences between west coast sand flounders and those in Tasman Bay, and between sand flounders on either side of the Auckland-Northland peninsula. Tagging experiments show that sand flounders, and other species of flounder, can move substantial distances off the east and south coasts of the South Island. However, among fish tagged in Tasman Bay and in the Hauraki Gulf, none have been recaptured very far from their point of release.

Thus, though the sand flounders off the east and south of the South Island appear to be a single, continuous population, fish in fairly enclosed waters may be effectively isolated from neighbouring populations and should be considered as separate stocks. Examples of such stocks are those in

Tasman Bay and the Hauraki Gulf and possibly areas such as Hawkes Bay and the Bay of Plenty. In order to maintain harvesting flexibility, the number of management boundaries placed in the flatfish fishery has been kept to a minimum.

There are no new data which would alter the stock boundaries used in previous assessment documents.

4.   STOCK ASSESSMENT

The yield estimates are based on commercial landings data only and have not changed since the 1992 Plenary Report.

4.1   Estimates of fishery parameters and abundance

Standardized CPUE was investigated as tool for monitoring FLA 1 (Coburn *et al*. 2005). The inshore FAWG concluded that the derived indices probably reflect abundance. At least 90% of flatfish catch in FLA 1 West consists of yellow-belly flounder (sand flounder makes up the remainder) and there was no evidence of a trend in catch composition during the analysis period (1989–90 to 2003–04). Standardized CPUE trends were derived for four sub-areas on west coast: Northwest, Kaipara, Manukau and Lower Waikato. Three quarters of the west coast catch is taken from Kaipara and Manakau Harbours. The Manakau CPUE series declined at a moderate rate between 1989–90 and 1995–96, then declined gradually to 2002–03 and then increased slightly to 2003–04. The Kaipara series declined at a moderate rate from 1989–90 to 1997–98, and was stable until 2003–04.

Most of the flatfish catch from the FLA 1 East, including a substantial and variable proportion of sand flounder, is taken from the Firth of Thames (Statistical area 007). Separate indices were calculated for sand and yellowbelly flounder. The area 007 yellowbelly CPUE index declined steeply from 1990–91 to 1995–96 and remained fairly stable after that. The sand flounder index increased from 1990–91 to 1993–94 and then declined somewhat dramatically. Accounting for a 2-year lag between egg production and recruitment, a fairly strong negative relationship between sea surface temperature and sand flounder abundance was established. The abundance of yellowbelly flounder did not appear to be related to temperature in the Firth of Thames.

Estimates of fishery parameters and abundance are not available.

4.2   Biomass estimates

Estimates of current and reference biomass are not available for flatfish.

4.3   Estimation of Maximum Constant Yield (MCY)

MCY was estimated using the equation, $MCY = cY_{AV}$ (Method 4). Y_{AV} is the reported catch over the period October 1983 to September 1988, and c was set equal to 0.6 based on the estimate of $M = 1.1$–1.3. These estimates of MCY are based on reported landings during a period of decreasing effort and are considered conservative. The MCY estimates for each Fishstock are given in Table 6.

Table 6: Yield estimates (t) (rounded to the nearest 10 t) for flatfish.

Parameter	Fishstock	Estimate
MCY	FLA 1	520
	FLA 2	200
	FLA 3	980
	FLA 7	530
	FLA 10	–
	Total	2 230
CAY	All	Cannot be determined

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

4.4 Estimation of Current Annual Yield (CAY)

No estimate of CAY is available for flatfish stocks.

4.5 Other Factors

The flatfish complex is comprised of eight species though typically only a few are dominant in any one QMA and some are not found in all areas. For management purposes all species are combined to form a unit fishery. The proportion that each species contributes to the catch is expected to vary annually. It is not possible to estimate MCY for each species and stock individually.

Because the adult populations of most species generally consist of only one or two year classes at any time, the size of the populations depends heavily on the strength of the recruiting year class and is therefore thought to be highly variable. Brill and turbot are notable exceptions with the adult population consisting of a number of year classes. Recent CPUE analyses revealed that although yellow belly flounder are short lived, inter-annual abundance in FLA 1 was not highly variable, suggesting that some factor, e.g., size of estuarine nursery area, could be smoothing the impact of random environmental effects on egg and larval survival.

Flatfish TACCs have purposely been set at high levels so as to provide fishers with the flexibility to take advantage of the inherent variability associated with annual flatfish abundance. For this reason TACCs should not be expected to be reached each year. Current catch levels appear to impose no threat to the productivity of the stock, as the minimum size limit provides protection for spawning fish before they recruit into the fishery.

In certain areas fishers target fishing for flatfish run out of quota for associated bycatch, but use their uncaught flatfish quota to continue target fishing, regardless of bycatch. This is a problem particularly with multi-species trawl fisheries. The high TACCs set for species like flatfish, whose availability is highly variable, provides an incentive to maximise target catch regardless of how much bycatch quota is held.

The inclusion of flatfish in the QMS was based partly on the assumption that a TAC would act to decrease competition for catch in poor years. However, current flatfish TACCs do not effectively decrease competition for fish in years of poor abundance. A number of fishers have entered the fishery through purchase of flatfish ITQ with no, or minimal bycatch quota. This increases competition for flatfish in poor years, both among commercial fishers and between commercial and recreational fishers, accentuating bycatch problems.

Fishing effort can vary with flatfish abundance and the relative profitability of alternative fisheries (e.g., albacore tuna, oysters, rock lobster and snapper).

Flatfish could be managed more appropriately using a CAY approach rather than an MCY approach, with strong or weak pre-recruit year classes being identified by surveys or monitoring. This approach would reduce the level of bycatch problems when biomass is low, while allowing the fishing industry

to take advantage of increased biomass following good recruitment. Adoption of this strategy would require increased information on flatfish abundance.

5.   STATUS OF THE STOCKS

Estimates of current and reference biomass are not available.

TACCs have never been reached since the introduction of the QMS, although landings approached the TACC for FLA 1 in 1992–93 and 1993–94, and for FLA 3 in 1988–89 and 1996–97. Typically flatfish populations consist of only one or two year classes at any time. The sizes of the populations depend heavily on the strength of the recruiting year classes and are therefore highly variable. For this reason a constant catch at the level of the current TACCs is unlikely to be attainable or sustainable, nor would it be likely to allow the stock to move towards a size that will support the MSY. It is unknown if recent catches will allow the stock to move towards a size that will support the MSY.

TACCs and reported landings are summarised in Table 7.

Table 7: Summary of yields (t), TACCs (t), and reported landings (t) of flatfish for the most recent fishing year.

Fishstock	QMA	MCY	2006–07 Actual TACC	2006–07 Reported Landings
FLA 1	Auckland (East) (West) 1 & 9	520	1 187	920
FLA 2	Central (East) (West) 2 & 8	200	726	296
FLA 3	South-East (Coast) (Chatham), 3, 4, 5, & 6 Southland and Sub-Antarctic	980	2 681	1 425
FLA 7	Challenger 7	530	2 066	1 411
FLA 10	Kermadec 10	–	10	0
Total		2 230	6 670	4 051

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