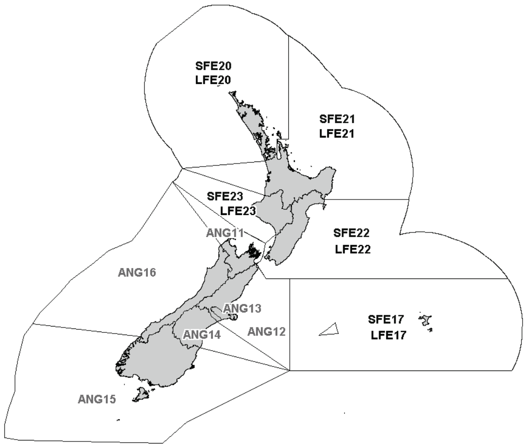
FRESHWATER EELS (SFE, LFE, ANG)

(Anguilla australis, Anguilla dieffenbachii, Anguilla reinhardtii)
Tuna



1. FISHERY SUMMARY

1.1 Commercial fisheries

The freshwater eel fishery is distributed throughout the freshwaters (lakes, rivers, streams, farm ponds, tarns) and some estuarine and coastal waters of New Zealand, including the Chatham Islands. The contemporary commercial fishery dates from the mid-1960s when markets were established in Europe and Asia.

The New Zealand eel fishery is based on the two temperate species of freshwater eels occurring in New Zealand, the shortfin eel *Anguilla australis* and the longfin eel *A. dieffenbachii*. A third species of freshwater eel, the Australasian longfin (*Anguilla reinhardtii*), identified in 1996, has been confirmed from North Island landings. The proportion of this species in landings is unknown but is thought to be small. Virtually all eels (98%) are caught with fyke nets. Eel catches are greatly influenced by water temperature, flood events (increased catches) and drought conditions (reduced catches). Catches decline in winter months (May to September), particularly in the South Island where fishing ceases.

The South Island eel fishery was introduced into the Quota Management System (QMS) on 1 October 2000 with shortfin and longfin species combined into six fishstocks (codes ANG 11 to ANG 16). The Chatham Island fishery was introduced into the QMS on 1 October 2003 with two fishstocks (shortfins and longfins separated into SFE 17 and LFE 17, respectively). The North Island eel fishery was introduced into the QMS on 1 October 2004 with eight fishstocks (four longfin stocks LFE 20-23 and four shortfin stocks SFE 20-23). The Australasian longfin eel is combined as part of the shortfin eel stocks in the Chatham and North Islands, as this species has productivity characteristics closer to shortfins than longfins, and because the catch is not sufficient to justify its own separate stocks. The occasional catch of Australasian longfins is mainly confined to the upper North Island. The fishing year for all stocks extends from 1 October to 30 September except for ANG 13 (Te Waihora/Lake Ellesmere) which has a fishing year from 1 February to 31 January (since 2002). Currently, there exist minimum and maximum commercial size limits for both longfins and shortfins (220g and 4 kg, respectively) throughout New Zealand. The major North Island processors have agreed to not land eels < 300g, and not process migratory eels. In the late 1990s, the South Island eel industry agreed to voluntarily increase the diameter of escapement tubes in fyke nets, allowing larger juvenile eels to escape and effectively increasing the minimum size limit of both main species to 280 g. A recent initiative by the North Island eel industry seeks to implement similar escapement tube measures to bring them in line with South Island fishers by October 2010.

Commercial catch data are available from 1965 and originate from different sources. Catch data prior to 1988 are for calendar years, whereas those from 1988 onwards are for fishing years (Table 1, Figure 1). Licensed Fish Receiver Returns (LFRRs), Quota Management Reports (QMRs), and Monthly Harvest Returns (MHRs) provide the most accurate data on landings over the period 1988/89 to 2008/09 for the whole of New Zealand.

There was a rapid increase in commercial catches that occurred during the late 1960s, with catches rising to a peak of 2077 t in 1972. Landings were relatively stable from 1983 to 2000, a period when access to the fishery was restricted, although overall catch limits were not in place. In 2000–01 landings dropped to 1070 t, and these were further reduced during 2001/02 to 2004/05 as eel stocks were progressively introduced into the Quota Management System (QMS). For the period 1991–92 to 2008/09, the North Island provided on average 63% of the total New Zealand eel catch (Table 2).

Table 1: Eel catch data (t) from for calendar years 1965 to 1988 and fishing years 1988/89 to 2008/09 based on MAF Fisheries Statistics Unit (FSU) and Licensed Fish Receiver Returns (LFRR), Quota Management Reports (QMR), and Monthly Harvest Returns (MHR).

Year	Landings	Year	Landings	Year	Landings	Year	Landings
1965	30	1977	906	1988–89	1 315	2000–01	1 071
1966	50	1978	1 583	1989–90	1 356	2001–02	962
1967	140	1979	1 640	1990–91	1 590	2002–03	804
1968	320	1980	1 395	1991–92	1 585	2003–04	738
1969	450	1981	1 043	1992–93	1 466	2004–05	708
1970	880	1982	872	1993–94	1 255	2005–06	771
1971	1 450	1983	1 206	1994–95	1 438	2006–07	730
1972	2 077	1984	1 401	1995–96	1 429	2007–08	660
1973	1 310	1985	1 505	1996–97	1 342	2008-09	517
1974	860	1986	1 166	1997–98	1 210		
1975	1 185	1987	1 114	1998–99	1 219		
1976	1 501	1988	1 281	1999–00	1 133		

● MFish data, 1965–1982; FSU, 1983 to 1989–90; CELR, 1990-91 to 1999-00; ECLR 2000-01 to 2003-04; MHR 2004-05-present.

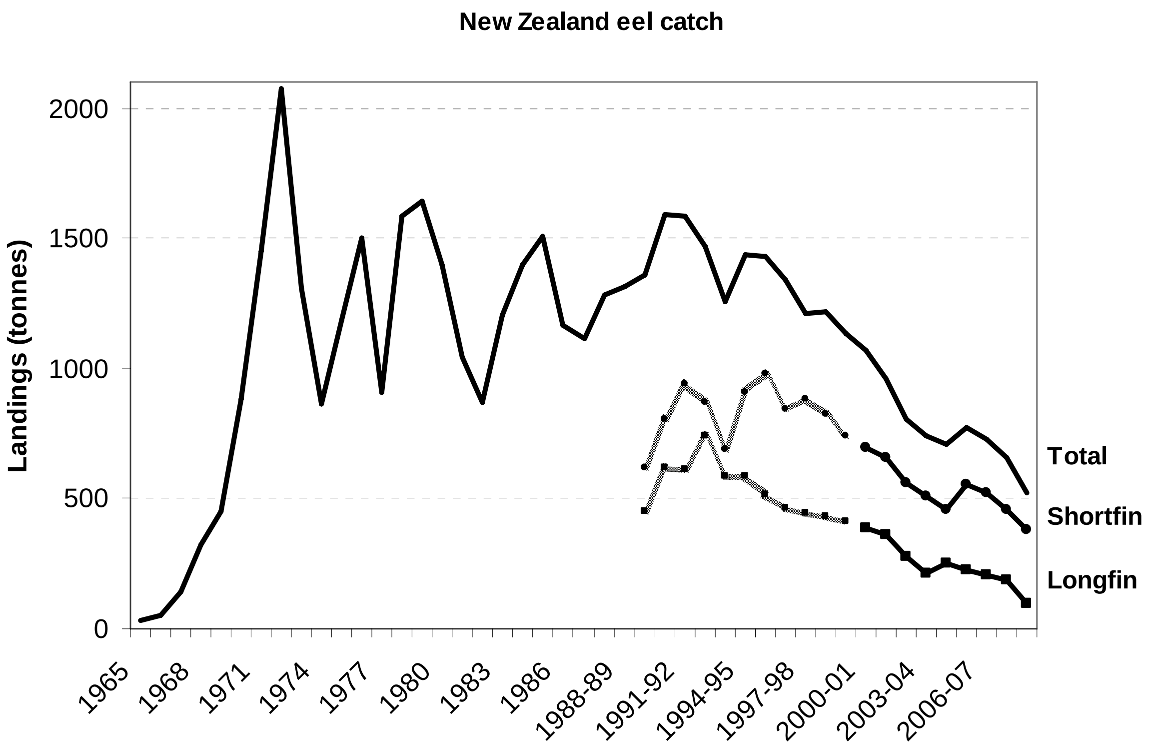


Figure 1: Total eel landings from 1965 to 2007/08, as well as separate shortfin and longfin landings from 1989/90 to 2008/09. The gray lines represent estimates for the period prior to the introduction of Eel Catch Landing Return (ECLR) forms, and were generated by pro-rating the unidentified eel catch by the LFE:SFE ration (see below).

Table 2: North and South Island eel catch (t) compiled from data from individual processors 1991–92 to 1999–00 and LFRR/QMR/MHR 2000/01 to 2008/09. Numbers in parentheses represent the percentage contribution from the North Island fishery.

Fishing year	North Island	South Island	Total individual processors	LFRR/QMR/MHR Total NZ (excluding Chatham Islands)
1991–92	989	631	1 621 (61%)	
1992–93	865	597	1 462 (59%)	
1993–94	744	589	1 334 (56%)	
1994–95	1 004	510	1 515 (66%)	
1995–96	962	459	1 481 (65%)	
1996–97	830	418	1 249 (66%)	
1997–98	795	358	1 153 (69%)	
1998–99	804	381	1 185 (68%)	
1999–00	723	396	1 119 (65%)	
2000–01	768	303		1 071 (72%)
2001–02	644	319		962 (67%)
2002–03	507	296		803 (63%)
2003–04	454	282		737 (62%)
2004–05	426	285		712 (60%)
2005–06	497	285		781 (64%)
2006–07	440	285		725 (61%)
2007–08	372	288		660 (56%)
2008–09	302	215		517 (58%)

Prior to the 2000/01 fishing year, three species codes were used to record species landed, SFE (shortfin), LFE (longfin) and EEU (eels unidentified). A high proportion of eels (46% in 1990/91) were identified as EEU between the fishing years 1989/90 and 1998/99. Pro-rating the EEU catch by the ratio of LFE : SFE by fishing year provides a history of landings by species (Table 3), although it should be noted that pro-rated catches prior to 1999–00 are influenced by the high proportion of EEU from some eel statistical areas (e.g., Waikato) and therefore may not provide an accurate species breakdown. The introduction of new Eel Catch Landing Return (ECLR) in 2000/01 improved the species composition information with the deletion of the EEU code. The species proportion has remained relatively constant since 2000/01 with shortfins comprising 64-80% of catches each year.

Table 3: Total NZ eel landings (t) by species and fishing year. Numbers in bold represent data collected following the introduction of the ECLR forms, whereas all others are pro-rated as described above. Numbers in parentheses represent the longfin proportion of total landings.

Fishing year	Shortfin (SFE)	Longfin (LFE)	Total landings
1989–90	617	453	1 069 (42%)
1990–91	808	616	1 424 (43%)
1991–92	941	612	1 553 (39%)
1992–93	872	741	1 613 (46%)
1993–94	692	588	1 279 (46%)
1994–95	909	588	1 497 (39%)
1995–96	977	518	1 495 (35%)
1996–97	841	465	1 307 (36%)
1997–98	881	442	1 323 (33%)
1998–99	824	434	1 258 (34%)
1999–00	741	413	1 154 (36%)
2000–01	**698**	**388**	**1 086 (36%)**
2001–02	**660**	**360**	**1 020 (35%)**
2002–03	**560**	**279**	**839 (33%)**
2003–04	**510**	**216**	**726 (30%)**
2004–05	**460**	**254**	**713 (36%)**
2005–06	**553**	**226**	**774 (29%)**
2006–07	**524**	**209**	**733 (29%)**
2007–08	**456**	**195**	**651 (30%)**
2008-09	**380**	**95**	**475 (20%)**

The species proportion of the landings varies by geographical area. From analyses of landings to eel processing factories and estimated catch from ECLRs, longfins are the dominant species in most areas of the South Island except for a few discrete locations such as lakes Te Waihora (Ellesmere) and Brunner, and the Waipori Lakes, where shortfins predominate in the landings. Shortfins are dominant in the North Island. In the North Island there has been a general decline in longfin landings relative to shortfin landings over a 17 year period from 1990/91 to 2006/07. Estimated longfin catches declined from around 340 t to 98 t over this period, while shortfin landings fluctuated between 300 t and 600 t, but showed no decline in landings. Landings since 2007/08 were affected by the reduction in TACCs in the North Island introduced on 1 Oct. 2007. The eel fishery catches predominantly pre-migratory feeding eels with the exception of Te Waihora (Lake Ellesmere) where significant quantities of seaward migrating male shortfin eels are taken during the period of February to March.

The Total Allowable Commercial Catch (TACC) and reported commercial landings for the South Island eel stocks are shown in Table 4 from 2000/01 (when eels were first introduced into the QMS) to 2008/09.

Table 4: TACCs and commercial landings (t) for South Island eel stocks.

Fishing	ANG11		ANG12		ANG13		ANG14		ANG15		ANG16		Total
Year	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	landings
2000-01	40	24	43	26	122	108	35	16	118	88	63	41	303
2001-02	40	23	43	22	122	69*	35	20	118	101	63	46	281
2002-03	40	19	43	16	122	93	35	20	118	82	63	32	262
2003-04	40	11	43	7	122	121	35	18	118	77	63	31	266
2004-05	40	6	43	5	122	122	35	9	118	95	63	44	280
2005-06	40	15	43	15	122	122	35	13	118	75	63	32	272
2006-07	40	15	43	8	122	122	35	12	118	80	63	49	286
2007-08	40	19	43	8	122	122	35	15	118	91	63	33	288
2008-09	40	6	43	1	122	122	35	4	118	50	63	32	215

*For the transition from a 1 0ctober to 1 February fishing year, an interim TACC of 78 t was set for the period 1 October 2001 to 31 January 2002. From January 2002 the Te Waihora (Lake Ellesmere) fishing year started 1 February to 31 January.

The TACCs and commercial landings for the Chatham Island and North Island shortfin and longfin eel stocks are shown in Tables 5 and 6. The Chatham Island and North Island fisheries were first introduced into the QMS in 2003/04 and 2004/05, respectively. Note that from 1 October 2007 the TACCs were reduced for all North Island shortfin and longfin stocks.

Table 5: TACCs and commercial landings (t) for Chatham Island (SFE17) and North Island shortfin stocks from 2003/04 to 2008/09.

Fishing	SFE17		SFE20		SFE21		SFE22		SFE23		Total
Year	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	landings
2003-04	10	<1	-	-	-	-	-	-	-	-	-
2004-05	10	1	149	78	163	123	108	81	37	15	298
2005-06	10	3	149	93	163	144	108	107	37	31	378
2006-07	10	<1	149	108	163	114	108	91	37	30	343
2007-08	10	0	86	76	134	125	94	83	23	16	300
2008-09	10	0	86	67	134	110	94	71	23	10	258

Table 6: TACCs and commercial landings (t) for Chatham Island (LFE17) and North Island longfin stocks from 2003/04 to 2008/09.

Fishing	LFE17		LFE20		LFE21		LFE22		LFE23		Total
Year	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	landings
2003-04	1	<1	-	-	-	-	-	-	-	-	-
2004-05	1	0	47	27	64	54	41	24	41	25	130
2005-06	1	<1	47	24	64	41	41	32	41	24	121
2006-07	1	0	47	27	64	30	41	26	41	15	98
2007-08	1	0	19	17	32	31	21	18	9	7	73
2008-09	1	0	19	12	32	23	21	8	9	3	46

1.2 Recreational fisheries

In October 1994, a recreational individual daily bag limit of six eels was introduced throughout New Zealand. There is no quantitative information on the recreational harvest of freshwater eels. The recreational fishery for eels includes any eels taken by people fishing under the amateur fishing regulations and includes any harvest by Maori not taken under customary provisions. The extent of the recreational fishery is not known although the harvest by Maori might be significant.

1.3 Customary non-commercial fisheries

Eels are an important food source for use in customary Maori practices. Maori developed effective methods of harvesting, and hold a good understanding of the habits and life history of eels. Fishing methods included ahuriri (eel weirs), hinaki (eel pots) and other methods of capture. Maori exercised conservation and management methods, which included seeding areas with juvenile eels and imposing restrictions on harvest times and methods. The customary fishery declined after the 1900s but in many areas Maori retain strong traditional ties to eels and their harvest.

In the South Island, Lake Forsyth (Waiwera) and its tributaries have been set aside exclusively for Ngai Tahu. Other areas, such as the lower Pelorus River, Taumutu (Te Waihora), Wainono Lagoon and its catchment, the Waihao catchment, the Rangitata Lagoon and the Ahuriri Arm of Lake Benmore, have been set aside as non-commercial areas for customary fisheries. In the North Island, commercial fishing has been prohibited from the Taharoa lakes, Whakaki Lagoon, Lake Poukawa and the Pencarrow lakes (Kohangapiripiri and Kohangatera) and associated catchments.

Customary non-commercial fishers desire eels of a greater size, over 750 mm and 1 kg. Currently, there appears to be a substantially lower number of larger eels in the main stems of the major river catchments throughout New Zealand, which limits customary fishing. Consequently the access to eels for customary non-commercial purposes has declined over recent decades in many areas. There is no overall assessment of the extent of the current or past customary non-commercial take. For the introduction of the South Island eel fishery into the QMS, an allowance was made for customary non-commercial harvest. It was set at 20% of the TAC for each QMA, equating to 107 t (Table 7). For the introduction of the North Island fishery into the QMS, the customary non-commercial allowance was set at 74 t for shortfins and 46 t for longfins (Tables 8 and 9). For the Chatham Islands, the customary non-commercial allowance was 3 t for shortfin and 1 t for longfin eels (Tables 8 and 9).

Table 7: TACs, and customary non-commercial and recreational allowances (t) for South Island eel stocks. Note that an allowance for other sources of fishing-related mortality has not been set.

	ANG 11	ANG 12	ANG 13	ANG 14	ANG 15	ANG 16
	Nelson/ Marlborough	North Canterbury	Te Waihora Lake Ellesmere	South Canterbury	Otago/Southland	West Coast
TAC	51	55	156	45	151	80
Customary Non-Commercial Allowance	10	11	31	9	30	16
Recreational Allowance	1	1	3	<1	3	2

Table 8: TACs, and customary non-commercial, recreational, and other fishing-related mortality allowances (t) for the Chatham Island and North Island shortfin stocks. Data cover the periods from 2003-04 (Chatham) and 2004/05 (North Island) to 2008/09. Numbers in parentheses reflect the current TACs following a review of catch limits for October 2007 for all North Island eel stocks.

	SFE17	SFE20	SFE21	SFE22	SFE23
TAC	15	211 (146)	210 (181)	135 (121)	50 (36)
Customary Non-Commercial Allowance	3	30	24	14	6
Recreational Allowance	1	28	19	11	5
Other fishing-related mortality	1	2	4	2	2

Table 9: TACs, and customary non-commercial, recreational, and other mortality allowances (t) for the Chatham Island and North Island longfin eel fisheries. Data cover the periods from 2003/04 (Chatham) and 2004/05 (North Island) to 2008/09. Numbers in parentheses reflect the current TACs following a review of catch limits for October 2007 for all North Island eel stocks.

	LFE17	LFE20	LFE21	LFE22	LFE23
TAC	3	67 (39)	92 (60)	54 (34)	66 (34)
Customary Non-Commercial Allowance	1	10	16	6	14
Recreational Allowance	1	8	10	5	9
Other fishing-related mortality	0	2	2	2	2

Eels may be harvested for customary non-commercial purposes under an authorization issued under fisheries regulations. Such authorizations are used where harvesting is undertaken beyond the recreational rules. Customary fisheries reports for Te Runanga o Ngai Tahu (which covers the majority of the South Island) showed that for the 2005/06 fishing year, 5503 individual eels and 500 kg of eels were harvested respectively under customary authorization. For the 2006/07 fishing year the reported harvest was 2256 eels and 100 kg. No harvest was reported in the fishing years 2003/04 and 2004/05. The majority of eels were harvested from ANG 12 (North Canterbury) and ANG 13 (Te Waihora/Lake Ellesmere). Customary regulations were only extended to freshwaters of the Chatham and North Islands in November 2008.

1.4 Illegal catch
There is no information available on illegal catch. There is some evidence of fishers exceeding the amateur bag limit, and some historical incidences of commercial fishers operating outside of the reporting regime, but overall the extent of illegal take is not considered to be significant.

1.5 Other sources of mortality
Although there is no information on the level of fishing-related mortality associated with the eel fishery (i.e., how many eels die while in the nets), it is not considered to be significant given that the fishing methods used are passive and catch eels in a live state.

Eels are subject to significant sources of mortality from non-fishing activities, although this has not been quantified. Direct mortality occurs through the mechanical clearance of drainage channels, and damage by hydro-electric turbines and flood control pumping. Survival of eels through hydroelectric turbines is affected by eel length, turbine type and turbine rotation speed. The mortality of larger eels (specifically longfin females), is estimated to be 100%. Given the large number of eels in hydro lakes, this source of mortality could be significant and reduce spawner escapement in New Zealand. In addition to these direct sources of mortality, eel populations are likely to have been significantly reduced since European settlement from the 1840's by wetland drainage (wetland areas have been reduced by up to 90% in some areas), and habitat modification brought about by irrigation, channelisation of rivers and streams and the reduction in littoral habitat. On-going drain maintenance activities by mechanical means to remove weeds may cause direct mortality to eels through physical damage or by stranding and subsequent desiccation.

2. BIOLOGY

Species and general life-history
There are 16 species of freshwater eel world-wide, with the majority of species occurring in the Indo-Pacific region. New Zealand freshwater eels are regarded as temperate species, similar to the Northern Hemisphere temperate species, the European eel *A. anguilla*, the North American eel *A. rostrata*, and the Japanese eel *A. japonica*. Freshwater eels have a life history unique among fishes that inhabit New Zealand waters. All *Anguilla* species are catadromous, living predominantly in freshwater and undertaking a spawning migration to an oceanic spawning ground. The major part of the life-cycle is spent in freshwater or estuarine/coastal habitat. Spawning of New Zealand species is presumed to take place in the south-west Pacific. Progeny undertake a long oceanic migration to freshwater where they grow to maturity before migrating to the oceanic spawning grounds. The average larval life is 6 months for shortfins and 8 months for longfins. Eels are presumed to spawn once and die after spawning.

The longfin eel is endemic to New Zealand and is thought to spawn east of Tonga. The shortfin eel is also found in South Australia, Tasmania, and New Caledonia; spawning is thought to occur northeast of Samoa. Larvae (leptocephali) are transported to New Zealand largely passively on oceanic surface currents, and the metamorphosed juveniles (glass eels) enter freshwater from August to November. The subsequent upstream migration of elvers (pigmented juvenile eels) in summer distributes eels throughout the freshwater habitat. The two species occur in abundance throughout New Zealand and have overlapping habitat preferences with shortfins predominating in lowland lakes and muddy rivers, while longfins prefer stony rivers and penetrate further inland to high country lakes.

Growth
Age and growth of New Zealand freshwater eels was reviewed by Horn (1996). Growth in freshwater is highly variable and dependent on food availability, water temperature and eel density. Eels, particularly longfins, are generally long lived. Maximum recorded age is 60 years for shortfins and

106 years for longfins. Ageing has been validated. Growth rates determined from the commercial catch sampling programme (1995/97) indicate that in both the North and South Islands, growth rates are highly variable within and between catchments. Shortfins often grow considerably faster than longfins from the same location, although in the North Island longfins grow faster than shortfins in some areas (e.g. parts of the Waikato catchment). South Island shortfins take, on average, 12.8 years (range 8.1–24.4 years) to reach 220 grams (minimum legal size), compared with 17.5 years (range 12.2–28.7 years) for longfins, while in the North Island the equivalent times are 5.8 years (3–14.1 years) and 8.7 years (range 4.6–14.9 years) respectively. Australasian longfin growth is generally greater than that of New Zealand longfins and closer to that of shortfins.

Growth rates are usually linear. Sexing immature eels is difficult, but from length at age data for migratory eels, there appears to be little difference in growth rate between the sexes. Sex determination in eels appears to be influenced by environmental factors and by eel density, with female eels being more dominant at lower densities. Age at migration may vary considerably between areas depending on growth rate. Males of both species mature and migrate at a smaller size than females. Migration appears to be dependent on attaining a certain length/weight combination and condition. The range in recorded age and length at migration for shortfin males is 5–22 years and 40–48 cm, and for females 9–41 years and 64–80 cm. For longfinned eels the range in recorded age and length at migration is 11–34 years and 48 - 74 cm for males, and 27–61 years and 75–158 cm for females. However because of the variable growth rates, eels of both sexes and species may migrate at younger ages.

Recruitment

Glass eels enter rivers and streams around New Zealand between August and December. Regional differences in mean size and condition show an arrival pattern from the north in an anti-clockwise dispersal pattern around New Zealand. There is some evidence of annual variation influenced by the El Nino Southern Oscillation (ENSO), with the arrival route of glass eels from the northwest being stronger during the La Nina phase and stronger from the northeast during the El Nino phase. Differences in ages of glass eels between Australia and New Zealand indicate that glass eels arriving in New Zealand do not do so via the East Australian Current, but arrive more directly from the north-west. The recent discovery of the Antarctic Circumpolar Wave that effects how the ENSO cycles develop could also provide a further mechanism for the periodic alteration of glass eel recruitment. Rather than a fixed spawning ground, it has been suggested that the tropical spawning grounds may not be geographically fixed but associated with thermal fronts that might move.

Unlike the Northern Hemisphere, there are few glass eel data or long term data sets on elver migrations in New Zealand which could provide information on recruitment. Northern Hemisphere stocks have shown substantial declines in recruitment over recent decades. Available information on recent recruitment trends of New Zealand eels is equivocal and has focused on glass eel recruitment, elver migrations, age class structure of juvenile eels and length frequency data from commercial catch sampling. From the age composition of juvenile eels there is evidence that glass eel recruitment has declined in two North Island and three South Island waters. There is evidence from duration of runs and catch-effort data that glass eel runs are now smaller in the Waikato River than in the 1970’s. Specific studies on the variability and temporal abundance of glass eels over a seven year period from 1995 to 2002 at five sites showed no decline in recruitment for either species. The density of shortfin glass eels exceeded that of longfins for any one year but the annual trends for both species were generally similar.

Long-term data series on either glass eel or elver abundance is necessary to assess trends in recruitment. Therefore, current research on recruitment is aimed at establishing a time series of relative abundance of elvers at key locations in New Zealand where the upstream passage is restricted by hydro dams (Table 10 and Figure 2). The largest runs of elvers monitored occur at the Karapiro Dam on the Waikato River and the Matahina Dam on the Rangitaiki River. Results from the 2007/08 season showed a substantial increase in elver numbers at both sites, with total and longfin numbers exceeding all previous years of records (since 1992/93). Although the total number of elvers from the subsequent 2008/09 season was still among the highest recorded for these two sites, the number of longfin elvers decreased by approximately 50% relative to the previous year.

Table 10: Estimated numbers (1000s) of elvers trapped at elver recruitment monitoring sites by season (Dec-April) 1992/93 to 2008/09. Figures in brackets represent the % of longfins present, whereas those in italics are incomplete records. (n/a) = sampling discontinued.

Year	Karapiro Dam	Matahina Dam	Patea Dam	Piripaua Dam	Waitaki Dam	Roxburgh Dam	Arnold River Dam
1992–93	92 (34)	>32	–	–	–	–	–
1993–94	518 (34)	>215	–	–	–	–	–
1994–95	282 (34)	>39	–	–	–	–	–
1995–96	1 155 (29)	>144	–	–	–	–	–
1996–97	1 220 (20)	*14 (29)*		*2.1 (0)*	–	0.3 (100)	–
1997–98	*2 040 (25)*	615 (22)		*7.3 (6)*	–	11 (100)	–
1998–99	1 097 (31)	*1 002*		*3.1 (13)*	–	7.4 (100)	–
1999–00	892 (10)	*2 001*		2.6 (1.9)	–	–	–
2000–01	782 (20)	*2 054*	495	6.0 (2.7)	*20.6*	–	–
2001–02	1 596 (15)	619 (4)	754 (6)	4.1 (10.4)	-	1 (100)	–
2002–03	1 942 (9)	1 484 (8)	380 (2)	10.2 (1.8)	0.0056 (100)	0.1 (100)	–
2003–04	2 131 (9)	945 (7)	391 (0.3)	4.9 (4.1)	4.6 (99.8)	1.4 (100)	–
2004–05	1 333 (10)	1 117 (1)	*450 (-)*	8.1 (5.6)	1.5 (100)	(n/a)	28 (26)
2005–06	2 177 (22)	1 193 (19)	562 (15)	2.7 (5.3)	4.7 (100)	(n/a)	14 (57)
2006–07	1296 (14)	485 (33)	896 (6)	4.2 (8)	3.3 (100)	(n/a)	107 (48)
2007–08	2728 (26)	3378 (27)	857 (11)	5.7 (18)	57.6 (100)	(n/a)	186 (42)
2008-09	2288 (13)	4307 (12)	663 (-)	9.0 (23)	4.7 (74)	(n/a)	183 (47)

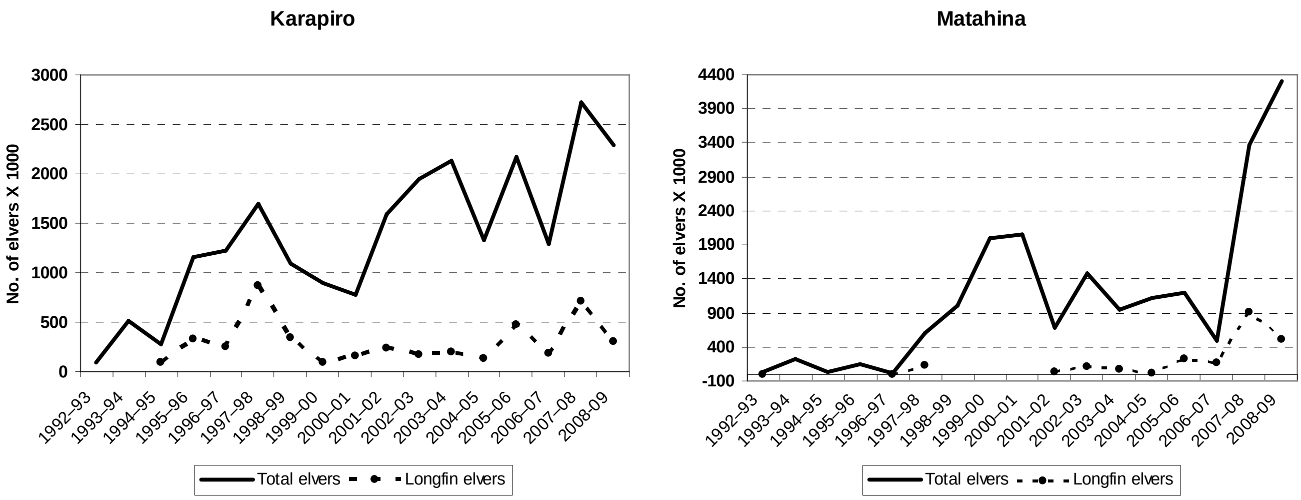


Figure 2: Trends in total elver numbers for the Karapiro and Matahina dams, together with the number of longfin elvers, from 1992/93 to 2008/09.

Spawning

As eels are harvested before spawning, the escapement of sufficient numbers of eels to maintain a spawning population is essential to maintain recruitment. For shortfin eels the wider geographic distribution for this species (Australia, New Zealand, south-west Pacific) means that spawning escapement occurs from a range of locations throughout its range. In contrast, the more limited distribution of longfin eels (New Zealand and offshore islands) means that the spawning escapement must occur from New Zealand freshwaters and offshore islands.

3. STOCKS AND AREAS

The lifecycle of each species has not been completely resolved but all evidence supports the proposition of a single (panmictic) stock for each species. Biochemical evidence suggests that shortfins found in both New Zealand and Australia form a single biological stock. Longfins are endemic to New Zealand and are assumed to be a single biological stock.

Within a catchment, adult eels undergo limited movement until their seaward spawning migration. Therefore once glass eels have entered a catchment, each catchment effectively contains a separate population of each eel species. The quota management areas mostly reflect a combination of these catchment areas. The broader provincial areas had previously been used since the 1980s to manage access under the non-QMS management framework (ie, area conditions on fishing permits).

Shortfin and longfin eel have different biological characteristics in terms of diet, growth, maximum size, age of maturity, reproductive capacity, and behavioural ecology. These differences affect the productivity of each species, and the level of yield that may be sustainable on a longer term basis, as well as their interactions with other species. In order that catch levels for each species is sustainable in the longer term, and the level of removals does not adversely affect the productivity of each species, it is appropriate that the level of removals of each species is effectively managed.

For management purposes, this has been achieved in the Chatham Islands and North Island where separate stocks for shortfin and longfin eels were introduced into the QMS in 2003 and 2004 respectively. When eel stocks in the South Island were introduced into the QMS in 2000, there was insufficient information on the South Island species composition of the commercial catch to implement stock definitions and catch limits based on each species. However, there is sufficient science information now available to redefine the combined eel stock (ANG) into shortfin (SFE) and longfin (LFE) stocks for the quota management areas of the South Island.

4. STOCK ASSESSMENT

There is no formal stock assessment available for freshwater eels. Furthermore, the only data on population estimates apply to small areas and have limited application to the rest of New Zealand (Table 11). Fu et al. (in press) recently developed a length-structured longfin population model that generated New Zealand-wide estimates of the pre-exploitation female spawning stock biomass (approximately 1700 t) as well as the pre-exploitation biomass of legal-sized eels (16 000 t in all fished areas and 6 000 t in protected areas). By contrast, the model estimated current female spawning stock biomass to be approximately 55% of pre-exploitation levels, whereas the current biomass of legal-sized eels ranged from 20% to 90% of the pre-exploitation level for the fished areas. However, the WG noted that further analyses be conducted to investigate the model's underlying assumptions, given that the results were strongly driven by estimates of longfin commercial catches from individual eel statistical areas as well as GIS-based estimates of recruitment.

Table 11: Estimates of fishery parameters.

1. Total mortality (Z)	Estimate	Source
Lake Ellesmere shortfins	0.1–0.3	Jellyman *et al.* (1995)
Lake Ellesmere longfins	0.09	Jellyman *et al.* (1995)

4.1 Catch-per-unit-effort analyses

Each species of eel comprises a single stock, and these can be more appropriately managed using an alternative to the maximum sustainable yield (MSY) approach, which is available under s.14 of the Fisheries Act 1996. To that end, standardised catch-per-unit-effort (CPUE) analyses have been conducted for the commercial shortfin and longfin eel fisheries from 1990/91 to 2006/07 for all North Island Eel Statistical Areas (ESAs) and to 2005/06 for all South Island ESAs (Tables 12 to 14 and Figures 3 and 4).

In the North Island, the ESAs with the largest longfin commercial catches (ESAs AA, AD, and AH) all showed declines of approximately 30-70% in CPUE indices in 2006/07 when compared to 1990/91, with the largest reduction occurring in ESA AH (Rangitikei-Wanganui). In ESAs AA and AD, the longfin CPUE index was relatively stable from 1990/91 to approximately 1998/99, thereafter declining until 2001/02 and remaining stable until 2006/07, whereas the decline in ESA AH was generally more continuous over the 17 year period.

For shortfins, the North Island ESAs with the largest commercial catches (ESAs AA, AD, and AG) showed a generally increasing CPUE index for ESA AA (Auckland) over the same period, whereas those for ESA AD (Waikato) and AG (Hawke's Bay) generally decreased until 2001/02 but increased thereafter. In 2006/07, the CPUE index for ESA AA was 1.5 times that estimated in 1990/91, whereas the indices for ESA AD and AG declined by 2% and 38%, respectively.

By contrast, although the main commercial longfin eel fisheries in the South Island (ESAs AX, AV, and AW) had either relatively stable or decreasing CPUE indices from 1990/91 to 2000/01 (the year eels were introduced into the QMS on the South Island), these generally increased from 2001/02 to 2005/06. Similar patterns were seen for the main shortfin eel fisheries (ESAs AX, AR, AV, AW, and AS), with the greatest increases in CPUE indices from 2000/01 to 2005/06 occurring in ESAs AX and AS.

Table 12: New Zealand Eel Statistical Areas (ESAs). Areas were given a numeric designation prior to Oct. 2001, at which point letter codes were assigned.

ESA	Letter code	Numeric code
Northland	AA	1
Auckland	AB	2
Hauraki	AC	3
Waikato	AD	4
Bay of Plenty	AE	5
Poverty Bay	AF	6
Hawke's Bay	AG	7
Rangitikei-Wanganui	AH	8
Taranaki	AJ	9
Manawatu	AK	10
Wairarapa	AL	11
Wellington	AM	12
Nelson	AN	13
Marlborough	AP	14
South Marlborough	AQ	14
Westland	AX	15
North Canterbury	AR	16
South Canterbury	AT	17
Waitaki	AU	18
Otago	AV	19
Southland	AW	20
Te Waihora (outside-migration area)	AS1	21
Te Waihora migration area	AS2	21
Chatham Islands	AZ	22
Stewart Island	AY	23

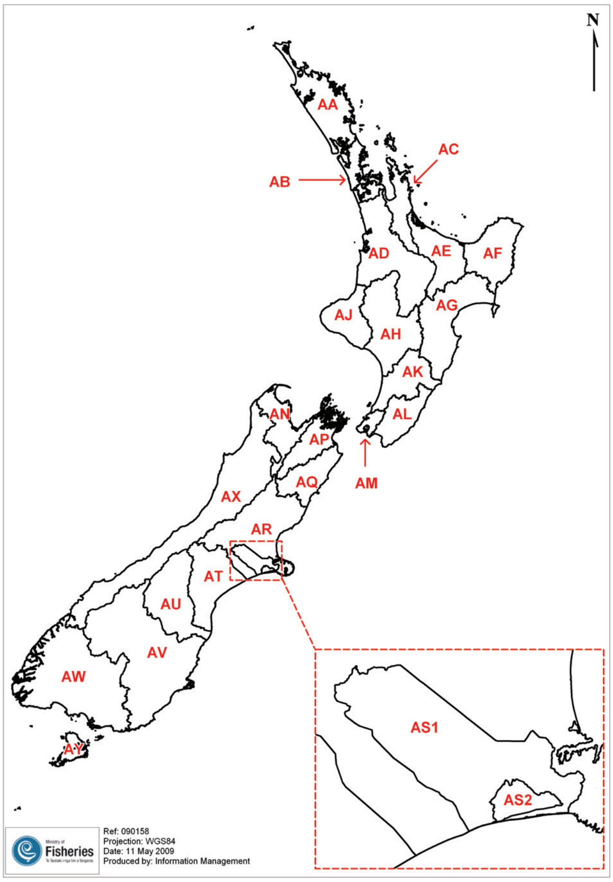


Table 13: CPUE indices for shortfin eels according to Eel Statistical Area (ESA). For the North Island, estimates are only available for the years prior to when the species was introduced into the QMS (2004/05). Fishing years are referred to by the second year (e.g., 1990/91 is referred to as 1991).

ESA	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
North Island																	
AA	0.80	0.75	0.78	0.72	0.91	0.97	0.93	1.13	1.23	1.27	1.28	1.02	1.03	1.07	1.03	1.14	1.22
AB	1.48	0.90	0.79	0.87	1.08	1.16	0.88	1.11	1.37	1.00	0.93	0.75	0.82	0.87	0.97	1.11	1.23
AC	0.99	0.96	1.14	1.07	1.11	1.17	0.83	0.76	0.79	0.91	0.87	1.19	1.01	1.16	1.07	1.10	1.02
AD	1.05	1.14	1.16	1.23	1.24	1.31	1.02	1.09	0.96	0.80	0.76	0.81	0.72	0.95	0.91	1.06	1.02
AE/AF	1.66	1.06	0.88	1.00	1.25	1.48	0.99	0.73	1.06	0.67	0.74	0.51	0.76	0.93	1.28	1.35	1.48
AG	1.53	1.60	1.51	1.42	1.47	1.13	0.89	0.70	0.97	0.82	1.10	0.53	0.59	0.78	0.83	1.13	0.95
AH	0.98	0.88	0.93	1.11	1.05	1.66	1.16	1.02	1.14	0.93	1.00	0.79	1.04	0.29	0.84	1.47	1.71
AJ	1.45	1.74	0.66	0.58	0.84	0.91	0.84	1.00	1.24	1.12	0.97	1.01	0.96	1.00	0.80	1.48	1.03
AK	3.08	5.13	2.06	0.68	0.65	0.51	0.48	0.69	0.92	0.69	0.74	0.87	0.48	-	1.02	1.30	1.62
AL	1.58	–	1.29	1.48	1.46	1.27	0.86	1.23	1.10	0.88	0.98	0.60	0.56	0.51	1.28	1.24	0.66
South Island																	
AN	0.40	-	1.27	0.31	0.70	0.58	0.78	0.60	0.83	2.42	2.02	2.86	–	–	–	2.84	
AP/AQ	1.46	1.34	1.20	0.98	0.89	0.55	0.46	0.16	0.33	0.42	1.52	2.10	2.36	1.90	1.90	3.16	
AX	0.84	0.63	1.03	0.78	0.83	0.44	0.44	1.11	1.37	1.17	1.12	1.41	1.15	1.54	1.69	1.74	
AR	1.32	1.15	0.99	1.09	0.99	1.19	1.06	1.17	1.37	1.11	–	1.66	0.54	0.48	0.69	0.92	
AT	1.64	0.91	0.73	0.77	0.71	0.99	0.91	1.40	0.66	0.94	–	1.31	1.23	1.32	–	–	
AU	1.58	0.73	0.61	0.74	0.76	1.37	1.07	0.89	1.53	1.17	–	–	–	1.10	–	–	
AV	1.54	1.16	0.88	0.83	0.87	0.84	0.87	0.95	0.60	1.06	1.23	0.96	0.99	1.01	1.28	1.29	
AW	1.13	1.31	1.29	1.74	1.12	1.33	1.15	1.54	1.28	1.22	0.55	0.49	0.56	0.61	1.02	0.77	
AS1/	0.81	1.19	0.92	0.63	0.53	0.88	1.03	0.97	1.04	0.73	0.89	0.81	1.01	1.40	1.75	2.78	

Table 14: CPUE indices for longfin eels according to Eel Statistical Area (ESA). For the North Island, estimates are only available for the years prior to when the species was introduced into the QMS (2004/05). Fishing years are referred to by the second year (e.g., 1990/91 is referred to as 1991).

ESA	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
North Island																	
AA	1.30	1.19	1.25	1.21	1.21	1.36	1.05	1.35	1.50	1.04	1.04	0.78	0.67	0.82	0.65	0.58	0.71
AB	1.04	1.47	1.56	1.51	1.56	1.48	0.95	1.05	1.22	1.16	1.44	0.86	0.74	0.87	0.51	0.43	0.48
AC	2.55	2.31	2.04	1.04	1.23	1.15	1.31	0.93	0.72	0.94	0.62	0.80	0.69	0.60	0.78	0.72	0.59
AD	1.17	1.47	1.04	1.23	1.30	1.13	1.21	0.85	0.88	0.97	0.99	0.84	0.88	0.88	0.85	0.82	0.79
AE/AF	1.81	1.81	1.08	1.11	0.84	0.69	0.93	1.11	1.98	0.70	1.56	0.86	0.78	0.80	0.70	0.85	0.61
AG	1.83	1.76	1.92	1.86	1.53	1.44	0.76	0.91	1.26	1.13	1.00	0.58	0.69	0.46	0.57	0.60	0.63
AH	1.86	2.07	1.59	1.78	1.45	1.38	1.39	0.81	0.79	0.90	0.66	0.63	0.60	0.49	0.77	1.04	0.59
AJ	1.55	1.80	1.31	1.15	1.38	1.26	1.16	1.02	0.90	0.81	0.72	0.68	0.68	0.80	0.82	0.83	0.88
AK	–	–	1.44	1.2	0.99	0.68	1.08	1.17	3.32	0.64	0.93	0.58	0.42	-	0.33	0.52	0.64
AL	1.03	–	1.67	0.91	1.69	1.21	1.55	1.16	1.05	0.89	0.92	0.57	0.48	0.96	0.52	0.69	2.15
South Island																	
AN	-	-	1.46	-	0.94	0.77	1.0	0.79	1.02	0.94	0.60	1.91	–	–	–	1.10	–
AP/AQ	2.05	1.71	0.97	1.22	1.30	1.35	0.85	0.69	0.61	0.35	1.09	1.04	0.94	0.96	1.07	-	–
AX	1.04	1.07	0.78	0.84	1.07	1.04	0.99	0.99	1.10	1.36	1.06	0.86	0.90	0.91	1.03	1.10	–
AR	2.10	0.82	1.00	1.11	0.77	2.06	1.86	1.40	1.58	2.18	0.61	0.50	0.78	0.53	0.36	0.81	–
AT	1.97	0.59	0.80	1.19	1.00	0.98	1.14	0.91	0.94	1.84	–	0.70	0.72	1.02	–	–	–
AU	1.09	1.97	0.76	1.06	0.69	1.06	1.05	0.84	1.10	0.96	–	–	–	0.84	–	–	–
AV	1.37	1.19	1.09	1.28	0.88	0.81	0.85	0.92	0.79	0.86	0.87	0.94	0.96	1.01	1.27	1.14	–
AW	1.57	1.25	1.20	1.25	1.02	1.05	0.94	0.85	0.71	0.88	0.79	0.93	0.90	0.80	1.11	1.10	–
AS1/ AS2	6.70	2.39	1.19	1.14	0.95	0.57	0.80	1.07	0.93	0.84	0.91	1.00	0.61	0.65	0.69	0.51	–

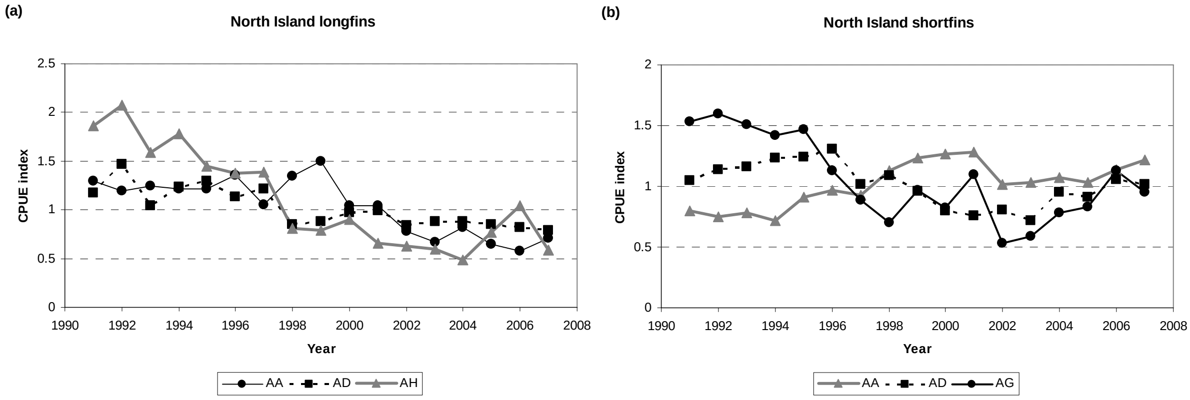


Figure 3: Trends in North Island longfin (panel a) and shortfin (panel b) CPUE indices for ESAs Northland (AA), Waikato (AD), Hawke's Bay (AG), and Rangitikei-Wanganui (AH) from 1990/91 to 2006/07.

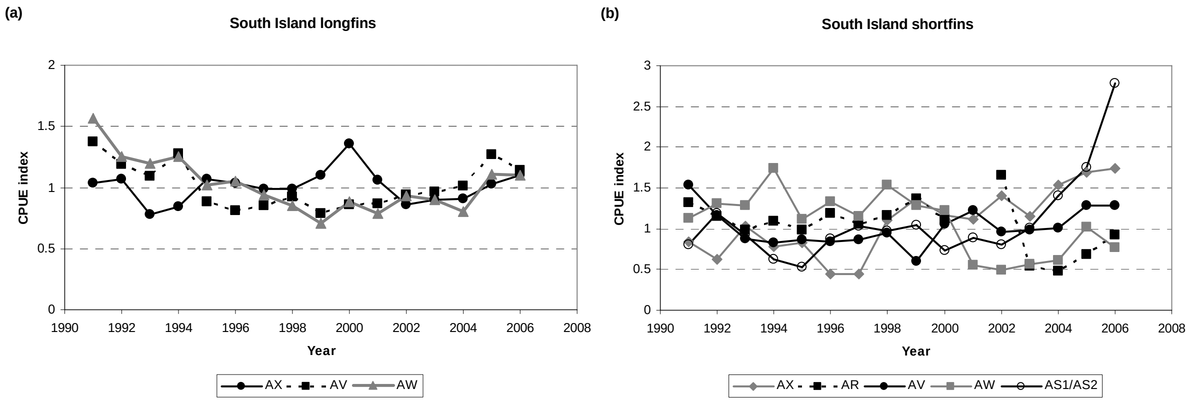


Figure 4: Trends in South Island longfin (panel a) and shortfin (panel b) CPUE indices for ESAs Westland (AX), Otago (AV), Southland (AW), North Canterbury (AR) and Te Waihora (AS1 and AS2) from 1990/91 to 2005/06.

Biological parameters relevant to stock assessment are given in Table 15.

Table 15: Estimates of biological parameters

Fishstock	Estimate	Source
1. Natural mortality (*M*)		
Unexploited shortfins (Lake Pounui)	M = 0.038	Jellyman (unpub. Data)
Unexploited longfins (Lake Pounui)	M = 0.036	Jellyman (unpub. Data)
Unexploited longfins (Lake Rotoiti)	M = 0.02	Jellyman (1995)
2. Weight (g) of shortfin and longfin eels at 500 mm total length		
	Mean weight	Range
Shortfins Lake Pounui	263	210–305
Shortfins Waihora	250	210–303
Longfins Lake Pounui	307	250–380

4.2 Biomass estimates

Estimates of current and reference biomass for any eel fish stock are not available. Recent estimates of approximately 12 000 t have been made for longfin eels (Graynoth et al. 2008, Graynoth and Booker 2009), but these are based on limited data on density, growth and sex composition of longfin eel populations in various habitat types, including lakes and medium to large rivers.

4.3 Estimation of Maximum Constant Yield (MCY)

The Eel Working Group considered it inappropriate to include estimates of MCY in this report.

4.4 Estimation of Current Annual Yield (CAY)

In the absence of accurate current biomass estimates, this could not be estimated.

4.5 Other yield estimates and stock assessment results
No information is available.

4.6 Other factors

Yield-per-recruit
Yield-per-recruit (YPR) models have been run on Te Waihora (Lake Ellesmere) and Lake Pounui data to test the impact of increases in size limit. Results indicated that an increase in minimum size should result in a small gain in YPR for shortfins in Te Waihora and longfins in Lake Pounui, but a decrease for shortfins in Lake Pounui.

A practical demonstration of the benefits of an increase in size limit has been reported from the Waikato area, where a voluntary increase in minimum size from 150 to 220 g in 1987 resulted in decreased CPUE for up to 18 months, but an increase thereafter.

Spawning escapement
A key component to ensuring the sustainability of eels is to maintain spawner escapement. Graynoth et al. (2008) estimated that, under catch levels prior to 2002, longfin spawning escapement was possibly sufficient to maintain existing depleted stocks but not sufficient for rebuilding stocks. However there is uncertainty in this assumption, even though catch limits have since been introduced and commercial catches reduced. As a sustainability measure, the Mohaka, Motu and much of the Whanganui River catchments were closed to commercial fishing in early 2005 to aid spawning escapement. The importance of adequate spawner escapement for eels is evident from the three northern hemisphere (*Anguilla anguilla, A rostrata and A. japonica*) species, which are all extensively fished and are subject to a variety of anthropogenic impacts similar to the situation in New Zealand. There has been a substantial decline in recruitment for all three northern hemisphere species from the mid 1970’s with less than 1% of juvenile resources remaining.

Based on GIS modelling it has been estimated that for longfin eels, 5% of habitat throughout New Zealand is in water closed to fishing where there is protected egress to the sea to ensure spawning escapement. A further 10% of longfin habitat is in areas closed to fishing in upstream areas but where the spawning migration could be subject to exploitation in downstream areas. An additional 17% of longfin habitat is in small streams that are rarely or not commercially fished. Therefore, about 30% of longfin habitat in the North Island and 34% in the South Island is either in a reserve or in rarely/non-fished areas, with ~ 49% of the national longfin stock estimate of ~ 12 000 t being contained in these waterways (Graynoth et al. 2008). These estimates do not take into account habitat reductions caused by hydro development and habitat loss. If these factors are included, and based on biomass estimates from several South Island rivers, it is estimated that the biomass of longfin eels above the minimum weight at migration is less than 20% of historical values. However, the longevity and fecundities of large female eels, combined with a general lack of natural predators, means that it is possible that glass eel recruitment in the past exceeded what was needed to maintain stocks, and that eel recruitment might be maintained with only 10% of the virgin biomass (Graynoth et al. 2008). Some evidence also suggests that the survival of juvenile and adult eels is density dependent, and reductions in eel recruitment (resulting from lower spawner escapements) may consequently be compensated for by increased survival of juveniles and adults.

Sex ratio
The shortfin fishery is based on the exploitation of immature female eels, as most shortfin male eels migrate before reaching the minimum size of 220 g. The longfin fishery is based on immature male and female eels. A study on the Aparima River in Southland found that female longfins were rare in the catchment. Only five of 738 eels sexed were females. This is in contrast to a predominance of larger female longfins in southern rivers established by earlier research in the 1940s and 1950’s, prior to commercial fishing.

The sex ratio in other southern catchments, determined from analysis of commercial landings, also show a predominance of males. In contrast some other catchments (Waitaki River, some northern South Island rivers) showed approximately equal sex ratios. The predominance of males in the size range below the minimum legal size of 220 g cannot be attributed directly to the effects of fishing. Because the sexual differentiation of eels can be influenced by environmental factors, it is possible that changing environmental factors are responsible for the greater proportion of male eels in these southern rivers.

Enhancement
The transfer of elvers and juvenile eels has been established as a viable method of enhancing eel populations and increasing productivity in areas where recruitment has been limited. Elver transfer operations are conducted in summer months when elvers reach river obstacles (e.g., the Karapiro Dam on the Waikato River; see Table 8) on their upriver migration. Over 5 million elvers are regularly caught and transferred upstream each year.

To mitigate the impact of hydro turbines on migrating eels, a catch and release programme for large longfin females has been conducted from Lake Aniwhenua with release below the Matahina Dam since 1995. A capture and release programme has also been conducted from Lake Manapöuri to below the Mararoa Weir on the Wairau River, Southland by Waiau Mahika Kai Trust since 1998. Adult eel bypasses have been installed at the Wairere Falls power station on the Mokau River since 2002 and controlled spillway openings have been undertaken at Patea Dam during rain events in autumn (when eels are predicted to migrate downstream) since the late 1990s.

Several projects have been undertaken to evaluate the enhancement of depleted customary fisheries through the transfer of juvenile eels. In 1997, over 2000 juvenile eels (100–200 g) were caught from Te Waihora (Lake Ellesmere), tagged and transferred to Cooper’s Lagoon a few kilometres away. Only ten tagged eels, all females, were recovered in 2001. It is likely that a large number of eels migrated to sea as males following the transfer. Another project in 1998 transferred 7600 (21% tagged) eels weighing less than 220 g from Lake Waahi in the Waikato catchment to the Taharoa Lakes near Kawhia. No tagged eels were recovered when the lakes were surveyed in 2001. It is considered that a large number of eels migrated from the lake as males following the transfer. The conclusion from these two transfers is that transplanted eels need to be females, requiring that eels larger than 220 g and above the maximum size of migration for shortfin males need to be selected for transfer. In 1998 approximately 10,000 juvenile eels were caught in the lower Clutha River, tagged and transferred to Lake Hawea. In 2001, 19.4% of the tagged eels were recovered. An estimated 80% of transferred eels survived after three years. The transferred eels showed accelerated growth and the mean annual growth in length was almost double that of eels from the original transfer site.

5. STATUS OF THE STOCKS

The Eel Fishery Assessment Working Group has focused its attention in recent years on the stock status of longfin eels. This species is more susceptible to overexploitation than shortfins because of their limited geographical distribution (confined to New Zealand and offshore islands) and longevity.

Longfin eel
The Working Group recognises that there are no stock assessments on which to base specific recommendations on longfin catch levels. Nevertheless, recruitment data, CPUE indices, and information on spawner escapement allow for a cautioned assessment to be made of longfin and shortfin stock status.

From the age composition of juvenile eels there is evidence that glass eel recruitment has declined in two North Island and three South Island waters, and there is evidence that glass eel runs are now smaller in the Waikato River than in the 1970’s. Nevertheless, results from 2007/08 show that, with the exception of 1997/98, the number of longfin elvers at two of the main monitoring stations (Karapiro and Matahina dams) was the highest that has been recorded in the previous 16 years. However, although the total number of elvers from the subsequent 2008/09 season was still among the highest recorded for these two sites, the number of longfin elvers decreased by approximately 50% relative to the previous year.

The only estimates of relative abundance are based on CPUE data. For the North Island, the ESAs with the largest longfin commercial catches (ESAs AA, AD, and AH) all showed declines of approximately 30-70% in CPUE indices from 1990/91 to 2006/07, with the largest reduction occurring in Rangitikei-Wanganui (ESA AH). By contrast, although the main commercial longfin fisheries in the South Island (ESAs AX, AV, and AW) had either relatively stable or decreasing CPUE indices from 1990/91 to 2000/01 (the year eels were introduced into the QMS on the South Island), these generally increased from 2001/02 to 2005/06.

A key component to ensuring the sustainability of eels is to maintain spawner escapement, and to that end approximately 30% of available longfin habitat in the North Island and 34% in the South Island is either in reserves or in rarely/non-fished areas. If hydro development and habitat loss are added to these estimates, and based on biomass estimates from several South Island rivers, it is estimated that the biomass of longfin eels above the minimum weight at migration is less than 20% of historical values.

Following concerns that exploitation rates of longfin eels were unsustainable, in early 2005 three areas were closed to commercial fishing (the Mohaka, Motu and much of the Whanganui River catchments), and in 2007 management actions included reductions in TACCs and the introduction of an upper size limit for longfin (and shortfin) eels in the North Island and on Chatham Island.

Shortfin eel

Based on available information, the Working Group does not consider that the same level of risk of unsustainable exploitation applies to shortfin eels. For example, shortfins have a wider geographic distribution than longfins, and their recruitment into New Zealand waters could be supplemented by juveniles which originate from other sources (e.g., South Australia, Tasmania, and New Caledonia stocks). Furthermore, the CPUE indices for the main commercial shortfin fisheries in the South Island (ESAs AX, AR, AV, AW, and AS) generally increased from 2001/02 to 2005/06, especially in ESAs AX (Westland) and AS (Te Waihora/Lake Ellesmere). By contrast, the North Island ESAs with the largest commercial catches (ESAs AA, AD, and AG) showed less consistent trends in CPUE indices, with ESA AA (Auckland) showing a general increase from 1990/91 to 2006/07 whereas those for ESA AD (Waikato) and AG (Hawke's Bay) generally decreased until 2001/02 but increased thereafter. However, caution is required in managing shortfin stocks given the nature of their biology and the fact that they are harvested before they can spawn.

6. FOR FURTHER INFORMATION

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