SUSTAINABLE HARVEST OF HOKI AND TARAKIHI IN NEW ZEALAND'S EXCLUSIVE ECONOMIC ZONE

FOR KELLOGGS RURAL LEADERSHIP PROGRAMME

November 2003 John Bird

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EXECUTIVE SUMMARY

Background

Fish and their products are a large export earner for New Zealand, and an employment opportunity for many people. Also the sea and its fruits are a part of Kiwi “culture”. It is a resource that is reliant on itself to survive, with little input from us who take from it. The fishing industry has always been of great interest to me which led me to the point of researching this project.

It is fairly obvious to any keen recreational fisher/diver that the stocks of many inshore species are very much depleted from the numbers our forebears harvested. Therefore it is my intention with this project to identify whether we are looking after what stock is remaining, so that the resource will be here for generations to come.

Objectives

1. To gain a greater understanding of the Quota Management System
2. To determine whether or not the current systems of monitoring of the Tarakihi and Hoki species are successful in maintaining a Maximum Sustainable Yield (MSY) in those fish stocks.
3. To identify if there are more accurate methods of monitoring the biomasss of these species.

Key Findings

Since the introduction of the Quota Management system in 1986, the monitoring of the two target fish species appears to be working, with the biomass of both fish under regular scrutiny. The documentation undertaken by all parties in the harvesting chain, and the collaboration of that plus other survey data by the group of scientists at the Ministry of Fisheries seems to be the most accurate method of maintaining Maximum Sustainable yields.

The harvest of Tarakihi appears to keeping the biomass of that fish stock at a sustainable yield. Whereas the Hoki fish stock does seem to have a slow rate of decline. This is of concern, but it is possibly due to poor recruitment (reproduction) over the past few years.

Recommendations

Apart from the use of acoustic surveillance or video surveillance, which would be prohibitively expensive and have a hugely greater margin of error, there are currently no other methods of monitoring the biomass of fish.

THE QUOTA MANAGEMENT SYSTEM (QMS)

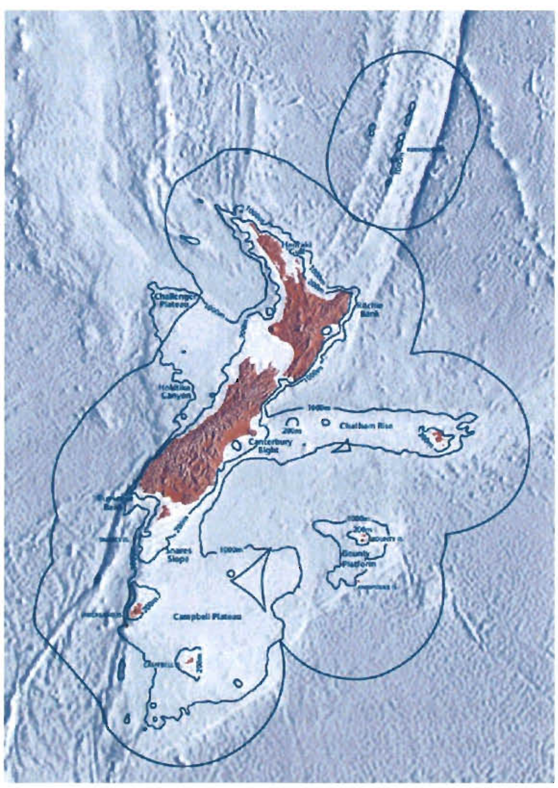
Background Of NZ Fishing Industry

By the early 1980s fishing pressure had considerably reduced the size of the many of New Zealand's major inshore fish stocks. The industry quickly became aware of the fact that if fishing was to continue at this rate, it could result in total collapse of some fish stocks. The current methods of management, being fishing method restrictions, fish sizes, and limits on vessel numbers in an area weren't working. Both the Government and the fishing industry worked together to seek a solution that would give the fishing industry a sustainable on going harvestable resource. The result of this collaboration being the introduction of the "Quota Management System".

The QMS was introduced in October 1986 to help conserve major fish stocks, and give the industry long term sustainability. The objectives of it were to:

1. Rebuild depleted fish stocks.
2. Ensure catches were sustainable long term.
3. Control harvest levels annually
4. Enhance recreational fishing.

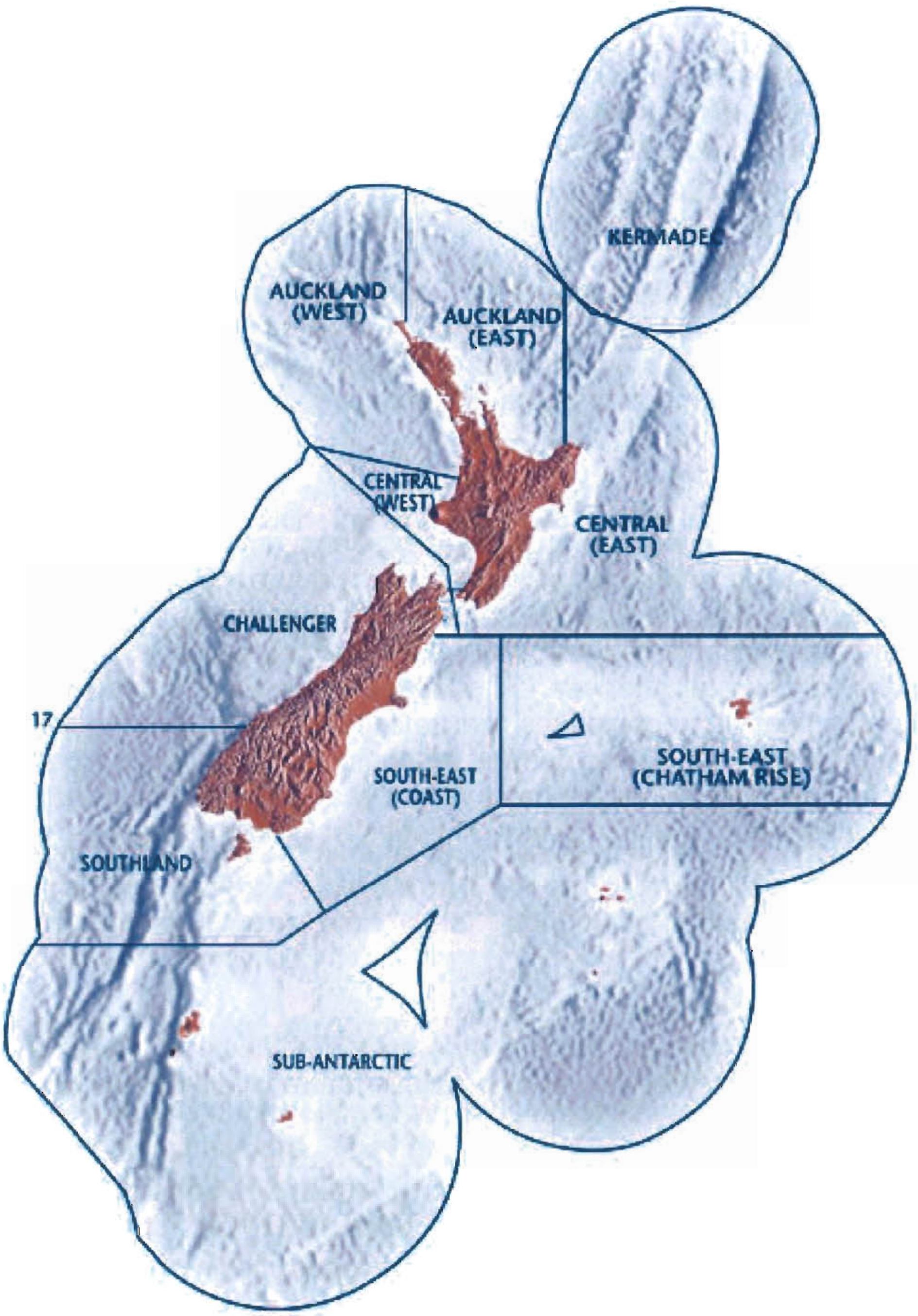
Figure 1: New Zealand Exclusive Economic Zone



Currently there are 180 fish species under the QMS with plans of introducing other species in the future.

Within New Zealand Exclusive Economic Zone (EEZ) there are ten Fishery Management Areas (FMAs), shown in Figure 2 below. It is within these defined areas that the stocks are monitored under the QMS. A catch limit is set for a particular fish species within a FMA on an annual basis. The process by which this tonnage is set goes as follows:

Figure 2: New Zealand's Fisheries Management Areas



Total Allowable Catch (TAC) and Total Allowable Commercial Catch (TACC)

TAC is set on an annual basis by the Ministry of Fisheries at a tonnage that allows a fish stock to be harvested at a level where by its population is being maintained or a level which it can grow to a sustainable yield if the current stock is deemed insufficient.

Once this tonnage has been determined, then a TACC is set. This is the tonnage of that species that can be harvested by commercial fishers, less the estimated tonnage taken by recreation and customary fishing. To put that in more simple terms:

TAC	
-**Recreational Catch**	*(also includes illegal*
-**Customary Take**	*catch estimates)*
=**TACC**	

TACC is then allocated amongst Quota owners. Quota ownerships were issued in 1986 to Commercial fishers in conjunction with the introduction of the QMS. Fishers had to show documented proof of previous catch history of a fish stock in a given QMA. In turn receiving a percentage of quota ownership.

Definitions of *MCY* and ***CAY***

The Fisheries Act (1996) defines Total Allowable Catch in terms of maximum sustainable yield (***MSY***). The definitions of the biological reference points, ***MCY*** and ***CAY***, derive from two ways of viewing ***MSY***: a static interpretation and a dynamic interpretation. The former, associated with ***MCY***, is based on the idea of taking the same catch from the fishery year after year. The latter interpretation, from which ***CAY*** is derived, recognises that fish populations fluctuate in size from year to year (for environmental and biological, as well as fishery, reasons) so that to get the best yield from a fishery it is necessary to alter the catch every year. This leads to the idea of maximum average yield (***MAY***) which is how fisheries scientists generally interpret ***MSY*** (Ricker 1975).

The definitions are:

MCY – Maximum Constant Yield
The maximum constant catch that is estimated to be sustainable, with an acceptable level of risk, at all probable future levels of biomass.

and

CAY – Current Annual Yield
The one-year catch calculated by applying a reference fishing mortality, F_{ref}, to an estimate of the fishable biomass present during the next fishing year. F_{ref} is the level of (instantaneous) fishing mortality that, if applied every year, would, within an acceptable level of risk, maximise the average catch from the fishery.

Quota Distribution

For each species under the QMS there are 100 million shares, which are allocated to Quota Owners on a percentage basis of that species. (e.g. Joe Bloggs owns 30T of a 100T TACC of a species in FMA3. So he receives 30 million shares for that fishing year of that species for that FMA). The quota owner then converts that share holding into tonnage of catch (i.e. kilograms) ACE (Annual Catch Entitlement). This tonnage of catch is now referred to as ACE. It can be traded for other ACE, leased or sold to another New Zealand registered fisher, or fished for by that Quota Owner.

Monitoring Tonnages Caught

Comprehensive, detailed documentation is done by commercial fishers both at sea and on shore, and is counted against ACE entitlement. A fishing vessel's catch details must match the details of the Licensed Fish Receiver on shore to whom the catch was delivered. All fishers must comply with this paper work, or quota's can be forfeited, along with vessels and other property. If at the completion of the fishing year the ACE is incomplete, then that entitlement can be carried over into the next year provided it doesn't exceed 10% of ACE. On the other hand if there is an overcatch of the ACE then penalties can be imposed depending on percentage over caught.

Deemed Values

So as to ensure overcatch and or by catch is landed by fishers, the Ministry of Fisheries set, what they call, "Deemed Values" for all QMS fish stocks. These values are set below usual market values, but are enough to encourage the landing of this catch, as opposed to the dumping of it. (This helps the Ministry in thorough monitoring of all QMS species).

Vessel Documentation

The skipper of a vessel must document all catch details i.e. vessel location, depth of trawl, species caught plus kilograms, FMA and to which "License Fish Receiver" it was delivered and in what form (Refer Table 1 and Table 2 below).

Licensed Fish Receivers

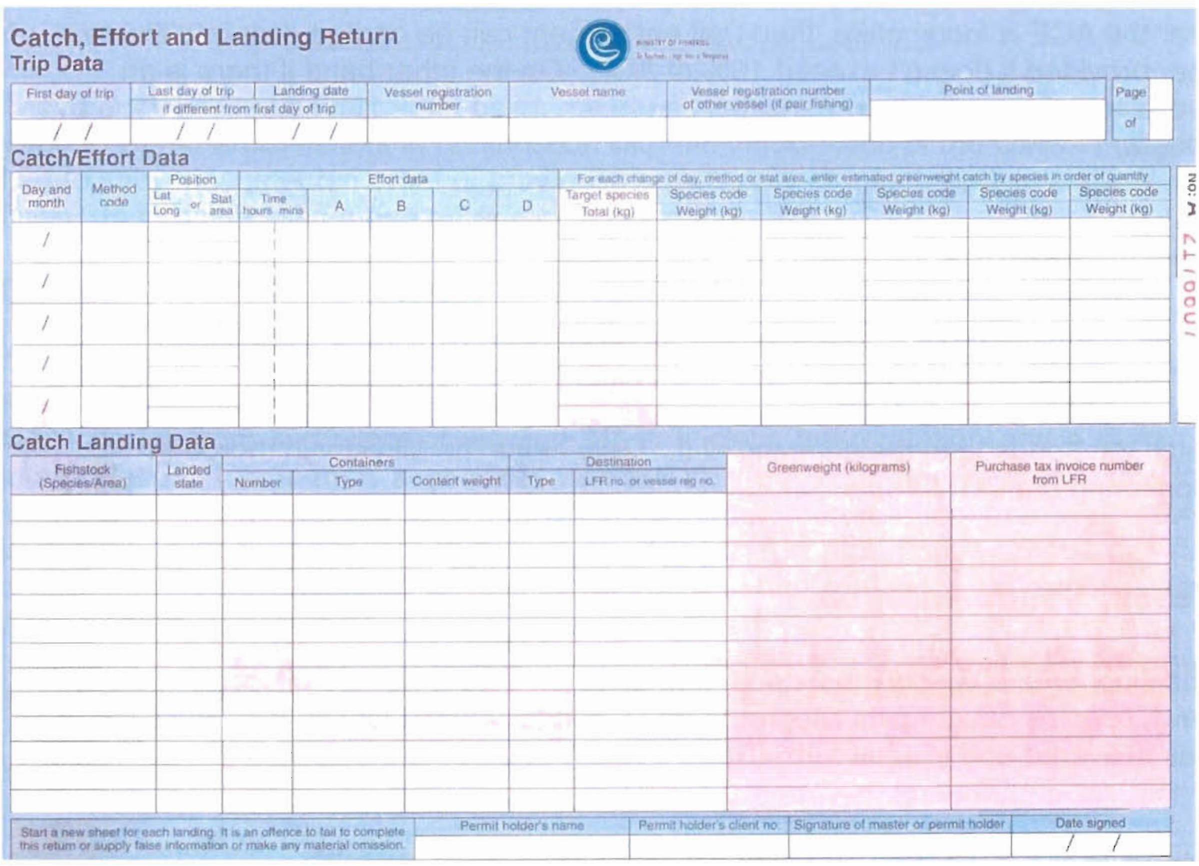
These people are wholesalers or processors on shore who are licensed to receive catch from permit holders. They are required to have accurate documentation of kilograms received, what species, vessel registration and in what form, which must match those of the delivering vessel.

Table 1: State of Landed Fish

GRE	Greenweight, whole fish intact
GUT	Whole fish less internal organs
AGU	Headed and gutted
DRE	Headed, gutted less pectoral fin
FIL	Fillet Skin On
FKF	Fillet Skin Off
MEA	Fish Meal
SUR	Fish Paste

Table 2: Catch Effort Data/Landing Data Form

(See completed form attached)



Catch, Effort and Landing Return

Trip Data

First day of trip	Last day of trip (if different from first day of trip)	Landing date (if different from first day of trip)	Vessel registration number	Vessel name	Vessel registration number of other vessel (if pair fishing)	Point of landing	Page ... of ...
/ /	/ /	/ /					

Catch/Effort Data

Day and month	Method code	Position: Lat Long or Stat area	Effort data: Time hours mins	A	B	C	D	Target species Total (kg)	Species code Weight (kg)	Species code Weight (kg)	Species code Weight (kg)	Species code Weight (kg)	Species code Weight (kg)
/													
/													
/													
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/													

For each change of day, method or stat area, enter estimated greenweight catch by species in order of quantity

NO: K

Catch Landing Data

Fishstock (Species/Area)	Landed state	Containers: Number	Containers: Type	Containers: Content weight	Destination: Type	Destination: LFR no. or vessel reg no.	Greenweight (kilograms)	Purchase tax invoice number from LFR

Start a new sheet for each landing. It is an offence to fail to complete this return or supply false information or make any material omission.	Permit holder's name	Permit holder's client no.	Signature of master or permit holder	Date signed
				/ /

TARAKIHI

(Nemadactylus macropterus)

Figure 3: Tarakihi Fishery Management Areas

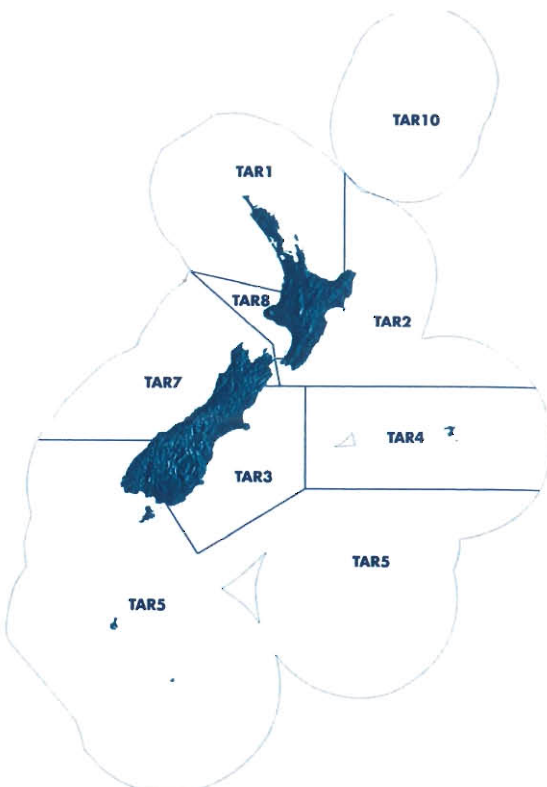


Figure 4: Tarakihi (attached)

This commercial fish species is caught in coastal waters all around New Zealand at an average depth of approximately 250m. The fish stock appears to be relatively stable. Between 1968, when the fishery was initially developed and 1985, both domestic and foreign landings combined, averaged 5042 + per year. The total landings since the introduction of the QMS have averaged around 5000-6000+ annually. These comparisons can be seen in Tables 3 and 4.

Table 3: Reported total landings (t) of tarakihi from 1968 to 1982–83.

Year	Landings	Year	Landings	Year	Landings
1968	5683	1974	5294	1980–81 *	4990
1969	4082	1975	4941	1981–82 *	5193
1970	5649	1976	4689	1982–83 *	4666
1971	5702	1977	6444		
1972	5430	1978–79 *	4427		
1973	4439	1979–80 *	4344		

Source – MAF data.

Table 4: Reported landings (t) of tarakihi by Fishstock from 1983–84 to 2001–02 and TACs (t) from 1986–87 to 2001–02.

Fishstock	TAR 1		TAR 2		TAR 3		TAR 4		TAR 5	
QMA (s)	1 & 9		2		3		4		5 & 6	
	Landings	TAC	Landings	TAC	Landings	TAC	Landings	TAC	Landings	TAC
1983–84*	1326	–	1118	–	902	–	287	–	115	–
1984–85*	1022	–	1129	–	1283	–	132	–	100	–
1985–86*	1038	–	1318	–	1147	–	173	–	48	–
1986–87†	912	1210	1382	1410	938	970	83	300	42	140
1987–88†	1093	1286	1386	1568	1024	1036	227	314	88	142
1988–89†	940	1328	1412	1611	758	1061	182	314	47	147
1989–90†	973	1387	1374	1627	1007	1107	190	315	60	150
1990–91†	1125	1387	1729	1627	1070	1148	367	316	35	153
1991–92†	1415	1387	1700	1627	1132	1148	213	316	55	153
1992–93†	1477	1397	1654	1633	813	1168	45	316	51	153
1993–94†	1431	1397	1594	1633	735	1169	82	316	65	153
1994–95†	1390	1398	1580	1633	849	1169	71	316	90	153
1995–96†	1422	1398	1551	1633	1125	1169	209	316	73	153
1996–97†	1425	1398	1639	1633	1088	1169	133	316	81	153
1997–98†	1509	1398	1678	1633	1026	1169	202	316	21	153
1998–99†	1436	1398	1594	1633	1097	1169	104	316	51	153
1999–00†	1387	1398	1741	1633	1260	1169	98	316	80	153
2000–01†	1403	1398	1658	1633	1218	1169	242	316	58	153
2001–02†	1474	1399	1729	1633	1241	1169	383	316	75	153

	TAR 7		TAR 8		TAR 10			
	7		8		10		Total	
	Landings	TAC	Landings	TAC	Landings	TAC	Landings§	TAC
1983–84*	896	–	109	–	0	–	5430	–
1984–85*	609	–	102	–	0	–	4816	–
1985–86*	519	–	122	–	0	–	5051	–
1986–87†	904	930	185	190	0	10	4446	5160
1987–88†	840	1046	197	196	0	10	4855	5598
1988–89†	630	1059	121	197	0	10	4090	5727
1989–90†	793	1069	114	208	0	10	4473	5873
1991–92†	710	1087	190	225	2	10	5417	5953
1992–93†	929	1087	189	225	0	10	5158	5989
1990–91†	629	1087	131	225	<1	10	5086	5953
1993–94†	780	1087	191	225	0	10	4878	5990
1994–95†	978	1087	171	225	0	10	5129	5991
1995–96†	890	1087	105	225	0	10	5375	5991
1996–97†	1013	1087	133	225	0	10	5512	5991
1997–98†	685	1087	153	225	0	10	5287	5991
1998–99†	1041	1087	175	225	0	10	5501	5991
1999–00†	964	1087	189	225	0	10	5719	5991
2000–01†	1178	1087	178	225	0	10	5935	5991
2001–02†	995	1088	222	225	0	10	6119	5993

* FSU data.
† QMS data.
§ Includes landings from unknown areas before 1986–87.

The main method of fishing for Tarakihi is trawling. The major fishing grounds are east of Northland (QMA1) from the Bay of Plenty to Cape Turnagin (QMA 1 and 2). Cook Strait to the Canterbury Bight (QMA 3) and Jackson Head to Cape Foulwind (QMA 7) 70-80% of the total catch is targeted around the North Island, leaving the remainder fished from the waters of the South Island. A percentage of the Tarakihi harvest is through bycatch occurring at other depths while targeting other species.

It is interesting to note that in FMA 1 the estimated harvest by recreational fishers is approximately 310t, which equates to 20% of the total landings of that area.

Table 5: Results of a national diary survey of recreational fishers in 1996.

Estimated number of tarakihi harvested by recreational fishers by Fishstock and the corresponding harvest tonnage. The mean weights used to convert numbers to catch weight are considered the best available estimates. Survey tonnages are presented as a range to reflect the uncertainty in the estimates (from Bradford, 1998

Fishstock	Number caught	c.v.(%)	Survey harvest (t)	Fishstock harvest (t)
TAR 1	498 000	8	280–330	305
TAR 2	114 000	14	55–75	65
TAR 3	3 000	–	–	–
TAR 5	3 000	–	–	–
TAR 7	69 000	13	20–30	24
TAR 8	46 000	17	25–35	28

Biology

Sexual maturity is reached at 25-25cm at an age of 4-6 years. The maximum age for this species is 40 years. Spawning occurs in the summer-autumn period, in three defined areas: Cape Runaway to East Cape, Kaikoura to Pegasus Bay and near Jackson Bay on the West coast of the South Island. The transition from the larval and postlarval metamorphosis to the juvenile stage occurs at 7-12 months of age, where the fish are found in shallower inshore waters. At 3-4 years of age the juveniles move out to deeper water. Research (*research from ….*) shows that these immature fish are not vulnerable to commercial operations as only a small percentage are caught in the trawl nets. Tarakihi tagged in the Kaikoura area during 1986 and 1987 were netted as far away as the Kaipara Harbour, Whangarei and Timaru proving that they are capable of moving long distances.

Stock Assessment

The most recent stock assessments for the Tarakihi species are estimates; some based on commercial landing data and others on actual trawl data surveys. IN TAR areas 2, 3 and 7 the most recent trawl surveys completed in 1996 and 1999 showed that the estimated biomass in TAR 2 and 3 is relatively stable, whereas in TAR 7 the biomass estimates have decreased. These trawl surveys were taken at a depth of 150-200m. It should be noted that the coefficient of variation of the trawl surveys vary but generally average approximately 20-22%.

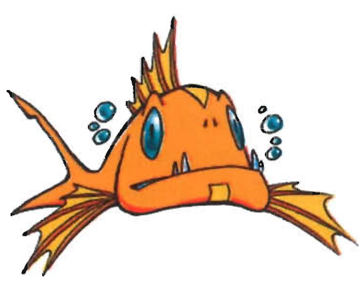


Table 6: Relative Biomass estimates for Tarakihi

Relative biomass estimates (t) and coefficients of variation (*c.v.*) for tarakihi available from trawl survey data. S = summer and W = winter survey (Note : because trawl survey biomass estimates are indices, comparisons between different seasons eg. summer and winter in the same area are not strictly valid).

QMA	Area	Year	Trip Code	Biomass (t)	c.v. (%)
TAR 2	Cape Runaway to Cook Strait	1993	KAH9304	885	27
		1994	KAH9402	1128	20
		1995	KAH9502	791	23
		1996	KAH9602	943	15
TAR 3	Pegasus Bay to Canterbury Bight	1991 W	KAH9105	1657	33
		1992 W	KAH9205	932	26
		1993 W	KAH9306	3805	55
		1994 W	KAH9406	2050	41
		1996 W	KAH9606	1656	24
		1996 S	KAH9618	3818	21
		1997 S	KAH9704	2036	24
		1998 S	KAH9809	4277	24
		1999 S	KAH9917	2606	15
		2000 S	KAH0014	1510	13
TAR 7	Tasman Bay to Haast	1992	KAH9204	1409	14
		1994	KAH9404	1420	14
		1995	KAH9504	1389	11
		1997	KAH9701	1087	12
		2000	KAH0004	964	19

MCY (Maximum Constant Yield for the Tarakihi fishery was estimated using the equation MCY = $_{c}Y_{av.}$ Y_{av} was the average of the combined domestic and foreign landings from 1968 to 1985 (5042+). This period was comparatively stable and constant. Natural mortality was very low at 0.08 to 0.15% and the species was long lived (40years +). The value of C was set at 0.9 based in the estimate of M = 0.10

$$MCY = 0.9 * 5042t = 4538t \text{ (rounded to 4540t)}$$

Table 7: Estimation of Current Annual Yield (CAY)

Yield estimates (t).

Parameter	Fishstock	Estimate
MCY	All except TAR 4 & 10	4540
CAY	All	Cannot be determined

Status of the Stocks

In 2002, the Plenary agreed that the TAR 1 stock could be considered for inclusion in the adaptive management programme at a higher TACC on the basis that there is a reasonable probability that current biomass is above the size that will support the maximum sustainable yield. To-date TAR 1 has not been accepted into the AMP and the TACC has not been increased.

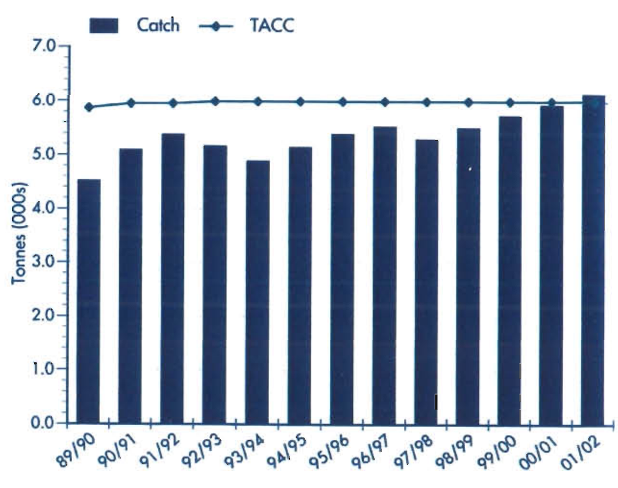
For TAR 3 estimates made in the mid 1980s indicated that F was less than $F_{0.1}$. These estimates are probably still relevant due to the long, stable catch history in these areas. Levels of F near or below $F_{0.1}$ are generally considered sustainable. For TAR 4, the fishery around the Chatham Islands has generally been lightly fished and the stock can probably support higher catch levels for the next few years.

Overall, landings from the North and South Islands have remained relatively stable since at least the late 1960s despite changes in effort and methods of fishing. Given the long, stable catch history of this fishery, current catch levels and TACCs are thought to be sustainable. However, for all Fishstocks (except TAR 1) it is not known if the current TACCs and recent catch levels will allow the stocks to move towards a size that will support the maximum sustainable yield.

Table 8: Summary of yield estimates (t), TACCs (t) and reported landings (t) for the most recent fishing year.

Fishstock	QMA		MCY	2001–02 Actual TACC	2001–02 Reported landings
TAR 1	Auckland	1 & 9		1399	1474
TAR 2	Central (East)	2		1633	1729
TAR 3	South–East (Coast)	3	4540	1169	1241
TAR 4	South–East (Chatham Rise)	4	–	316	383
TAR 5	Southland and Sub–Antarctic	5 & 6		153	75
TAR 7	Challenger	7		1088	995
TAR 8	Central (Egmont)	8		225	222
TAR 10	Kermadec	10	–	10	0
Total				5993	6119

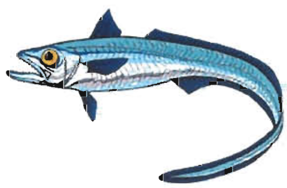
Figure 4: Catch History for Tarakihi

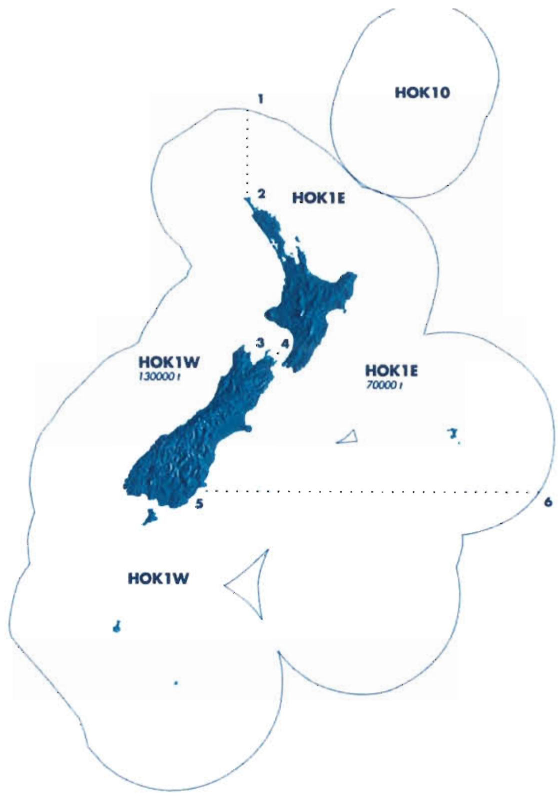


HOKI

(*Macruronus novaezelandiae*)

Figure 5: Hoki Fishery Management Areas





Historically the main fishery for Hoki has operated from mid July to late August on the west coast of the South Island where Hoki aggregate to spawn. The spawning aggregations begin to concentrate in depths of 300-700m around the Hokitika Canyon. Fishing in these areas continues into September in some years. Since 1988 another major fishery has developed in Cook Strait.

Outside the spawning season, Hoki disperse to their feeding grounds, on the Chatham Rise and in the sub-Antarctic. These fisheries operate in depths of 400-800m.

Japanese and Soviet vessels developed the hoki fishery in the early 1970s. Catches peaked at 100 000 t in 1977, but dropped to less than 20 000 t in 1978 when the EEZ was declared and quota limits were introduced (Table 8). From 1979 on, the hoki catch increased to about 50 000 t then in 1987-1988 was expanded to 225,000t. Catches peaked in 1997-98 at 269,000t. Since then they have been in decline and the TACC has been reduced from 250,000t to 200,000t in 2001-2002.

Table 9: Reported trawl catches (t) from 1969 to 1987–88, 1969–83 by calendar year, 1983–84 to 1987–88 by fishing year (Oct-Sept). Source – FSU data

				New Zealand		
Year	**USSR**	**Japan**	**South Korea**	**Domestic**	**Chartered**	**Total**
1969	–	95	–	–	–	95
1970	–	414	–	–	–	414
1971	–	411	–	–	–	411
1972	7 300	1 636	–	–	–	8 936
1973	3 900	4 758	–	–	–	8 658
1974	13 700	2 160	–	125	–	15 985
1975	36 300	4 748	–	62	–	41 110
1976	41 800	24 830	–	142	–	66 772
1977	33 500	54 168	9 865	217	–	97 750
1978*	2 028 †	1 296	4 580	678	–	8 581
1979	4 007	8 550	1 178	2 395	7 970	24 100
1980	2 516	6 554	–	2 658	16 042	27 770
1981	2 718	9 141	2	5 284	15 657	32 802
1982	2 251	7 591	–	6 982	15 192	32 018
1983	3 853	7 748	137	7 706	20 697	40 141
1983–84	4 520	7 897	93	9 229	28 668	50 407
1984–85	1 547	6 807	35	7 213	28 068	43 670
1985–86	4 056	6 413	499	8 280	80 375	99 623
1986–87	1 845	4 107	6	8 091	153 222	167 271
1987–88	2 412	4 159	10	7 078	216 680	230 339

* Catches for foreign licensed and New Zealand chartered vessels from 1978 to 1984 are based on estimated catches from vessel logbooks. Few data are available for the first 3 months of 1978 because these vessels did not begin completing these logbooks until 1 April 1978.

† Soviet hoki catches are taken from the estimated catch records and differ from official MAF statistics. Estimated catches are used because of the large amount of hoki converted to meal and not recorded as processed fish.

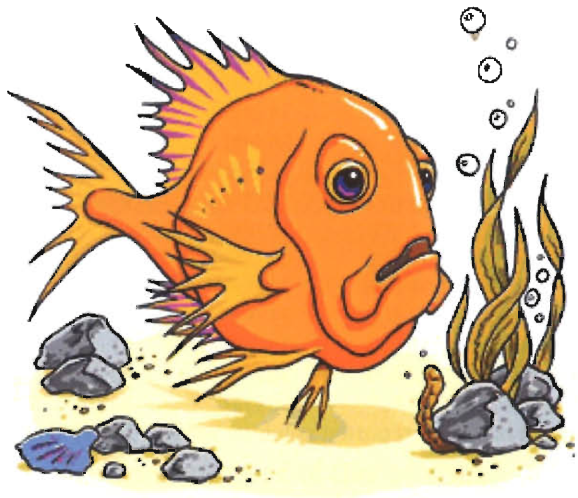


Table 10: Reported catch (t) from QMS or MHR, estimated catch (t) from TCEPR and CELR data, and TACC (t) for HOK1 from 1986– 87 to 2001–02

Reported	Estimated		
Year	catch	catch	TACC
1986–1987	158 171	175 000	250 000
1987–1988	216 206	255 000	250 000
1988–1989	208 500	210 000	250 000
1989–1990	210 000	210 000	251 884
1990–1991	215 000	215 000	201 897
1991–1992	215 000	215 000	201 897
1992–1993	195 000	195 000	202 155
1993–1994	191 000	190 000	202 155
1994–1995	174 000	168 000	220 350
1995–1996	210 000	194 000	240 000
1996–1997	246 000	230 000	250 000
1997–1998	269 000	261 000	250 000
1998–1999	244 500	234 000	250 000
1999–2000	242 000	237 000	250 000
2000–2001	230 000	226 000	250 000
2001–2002	196 000	200 000	200 000

Note: Discrepancies between QMS data and actual catches from 1986 to 1990 arose from incorrect surimi conversion factors. The estimated catch in those years has been corrected from conversion factors measured each year by Scientific Observers on the WCSI fishery. Since 1990 the new conversion factor of 5.8 has been used, and the total catch reported to the QMS is considered to be more representative of the true level of catch.

Table 11: Estimated* catch (t) of hoki by area, 1988–89 to 2001–02

				Spawning fisheries			Non-spawning fisheries		
	Spawning fisheries		Non-spawning fisheries						
Fishing year	WCSI	Puysegur	Cook Strait	ECSI	Sub-Antarctic	Chatham Rise and ECSI	ECNI	Unrep.	Total catch
1988–1989	188 000	3 500	7 000	–	5 000	5 000	–	–	208 500
1989–1990	165 000	8 000	14 000	–	10 000	13 000	–	–	210 000
1990–1991	154 000	4 000	26 500	1 000	18 000	11 500	–	–	215 000
1991–1992	105 000	5 000	25 000	500	34 000	45 500	–	–	215 000
1992–1993	98 000	2 000	21 000	–	26 000	43 000	2 000	3 000	195 000
1993–1994	113 000	2 000	37 000	–	12 000	24 000	2 000	1 000	191 000
1994–1995	80 000	1 000	40 000	–	13 000	39 000	1 000	–	174 000
1995–1996	73 000	3 000	67 000	1 000	12 000	49 000	3 000	2 000	210 000
1996–1997	91 000	5 000	61 000	1 500	25 000	56 500	5 000	1 000	246 000
1997–1998	107 000	2 000	53 000	1 000	24 000	75 000	4 000	3 000	269 000
1998–1999	96 000	3 000	46 000	500	23 000	73 500	2 500	–	244 500
1999–2000	103 000	2 500	42 000	1 000	34 000	57 000	1 500	1 000	242 000
2000–2001	103 500	5 500	35 500	2 000	30 000	50 500	2 000	1 000	230 000
2001–2002	93 000	5 000	23 500	3 000	30 000	39 000	1 000	1 500	196 000

* Estimated catches adjusted pro rata to the reported catch in Table 9 for 1994–95 to 2001–02.

– Catch less than 500 t.

Table 12: Proportions of total catch.

Fishing Year	Spawning fisheries West	Spawning fisheries East	Non-spawning fisheries West	Non-spawning fisheries East
1988–1989	92%	3%	2%	3%
1989–1990	82%	7%	5%	6%
1990–1991	74%	13%	8%	5%
1991–1992	51%	12%	16%	21%
1992–1993	51%	11%	14%	24%
1993–1994	60%	19%	7%	14%
1994–1995	47%	23%	7%	23%
1995–1996	36%	33%	6%	25%
1996–1997	39%	26%	10%	25%
1997–1998	41%	20%	9%	30%
1998–1999	41%	19%	9%	31%
1999–2000	44%	18%	14%	24%
2000–2001	48%	16%	13%	23%
2001–2002	50%	13%	16%	21%

Biology

Hoki are distributed widely through NZ waters at depths between 10m to over 900m. The greatest abundance of the fish occurring between 200 and 600m. Adult fish are generally found deeper than 400m, while juveniles are more abundant in shallow waters. Outside of spawning adult Hoki are found around the edge of Stewart and Snares Shelf and over large areas of sub-Antarctic and Chatham Rise, and to a lesser extent around the North Island.

Hoki have high fecundity. The average size female produces multiple batches of eggs, spawning over 1 million eggs per season. A study of 7yr old females in the sub-Antarctic in May 1993 estimated that 82% would spawn in winter 1993. Where as a similar study in 1998 estimated a lower proportion at 40%. (The 1998 survey was done one month earlier than in 1993, so could have had an affect on the percentage).

Growth is fairly rapid, with juveniles reaching 27-30cm by the end of the 1st year. Hoki generally reach 40-45, 50-55 and 60-65cm respectively in the following three years. Maturity is reached at approximately 65cm. Females grow larger than males, some reaching 7kgs in weight. Maximum age of the fish is 20-25 years.

Stock Assessment

The most common method of assessment of the biomass of the Hoki fish stock is by acoustic survey. Sound waves that are sent out strike the schools of fish and are reflected back. The energy of the sound wave is measured and through this it is possible to estimate the biomass. There is however a margin of error depending on the size of the fish and their orientation, that is, whether a fish has its head up or down or even on a slight angle, and whether the signal is from a cluster or a mix of different species.

Trawl surveys are the next most common method. A specific number of trawls are carried out in a particular area. The width of net is measured, as is its depth, and from the catch taken it is possible to estimate the total population in that area.

Surveys are carried out at the same time each year, to get accurate comparisons. Other biological details such as length, weight and sex of the fish are also recorded. Parts of the fish's inner ear, known as the otoliths are collected to analyse their ages.

Underwater filming with stereo cameras provides three dimensional images of spawning schools of Hoki. The aim is to identify species, their size, density and orientation. This assessment process is still in its infancy, and one problem already encountered here is the light needed for the cameras can change the behaviour of the fish.

Abundance Indices

Abundance indices of the five fishing areas for Hoki can be seen in Table 12 below, using both acoustic and trawl survey data.

Table 13: Hoki abundance indices

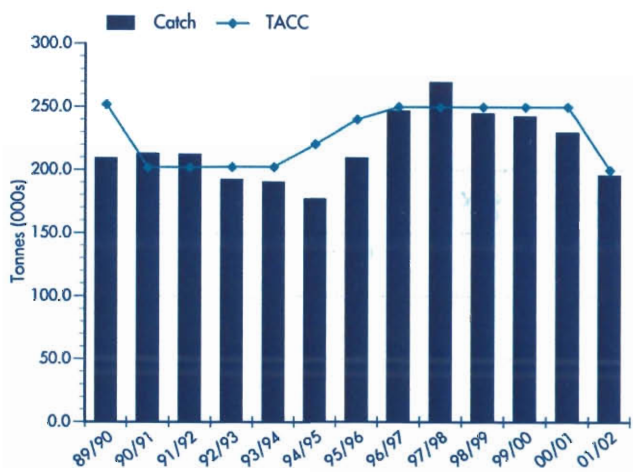
('000 t) used in the stock assessment. Years are fishing years (1990 = 1989–90). – no data.

Year	Acoustic survey, WCSI, winter WCacous	Trawl survey sub-Antarctic, December SAsumbio	Trawl survey sub-Antarctic, April SAautbio	Trawl survey Chatham Rise, January CRsumbio	Acoustic survey, Cook Strait, winter CSacous
1988	417	–	–	–	–
1989	249	–	–	–	–
1990	255	–	–	–	–
1991	340	–	–	–	126
1992	345	80	68	120	–
1993	550	87	–	186	418
1994	–	100	–	146	420
1995	–	–	–	120	298
1996	–	–	89	153	138
1997	654	–	–	158	209
1998	–	–	68	87	115
1999	–	–	–	109	175
2000	396	–	–	72	–
2001	–	56	–	60	155
2002	–	38	–	74	225
2003	–	40	–	53	–

With the Hoki fishery, uncertainty increased the further we go into the future. There is good reason to believe that the western stock biomass will decrease in the next few years, because of the recent poor recruitment. However it is possible that recruitment will improve, as has been the case in the eastern fishery since the early 1980s. In recent years some fishers have reported increasing densities of spawning Hoki off the east coast of the South Island in Pegasus Canyon. A recent NIWA/Industry acoustic survey estimated the spawning biomass of Pegasus Canyon and Conway Trough to be approximately 35% of that of the Cook Strait spawning ground. So perhaps the spawning areas are shifting.

In summary, the western stock will continue to decline at the current rate of fishing. The eastern stock at its current catch levels will remain relatively stable.

Figure 6: Hoki Catch History



OTHER MONITORING METHODS

The latest methods of monitoring fish stocks are the use of acoustic surveillance and more recently, camera surveillance.

Acoustic surveys

Acoustic surveys aim to estimate the biomass. The technique is mainly used for hoki, orange roughy and southern blue whiting.

Sound waves which are sent out from the research ship strike schools of fish and are reflected back. The energy of the sound waves is measured and it is possible to estimate the biomass.

Problems:

- The strength of the signal varies depending on the size of the fish and their orientation, that is, whether a fish has its head up or down or even on a slight angle, and whether the sound signal is from a cluster or a mix of different species.

Underwater filming

Stereo camera equipment provides three-dimensional images of spawning schools of hoki and orange roughy, taken hundreds of metres below the sea's surface. The aim is to identify fish species and provide information about their size, density and orientation. As a technique it is still in its early stages.

The stereo camera is lowered to depths of up to 1200 metres by a connecting cable, which carries data and a photographic signal back to the vessel.

The video may revolutionise marine photography. It works on the same principle as the stereo camera, with two videos mounted side by side. It provides immediate results, whereas it takes weeks to process photographs from stereo cameras.

Problems:
The lights needed for the video cameras may change the behaviour of the fish, so on occasions still photos are taken instead, using flash lights.

Other than these more recent advances in monitoring fish biomass, there are currently no other methods.

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- Clement & Associates Ltd Nelson: The Atlas of Area Codes and The Guide to the Quota Management System.
- Ministry of Fisheries website
- Ministry of Fisheries Napier, Mike Buick (Marine Biologist).
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- Sally Bird, Typing and editing.

Catch, Effort and Landing Return

MINISTRY OF FISHERIES
Te Tautiaki i nga tini a Tangaroa

Trip Data

First day of trip	Last day of trip (if different from first day of trip)	Landing date (if different from first day of trip)	Vessel registration number	Vessel name	Vessel registration number of other vessel (if pair fishing)	Point of landing	Page ___ of ___
/ /	/ /	/ /					

Catch/Effort Data

No: A 2176633

Day and month	Method code	Position: Lat / Long or Stat area	Effort data: Time hours mins	A	B	C	D	Target species / Total (kg)	Species code / Weight (kg)	Species code / Weight (kg)	Species code / Weight (kg)	Species code / Weight (kg)	Species code / Weight (kg)
/													
/													
/													
/													
/													

For each change of day, method or stat area, enter estimated greenweight catch by species in order of quantity

Catch Landing Data

Fishstock (Species/Area)	Landed state	Containers			Destination		Greenweight (kilograms)	Purchase tax invoice number from LFR
		Number	Type	Content weight	Type	LFR no. or vessel reg no.		

Start a new sheet for each landing. It is an offence to fail to complete this return or supply false information or make any material omission.	Permit holder's name	Permit holder's client no.	Signature of master or permit holder	Date signed
				/ /

MINISTRY OF FISHERIES
Te Tautiaki i nga tini a Tangaroa

Catch Landing Return
Trip Data

2860321

First day of trip	Last day of trip	Landing date	Vessel registration number	Vessel name	Vessel registration number of other vessel (if pair fishing)	Point of landing	Page	
/ /	/ /	/ /					of	

Catch Landing Data

Fishstock (Species/Area)	Landed state	Containers			Destination		Greenweight (kilograms)	Purchase tax invoice number from LFR
		Number	Type	Content weight	Type	LFR no. or vessel reg no.		

Start a new sheet for each landing. It is an offence to fail to complete this return or supply false information or make any material omission.	Permit holder's name	Permit holder's client number	Signature of master	Date signed
				/ /

MINISTRY OF FISHERIES
Te Tautiaki i nga tini a Tangaroa

Trawl, Catch, Effort and Processing Return

To be completed on each day at sea

Date	Vessel's registration number (your vessel)	Vessel name (your vessel)
20/11/03	69054	Viking King
	Vessel registration number of other vessel (if pair fishing)	

Position at midday (noon)				Water temperature at shot 1		Page	1
Latitude		Longitude	E/W	Surface	Bottom	of	1
40 – 12	S	173 – 21	E	14.6°	14.4°		

Shot		Time	Latitude			Longitude			Gear code / Headline height	Depth groundrope / Depth bottom	Trawling speed	Target species	Estimated catch by species in order of quantity					
			Deg	Min		Deg	Min	E/W					Quantity	Species code / Quantity (kg)	Species code / Quantity (kg)	Species code / Quantity (kg)	Species code / Quantity (kg)	Species code / Quantity (kg)
1	START	0800	40	08	S	173	27	E	BT 35	95	5.0	JMA	Total (kg)	JMA	BAR			
	END	1140	40	11	S	173	20	E	7	95			5000	4000	1000			
2	START	1220	40	14	S	173	17	E	BT 35	85	4.8	JMA	Total (kg)	JMA	BAR	FRO	TAR	
	END	1650	40	20	S	173	36	E	7	85			7000	4500	2000	300	200	
3	START	2205	40	26	S	174	05	E	MW 40	99	5.2	JMA	Total (kg)	JMA				
	END	2340	40	25	S	174	02	E	40	130			15000	15000				
4	START				S								Total (kg)					
	END				S													
5	START				S								Total (kg)					
	END				S													
6	START				S								Total (kg)					
	END				S													

Daily Processing Summary

Species	Processed state	Number of processed units	Unit weight (kg)	Processed catch weight (kg)	Conversion factor	Calculated weight before processing (kg)
JMA	HGU	266	21.5	5719	1.5	8579
FRO	DRE	12	21.5	258	1.8	464
BAR	DRE	90	21.5	1935	1.55	2999
BAR	DRE	5	20.0	100	1.55	155
TAR	SKF	5	21.5	106	2.4	254

Species	Processed state	Number of processed units	Unit weight (kg)	Processed catch weight (kg)	Conversion factor	Calculated weight before processing (kg)
SPD	DIS	N/A	N/A	N/A	N/A	150

I declare that the information I have given on this return is correct and complete, and that I have read and understood the explanatory notes supplied with this return.

Product from offal only		Activity comment (Transhipping, steaming etc)	Permit holder's name	Permit holder's client number	Signature of master	Date signed
Meal (kg)	Oil (litres)					
150			John Citizen	8459894	J Bloggs.	21/11/03