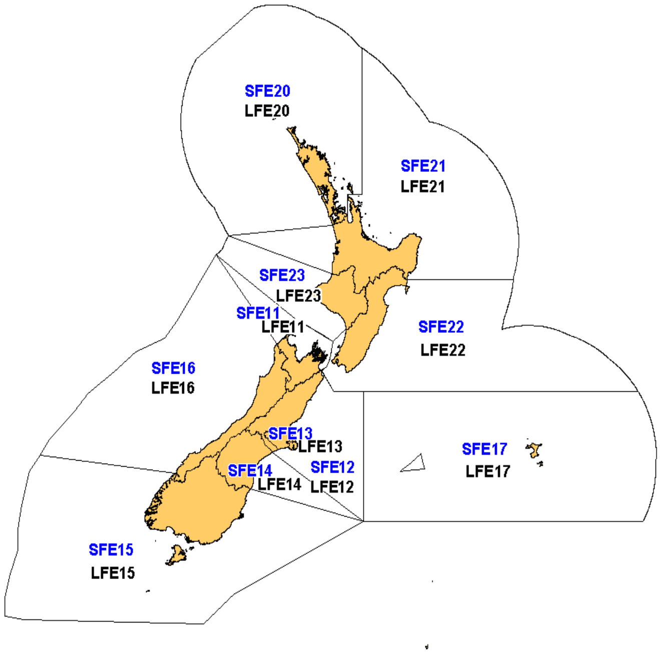
FRESHWATER EELS (SFE, LFE, ANG)

(Anguilla australis, Anguilla dieffenbachii, Anguilla reinhardtii)
Tuna



1. FISHERY SUMMARY

1.1 Commercial fisheries

The freshwater eel fishery is distributed throughout accessible 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 (*A. 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 fish stocks (codes ANG 11 to ANG 16). The Chatham Island fishery was introduced into the QMS on 1 October 2003 with two fish stocks (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 fish stocks (four longfin stocks LFE 20–23 and four shortfin stocks SFE 20–23). On 1 October 2017 the former South Island ANG QMAs were split into corresponding longfin (LFE 11–16) and shortfin (SFE 11–16) QMAs, each with its own TACC. The Australasian longfin eel is combined as part of the shortfin eel stocks in the Chatham Islands and North Island, because 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 (220 g and 4 kg, respectively) throughout New Zealand. North Island quota owners agreed in August 2012 to use 31 mm escapement tubes (equivalent to South Island regulation). The minimum legal diameter for escape tubes on the North Island was increased to 31 mm in October 2013. Quota owners from both islands formally agreed in 1995–96 not to land migratory female longfin eels. In the South Island the eel industry agreed to voluntary incremental increases in the diameter of escape tubes in fyke nets which increased from 25 mm to 26 mm in 1990–91, to 27 mm in 1993–94, to 28.5 mm in 1994–95, and finally to 31 mm in 1997–98, which effectively increases the minimum size limit of both main species to about 300 g. Since about 2006 there has been a voluntary code of practice to return all longfin eels caught in Te Waihora; catches of these longfins and all eels of legal size (220 g – 4 kg) were required to be recorded on Eel Catch Effort Returns (ECERs) and recorded under 'Destination X' on the Eel Catch Landing Returns (ECLRs). The introduction of the Electronic Reporting System (ERS) for the commercial eel fishery in late 2019 (replacing the ECER and ECLR) requires estimated weight of legal-sized eels that are caught and released to be recorded on the Catch Record, and on the Disposal Report under disposal code 'X'.

In early 2005 the Mohaka, Motu, and much of the Whanganui river catchments were closed to commercial fishing and there are a number of smaller areas elsewhere that have been reserved as customary fisheries (see section 1.3). In addition, all Public Conservation lands managed by the Department of Conservation require at a minimum a concession to be commercially fished and most are closed to commercial fishing. In the Waikato-Tainui rohe (region), fisheries bylaws were introduced in March 2014 to limit the minimum harvest size to 300 g for SFE and 400 g for LFE. Amongst other things, these bylaws also introduced an upper limit of 2 kg for both species (to prevent the taking of longfin females that are in a migratory state) and added seasonal closures in some reaches.

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 2020–21 for the whole of New Zealand.

Table 1: Eel catch data (t) for calendar years 1965 to 1988 and fishing years 1988–89 to present 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	1980	1 395	1994–95	1 438	2009–10	560
1966	50	1981	1 043	1995–96	1 429	2010–11	626
1967	140	1982	872	1996–97	1 342	2011–12	755
1968	320	1983	1 206	1997–98	1 210	2012–13	717
1969	450	1984	1 401	1998–99	1 219	2013–14	678
1970	880	1985	1 505	1999–00	1 133	2014–15	547
1971	1 450	1986	1 166	2000–01	1 071	2015–16	455
1972	2 077	1987	1 114	2001–02	978	2016–17	511
1973	1 310	1988	1 281	2002–03	808	2017–18	505
1974	860	1988–89	1 315	2003–04	729	2018–19	422
1975	1 185	1989–90	1 356	2004–05	708	2019–20	326
1976	1 501	1990–91	1 590	2005–06	771	2020–21	311
1977	906	1991–92	1 585	2006–07	718	2021–22	327
1978	1 583	1992–93	1 466	2007–08	660	2022–23	214
1979	1 640	1993–94	1 255	2008–09	518		

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

There was a rapid increase in commercial catches 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 reduced further during 2001–02 to 2004–05 as eel stocks were progressively introduced into the Quota Management System (QMS). Landings on the North Island were further constrained by the reduction in TACCs for both species introduced on 1 October 2007. Eel landings have remained below the TACCs as a result of reduced international market demand and deliberate decisions not to use ACE by some iwi and, from 2011–12 to 2019–20, have fluctuated around a declining trend from 755 t to 326 t. For the period 1991–92 to 2019–20, the North Island provided on average 60% of the total New Zealand eel catch, although 2019–20 provides the lowest percentage (Table 2).

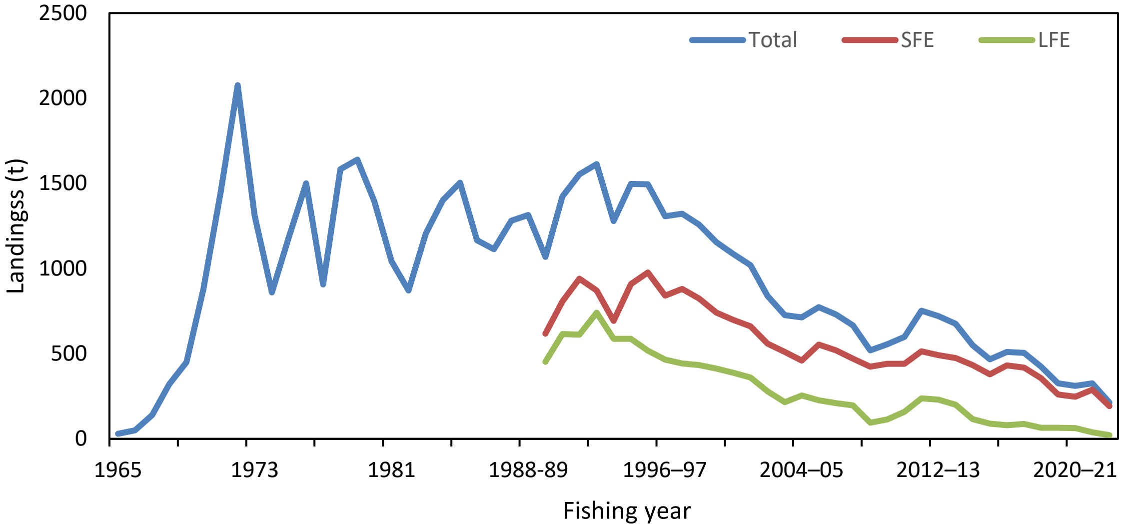


Figure 1: Total eel landings from 1965 to present, as well as separate shortfin and longfin landings from 1989–90 to present. Prior to 1988–89, the data points represent estimates for the period prior to the introduction of Eel Catch Landing Return (ECLR) forms and were generated by prorating the unidentified eel catch by the LFE:SFE ratio (see below).

Table 2: North Island and South Island eel catch (t) compiled from data from individual processors 1991–92 to 1999–00 and LFRR/QMR/MHR 2000–01 to present. 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	278	–	718 (61%)
2007–08	372	288	–	660 (56%)
2008–09	303	215	–	517 (59%)
2009–10	318	242	–	560 (57%)
2010–11	330	296	–	626 (53%)
2011–12	418	337	–	755 (55%)
2012–13	364	353	–	717 (51%)
2013–14	367	311	–	678 (54%)
2014–15	306	241	–	547 (56%)
2015–16	254	201	–	455 (56%)
2016–17	297	214	–	511 (58%)
2017–18	296	209	–	505 (59%)
2018–19	269	155	–	424 (63%)
2019–20	156	170	–	326 (48%)
2020–21	179	132	–	311 (58%)
2021–22	224	103	–	327 (69%)
2022–23	206	8	–	214 (96%)

In 2016, South Island eel stocks (ANG 11–16) were separated into individual shortfin (SFE 11–16) and longfin (LFE 11–16) stocks. The new stocks utilise the same geographical areas as the pre-existing stocks (ANG 11–16) but were separated to allow species-specific management of the individual eel species. After the stocks were separated new catch limits and allowances were set. For the SFE stocks the new TACs were based on the highest historical catch, apart from SFE 13, which received a 10% increase because the CPUE index was well above the target. For LFE stocks, the TAC was reduced to a point that effectively eliminated commercial targeting (a TAC close to zero) for four of the six stocks (LFE 11, 12, 13, and 14). For the remaining two LFE stocks (LFE 15 and 16), TACs allow continued commercial utilisation, but at significantly reduced levels. The separated stocks and their associated catch limits and allowances came into force on 1 October 2016 for SFE/LFE 11, 12, 14, 15, and 16 and 1 Feb 2017 for SFE/LFE 2013.

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. Prorating 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 prorated catches prior to 1999–2000 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 the new Eel Catch Landing Return (ECLR) form in 2001–02 improved the species composition information, because the EEU code was not included. There was a gradual decline in the proportion of longfin eels in landings, from over 40% in 1989–90 to about 30% in 2007–08, followed by a marked drop to 18% in 2008–09 (Table 3).

Table 3: Total New Zealand eel landings (t) by species and fishing year. 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	520	210	730 (29%)
2007–08	470	196	666 (29%)
2008–09	424	95	519 (18%)
2009–10	441	114	555 (20%)
2010–11	440	159	599 (26%)
2011–12	515	237	752 (32%)
2012–13	491	230	721 (32%)
2013–14	475	201	676 (30%)
2014–15	434	116	550 (21%)
2015–16	378	89	467 (19%)
2016–17	431	81	511 (16%)
2017–18	418	87	505 (17%)
2018–19	357	66	424 (16%)
2019–20	261	65	326 (20%)
2020–21	247	64	311 (21%)
2021–22	289	38	327 (12%)
2022–23	192	22	214 (10%)

The Total Allowable Commercial Catch (TACC) and reported commercial landings by species for the South Island eel stocks are shown in Table 4 from 2000–01 (when eels were first introduced into the QMS) to 2018–19. The annual landings are based on data recorded on ECLR forms, because the MHR forms report QMA catches for the two species combined.

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 markedly reduced for all North Island shortfin and longfin stocks.

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

Fishing	ANG11		ANG12		ANG13		ANG14		ANG15		ANG16		Total
year	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	landings
Shortfin Eel (SFE)													
2000–01	40	4.5	43	4.4	122	102.2	35	6.1	118	19.4	63	9.8	146.6
2001–02	40	18.9	43	5.7	122	63.6*	35	10.1	118	20.2	63	20.2	83.8
2002–03	40	19.2	43	5.9	122	95.4	35	9.9	118	11.7	63	4.5	146.7
2003–04	40	8.7	43	4.8	122	118.2	35	7.5	118	13.0	63	9.4	161.8
2004–05	40	2.7	43	1.4	122	121.3	35	5.7	118	1.5	63	9.6	156.0
2005–06	40	9.0	43	4.3	122	119.9	35	7.4	118	12.0	63	11.2	164.0
2006–07	40	10.9	43	6.3	122	121.5	35	4.4	118	15.4	63	16.5	175.2
2007–08	40	8.5	43	1.2	122	119.7	35	5.8	118	21.2	63	11.5	167.9
2008–09	40	4.7	43	< 1	122	123.0	35	1.8	118	16.6	63	19.7	166.0
2009–10	40	3.8	43	5.8	122	97.3	35	3.9	118	29.1	63	30.3	170.2
2010–11	40	10.0	43	6.9	122	89.3	35	3.7	118	19.4	63	19.9	149.2
2011–12	40	8.8	43	10.8	122	113.3	35	7.3	118	21.4	63	13.1	174.8
2012–13	40	7.6	43	19.9	122	125.0	35	2.6	118	16.7	63	22.8	194.6
2013–14	40	3.4	43	16.5	122	119.3	35	2.5	118	11.7	63	16.8	170.2
2014–15	40	2.8	43	13.6	122	112.1	35	1.3	118	14.4	63	11.8	156.0
2015–16	40	< 1.0	43	0	122	109.9	35	< 1.0	118	22.7	63	10.2	144.4
New FMA	**SFE11**		**SFE 12**		**SFE 13**		**SFE 14**		**SFE 15**		**SFE 16**		**Total**
2016–17	19	0	20	0.2	134.1	132.8	10	0	29	20.7	30	12.97	166.7
2017–18	19	6.2	20	2.7	134.1	130.3	10	1.0	29	15.1	30	5.9	161.2
2018–19	19	4.1	20	4.2	134.1	81.6	10	0.2	29	12.3	30	8.5	110.9
2019–20	19	0	20	< 0.1	134.1	96.0	10	0.3	29	18.9	30	9.5	124.8
2020–21	19	0	20	2.2	134.1	65.9	10	2.1	29	11.3	30	3.9	85.5
2021–22	19	1.4	20	0	134.1	71.2	10	0.9	29	2.7	30	6.8	82.9
2022–23	19	0.4	20	0	134.1	0	10	2.1	29	0.5	30	0	3.1
Longfin Eel (LFE)													
2000–01	40	10.6	43	22.6	122	2.1	35	12.6	118	63.6	63	28.4	140.1
2001–02	40	16.4	43	15.6	122	1.0*	35	6.0	118	80.5	63	30.2	150.1
2002–03	40	10.6	43	10.1	122	1.4	35	10.0	118	73.0	63	27.2	132.6
2003–04	40	2.8	43	2.7	122	< 1.0	35	10.2	118	64.7	63	21.2	102.9
2004–05	40	2.8	43	3.4	122	< 1.0	35	2.3	118	79.6	63	34.4	123.7
2005–06	40	6.0	43	9.8	122	< 1.0	35	6.4	118	61.1	63	21.1	105.5
2006–07	40	4.4	43	1.7	122	<1.0	35	7.0	118	65.0	63	32.8	112.1
2007–08	40	11.9	43	6.5	122	< 1.0	35	7.4	118	73.0	63	23.1	122.9
2008–09	40	1.4	43	< 1.0	122	0	35	2.3	118	33.7	63	13.2	51.0
2009–10	40	8.0	43	< 1.0	122	< 1.0	35	3.2	118	40.0	63	15.3	68.0
2010–11	40	13.1	43	6.1	122	< 1.0	35	6.7	118	73.9	63	14.1	114.9
2011–12	40	11.2	43	11.0	122	2.0	35	18.4	118	85.4	63	27.6	155.7
2012–13	40	15.6	43	7.6	122	< 1.0	35	22.3	118	88.6	63	30.4	164.5
2013–14	40	14.0	43	6.1	122	< 1.0	35	10.7	118	77.9	63	29.3	138.5
2014–15	40	2.5	43	3.7	122	0	35	2.1	118	56.3	63	15.3	79.9
2015–16	40	< 1.0	43	0	122	0	35	4.5	118	43.0	63	10.5	59.0
New FMA	**LFE11**		**LFE 12**		**LFE 13**		**LFE 14**		**LFE 15**		**LFE 16**		**Total**
2016–17	1	0	1	< 1.0	1	0	1	0	52	33.4	25	14.1	47.5
2017–18	1	0	1	0.3	1	0.5	1	0.5	52	36.2	25	10.1	47.6
2018–19	1	0	1	0.2	1	0	1	0	52	34.2	25	9.5	43.9
2019–20	1	0	1	0.2	1	0	1	0	52	36.9	25	7.9	45.0
2020–21	1	0	1	0.4	1	0	1	0.2	52	38.2	25	7.3	46.2
2021–22	1	0.2	1	0	1	0	1	0.1	52	18.9	25	0.8	19.9
2022–23	1	0.5	1	0	1	0	1	0.2	52	4.5	25	0	5.1

*For the transition from a 1 October 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 was 1 February to 31 January. Fishing year for all other areas is 1 October to 30 September.

Table 5: TACCs and commercial landings (t) for Chatham Island (SFE 17) and North Island shortfin stocks from 2003–04 to present (based on ECLR data).

Fishing	SFE 17		SFE 20		SFE 21		SFE 22		SFE 23		Total
year	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	landings
2003–04	10	0.7	–	–	–	–	–	–	–	–	0.7
2004–05	10	1.3	149	78.4	163	123.0	108	80.5	37	15.0	298.1
2005–06	10	2.7	149	93.3	163	144.3	108	106.9	37	31.5	378.6
2006–07	10	0.0	149	107.8	163	113.5	108	91.3	37	30.2	342.8
2007–08	10	0.0	86	76.0	134	125.3	94	82.5	23	15.8	299.5
2008–09	10	0.0	86	66.8	134	110.0	94	70.9	23	10.3	258.0
2009–10	10	0.0	86	60.2	134	124.1	94	68.5	23	17.5	270.3
2010–11	10	0.0	86	85.5	134	133.9	94	58.8	23	16.1	294.3
2011–12	10	0.0	86	85.6	134	140.9	94	95.7	23	18.8	341.0
2012–13	10	0.0	86	78.8	134	124.3	94	82.0	23	14.7	299.8
2013–14	10	0.0	86	71.6	134	139.2	94	82.1	23	14.5	307.4
2014–15	10	0.0	86	63.8	134	122.8	94	73.3	23	13.7	273.6
2015–16	10	0.0	86	53.8	134	119.1	94	49.2	23	10.4	232.5
2016–17	10	0.0	86	46.2	134	123.4	94	81.3	23	13.0	263.9
2017–18	10	0.0	86	59.6	134	120.3	94	67.1	23	10.0	257.1
2018–19	10	0.0	86	61.3	134	108.5	94	68.3	23	8.3	246.4
2019–20	10	0.0	86	34.0	134	55.3	94	41.7	23	4.9	135.93
2020–21	10	0.0	86	45.4	134	69.7	94	38.1	23	8.0	161.1
2021–22	10	0.0	86	45.1	134	110.9	94	41.6	23	8.5	206.1
2022–23	10	0.0	86	40.6	134	105.0	94	35.9	23	7.4	188.8

Table 6: TACCs and commercial landings (t) for Chatham Island (LFE 17) and North Island longfin stocks from 2003–04 to present (based on ECLR data).

Fishing	LFE 17		LFE 20		LFE 21		LFE 22		LFE 23		Total
Year	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	landings
2003–04	1	< 1	–	–	–	–	–	–	–	–	0.2
2004–05	1	< 1	47	27.4	64	53.5	41	23.9	41	24.5	129.3
2005–06	1	< 1	47	23.7	64	41.2	41	31.6	41	24.2	120.8
2006–07	1	0	47	27.2	64	29.8	41	25.9	41	14.5	97.4
2007–08	1	0	19	17.5	32	31.0	21	17.7	9	6.5	72.8
2008–09	1	0	19	11.5	32	22.7	21	7.7	9	2.5	44.4
2009–10	1	< 1	19	9.6	32	21.6	21	10.6	9	5.8	47.6
2010–11	1	< 1	19	10.2	32	13.7	21	5.7	9	6.2	35.8
2011–12	1	< 1	19	19.9	32	32.0	21	18.6	9	6.7	77.3
2012–13	1	< 1	19	18.3	32	25.1	21	15.1	9	5.6	64.1
2013–14	1	0	19	14.7	32	25.9	21	14.7	9	4.4	59.7
2014–15	1	0	19	10.1	32	9.9	21	12.0	9	3.3	35.3
2015–16	1	< 1	19	6.5	32	9.4	21	4.1	9	1.5	21.5
2016–17	1	0	19	8.0	32	13.9	21	7.4	9	3.9	33.2
2017–18	1	0	19	13.1	32	12.2	21	9.5	9	4.5	39.3
2018–19	1	0	14	5.8	23	11.8	13	4.8	5	0.3	22.3
2019–20	1	0	14	5.9	23	10.8	13	3.1	5	0.3	20.0
2020–21	1	0	14	4.8	23	8.9	13	3.9	5	0.6	18.2
2021–22	1	0	14	5.6	23	8.2	13	3.7	5	0.2	17.8
2022–23	1	0	14	5.1	23	9.4	13	2.0	5	0.2	16.7

The proportion of longfins in the catch then gradually increased and was about 30% of the total in 2013–14, before once again declining to 16% in 2016–17, then increasing to 20% by 2019–20. Several factors have contributed to the pattern in the proportion of longfin eels, including: declining abundance in the early part of the series, reduced quotas, the closure of some catchments to commercial fishing, and declining/fluctuating market demand.

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 dominate landings. Shortfins are dominant in North Island landings. The shortfin eel catches mostly comprise pre-migratory female feeding eels, with the exception of Te Waihora (Lake Ellesmere), where significant quantities of seaward migrating male shortfin eels (under 220 g) are taken during February to March.

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 Māori not taken under customary provisions. The extent of the recreational fishery is not known although the harvest by Māori might be significant.

1.3 Customary non-commercial fisheries

Eels are an important customary food source for Māori. Māori have a deep understanding of the habits and life history of eels (tuna), which they have used to develop effective harvesting methods and management strategies. Traditional fishing methods include ahuriri (eel weirs), hīnaki (eel pots), and other methods of capture. Māori 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 most areas tangata whenua retain strong traditional ties to eels and their management and harvest.

In the South Island, several areas have been set aside as designated customary fishery management areas. This includes Lake Forsyth (Waiwera) and its tributaries, lower Pelorus River, Horomaka Kohanga (Te Waihora), Wainono Lagoon and its catchment, the Waihao catchment, the Rangitata Lagoon, and the Ahuriri Arm of Lake Benmore. No commercial fishing is carried out in these areas and they are utilised only as customary fisheries. Mātaitai reserves covering freshwater have been established in the South Island on the Mataura River, Okarito Lagoon, Waihao River (including Wainono Lagoon and parts of Waituna Stream and Hook River), Lake Forsyth, Waikawa River, Waikouaiti River, Opihi River, Washdyke Lagoon, Kahutara River, Oaro River, and the Conway River. Commercial fishing is generally prohibited in mātaitai reserves. 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 fishery preferences vary between whanau, hapu, and iwi, but some customary fisheries focus on larger sizes of eels over 750 mm (1kg). Currently, there appears to be a substantially lower number of these larger eels in the main stems of some major river catchments throughout New Zealand, which may limit customary fishing opportunities. Consequently the availability of 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).

Eels may be harvested for customary non-commercial purposes only under regulations made under section 186 of the Fisheries Act 1996. The majority of the South Island customary harvest comes from QMAs ANG 12 (North Canterbury) and ANG 13 (Te Waihora/Lake Ellesmere).

Table 7: TACs, TACCs, 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.

	LFE 11 Nelson/ Marlborough	LFE 12 North Canterbury	LFE 13 Te Waihora Lake Ellesmere	LFE 14 South Canterbury	LFE 15 Otago/ Southland	LFE 16 West Coast
2016 TAC	3	3	3	3	66.54	32.41
TACC	1	1	1	1	52.00	25.00
Customary non-commercial allowance	1	1	1	1	13.27	6.41
Recreational allowance	1	1	1	1	1.27	1.00
	SFE 11	**SFE 12**	**SFE 13**	**SFE 14**	**SFE 15**	**SFE 16**
2016 TAC	24.87	26.1	171.94	13.57	37.42	38.69
TACC	19.0	20.0	134.12	10.00	29.00	30.00
Customary non-commercial allowance	4.87	5.1	34.38	2.57	7.42	7.69
Recreational allowance	1.0	1.0	3.44	1.00	1.00	1.00

Table 8: TACs and customary non-commercial, recreational, and other fishing-related mortality allowances (t) for the Chatham Island and North Island shortfin stocks.

	SFE 17	SFE 20	SFE 21	SFE 22	SFE 23
TAC	15	148	181	121	36
Customary non-commercial allowance	3	30	24	14	6
Recreational allowance	1	28	19	11	5
Other fishing-related mortality	1	4	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.

	LFE 17	LFE 20	LFE 21	LFE 22	LFE 23
TAC	3	34	51	26	30
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

1.4 Illegal catch

No reliable estimates of illegal catch are available. There is some evidence of fishers exceeding the amateur bag limit, and some historical incidences of commercial fishers operating outside the reporting regime, but overall the extent of any current 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 (Beentjes et al 2005). 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 from New Zealand. Mitigation activities such as trap and transfer of downstream migrants, installation of downstream bypasses, and spillway opening during runs are expected to have reduced this impact at those sites where such measures have been implemented. In addition to these direct sources of mortality, eel populations are likely to have been significantly reduced since European settlement from the 1840s by wetland drainage (wetland areas have been reduced by up to 90% in some areas), and ongoing habitat modification brought about by irrigation, channelisation of rivers and streams, and the reduction in littoral habitat. Ongoing 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 worldwide, 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 facultative catadromous, living predominantly in freshwater, and undertaking a spawning migration to an oceanic spawning ground. They spawn once and then die (i.e., are semelparous). 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 southwest 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.

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 predominant in lowland lakes and slow moving, soft bottom rivers and streams, whereas longfins prefer fast flowing stony rivers and are dominant in 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 (e.g., Chisnall & Kalish 1993). Growth rates determined from the commercial catch sampling programme (1995–97) indicate that in both the North Island and South Island, 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, whereas in the North Island the equivalent times are 5.8 years (range 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 (in length) 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 longfin 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 or older ages.

Recruitment

The most sensitive measure of recruitment is monitoring of glass eels, the life-stage of arrival into fresh water from the sea. In the Northern Hemisphere where glass eel fisheries exist, catch records provide a long-term time series that is used to monitor eel recruitment. In the absence of such fisheries in New Zealand, MPI took the unique opportunity to monitor the relative abundance of elvers arriving at large in-stream barriers, where established elver trap and transfer programmes operate. Provided that the data are collected in a consistent manner every year, these data can be used to provide an index of eel recruitment into New Zealand's freshwaters.

Although New Zealand has a small dataset of elver catch data compared with Asian, European, and North American recruitment records, including the 2020–21 season, there are now up to 27 years of reliable and accurate elver catch information for some sites (Crow *et al* 2020, 2023). These records show that the magnitude of the elver catch varies markedly between sites and that there are large variations in catches between seasons at all the sites (Table 10a). Although the majority of this variability is likely to be caused by natural oceanic and climatic influences, some is due to changes in fishing effort, technological advances, and recording procedures. These changes in fishing effort and capture efficiency through time have meant that a number of existing records needed to be excluded from recruitment trend analyses.

Because of the variability between sites and years, elver catch records were normalised following the method of Durif et al (2008), and a 'normal'catch index was calculated for each species, season, and location. The normalised catch index (Xij) is calculated as follows:

$$X_{i,j} = (x_{i,j} - \mu_j)/\sigma_j$$

Where:

$x_{i,j}$ = elver catch for a season
μ_j = mean elver catch at a site for all seasons
σ_j = standard deviation of elver catch at a site for all seasons.

Variation in the altitude of the dam sites and possibly differences in migration rates and growth rate between rivers has resulted in some variability in the size and age structure of elvers captured at the monitored sites. Consequently the median ages of elvers at key sites were determined from examination of otoliths extracted from elvers randomly captured throughout the 2013–14 to 2021–22 seasons (Table 10b). The median ages were then used to adjust the normalised catch index by the median elver age so that it reflected the relative recruitment of glass eels (0 yrs old) into each catchment (Recruitment Index hereafter).

Elver catches in New Zealand were highly variable within sites between seasons (years), which makes assessing trends difficult. A good example of this variability can be seen at Matahina, where catch differed by a magnitude of up to 54-fold over three seasons (Table 10a). At present, there is no estimate of uncertainty associated with the annual elver catch estimate, but this is presently being developed and will be available in the next elver recruitment report. Uncertainty estimates will aid in future interpretations of trends in Catch Indices.

No trends in catch indices were apparent at any site for longfin elvers at the North Island sites (Figure 2a). A decreasing trend until 2011–12 occurred at Patea Dam and a slight increasing trend occurred at Piripaua Dam in shortfin catch indices (Figure 2a). This increase was mainly associated with higher catches after the 2011–12 season, with previous catches being low and stable.

On the South Island, catch indices were increasing, although variable, for both species at Arnold and Waitaki dams and for longfins at the Mararoa Lake Control Structure (Figure 2b). The increase at Waitaki Dam may be an effect of the installation of an additional trap in the 2019–20 season. Because of this change in capture efficiency, we recommend future trend assessments should consider this site as two separate time series (pre- and post-2019–20). Shortfin catch has been increasing since 2013–14 at the Mararoa Lake Control Structure. At Roxburgh Dam, the increase in 2021–22 may have been due to modifications to the traps prior to the 2020–21 season (see Section 3.3 in Crow et al 2023) or may be an actual increase in abundance for this area. Further information (more seasons of capture) are needed to determine whether it was solely caused by a change in capture efficiency.

Table 10a: Estimated annual total number (in 1000s) of shortfin and longfin elvers captured at the primary (*) and selected secondary sites that have a reliable time series of catch data available. Unreliable annual records for individual sites have been removed (see appendix A of Crow et al 2023).

	Wairua*		Karāpiro*		Matahina*		Patea*		Piripaua		Arnold*		Waitaki*		Roxburgh		Mararoa		Total	
Season	Longfin	Shortfin	Longfin	Shortfin	Longfin	Shortfin	Longfin	Shortfin	Longfin	Shortfin	Longfin	Shortfin	Longfin	Shortfin	Longfin	Shortfin	Longfin	Shortfin	Longfin	Shortfin
1995–96			333	822															333	822
1996–97			246	974															246	974
1997–98			510	1 529	136	479													646	2 008
1998–99			341	756															341	756
1999–00			94	798															94	798
2000–01			155	627															155	627
2001–02			246	1 351	27	592	48	707	0.4	3.7									321	2 654
2002–03			176	1 766	124	1 360	8	372	0.2	10.0									308	3 508
2003–04			200	1 931	64	881	1	390	0.2	4.7			4.7						270	3 207
2004–05			132	1 201	15	1 102			0.5	7.7			1.6				64		213	2 311
2005–06			483	1 695	228	965	87	475	0.1	2.6			4.7				46		849	3 138
2006–07			179	1 117	159	326	53	843	0.3	3.8	52	55	3.3				118		565	2 345
2007–08			701	2 027	928	2 450	98	759	1.1	4.7	78	108	4.1				136		1 946	5 348
2008–09			298	1 990	517	3 791	82	399	2.2	7.3	87	96	3.5	1.3			81		1 071	6 285
2009–10			232	1 476	78	924	20	290	2.9	7.3			2.1	0.3			71		406	2 697
2010–11			175	1 260	84	1 758	20	227	2.5	9.3	49	65					198		529	3 319
2011–12	11	3 167	36	967	15	666	9	82	3.1	12.5	26	50					266		365	4 944
2012–13	98	5 389	139	1 632	317	2 104	51	183	5.2	25.1	36	55	7.1	1.8	13.8		128		795	9 390
2013–14	16	2 764	160	1 683	220	1 848	24	170	7.9	60.8	29	36	0.1	0.1	0.8		145	0	603	6 561
2014–15	118	2 893	160	1 445	275	4 460	23	237	4.7	59.5	65	88	4.6	1.3	1.3		136	0	787	9 183
2015–16	79	8 200	517	2 674	771	6 413	180	556	15.6	144.9	69	118	1.3	1.1	1.4		86	3	1 719	18 109
2016–17	0	2 947	221	2 312	6	370	56	230	1.3	27.5	10	22	1.0	1.4			41		337	5 910
2017–18	8	2 438	373	1 856	8	125	103	308	5.7	64.3	98	213	3.2	1.5	8.7		157	20	765	5 026
2018–19	0	3 352	176	905	324	2 394	67	206	1.4	55.6	240	226	2.5	1.8	25.8		150	48	986	7 188
2019–20			159	595	80	1 399	42	186	10.3	100.5	111	133	5.0	4.0	2.4		13	7	423	2 425
2020–21			330	752	114	1 206	72	285	4.0	37.4	97	185	6.8	2.8	17.5		48	16	689	2 484
2021–22			465	1 115	57	1 542	39	243	9.8	44.7	131	192	8.8	2.6	67.9	10.1	103	65	881	3 214
Median	14	3 057	221	1 351	119	1 283	49	299	2.5	12.5	69	96	3.5	1.4	5.6	10.1	111	12	529	3 207
Mean	41	3 894	268	1 380	207	1 689	54	368	3.8	33.0	79	109	3.8	1.7	14.0	10.1	110	20	616	4 268
Std Dev	49	1 960	155	543	245	1 512	42	220	4.1	37.4	56	67	2.3	1.1	20.8	NA	62	24	439	3 692
Max	118	8 200	701	2 674	928	6 413	180	843	15.6	144.9	240	226	8.8	4.0	67.9	10.1	248	65	1 946	18 109
Min	0	2 438	36	595	6	125	1	82	0.1	2.6	10	22	0.1	0.1	0.0	10.1	13	0	94	627

Table 10b: Median ages of elvers used to calculate the Recruitment Series. * = these sites had not age data collected within recent study (Crow *et al* 2023), therefore median age data came from Martin *et al.* (2013).

Species	Site	Samples	Median
Shortfin	Arnold	1 096	3
	Karapiro	2 050	1
	Mararoa*	NA	NA
	Matahina	1 026	2
	Patea	2 464	1
	Piripaua*	NA	1
	Waitaki*	NA	2
	Wairua	480	0
Longfin	Arnold	1 092	4
	Karapiro	1 520	2
	Mararoa*	NA	2
	Matahina	554	3
	Patea	1 770	1
	Piripaua*	NA	2
	Waitaki*	NA	4
	Wairua	4	0

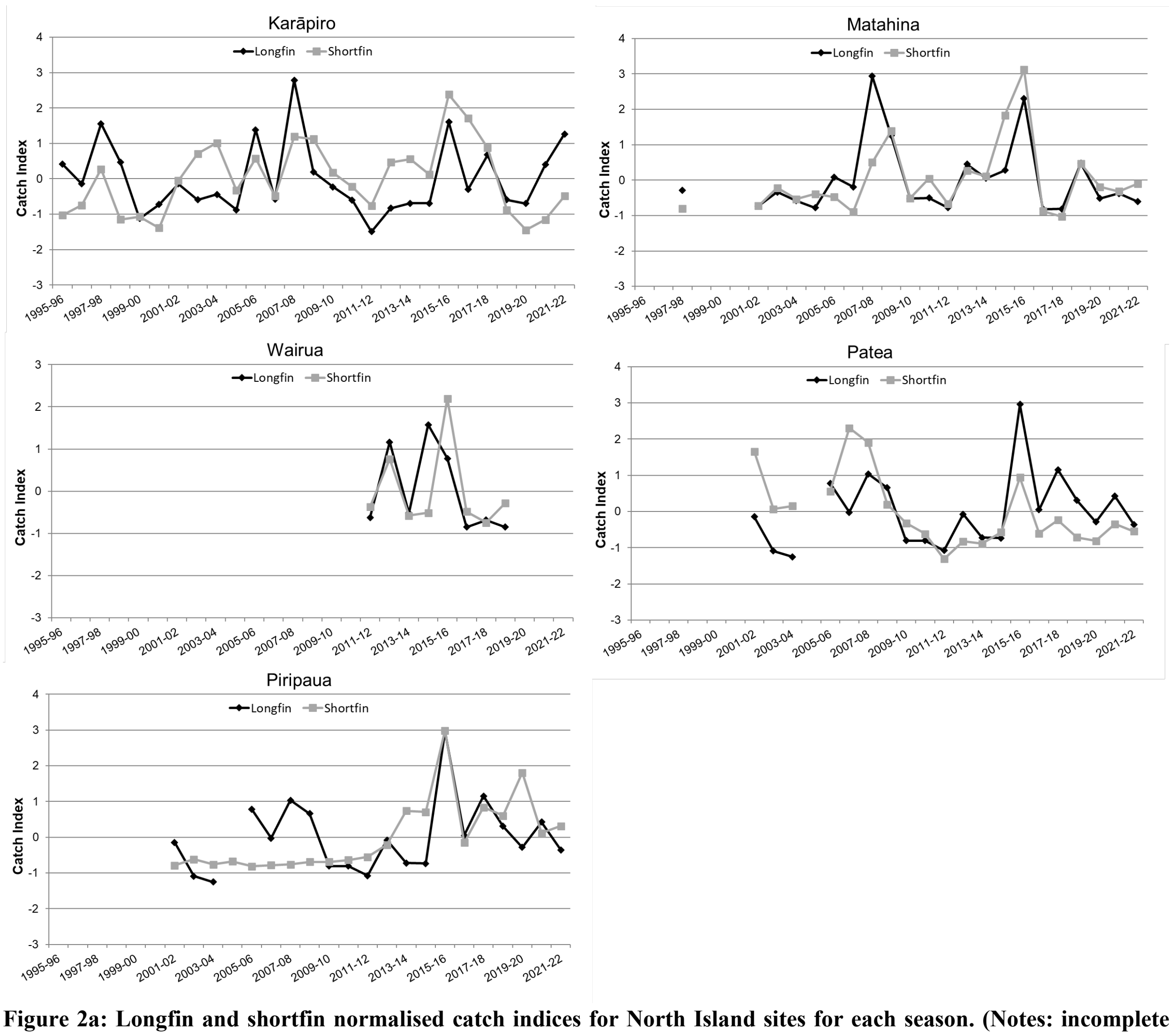


Figure 2a: Longfin and shortfin normalised catch indices for North Island sites for each season. (Notes: incomplete records for season have been omitted; 0 = mean index for entire monitoring period for each site; few shortfins recorded at Mararoa Weir). Mararoa has inconsistent fishing effort so the trend shown may reflect increased trapping efficiency rather than increased recruitment.

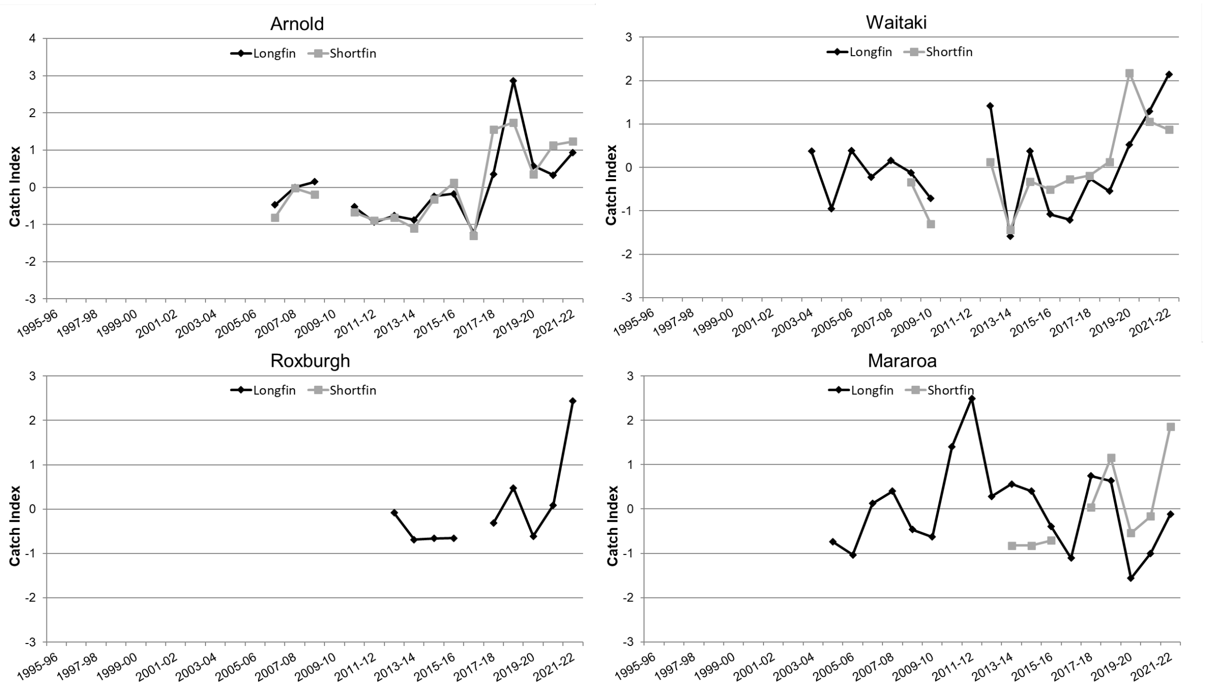


Figure 2b: Longfin and shortfin normalised catch indices for South Island sites for each season. (Notes: incomplete records for season have been omitted; 0 = mean index for entire monitoring period for each site). Mararoa has inconsistent fishing effort so any trends shown may reflect changes in capture efficiency rather than changes in abundance.

Combined recruitment indices among all sites and all seasons showed that shortfin and longfin recruitment is variable within and between sites but overall has remained stable across the entire timeseries with a large degree of interannual variability. This is consistent with previous studies, indicating that recruitment of elvers into New Zealand has remained stable within the time frames of the datasets available (Figure 3 and Figure 4).

Spawning

Because 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, southwest 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.

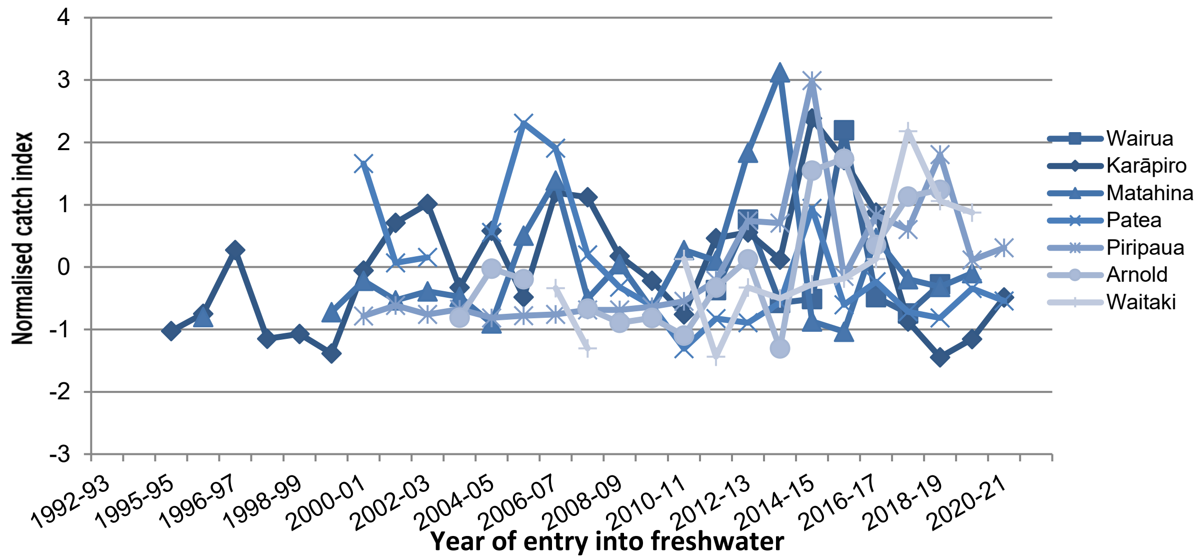


Figure 3: Recruitment Indices (i.e., Normalised Catch Indices offset by median age) by season for shortfin elvers. Plots are for all primary sites as well as Piripaua. A value of 0 indicates the mean catch for each site.

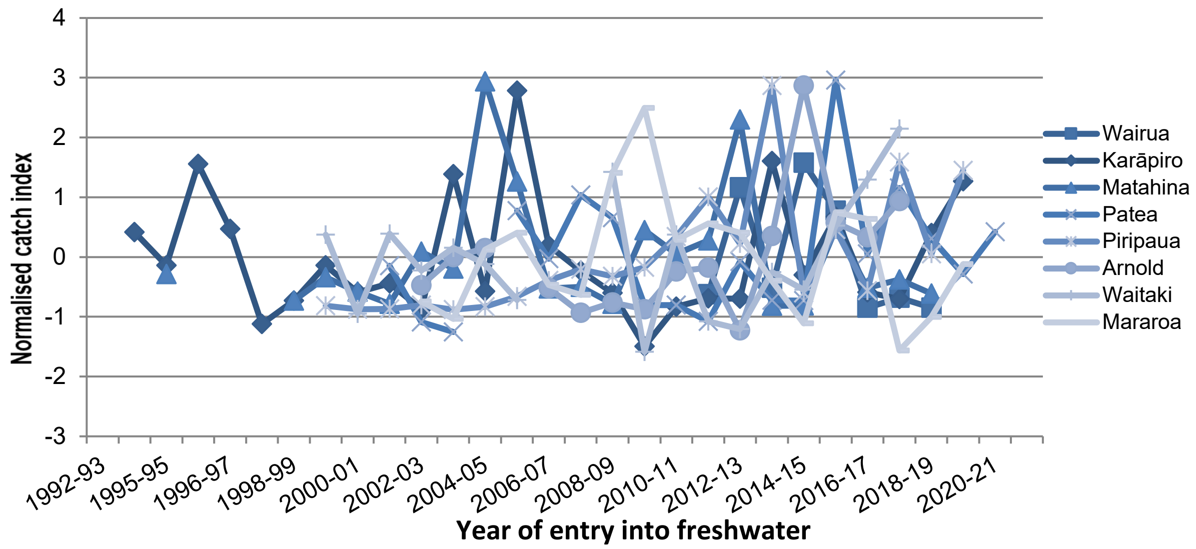


Figure 4: Recruitment Indices (i.e., Normalised Catch Indices offset by median age) for longfin elvers. Plots are for all primary sites as well as Piripaua and Mararoa. A value of 0 indicates the mean catch for each site.

3. STOCKS AND AREAS

The lifecycle of each species has not been completely resolved but 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, post-elver eels generally 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.

Shortfin and longfin eels 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 are 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.

4. STOCK ASSESSMENT

There is no formal stock assessment available for freshwater eels. Fu et al (2012) 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 6000 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 Working Group did not accept the assessment and noted that further analyses were necessary to investigate the models 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.

4.1 Size/age composition of commercial catch

Catch sampling programmes sampled commercial eel landings throughout New Zealand over three consecutive years between 1995–96 and 1997–98, and then in 1999–2000 and 2003–04 (Speed et al 2001, Beentjes 2005). Sampling provided information on the length and age structure, and sex composition of the commercially caught eel populations throughout the country, and indicated a high degree of variability within and among catchments.

Monitoring commercial eel fisheries programme
The commercial eel monitoring programme collects processor recorded catch data for each species by size grade (market determined; two to three grades) and catch location (eel statistical sub-area; catchment based), from virtually all commercial landings throughout New Zealand. This programme began in 2003–04 in the North Island and 2010–11 in the South Island (Beentjes 2013, 2016, 2019) with eighteen years of North Island data and eleven years of South Island data collected by the end of 2020–21.

North Island (2003–04 to 2017–18). The North Island commercial eel catch is highly aggregated with nearly one-third of the shortfin catch caught from just 3 of the 65 subareas (AA4, Dargaville; AD12, Lake Waikare and Port Waikato; and AC1, Hauraki Plains west). Similarly, one third of North Island longfin was caught from just four subareas (AA4, Dargaville; AD10, Waipa River; AD12, Lake Waikare, Port Waikato; and AL1, Lake Wairarapa). North Island shortfin annual catch over 15 years (2003–04 to 2017–18) showed no consistent trend in annual catch weight or in the distribution of these catches in the three size grades. The longfin fishery is more prone to market demand fluctuations than shortfin because it is a less desirable species of eel. Longfin landed catches over the same period fluctuated more than shortfin and are characterised by particularly low catches in 2008–09 to 2010–11 and since 2014–15, with an overall trend of declining catch. Factors that may have influenced annual longfin catches, overall and within size ranges, include the 58% TACC reductions for North Island longfin stocks for the 2007–08 fishing year, fluctuating market demands, annual rainfall, and, more recently and most importantly, a progressive decline in the availability of ACE to fishers. The number of subareas for which shortfin and longfin catch was landed has been declining, indicating a contraction in the spatial distribution of fishing effort over time. Despite this, the catch of both species in the key subareas over the 15 years shows no apparent trends.

South Island (2010–11 to 2017–18). South Island commercial eel catch is highly aggregated especially shortfin where nearly three-quarters of the catch originates from just two of the 58 subareas (Te Waihora, AS1 and AS2; and Lake Brunner, AX4). Longfin in the South Island is less aggregated than shortfin, but half of the catch originated from just seven subareas (AW11, Mataura River coast; AW9, Oreti River coast; AW3, Oreti River inland down to Bog Burn; AV10, Clutha River coast; AP2,Wairau River; AU5,Waitaki River; and AX3, Grey River Arnold River). There is no consistent trend in annual shortfin landed catch over the eight-year time series (2010–11 to 2017–18), although the proportions of large eels has declined. There is a trend of declining longfin landed catch over the same period, and in the largest weight grade. The lower longfin landed catch in recent years can be attributed to lower port price for large longfin, and primarily the split into separate shortfin and longfin stocks in 2016–17. The longfin landed catch is also well below the current TACC introduced in 2016–17, as a result of fisher retirements, shelved quota, and ACE imbalances resulting from the nominal 1 t TACCs set in LFE 11 to LFE 14 essentially closing these areas to target longfin fishing. Catch of longfin has been stable in the key subareas, but more variable for the subareas with smaller catches. The pattern of South Island shortfin landed catch by subarea is generally similar over the eight years, except that AS1 and AS2 catches tend to display opposite trends because fishers can catch their quota from either.

4.2 Catch-per-unit-effort analyses

Each species of eel is considered to be a New Zealand wide stock, with common species-specific spawning grounds within the Fiji Basin. However, once recruited to a river system, eels do not move between catchments, so eels within each catchment may be regarded as separate sub-populations for management purposes. Maintaining sub-populations within each QMA at or above (sub-area proxies) B_{MSY}, will ensure that the entire (national) stock of each species is maintained at that level. To develop subarea proxies, standardised catch-per-unit-effort (CPUE) analyses have been conducted for the commercial shortfin and longfin eel fisheries by Eel Statistical Area (ESA; Figure 5 and Table 11) from 1990–91 to 2017–18 for all North Island ESAs and from 1990–91 to 2018–19 for all South Island ESAs (Tables 12a,b–13a,b and Figures 6–9). These CPUE series monitor the relative abundance of each eel species within the area fished commercially within each ESA.

North Island CPUE

The North Island CPUE analyses undertaken using data up to 2014–15 included, for the first time, a binomial analyses on the valid zero catches, as well as the routine GLM analyses of positive catch. In addition, reconstructed target species was included as an explanatory variable, as were water quality variables. The variable 'catcher_ID' was not included because it has only been recorded since 2001–02 on the new ECER forms (Beentjes & McKenzie 2017); however, the data were linked by permit holder and client name (see below). Target species was recorded on CELR forms, but not on ECER forms. Target species was reconstructed for all records from recorded CELR target species and species proportions using a simple optimisation to evaluate the best proportion to use (Cohen's kappa coefficient). Target species was reconstructed for all records, including those from CELR data. In some cases, target species was defined on the basis of a minimum catch composition of 80%. Higher values tended to assign too many records to the category 'either', when kappa was above 80%. Target species often explained the most variance in the positive catch GLM, especially for longfin for which the trends in CPUE changed more than shortfin compared with previous analyses when target was not offered to the model. Target species could not be offered to the binomial model because, by definition, a target of longfin or shortfin cannot result in zero catch in the models and consequently the May 2017 plenary rejected the binomial model.

Prior to the introduction of North Island eel stocks into the QMS in 2004–05, some fishers had fished for existing permit holders during the permit moratorium and following introduction of eels into the QMS began fishing under their own permit numbers (Beentjes & Dunn 2010). If these fishers had fished for someone else pre-QMS and if they were the only fisher that had landed catch under a pre-QMS *Client_name*, and that client did not land catch pre- and post-QMS, they were linked in the analyses. There were 16 linkages made.

The transition between CELR and ECER in 2001–02 is unlikely to have biased trends in relative abundance (CPUE) because there was no change in the estimation of catches or recording of effort data, with both forms providing estimated catch of shortfin and longfin eels, the number of nets set per night, and the statistical area where eels were caught.

The most recent CPUE analyses using data up to 2017–18 used the same methods described above but no binomial analyses were carried out (Beentjes 2020). In general, CPUE for North Island shortfin, with the exception of Northland (ESA AA) where CPUE steadily increased throughout the time series, either initially declined or there were no trends, followed by strong increases, beginning from around 2002 (Table 12a, Figure 6) (Beentjes 2020). For longfin there were generally fewer data than for shortfin for most areas and indices were often more variable, associated with wider confidence intervals, or could not be estimated for all years (Table 12b, Figure 7). In general, longfin CPUE indices declined over the first 10 years of the time series, and then either remained stable or slightly increased (Table 12b, Figure 7).

Several factors may have resulted in conservative estimates of North Island longfin eel CPUE, especially after 2005–06:

1. The unrecorded return of small and medium sized longfin eels to the water. This became more prevalent after the substantial reduction in North Island longfin quotas in 2007–08, because many fishers did not have ACE to cover all of their catch (larger longfins are more valuable than small and medium specimens). Industry were previously unaware that eels of legal size (220 g to 4 kg) that are released are supposed to be recorded on ECLRs under the Destination 'X ' code which was only available as a legitimate code on ECLRs from 2007–08. Further, at the Eel Working Group Meeting in April 2017 it was established that some fishers were incorrectly recording only their retained legal-sized eels on the ECERs and thus the estimated catch used in CPUE analyses was possibly biased downward as was the CPUE. North Island Destination 'X' catch was only 3% of the landed eel catch in 2014–15. Destination 'X' was first used in 2008 for shortfin and in 2009 for longfin and its use has generally increased each year peaking in 2017 when 12.7 t of longfin and 4.3 t of shortfin were released and recorded under Destination 'X' accounting for 13% and 2% of the species estimated catch, respectively (Beentjes 2020). Investigations into catch recorded on ECERs and ECLRs in 2019 indicate that, Destination 'X' is now being used by most fishers as intended (Beentjes 2020). In 2007–08, a maximum size of 4 kg was introduced for longfins.

Longfins over 4 kg could be legally landed before this date. There was no legal requirement to record the catch of eels over 4 kg on ECLRs. The introduction of electronic catch and position reporting for the eel fishery in 2019 requires fishers to record the numbers and weight of all longfin eels over 4 kg released, as well as other information such as finer-scale catch location details. This will provide estimates of the quantities of longfins (over 4 kg) that are caught and released but not included in the estimated catch used for CPUE analyses.

2. Avoidance of longfin habitat post 2006–07 in some statistical areas because there is currently insufficient available ACE to allow targeting of longfin eels. The QMA most affected is LFE 23 (current TACC is 9 t) where, since 2007–08, up to half the ACE has not been made available for lease. Of the available longfin ACE, almost all is leased to a fisher operating in the Taranaki statistical area (AJ) of this QMA, leaving very little for the Whanganui-Rangitikei statistical area. The fisher in the latter statistical area consequently targets shortfin eels in farm dams, dune lakes, and the lower reaches of some rivers; thereby avoiding high longfin eel catch rates in the Rangitikei River. Shelving of ACE continued to 2017–18 for all QMAs but was most marked in SFE 23 and LFE 23 (Beentjes 2019).

3. Voluntary uptake of larger escape tubes (31 mm) from 2010–11 (regulated in 2012–13) may have resulted in a stepped drop in CPUE. This is expected to result in a stepped increase in CPUE in future analyses, when excluded eels begin recruiting to the fishery.

Figure 5: New Zealand Eel Statistical Areas (ESAs).

Table 11: 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 Bay	AG	7
Rangitikei-Whanganui	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 12a: North Island CPUE indices for shortfin eels by Eel Statistical Area (ESA). Fishing years are referred to by the second year (e.g., 1990–91 is referred to as 1991). – insufficient data. See Table 11 for ESA area names; data from Beentjes (2020).

	Shortfin (North Island ESAs)										
Year	AA	AB	AC	AD	AE	AF	AG	AH	AJ	AK	AL
1991	0.71	1.20	1.09	0.83	1.01	–	1.12	1.1	1.66	1.86	–
1992	0.65	0.82	0.95	0.85	0.73	–	1.15	0.99	2.70	3.79	–
1993	0.67	0.76	1.06	0.97	0.65	0.92	1.1	0.92	1.00	2.11	0.67
1994	0.61	0.93	0.96	1.07	0.71	0.63	1.16	1.04	0.69	0.71	1.03
1995	0.81	0.98	1.07	1.09	0.86	0.93	1.25	0.97	1.35	0.63	1.12
1996	0.86	1.04	1.03	1.16	0.92	1.17	0.92	1.24	1.23	0.53	1.06
1997	0.83	0.77	0.80	1.03	0.73	0.71	0.72	0.90	1.09	0.86	0.77
1998	0.91	0.97	0.73	1.02	0.48	–	0.64	0.82	0.96	0.70	0.85
1999	1.06	1.16	0.68	0.90	0.72	–	0.84	0.84	1.02	0.90	0.75
2000	1.03	0.86	0.82	0.78	0.45	0.95	0.75	0.77	0.93	0.47	0.74
2001	1.05	0.84	0.79	0.78	0.60	1.29	0.83	0.83	0.77	0.57	0.77
2002	0.97	0.72	1.07	0.81	0.42	0.82	0.49	0.65	0.8	0.74	0.58
2003	0.96	0.72	0.92	0.74	0.60	0.46	0.52	0.78	0.72	0.47	0.49
2004	1.01	0.84	1.07	0.90	0.69	1.37	0.73	0.21	0.87	1.25	–
2005	0.97	0.88	0.93	0.93	1.04	0.73	0.78	0.67	0.74	1.02	1.10
2006	1.02	0.92	1.00	1.01	1.08	1.54	0.94	1.06	0.97	1.06	1.08
2007	1.12	0.99	0.85	1.00	1.13	1.19	0.74	1.07	0.71	1.23	1.20
2008	1.12	1.21	0.89	1.04	1.37	–	0.90	1.16	0.91	1.36	1.30
2009	1.05	0.99	0.91	1.11	1.53	2.64	1.03	1.42	–	0.95	0.99
2010	1.18	1.05	0.93	1.16	1.47	–	1.08	1.13	1.33	1.11	1.48
2011	1.15	1.10	1.23	1.18	1.60	–	0.99	1.40	0.91	0.94	1.38
2012	1.15	1.06	1.33	1.00	2.12	–	1.09	1.64	0.88	0.87	1.45
2013	1.19	1.10	1.28	0.98	1.78	–	1.44	1.39	1.43	0.98	0.94
2014	1.12	1.12	1.32	0.98	1.28	–	1.73	1.12	0.74	1.03	1.23
2015	1.24	1.16	1.10	1.01	1.55	–	1.39	1.10	0.96	1.27	1.15
2016	1.18	1.38	1.08	1.16	–	–	1.74	1.88	–	1.24	0.96
2017	1.45	1.50	1.29	1.41	2.58	–	1.95	1.30	–	1.56	1.78
2018	1.62	1.45	1.28	1.41	2.61	–	1.74	1.37	–	1.17	1.24

Table 12b: North Island CPUE indices for longfin eels by Eel Statistical Area (ESA). Fishing years are referred to by the second year (e.g., 1990–91 is referred to as 1991). – insufficient data. See Table 11 for ESA area names; data from Beentjes (2020).

	Longfin (North Island ESAs)										
Year	**AA**	**AB**	**AC**	**AD**	**AE**	**AF**	**AG**	**AH**	**AJ**	**AK**	**AL**
1991	1.15	0.68	1.73	1.09	1.78	–	1.23	1.73	1.50	–	0.87
1992	1.00	1.21	1.80	1.19	1.24	–	1.34	1.88	1.75	–	–
1993	1.07	1.07	1.55	0.96	1.03	0.74	1.30	1.38	1.23	2.49	1.34
1994	1.02	1.04	1.13	1.15	1.05	1.10	1.23	1.66	1.07	1.84	0.85
1995	0.98	1.19	1.33	1.24	0.99	0.74	0.99	1.37	1.30	1.14	1.08
1996	1.07	0.90	1.47	1.06	0.74	0.69	1.03	1.36	1.24	1.26	0.92
1997	0.86	0.91	1.19	0.97	0.67	–	0.62	1.43	1.10	–	0.73
1998	1.06	1.23	0.94	0.87	0.76	–	0.79	0.90	1.06	0.52	0.83
1999	1.16	1.26	1.02	0.82	1.31	–	1.02	0.86	0.97	–	0.73
2000	1.09	1.07	1.02	0.85	0.59	0.92	1.11	1.03	0.94	0.86	0.69
2001	1.19	1.22	0.80	0.92	1.32	1.16	0.86	0.73	0.82	1.01	0.72
2002	1.05	0.89	0.82	0.83	0.81	1.10	0.64	0.68	0.82	0.45	0.66
2003	0.97	0.89	0.87	0.86	0.86	–	0.82	0.61	0.70	0.44	0.66
2004	1.02	0.95	0.84	0.95	1.06	–	0.70	0.47	0.77	1.18	1.08
2005	0.96	1.26	1.18	0.94	0.82	1.11	0.95	0.72	0.85	1.03	0.86
2006	0.99	0.82	0.91	0.91	1.10	–	0.88	0.82	0.83	0.86	1.15
2007	0.99	1.02	0.83	0.97	0.94	1.83	0.86	0.75	0.90	1.22	1.16
2008	0.97	1.02	0.84	0.95	1.02	–	0.78	–	0.97	0.99	1.06
2009	0.72	0.82	0.81	0.99	1.35	–	–	–	–	0.97	0.81
2010	0.82	0.89	0.77	1.06	0.84	–	–	–	0.89	1.14	1.13
2011	0.84	0.81	0.84	1.04	1.33	–	–	–	1.05	1.23	1.54
2012	0.83	1.02	1.01	1.10	1.23	–	1.02	–	1.11	1.09	1.38
2013	0.97	1.00	0.94	1.06	1.36	–	1.20	–	1.02	1.01	1.07
2014	0.80	0.97	0.93	0.95	0.69	–	1.52	–	0.88	0.89	1.14
2015	0.92	0.93	0.54	1.00	–	–	1.23	–	0.79	0.93	1.00
2016	0.92	0.82	0.92	0.98	–	–	1.58	–	–	1.18	1.08
2017	1.51	1.17	0.87	1.27	–	–	1.18	–	0.88	0.87	1.71
2018	1.39	1.33	1.10	1.27	–	–	0.88	–	1.17	1.08	1.87

South Island CPUE

The Eel Working Group in 2012 (EELWG-2012-05) made the decision to split South Island CPUE analyses into pre- and post-QMS time series with post-QMS CPUE analyses only required for areas with sufficient data and fishers (ESAs: Westland AX, Otago AV, Southland AW, Te Waihora AS1 outside migration area). This was done because many fishers fishing under existing permits pre-QMS obtained their own quota and entered the fishery as 'new' entrants when the QMS was introduced. Fishing coefficients for existing permit holders were therefore likely to have changed considerably after the QMS was introduced. It is not possible to separate catches in the pre-QMS data into individual fisher catch and effort, as was done in the North Island analysis, because the CELR forms used up to 2001–02 included only a field for permit holder, with no way of identifying individual operators. This problem was solved in 2001–02 with the introduction of the new ECER form by adding a field which identified the fisher (i.e., 'catcher') filling out the form.

This problem was less severe in the North Island because North Island eels were introduced to the QMS after the new ECER forms had been developed, making it possible to link catcher and permit holders before and after the introduction to the QMS. The two most recent South Island CPUE analyses, up to 2012–13, and up to 2018–19, included predictor variables: target species, water quality data (e.g., nitrogen, phosphates, clarity, temperature), and catcher (Beentjes & Dunn 2015, Beentjes 2021). Catcher was only available for the post-QMS analyses. The first year in the post-QMS standardised CPUE time series is 2001–02 when catcher was first recorded on the new ECERs.

Shortfin

CPUE for South Island shortfin showed four distinct patterns in the data rich areas: a steady decline pre-QMS followed by a steady increase post-QMS (Southland), a steady decline pre-QMS followed by a stable period post-QMS with no trend (Otago), a steady increase pre- and post-QMS (Westland), and a steep increase, followed by a stable period and then a steep decline (Te Waihora, AS1) (Table 13a, Figure 8).

Longfin

CPUE for South Island longfin showed two distinct patterns in the data rich areas: a steady decline pre-QMS followed by a stable period post-QMS with no clear trend (Otago and Southland), and a steady increase pre- and post-QMS (Westland) (Table 13b, Figure 8).

Table 13a: South Island CPUE indices for shortfin eels by Eel Statistical Area (ESA). Separate indices are presented for pre-QMS (1991–2000) and post-QMS (2001–2019). Fishing years are referred to by the second year (e.g., 1990–91 is referred to as 1991). – insufficient data. See Table 11 for ESA area names; data from Beentjes (2021).

QMS		Shortfin (South Island ESAs)								
status	Year	AN	AP_AQ	AR	AT	AU	AV	AW	AX	AS1
Pre-QMS	1991	–	2.36	1.15	1.84	1.65	1.51	1.30	0.95	–
	1992	–	1.95	1.14	0.99	1.63	1.20	1.03	0.61	–
	1993	1.42	1.61	0.90	0.84	0.74	1.05	0.99	1.07	–
	1994	–	1.34	1.00	1.00	1.08	1.03	1.33	0.96	–
	1995	1.68	1.15	0.84	0.79	0.76	0.92	1.01	1.00	–
	1996	1.03	0.66	0.98	1.02	1.21	0.87	0.88	0.79	–
	1997	0.32	0.55	0.98	0.89	0.80	0.90	0.79	0.74	–
	1998	0.82	0.39	0.99	1.10	1.09	0.84	0.89	1.27	–
	1999	1.52	0.72	1.08	0.70	0.60	0.83	0.90	1.55	–
	2000	1.02	0.86	0.98	1.20	0.96	1.02	1.01	1.48	–
	2001	–	–	–	–	–	–	–	–	–
Post-QMS	2002	–	–	–	–	–	0.82	0.67	0.76	0.31
	2003	–	–	–	–	–	0.94	0.64	0.66	0.37
	2004	–	–	–	–	–	0.79	0.84	0.81	0.50
	2005	–	–	–	–	–	0.98	0.91	0.93	0.60
	2006	–	–	–	–	–	0.96	1.06	0.82	0.75
	2007	–	–	–	–	–	1.16	0.97	0.93	1.02
	2008	–	–	–	–	–	0.77	1.28	0.82	1.20
	2009	–	–	–	–	–	1.19	0.90	1.41	1.32
	2010	–	–	–	–	–	1.33	1.21	1.09	1.07
	2011	–	–	–	–	–	1.24	1.41	1.09	2.08
	2012	–	–	–	–	–	0.97	0.96	1.09	2.19
	2013	–	–	–	–	–	0.74	1.02	1.06	2.04
	2014	–	–	–	–	–	0.68	1.05	0.98	2.39
	2015	–	–	–	–	–	0.76	1.14	1.10	1.50
	2016	–	–	–	–	–	1.27	1.06	1.08	0.86
	2017	–	–	–	–	–	0.89	1.02	1.18	0.79
	2018	–	–	–	–	–	1.56	0.99	0.99	0.93
	2019	–	–	–	–	–	1.51	1.21	1.59	1.08

Table 13b: South Island CPUE indices for longfin eels by Eel Statistical Area (ESA). Separate indices are presented for pre–QMS (1991–2000) and post QMS (2001–2019). Fishing years are referred to by the second year (e.g., 1990–91 is referred to as 1991). - insufficient data; –, no analysis. See Table 11 for ESA area names; data from Beentjes (2021).

		Longfin (South Island ESAs)							
QMS status	Year	AN	AP_AQ	AR	AT	AU	AV	AW	AX
Pre-QMS	1991	2.10	1.77	1.16	1.89	1.25	1.35	1.46	1.08
	1992	1.17	1.29	0.97	0.74	1.25	1.20	1.13	0.95
	1993	0.80	1.25	0.89	0.78	0.84	1.14	1.13	0.76
	1994	0.90	1.40	0.96	1.05	0.91	1.27	1.22	0.89
	1995	0.78	1.12	0.71	0.88	0.64	0.93	0.99	1.10
	1996	0.80	1.13	1.28	0.78	1.06	0.80	1.00	1.00
	1997	0.70	0.64	1.12	0.96	0.95	0.86	0.92	0.94
	1998	0.79	0.75	0.84	0.99	0.96	0.87	0.79	0.97
	1999	1.15	0.82	0.99	0.85	1.29	0.85	0.68	1.10
	2000	1.42	0.50	1.23	1.59	1.04	0.91	0.91	1.30
	2001	–	–	–	–	–	–	–	–
Post-QMS	2002	–	–	–	–	–	0.91	1.02	0.77
	2003	–	–	–	–	–	0.91	1.10	0.77
	2004	–	–	–	–	–	0.89	0.86	0.91
	2005	–	–	–	–	–	1.10	1.12	0.91
	2006	–	–	–	–	–	0.92	1.08	0.92
	2007	–	–	–	–	–	1.02	0.83	0.96
	2008	–	–	–	–	–	0.97	0.94	0.92
	2009	–	–	–	–	–	1.14	0.93	1.01
	2010	–	–	–	–	–	0.87	0.84	1.26
	2011	–	–	–	–	–	1.31	1.24	1.18
	2012	–	–	–	–	–	0.91	1.07	0.95
	2013	–	–	–	–	–	0.96	1.11	1.06
	2014	–	–	–	–	–	0.83	1.04	0.92
	2015	–	–	–	–	–	0.70	0.99	0.95
	2016	–	–	–	–	–	1.46	0.94	1.13
	2017	–	–	–	–	–	1.21	0.89	1.39
	2018	–	–	–	–	–	1.20	0.97	1.04
	2019	–	–	–	–	–	0.95	1.15	1.18

Te Waihora

CPUE analyses for Te Waihora were only carried out for AS1 feeder shortfin (the lake, outside the migration area) from 2000–01, coinciding with the introduction of the reporting codes (AS1 and AS2), to 2012–13. The two most recent analyses included new predictor variables: lake level, status of lake opening (i.e., open or closed), and catcher (Beentjes & Dunn 2015, Beentjes 2021). The standardised CPUE time series begins in 2001–02, when the new ECER form was introduced and catcher was first recorded. CPUE of feeder shortfin eels in Te Waihora increased more than seven fold in nine years from 2001–02 to 2010–11 and then was reasonably stable until 2013–14 before steeply declining over the next two years then levelling out (Figure 9).

It is very likely that the fishery has initially experienced a progressive improvement in yield-per-recruit (YPR) as the minimum legal size was incrementally increased by 10 g per year from 140 g in 1993–94 to 220 g in 2001–02. This was then followed by a decline in YPR over the last five years. Analyses of the commercial shortfin eel size composition harvested from the lake in the 1990s compared with that over the last nine years demonstrates that the average size of commercially caught eels substantially increased over time before decreasing again, supporting the concept of a fluctuating yield-per-recruit (Figure 10; Beentjes & Dunn 2014, Beentjes 2021). CPUE appears to have been highest when mean size was larger and vice versa. Further, shortfin eels are reported to be in poor condition in recent years and bully numbers are low, both signs of a reduction in lake productivity.

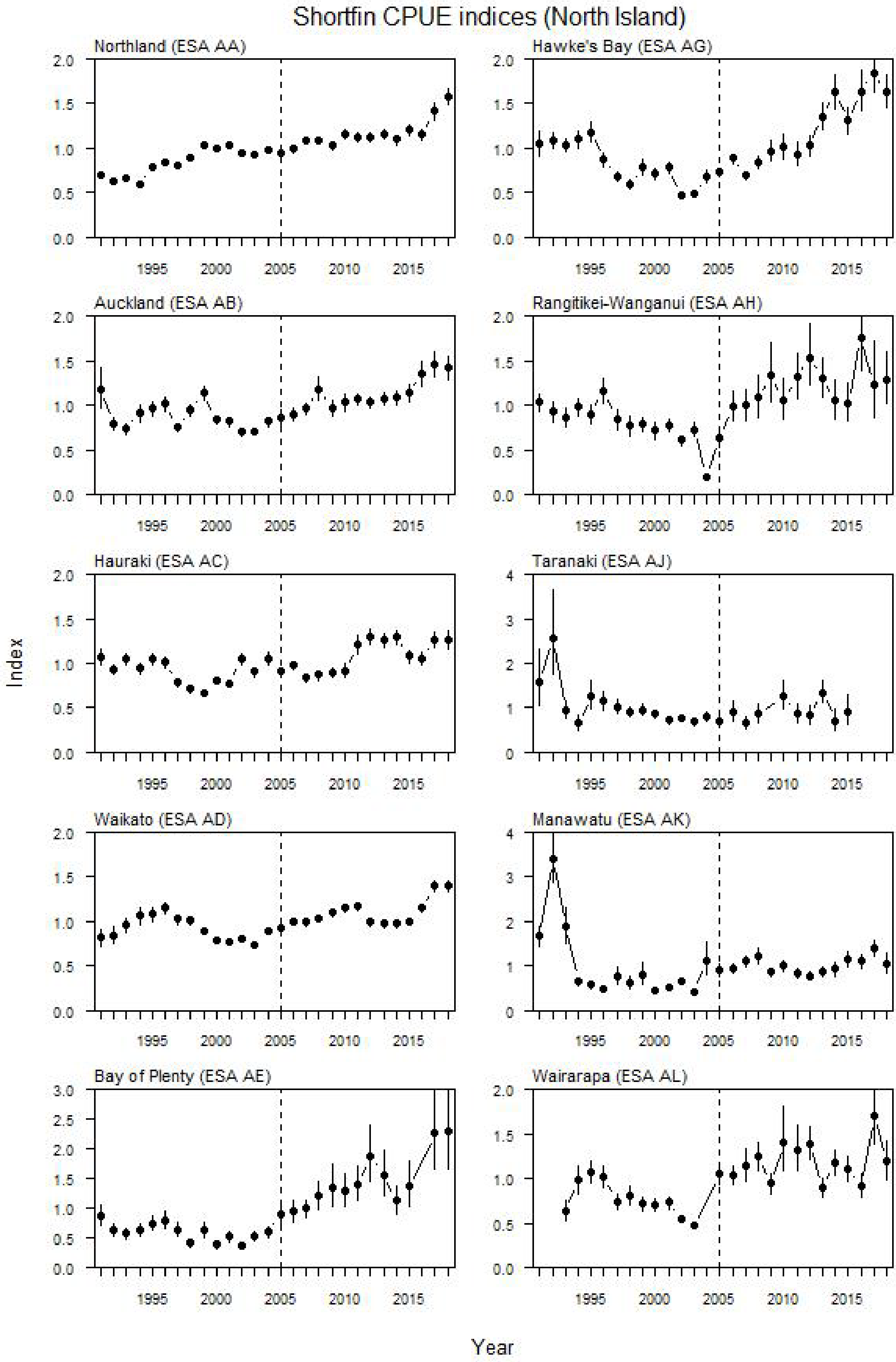


Figure 6: Trends in North Island shortfin CPUE indices for all North Island ESAs from 1990–91 to 2017–18, except Poverty Bay (AF) and Wellington (AM) where there were insufficient data. Vertical dotted line indicates the introduction to the QMS in 2004–05 (from Beentjes 2020).

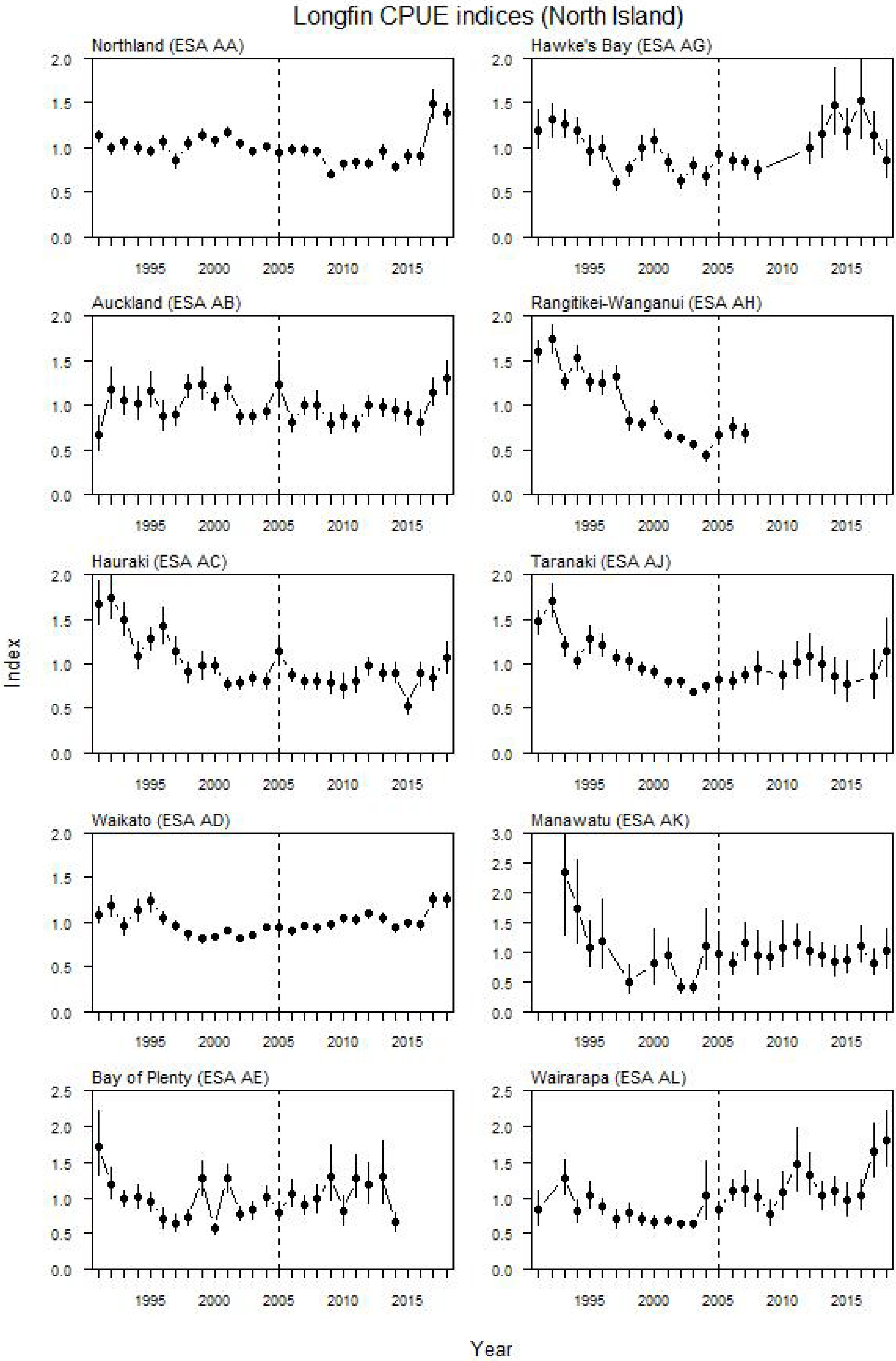


Figure 7: Trends in North Island longfin CPUE indices for all North Island ESAs from 1990–91 to 2017–18, except Poverty Bay (AF) and Wellington (AM) where there were insufficient data. Vertical dotted line indicates the introduction to the QMS in 2004–05 (from Beentjes 2020).

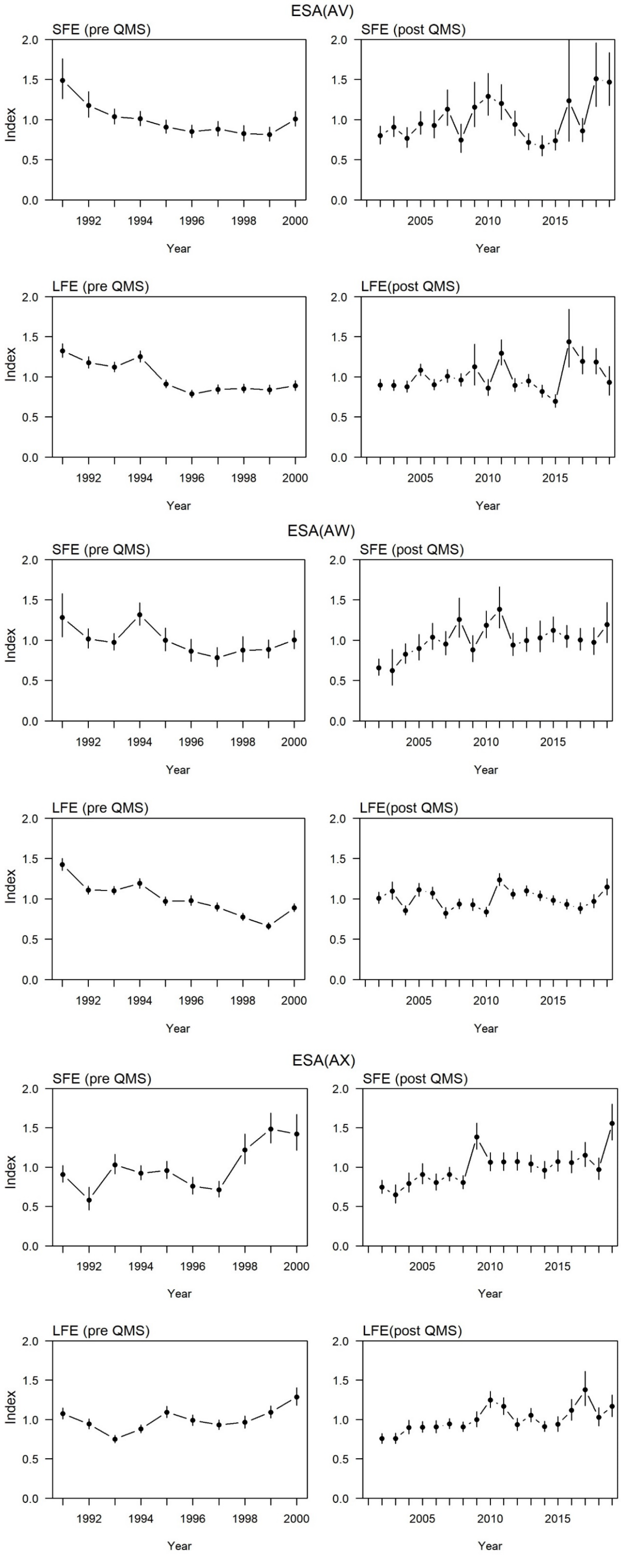


Figure 8: Trends in South Island shortfin and longfin CPUE indices for key ESAs: Otago (AV), Southland (AW), and Westland (AX). Separate indices are presented for pre-QMS (1991–2000) and post-QMS (2002–2019) (from Beentjes 2021).

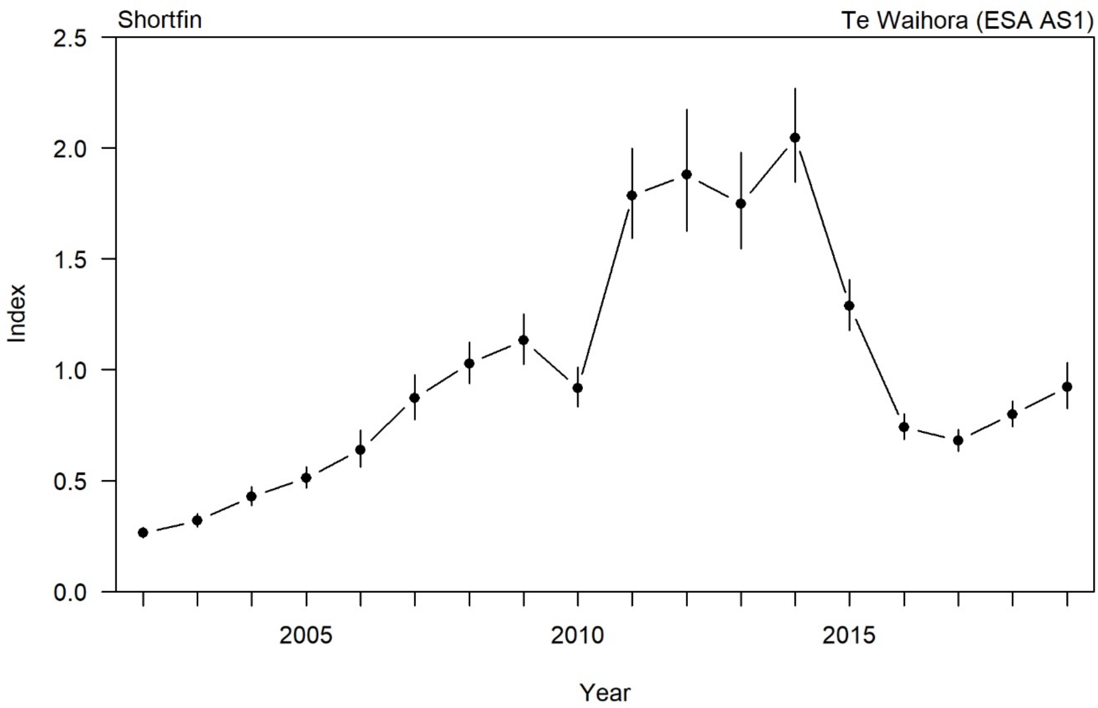
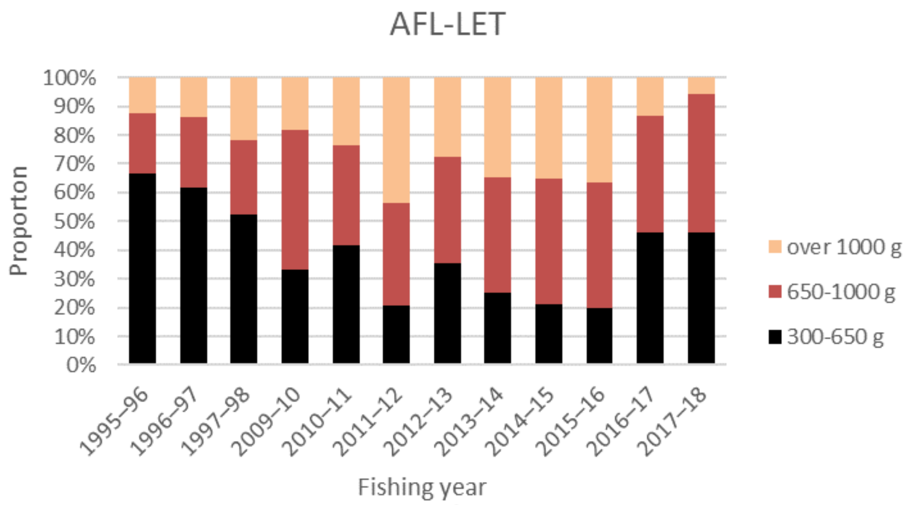


Figure 9: Te Waihora shortfin CPUE indices for AS1 (outside migration area) from 2001–02 to 2018–19 (from Beentjes 2021).



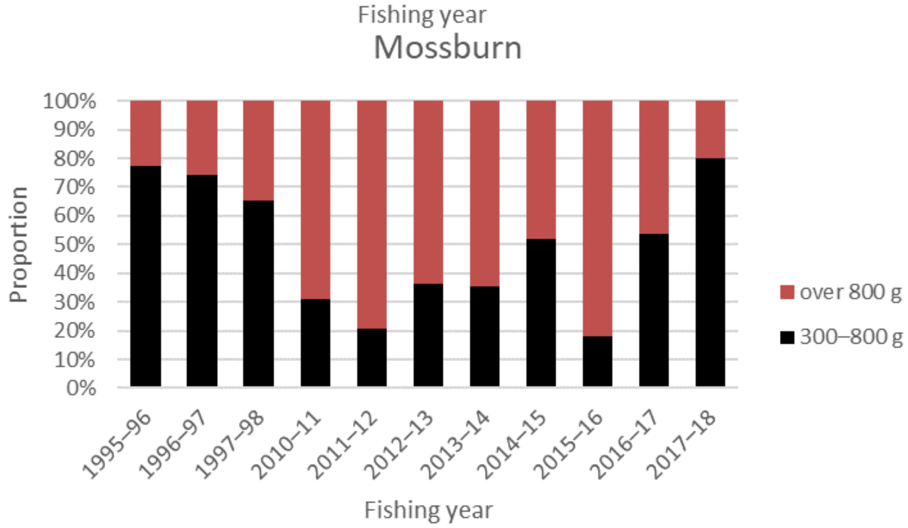


Figure 10: Size grade proportions of shortfin eels harvested from Te Waihora AS1 (lake) from eel processors AFL-Levin Eel Trading Ltd in 2009–10 to 2017–18, and Mossburn Enterprises Ltd in 2010–11 and 2017–18. The equivalent size grades have been estimated from the length of eels taken during commercial catch sampling of the commercial catch from Te Waihora in 1995–96 to 1997–98 (Beentjes & Dunn 2014, Beentjes 2020).

4.3 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 & 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.

4.4 Yield estimates and projections

In the absence of accurate current biomass estimates, this could not be estimated. Biological parameters relevant to the stock assessment are given in Table 14.

Table 14: 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

4.5 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. 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 (*A. anguilla, A. rostrata*, and *A. japonica*) species, which are all extensively fished at all stages of their estuarine/freshwater life 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 since the mid-1970s with less than 1% of juvenile resources estimated to be remaining for major populations in 2003 (Québec Declaration of Concern 2003). More recently, Dekker & Casselman (2014) concluded that "the recent recruitment increase of some [northern hemisphere] stocks, and the relative stability of others, indicate that after many decades of continued decline depleted eel stocks around the world have the potential to recover".

Longfin habitat

It was estimated, based on GIS modelling in the early 2000s (Graynoth et al 2008), that 5% of longfin eel 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 was estimated to be in areas closed to fishing in upstream areas but where the spawning migration could be subject to exploitation in downstream areas (migratory eels are not normally taken by commercial fishers). An additional 17% of longfin habitat was 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 was either in a reserve or in rarely/non-fished areas (Graynoth et al 2008). However, the estimate of the proportion of longfin habitat in streams rarely or not commercially fished was based on poor assumptions and was consequently vastly underestimated.

In 2015, commercial longfin eel fishing effort throughout New Zealand was mapped using GIS methods, providing the first detailed and high resolution representation of where and how often fishers set their nets in New Zealand rivers, lakes, and harbours (Beentjes et al 2016). The data used in the study came from face to face interviews with 53 commercial longfin fishers from throughout New Zealand and covered the five year period from 2009–10 to 2013–14. From these data, estimates were made of the proportion of longfin habitat that is currently fished (Beentjes et al 2016). The total current longfin habitat in rivers was derived from 'probability of longfin capture' models. About one quarter (27.2%) of the New Zealand longfin river and lake habitat, currently accessible to longfin eels, was commercially fished (32.5% in the South Island and 22.5% in the North Island) (Table 15). The proportion of virgin/original longfin habitat affected by anthropogenic activity (impeded access by dams and other structures, habitat degradation, and commercial fishing) is estimated at 42% (= Max. impacted abundance) (Table 15). Forty percent of the current habitat available to longfin eels in New Zealand is estimated to be within DOC Public Conservation Land, and just over half of this is in natural lakes (Beentjes et al 2016). Generally, DOC will not issue concessions for commercial eel fishing in Public Conservation Land, except for shortfin eels in Lake Brunner.

Table 15: Estimates of total current longfin habitat fished, virgin habitat fished, and maximum impacted abundance from all rivers and lakes by QMA, eel statistical area, and overall for South Island, North Island, and New Zealand. Current lake habitat includes that from natural lakes over 0.9 km^2, and rivers where longfin eels have unimpeded access to, and egress to the sea. Maximum impacted abundance is the proportion of virgin habitat affected by anthropogenic activities including loss to dams, impeded access, commercial fishing, and habitat loss. Max, maximum. QMA, Quota Management Area (from Beentjes et al 2016).

					Percent (%)
Island	QMA	Eel Statistical Area	Current habitat fished	Virgin habitat fished	Max. impacted abundance
North Island	LFE 20	AA	36.1	34.7	40.2
North Island	LFE 20	AB	34.9	33.8	38.2
North Island	LFE 21	AC	50.0	47.6	55.0
North Island	LFE 21	AD	43.2	34.4	55.7
North Island	LFE 21	AE	17.4	16.2	23.9
North Island	LFE 21	AF	8.6	8.2	13.6
North Island	LFE 22	AG	17.3	16.0	24.7
North Island	LFE 23	AH	24.8	23.6	29.9
North Island	LFE 23	AJ	17.0	15.9	23.6
North Island	LFE 22	AK	36.0	34.5	40.6
North Island	LFE 22	AL	4.2	4.1	5.0
North Island	LFE 22	AM	2.4	2.2	7.4
South Island	ANG 11	AN	11.5	11.1	15.5
South Island	ANG 11	AP	42.1	40.1	47.1
South Island	ANG 12	AQ	7.9	7.6	12.4
South Island	ANG 12	AR	58.1	55.9	61.7
South Island	ANG 13	AS	0.0	0.0	0.4
South Island	ANG 14	AT	38.6	37.3	42.1
South Island	ANG 14	AU	52.2	12.4	85.9
South Island	ANG 15	AV	46.2	12.5	82.8
South Island	ANG 15	AW	32.2	24.2	40.7
South Island	ANG 16	AX	30.2	29.0	34.0
North Island	All	All	22.5	20.9	29.0
South Island	All	All	32.5	21.8	52.6
New Zealand	All	All	27.2	21.4	42.1

Sex ratio

The shortfin fishery is based on the exploitation of immature female eels, because most shortfin male eels migrate before reaching the minimum size of 220 g. The exception to this is Te Waihora where migratory male shortfin eels are also harvested. The longfin fishery is based on immature male and female eels.

A study on the Aparima River in Southland in 2001–02 found that female longfins were rare in the catchment. Only five of 738 eels sexed were females (McCleave & Jellyman 2004). This is in contrast to a predominance of larger female longfins in southern rivers established by earlier research in the

1940s and 1950s, 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 (Davey & Jellyman 2005).

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 10a) on their upriver migration. Nationally some 10 million elvers are now regularly caught and transferred upstream of dams 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. An extensive capture and release programme has also been conducted from Lake Manapouri to below the Mararoa Weir on the Waiau River, Southland by Meridian Energy since 1998. Limited numbers of longfin migrants are also transferred to below the Waitaki Dam by local Runanga. Adult eel bypasses have been installed at the Wairere Falls and Mokauiti power stations in the Mokau River catchment 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. Additional eel protection infrastructure is currently being installed at Patea Dam and ongoing studies, including downstream bypass trials are in progress at Karapiro Dam (Waikato), Lake Whakamarino (Waikaremoana Power Scheme), and Wairua (Titoki) Power Station. So far, the effectiveness of none of these varied mitigation activities has been fully assessed.

Several projects have been undertaken to evaluate the enhancement of depleted customary fisheries through the transfer of juvenile eels. In 1997, over 2000 juvenile shortfin eels (100–200 g) were caught from Te Waihora (Lake Ellesmere), tagged, and transferred to Cooper's Lagoon a few kilometres away (Jellyman & Beentjes 1998, Beentjes & Jellyman 2002). 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) mostly shortfin eels weighing less than 220 g from Lake Waahi in the Waikato catchment to the Taharoa Lakes near Kawhia (Chisnall 2000). No tagged eels were recovered when the lakes were surveyed in 2001. It is considered that a large number of shortfin eels migrated from the lake as males following the transfer. The conclusion from these two transfers is that transplanted shortfin 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 longfin eels were caught in the lower Clutha River and transferred to Lake Hawea, of which 2010 (about 20%) were tagged (Beentjes 1998). In 2001, of 216 recaptured eels, 42 (19.4%) had tags (i.e., very little tag loss) (Beentjes & Jellyman 2003). The transferred eels showed accelerated growth and the mean annual growth in length was almost double that of eels from the original transfer site and all recaptures were females. A further sample of Lake Hawea in 2008 showed that of 399 longfin eel recaptures, 79 had tags (19.2%), indicating continued good tag retention (Beentjes & Jellyman 2011). Growth rate from the 2008 tag recaptures was significantly greater than at release, but less than in 2001, and all recaptures were females.

Trends in the commercial catches from areas upstream of hydro dams on the Waikato, Rangitaiki, and Patea rivers indicate that elver trap and transfer operations have improved or at least maintained the eel populations upstream of barriers (Beentjes & Dunn 2010). Comparison of historical eel survey results have confirmed these observations (e.g., Beentjes et al 1997, Boubée & Hudson 2009, Crow & Jellyman 2010).

5. FUTURE RESEARCH CONSIDERATIONS

- Examine further the 'target species' reconstruction based on CELR data by, for example, running sensitivities to determine the effect of different assumptions.
- For the Te Waihora shortfin CPUE, explore the possibility of developing an index of the ratio between the AS1 and AS2 catch as a potential explanatory variable.
- Investigate the utility of using more stringent criteria for choosing core permits.
- Examine trends over time for individual fishers; i.e., consider deriving fisher-based indices as an alternative way of standardising.
- Determine whether ancillary data exist to refine or verify the derived targets.
- Determine the proportion of fishers using destination code 'X' to report the catches of legal-size fish that are released.
- Identify the fishers who haven't been using destination 'X 'correctly and fix this to the extent possible. Identify whether the issue is specific to certain areas. For some fishers it may be necessary to add the destination code 'X' estimates from the ECLR forms to the catch estimates from the ECER forms to obtain a more accurate estimate of catch per day for the CPUE analyses.
- Investigate ways of compensating for the lack of recording of eels over 4 kg since 2007–08 (especially since this should be rectified once new forms are developed).
- For areas with few fishers or records, the Eel Working Group should consider merging statistical areas and analysing data at the QMA level. Alternatively the working group needs to consider ways to develop statements about stock status for areas with few fisheries or low effort.
- Investigate the possibility of augmenting the current data with information from customary fisheries.
- Calculate a weighted CPUE by QMA, with the weighting based on the amount of suitable habitat in each area.

6. STATUS OF THE STOCKS

There are no Level 1 Full Quantitative Stock Assessments on which to base specific recommendations on eel catch levels. Nevertheless, recruitment data, commercial CPUE indices, information on spawner escapement, and information on the proportion of longfin habitat fished allow for Level 2 Partial Quantitative Stock Assessments of longfin and shortfin eels.

Stock Structure Assumptions

Longfin and shortfin eels are considered to be New Zealand-wide stocks, with common species-specific spawning grounds within the Fiji Basin. However, once recruited to a river system, eels do not move between catchments, so eels within each catchment may be regarded as separate sub-populations for management purposes. Maintaining sub-populations within each QMA at or above (sub-area proxies for) B_{MSY}, will ensure that the entire (national) stock of each species is maintained at that level. North Island QMAs have from two to four ESAs, and South Island QMAs all have two, except Westland (LFE 16 and SFE 16) which has one. ESAs also contain multiple catchments or sub-populations from which eels are harvested.

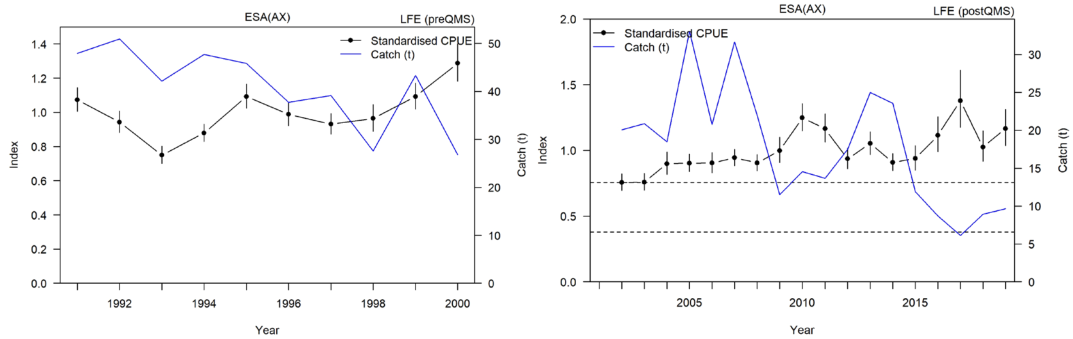
Status of South Island Eels

Level 2 Partial Quantitative Stock Assessments are conducted by statistical area and species and are only possible where accepted indices of abundance are available; i.e., Westland, Otago, Southland, and Te Waihora. Standardised CPUE provides information on the abundance of commercially harvested eels (300–4000 g) in areas that are fished commercially. Aproximately 67% of currently available longfin habitat in the South Island is either in reserves or in areas rarely or never fished by commercial fishers.

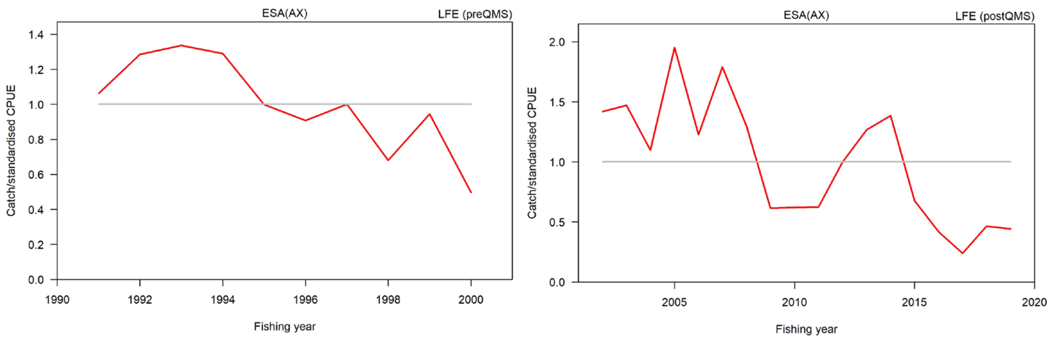
- **Westland (AX) longfin**

Stock Status		
Most Recent Assessment Plenary Publication Year	2021	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE	
Reference Points	Target: B_{MSY} assumed, but not estimated Interim Soft Limit: Mean CPUE from 2001–02 to 2002–03 Hard Limit: 50% of Soft Limit Overfishing threshold: F_{MSY} assumed, but not estimated	
Status in relation to Target	Unknown	
Status in relation to Limits	Soft Limit: Unlikely (< 40%) to be below Hard Limit: Very Unlikely (< 10%) to be below	
Status in relation to Overfishing	Unknown	

Historical Stock Status Trajectory and Current Status



Comparison of standardised CPUE for longfin eels in Westland (AX) from 1990–91 to 1999–2000 (pre-QMS) and 2001–02 to 2018–19 (post-QMS) (from Beentjes 2021). Also shown is the total estimated core fisher longfin catch in AX from from ECERs. The two CPUE series have been scaled to the mean for each time series. Horizontal lines post-QMS represent the soft and hard limits. 2000 = 1999–2000 fishing year. Error bars are 95% confidence intervals.



Annual relative exploitation rate for longfin eels in the Westland (AX) pre- and post-QMS. 2000 = 1999–2000 fishing year.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Pre-QMS CPUE declined from 1990–91 to 1992–93, and then increased steadily to 1999–2000. Post-QMS CPUE increased steadily from 2001–02 to 2018–19.
Recent Trend in Fishing intensity or Proxy	Relative exploitation rate declined steeply throughout the pre-QMS time series and declined substantially post-QMS.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of longfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data

	begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unlikely (< 40%) if catch remains at current levels Hard Limit: Unlikely (< 40%) if catch remains at current levels
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unlikely (< 40%) if catch remains at current levels

Assessment Methodology and Evaluation		
Assessment Type	Level 2 – Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2021	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series (pre-QMS)	

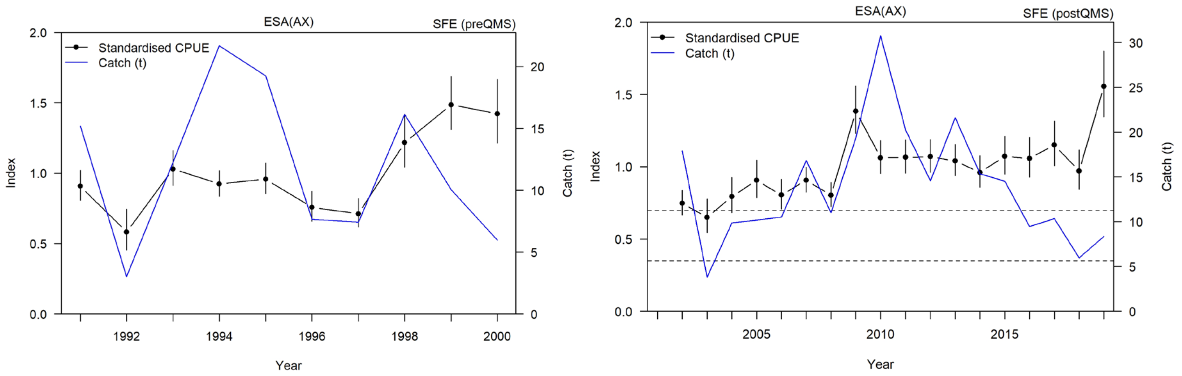
Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as culling (primarily 1930s to 1950s) and habitat alteration (historical and current), have also reduced abundance prior to the CPUE series. The basis for the biological reference points is tenuous and should be revised whenever new relevant information becomes available. The proportion of current longfin habitat in Westland (Statistical Area AX, ANG 11) fished commercially during the period 2009–10 and 2013–14 is estimated at 30% (Table 15). The proportion of virgin habitat impacted by hydro dams, commercial fishing, and other anthropogenic activity was estimated to be 34%.

Fishery Interactions
Bycatch of other species in the commercial eel fishery is low and may include brown trout, galaxiids, yelloweye mullet, and kōura in order of amount caught. Bycatch species are usually returned alive.

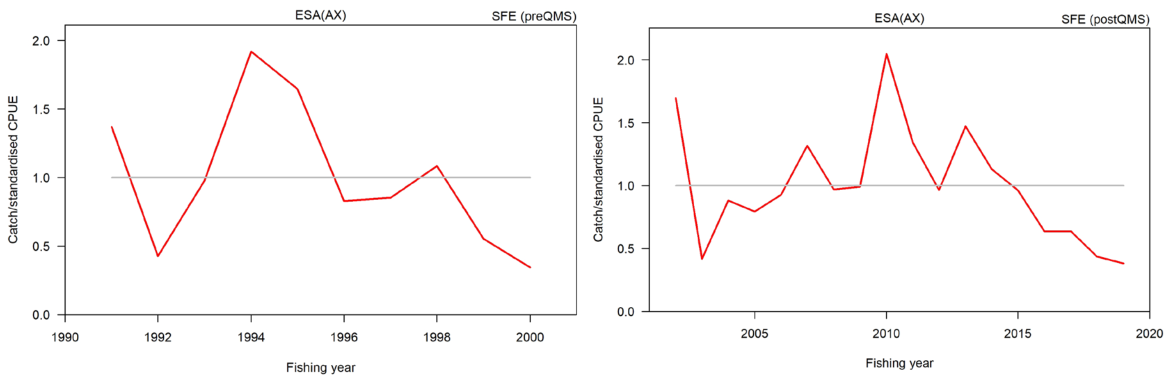
- **Westland (AX) shortfin**

Stock Status		
Most Recent Assessment Plenary Publication Year	2021	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE	
Reference Points	Target: B_{MSY} assumed, but not estimated Interim Soft Limit: Mean CPUE from 2001–02 to 2002–03 Hard Limit: 50% of Soft Limit Overfishing threshold: F_{MSY} assumed, but not estimated	
Status in relation to Target	Unknown	
Status in relation to Limits	Soft Limit: Unlikely (< 40%) to be below Hard Limit: Very Unlikely (< 10%) to be below	
Status in relation to Overfishing	Unknown	

Historical Stock Status Trajectory and Current Status



Comparison of standardised CPUE for shortfin eels in Westland (AX) from 1990–91 to 1999–2000 (pre-QMS) and 2001–02 to 2018–19 (post-QMS) (from Beentjes 2021). Also shown is the total estimated core fisher shortfin catch in AX from ECERs. The two CPUE series have been scaled to the mean of each time series. Horizontal dashed lines post-QMS represent the soft and hard limits. 2000 = 1999–2000 fishing year. Error bars are 95% confidence intervals.



Annual relative exploitation rate for shortfin eels in the Westland (AX) pre- and post-QMS. 2000 = 1999–2000 fishing year.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Pre-QMS CPUE fluctuated without trend from 1990–91 to 1996–97 and then increased sharply to 1999–2000. Post-QMS CPUE increased steadily from 2001–02 to 2018–19.
Recent Trend in Fishing intensity or Proxy	Relative exploitation rate has shown large inter-annual fluctuations, with an increasing trend from 2003 to 2010, followed by a strongly declining trend.

Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of shortfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unlikely (< 40%) if catch remains at current levels Hard Limit: Very Unlikely (< 10%) if catch remains at current levels
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unlikely (< 40%) if catch remains at current levels

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2021	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series (pre-QMS)	

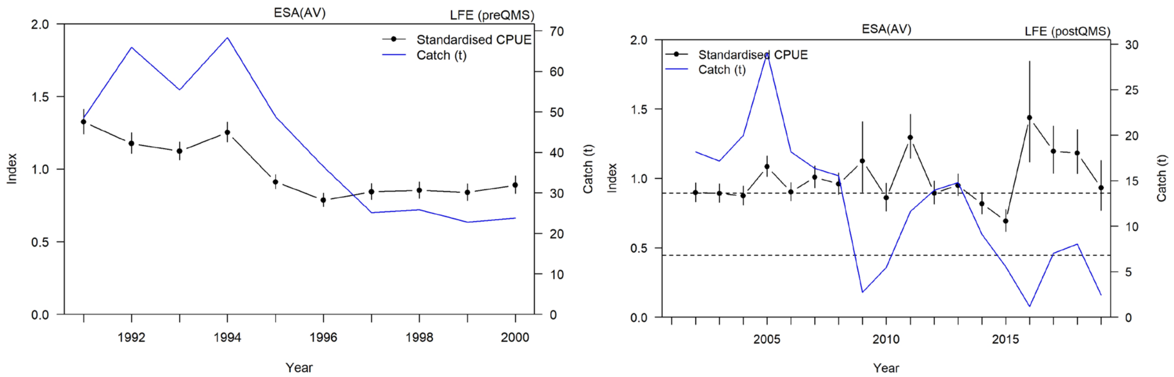
Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as culling (primarily 1930s to 1950s) and habitat alteration (historical and current), have also reduced abundance prior to the CPUE series. The basis for the biological reference points is tenuous and should be revised whenever new relevant information becomes available.

Fishery Interactions
Bycatch of other species in the commercial eel fishery is low and may include brown trout, galaxiids, yelloweye mullet, and kōura in order of amount caught. Bycatch species are usually returned alive.

- **Otago (AV) longfin**

Stock Status		
Most Recent Assessment Plenary Publication Year	2021	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE	
Reference Points	Target: B_{MSY} assumed, but not estimated Interim Soft Limit: Mean CPUE from 2001–02 to 2002–03 Hard Limit: 50% of Soft Limit Overfishing threshold: F_{MSY} assumed, but not estimated	
Status in relation to Target	Unknown	
Status in relation to Limits	Soft Limit: About as Likely as Not (40–60%) to be below. Hard Limit: Very Unlikely (< 10%) to be below	
Status in relation to Overfishing	Unknown	

Historical Stock Status Trajectory and Current Status



Comparison of standardised CPUE for longfin eels in Otago (AV) from 1990–91 to 1999–2000 (pre-QMS) and 2001–02 to 2018–19 (post-QMS) (from Beentjes 2021). Also shown is the total estimated core fisher longfin catch in AV from ECERs. The two CPUE series have been scaled to the mean of each time series. Horizontal lines post-QMS represent the soft and hard limits 2000 = 1999–2000 fishing year. Error bars are 95% confidence intervals.

Annual relative exploitation rate for longfin eels in the Otago (AV) pre- and post-QMS. 2000 = 1999–2000 fishing year.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Pre-QMS CPUE declined steadily from 1990–91 to 1995–96 and was stable to 1999–2000. Post-QMS CPUE is variable with no clear long-term trend.
Recent Trend in Fishing intensity or Proxy	Relative exploitation rate was variable but overall declined markedly from 2002 to 2019.
Other Abundance Indices	-

Trends in Other Relevant Indicators or Variables	Catches of longfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data began in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term if catch remains at current levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: About as Likely as Not (40–60%) if catch remains at current levels Hard Limit: Unlikely (< 40%) if catch remains at current levels
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown if catch remains at current levels Unknown if catch were to increase to the level of the TACC

Assessment Methodology		
Assessment Type	Level 2 – Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2021	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series (pre-QMS)	

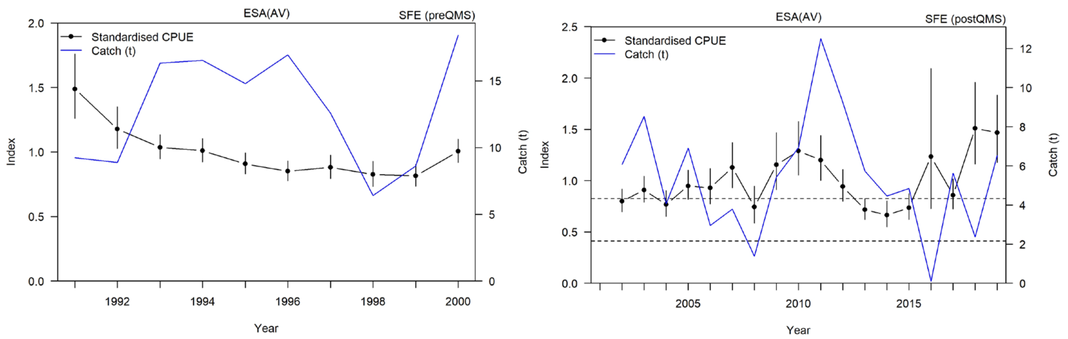
Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as culling (primarily 1930s to 1950s) and habitat alteration (historical and current), have also reduced abundance prior to the CPUE series. The basis for the biological reference points is tenuous and should be revised whenever new relevant information becomes available. The proportion of current longfin habitat in Otago (Statistical Area AV) fished commercially during the period 2009–10 and 2013–14 is estimated at 46% (Table 15). The proportion of virgin habitat impacted by hydro dams, commercial fishing, and other anthropogenic activity was estimated to be 82.8%.

Fishery Interactions
Bycatch of other species in the commercial eel fishery is low and may include brown trout, galaxiids, yelloweye mullet, and kōura in order of amount caught. Bycatch species are usually returned alive.

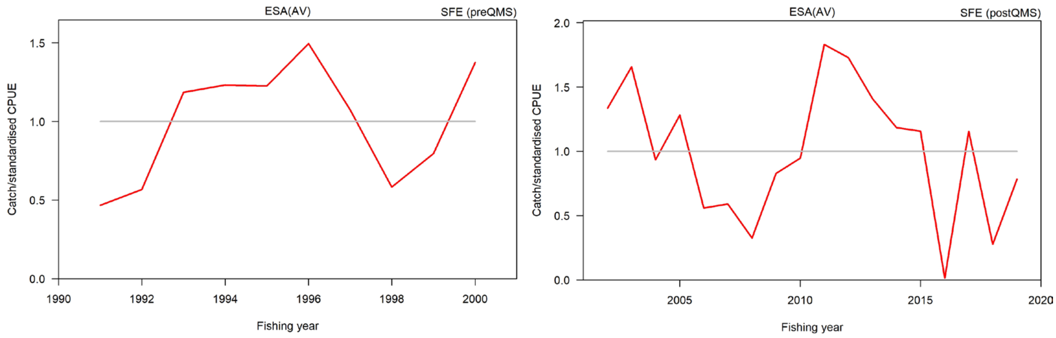
- **Otago (AV) shortfin**

Stock Status		
Most Recent Assessment Plenary Publication Year	2021	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE	
Reference Points	Target: B_{MSY} assumed, but not estimated Interim Soft Limit: Mean CPUE from 2001–02 to 2003–04 Hard Limit: 50% of Soft Limit Overfishing threshold: F_{MSY} assumed, but not estimated	
Status in relation to Target	Unknown	
Status in relation to Limits	Soft Limit: Unlikely (< 40%) to be below Hard Limit: Very Unlikely (< 10%) to be below	
Status in relation to Overfishing	Unknown	

Historical Stock Status Trajectory and Current Status



Comparison of standardised CPUE for shortfin eels in Otago (AV) from 1990–91 to 1999–2000 (pre-QMS) and 2001–02 to 2018–19 (post-QMS) (from Beentjes 2021). Also shown is the total estimated shortfin core fisher catch in AV from ECERs. The two CPUE series have been scaled to the mean of each time series. Horizontal lines post-QMS represent the soft and hard limits 2000 = 1999–2000 fishing year. Error bars are 95% confidence intervals.



Annual relative exploitation rate for shortfin eels in the Otago (AV) pre- and post-QMS. 2000 = 1999–2000 fishing year.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Pre-QMS CPUE declined steadily from 1990–91 to 1998–99 and then increased slightly to 1999–2000. Post-QMS CPUE fluctuated without trend until 2015, after which it has increased.
Recent Trend in Fishing intensity or Proxy	Relative exploitation rate has fluctuated without trend since 2002 but has largely been below the long-term mean since 2015.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of shortfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data

	begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Because both catch and exploitation rate show large inter-annual variation, it is not clear whether the population will continue to increase.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unlikely (< 40%) if catch remains at current levels Hard Limit: Unlikely (< 40%) if catch remains at current levels
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown if catch remains at current levels Likely (> 40%) if catch were to increase to the level of the TACC

Assessment Methodology and Evaluation		
Assessment Type	Level 2 – Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2021	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series (pre-QMS)	

Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as culling (primarily 1930s to 1950s) and habitat alteration (historical and current), have also reduced abundance prior to the CPUE series.

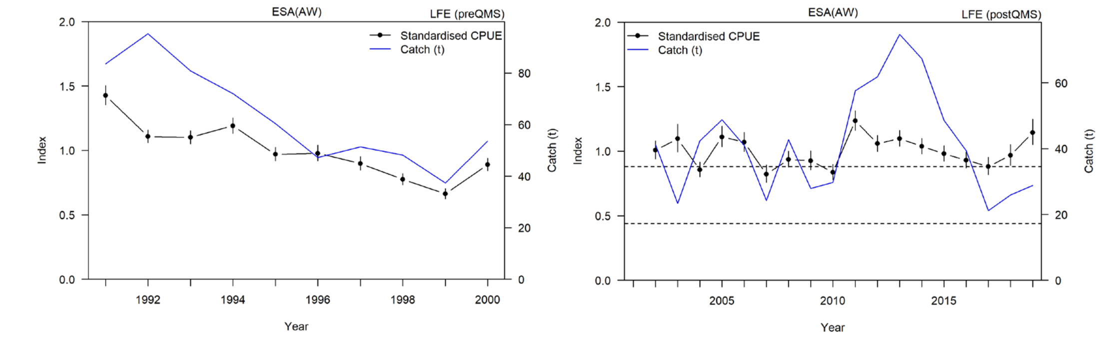
Fishery Interactions
Bycatch of other species in the commercial eel fishery is low and may include brown trout, black flounder, kōura, yelloweye mullet, galaxiids, yellowbelly flounder, and bullies in order of amount caught. Bycatch species are usually returned alive.

- **Southland (AW) longfin**

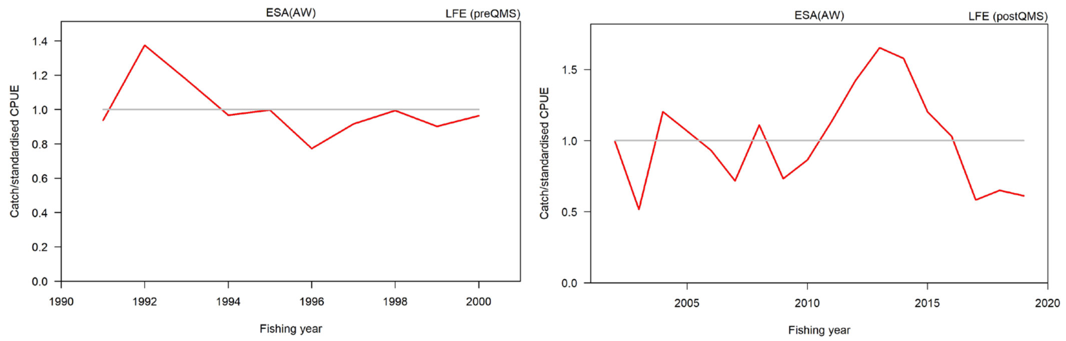
Stock Status		
Most Recent Assessment Plenary Publication Year	2021	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE	

Reference Points	Target: B_{MSY} assumed, but not estimated Interim Soft Limit: Mean CPUE from 2006–07 to 2009–10 Hard Limit: 50% of Soft Limit Overfishing threshold: F_{MSY} assumed, but not estimated
Status in relation to Target	Unknown
Status in relation to Limits	Soft Limit: Unlikely (< 40%) to be below Hard Limit: Very Unlikely (< 10%) to be below
Status in relation to Overfishing	Unknown

Historical Stock Status Trajectory and Current Status



Comparison of standardised CPUE for longfin eels in Southland (AW) from 1990–91 to 1999–2000 (pre-QMS) and 2001–02 to 2018–19 (post-QMS) (from Beentjes 2021). Also shown is the total estimated core fisher longfin catch in AW from ECERs. The two CPUE series have been scaled to the mean of each time series. Horizontal lines post-QMS represent the soft and hard limits. 2000 = 1999–2000 fishing year. Error bars are 95% confidence intervals.



Annual relative exploitation rate for longfin eels in the Southland (AW) pre- and post-QMS. 2000 = 1999–2000 fishing year.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Pre-QMS CPUE declined steadily from 1990–91 to 1998–98 and increased to 1999–2000. Post-QMS CPUE is variable with no long-term trend.
Recent Trend in Fishing intensity or Proxy	Relative exploitation rate has fluctuated without trend since 2002.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of longfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline under recent levels of catch and exploitation rate
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unlikely (< 40%) if catch remains at current levels Hard Limit: Unlikely (< 40%) if catch remains at current levels

Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown if catch remains at current levels

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2021	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series (pre-QMS)	

Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as culling (primarily 1930s to 1950s) and habitat alteration (historical and current), have also reduced abundance prior to the CPUE series. The basis for the biological reference points is tenuous and should be revised whenever new relevant information becomes available. The proportion of current longfin habitat in Southland (Statistical Area AW) fished commercially during the period 2009–10 and 2013–14 is estimated at 32% (Table 15). The proportion of virgin habitat impacted by hydro dams, commercial fishing, and other anthropogenic activity was estimated to be 41%.

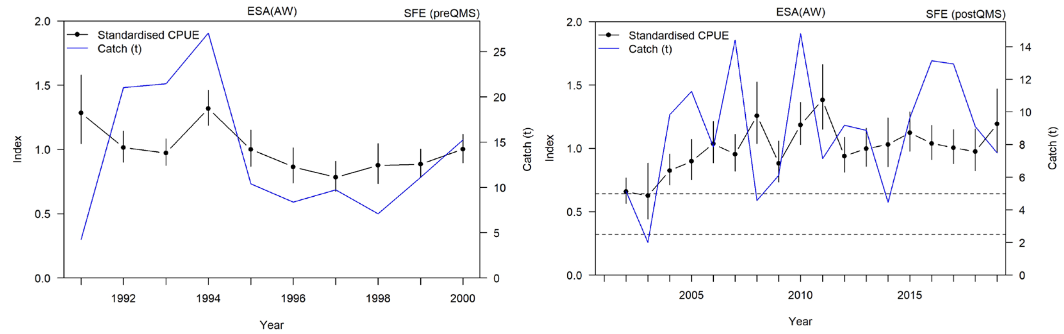
Fishery Interactions
Bycatch of other species in the commercial eel fishery is low and may include brown trout, giant bullies, kōura, galaxiids, and common bullies in order of amount caught. Bycatch species are usually returned alive.

- **Southland (AW) shortfin**

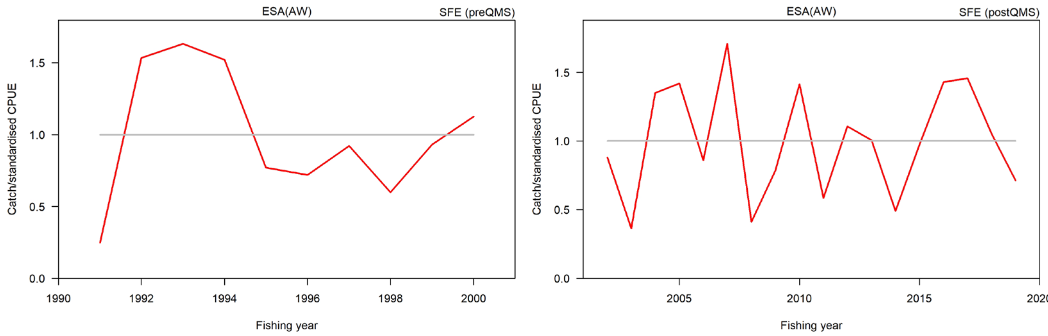
Stock Status		
Most Recent Assessment Plenary Publication Year	2021	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE	
Reference Points	Target: B_{MSY} assumed, but not estimated Interim Soft Limit: Mean CPUE from 2001–02 to 2002–03 Hard Limit: 50% of Soft Limit Overfishing threshold: F_{MSY} assumed, but not estimated	
Status in relation to Target	Unknown	

Status in relation to Limits	Soft Limit: Unlikely (< 40%) to be below Hard Limit: Very Unlikely (< 10%) to be below
Status in relation to Overfishing	Unknown

Historical Stock Status Trajectory and Current Status



Comparison of standardised CPUE for shortfin eels in Southland (AW) from 1990–91 to 1999–2000 (pre-QMS) and 2001–02 to 2018–19 (post-QMS) (from Beentjes in press). Also shown is the total estimated core fisher shortfin catch in AW from ECERs. The two CPUE series have been scaled to the mean of each time series. Horizontal lines post-QMS represent the soft and hard limits. 2000 = 1999–2000 fishing year. Error bars are 95% confidence intervals.



Annual relative exploitation rate for shortfin eels in the Southland (AW) pre- and post-QMS. 2000 = 1999–2000 fishing year.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Pre-QMS CPUE declined slowly from 1990–91 to 1996–97 and then gradually increased to 1999–2000. Post-QMS CPUE fluctuated but increased substantially from 2001–02 to 2018–19.
Recent Trend in Fishing intensity or Proxy	Relative exploitation rate has fluctuated without trend since 2002.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of shortfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Likely to remain stable in the medium term under current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unlikely (< 40%) if the catch remains at current levels Hard Limit: Very Unlikely (< 10%) if the catch remains at current levels
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown if catch remains at current levels

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2021	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series (pre-QMS)	

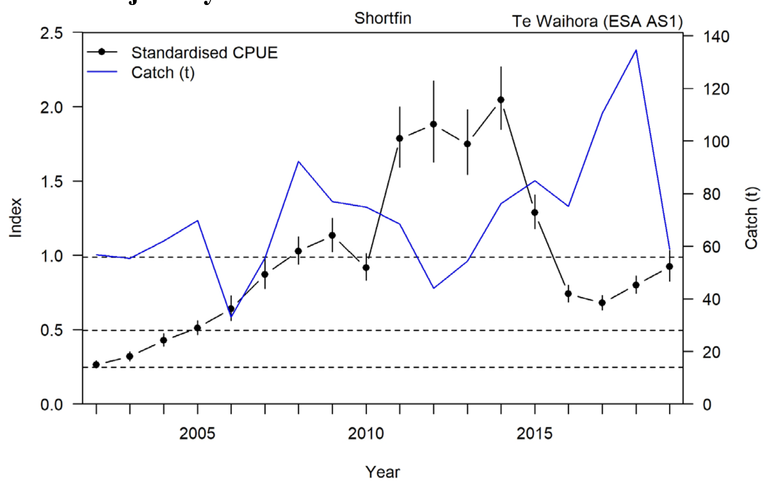
Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as culling (primarily 1930s to 1950s) and habitat alteration (historical and current), have also reduced abundance prior to the CPUE series. The basis for the biological reference points is tenuous and should be revised whenever new relevant information becomes available.

Fishery Interactions
Bycatch of other species in the commercial eel fishery is low and may include brown trout, giant bullies, kōura, galaxiids, and common bullies in order of amount caught. Bycatch species are usually returned alive.

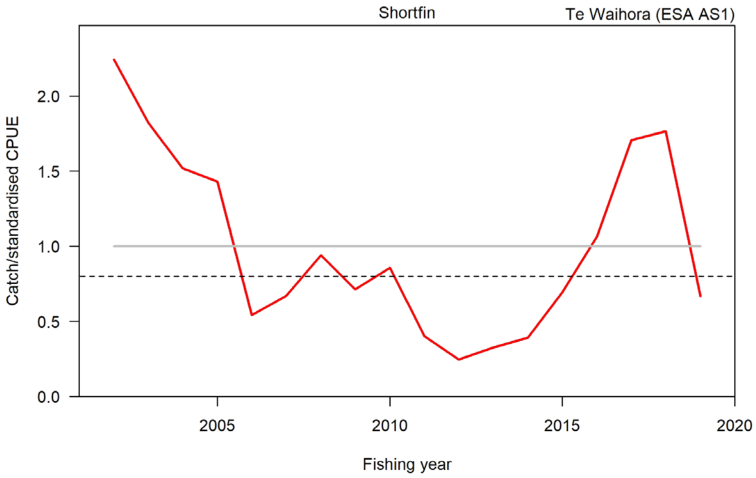
- **Te Waihora (AS1) shortfin**

Stock Status		
Most Recent Assessment Plenary Publication Year	2021	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE of feeder eels in AS1	
Reference Points	Interim Target: B_{MSY}-compatible proxy based on mean CPUE for the period: 2006–07 to 2009–10. Soft Limit: 50% of target Hard Limit: 50% of soft limit Overfishing threshold: F_{MSY}	
Status in relation to Target	About as Likely as Not (40–60%) to be at or above B_{MSY}	
Status in relation to Limits	Soft Limit: Unlikely (< 40%) to be below Hard Limit: Very Unlikely (< 10%) to be below	
Status in relation to Overfishing	Overfishing is About as Likely as Not (40–60%) to be occurring	

Historical Stock Status Trajectory and Current Status



Comparison of standardised CPUE for shortfin eels in Te Waihora (AS1) from 2001–02 to 2018–19 (post-QMS) (from Beentjes 2021). Also shown is the total estimated core fisher shortfin catch in AS1 from ECERs. The CPUE series have been scaled to the mean of each time series. Horizontal lines represent the target, and soft and hard limits. 2002 = 2001–2002 fishing year. Error bars are 95% confidence intervals.



Annual relative exploitation rate for shortfin eels in the Te Waihora (AS1) post-QMS. 2002 = 2001–02 fishing year. Horizontal dashed line represents the overfishing threshold which is the mean relative exploitation rate for the target reference period.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	CPUE of feeder shortfin eels in Te Waihora (AS1) increased 7-fold from 2001–02 to 2010–11, before levelling off between 2011 and 2014, followed by a steep decline to below the target in 2016. CPUE increased gradually after 2016 to about the target in 2019.
Recent Trend in Fishing intensity or Proxy	Relative exploitation rate declined substantially (9-fold) from 2002 to 2012, then increased 7-fold before another steep decline after 2019.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of shortfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment. Increasing mean size since the mid-1990s suggests reduced exploitation rates. Mean size appears to have declined since the peak CPUE in 2011 to 2014.

Projections and Prognosis	
Stock Projections or Prognosis	About as Likely as not (40–60%) to remain at or above the

	target in the medium term under current catch levels Likely (> 60%) to decline if the catch of feeder eels increased to the level of the TACC
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unlikely (< 40%) if catch remains at current levels Hard Limit: Very Unlikely (< 10%) if catch remains at current levels Likely (> 60%) to decline below the soft limit if catch were to increase to the level of the TACC, especially if all the catch is taken from AS1
Probability of Current Catch or TACC causing Overfishing to continue or to commence	About as Likely as Not (40–60%) if catch remains at current levels Very Likely (> 90%) if catch was to increase to the level of the TACC and if all of the catch was taken from AS1. AS2 catch (migrating shortfin males) has declined in the last few years and was zero in 2019.

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2021	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Exclusion of zero catches • Changes in MLS and retention in early parts of the series (pre-QMS)	

Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series. The shortfin eel catch from Te Waihora comprises small migrant males from AS2 and feeder females from AS1. The index of abundance is based on the catch rates of feeder eels. The basis for the biological reference points is tenuous and should be revised whenever new relevant information becomes available. Commercial fishers in Te Waihora have varied the size of escape tubes since 2015 to avoid smaller eels when there was no market for them.

Fishery Interactions
Bycatch of other species in the commercial eel fishery may include: bullies, black flounder, yellowbelly flounder, sand flounder, and goldfish in order of the amount caught. The flatfish species are usually released alive or retained if caught under quota. Longfin eels are not abundant and are usually voluntarily released alive. All other bycatch is released alive.

Status of North Island Eels

Level 2 Partial Quantitative Stock Assessments are conducted by statistical area and species where accepted indices of abundance are available. Standardised CPUE provides information on the abundance of commercially harvested eels (300–4000 g) in areas that are fished commercially.

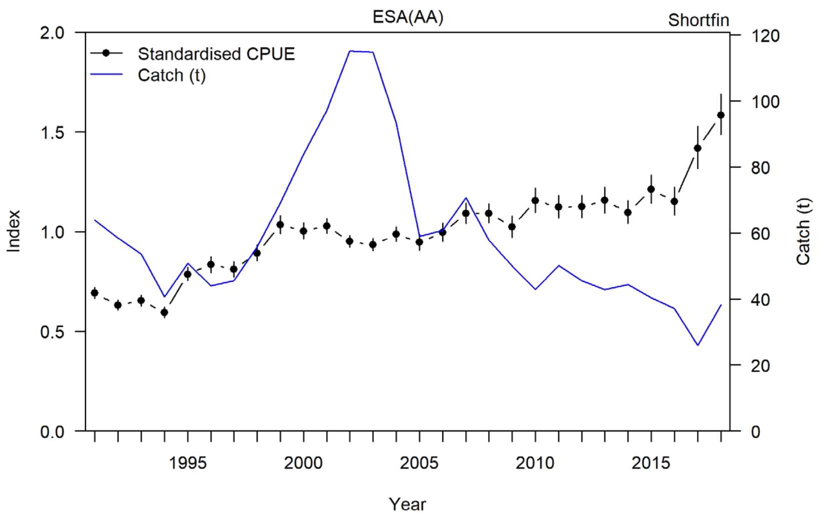
Aproximately 73% of current longfin habitat in the North Island is either in reserves or in areas rarely or never fished by commercial fishers. Statements regarding the status of longfin eels in relation to reference points are made separately for the entire ESA and for the area commercially fished within it. There is no information available on the proportion of shortfin habitat in each ESA that is fished commercially.

QMA SFE 20 and LFE 20 (includes ESAs AA and AB)

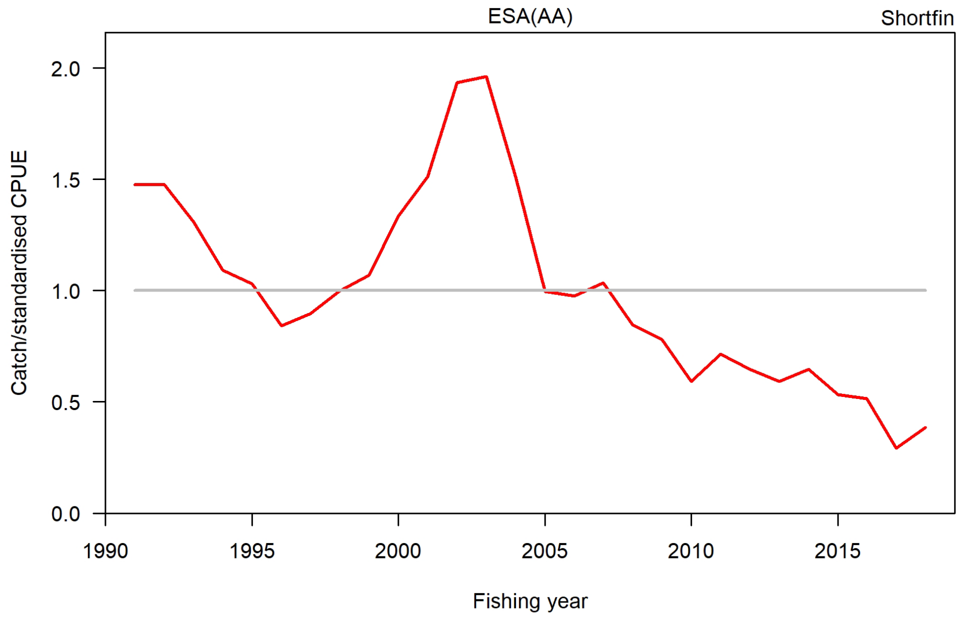
- **Northland (AA) shortfin**

Stock Status		
Most Recent Assessment Plenary Publication Year	2020	
Catch in most recent year of assessment	Year:	Catch:
Assessment Runs Presented	Standardised CPUE on positive catch	
Reference Points	Target: B_{MSY} proxy based on CPUE; not determined Default Soft Limit: 20% B_0 Default Hard Limit: 10% B_0 Overfishing threshold: F_{MSY} proxy based on relative exploitation rate; not determined	
Status in relation to Target	Unknown	
Status in relation to Limits	Soft Limit: Unknown Hard Limit: Unknown	
Status in relation to Overfishing	Unknown	

Historical Stock Status Trajectory and Current Status



Standardised CPUE for shortfin eels in Northland (AA) from 1990–91 to 2017–18 (from Beentjes 2020). Also shown is the total estimated core fisher shortfin catch in AA from ECERs. Error bars are 95% confidence intervals. Before 2001, 37% of the catch was recorded as EEU (unidentified) and these catches are omitted. 2000 = 1999–2000 fishing year.



Annual relative exploitation rate for shortfin eels in the Northland (AA). Because some catch of shortfin was reported as EEU (unidentified) and has not been allocated to species, the exploitation rate is likely to have been higher than shown before 2001.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Increasing trend in CPUE since early 1990s, with steep increase in the last two years
Recent Trend in Fishing intensity or Proxy	The relative exploitation rate has declined steeply since 2003 and in 2018 was well below the series mean
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of shortfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2020	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	

Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series and increased escape tube size from 25 mm to 31 mm in 2012–13 • Failure of some fishers to record on ECE returns all legal-sized eels caught, not just those retained

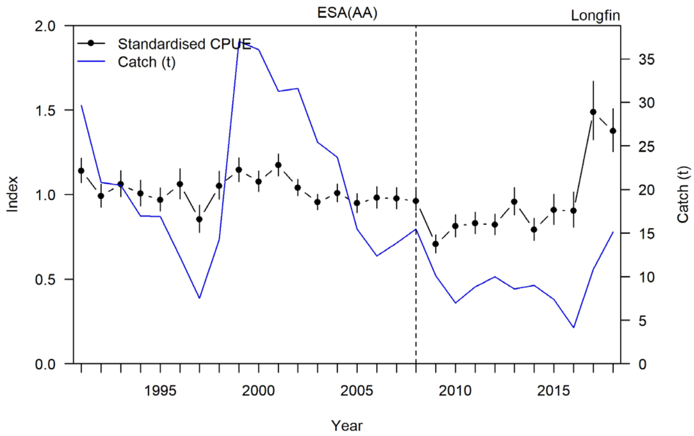
Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series.

Fishery Interactions
Bycatch of other species in the commercial Northland eel fishery includes mainly catfish, with lesser quantities of kōura, goldfish, and perch. Most bycatch species are usually returned alive.

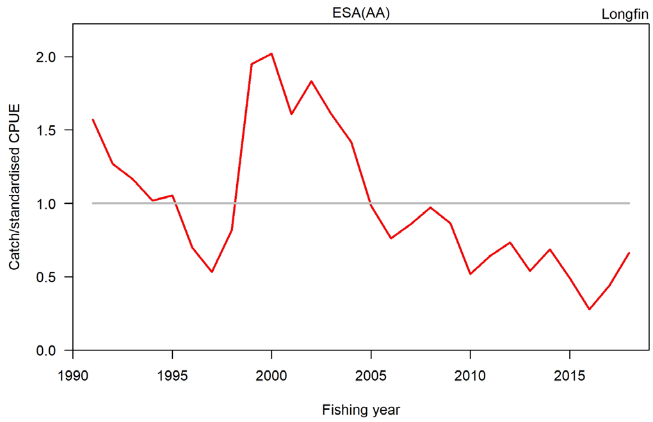
- **Northland (AA) longfin**

Stock Status		
Most Recent Assessment Plenary Publication Year	2020	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE on positive catch	
Reference Points	For ESA, Interim Target is 40% B_0 For commercially fished area, Target is B_{MSY} proxy based on CPUE; not determined Default Soft Limit: 20% B_0 Default Hard Limit: 10% B_0 For ESA, Overfishing threshold is F_{MSY} For commercially fished area, Overfishing threshold is F_{MSY} proxy based on relative exploitation rate; not determined	
Status in relation to Target	For total ESA: Likely (> 60%) to be at or above For fished area: Unknown	
Status in relation to Limits	For ESA, Soft Limit: Very Unlikely (< 10%) to be below For ESA, Hard Limit: Very Unlikely (< 10%) to be below	
Status in relation to Overfishing	For ESA: Unlikely (< 40%) to be overfishing For fished area: Unknown	

Historical Stock Status Trajectory and Current Status



Standardised CPUE for longfin eels in Northland (AA) from 1990–91 to 2017–18 (from Beentjes 2020). Also shown is the total estimated core fisher longfin catch in AA from ECERs. Error bars are 95% confidence intervals. Vertical dashed line indicates when the 4 kg maximum size was introduced in 2007–08 after which longfin eels 4 kg and over are not recorded on ECERs. Before 2001, 37% of the catch was recorded as EEU (unidentified) and these catches are omitted.



Annual relative exploitation rate for longfin eels in the Northland (AA). Because some catch of longfin was reported as EEU (unidentified) and has not been allocated to species, the exploitation rate is likely to have been higher than shown before 2001.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Very slight downward trend in CPUE over the time series, with large increase in last two years.
Recent Trend in Fishing intensity or Proxy	The relative exploitation rate has declined steeply since 2002 and in 2018 was well below the series mean.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of longfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	For ESA, Soft Limit: Very Unlikely (< 10%) if catch remains at current levels For ESA, Hard Limit: Very Unlikely (< 10%) if catch remains at current levels
Probability of Current Catch or TACC causing Overfishing to continue or to commence	For ESA, Unlikely (< 40%) if catch remains at current levels

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2020	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers (for some ESAs) • Uncertainty in the method used to derive target species • Changes in MLS and retention in early parts of the series and increased escape tube size from 25 mm to 31 mm in 2012–13 • Failure of some fishers to record on ECE returns all legal-sized eel caught, not just those retained • Unrecorded release of > 4kg eels since 2007–08	

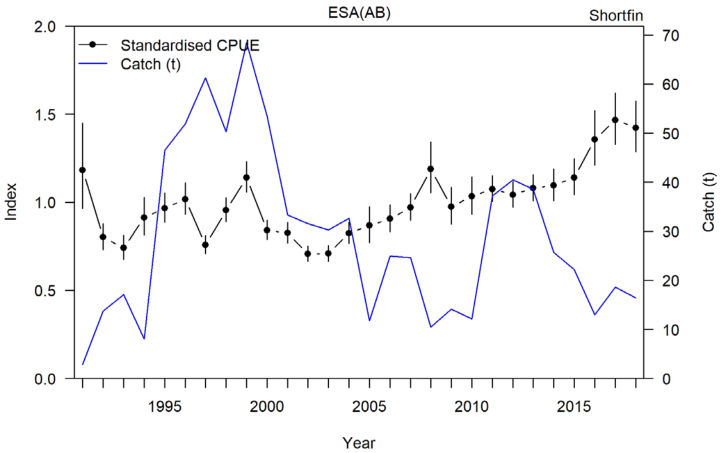
Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series. The proportion of current longfin habitat in Northland (Statistical Area AA) fished commercially during the period 2009–10 and 2013–14 is estimated at 36% (Table 15). The proportion of virgin habitat impacted by hydro dams, commercial fishing, and other anthropogenic activity was estimated to be 40%.

Fishery Interactions
Bycatch of other species in the commercial Northland eel fishery includes mainly catfish, with lesser quantities of kōura, goldfish, and perch. Most bycatch species are usually returned alive.

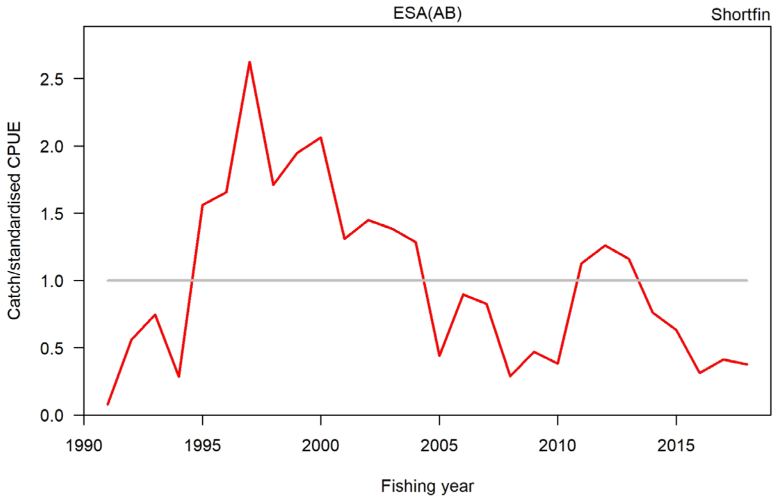
- **Auckland (AB) shortfin**

Stock Status		
Most Recent Assessment Plenary Publication Year	2020	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE on positive catch	
Reference Points	Target: B_{MSY} proxy based on CPUE; not determined Default Soft Limit: 20% B_0 Default Hard Limit: 10% B_0 Overfishing threshold: F_{MSY} proxy based on relative exploitation rate; not determined	
Status in relation to Target	Unknown	
Status in relation to Limits	Soft Limit: Unknown Hard Limit: Unknown	
Status in relation to Overfishing	Unknown	

Historical Stock Status Trajectory and Current Status



Standardised CPUE for shortfin eels in Auckland (AB) from 1990–91 to 2017–18 (from Beentjes 2020). Also shown is the total estimated core fisher shortfin catch in AB from ECERs. Error bars are 95% confidence intervals. Before 2000, 26% of the catch was recorded as EEU (unidentified) and these catches are omitted.



Annual relative exploitation rate for shortfin eels in the Auckland (AB). Because some catch of shortfin was reported as EEU (unidentified) and has not been allocated to species, the exploitation rate is likely to have been higher than shown before 2000.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	No trend in CPUE until 2003, after which it increases consistently and steeply in the last three years.
Recent Trend in Fishing intensity or Proxy	The relative exploitation rate declined from 2012 and in 2018 was below the series mean.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of shortfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Unknown

Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2020	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series and increased escape tube size from 25 mm to 31 mm in 2012–13 • Failure of some fishers to record on ECE returns all legal-sized eels caught, not just those retained	

Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series.

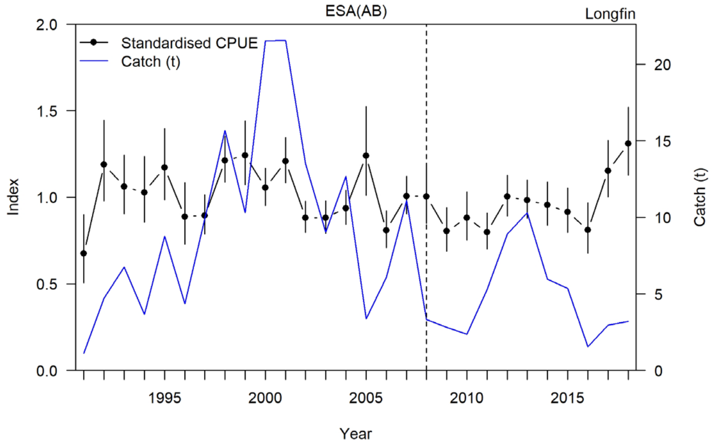
Fishery Interactions
Bycatch of other species in the commercial Auckland eel fishery includes mainly catfish, with lesser quantities of koi carp, goldfish, kōura, grey mullet, and yellowbelly flounder. Most bycatch species are usually returned alive.

- **Auckland (AB) longfin**

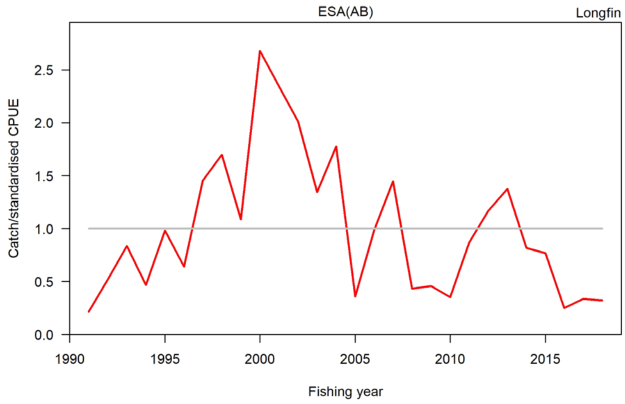
Stock Status		
Most Recent Assessment Plenary Publication Year	2020	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE on positive catch	
Reference Points	For ESA, Interim Target is 40% B_0 For commercially fished area, Target is B_{MSY} proxy based on CPUE; not determined Default Soft Limit: 20% B_0 Default Hard Limit: 10% B_0 For ESA, Overfishing threshold is F_{MSY} For commercially fished area, Overfishing threshold is F_{MSY} proxy based on relative exploitation rate; not determined	
Status in relation to Target	For total ESA: Likely (> 60%) to be at or above	

	For fished area: Unknown
Status in relation to Limits	For ESA, Soft Limit: Very Unlikely (< 10%) to be below For ESA, Hard Limit: Very Unlikely (< 10%) to be below
Status in relation to Overfishing	For ESA: Unlikely (< 40%) to be overfishing For fished area: Unknown

Historical Stock Status Trajectory and Current Status



Comparison of standardised CPUE for longfin eels in Auckland (AB) from 1990–91 to 2017–18 (from Beentjes 2020). Also shown is the total estimated core fisher longfin catch in AB from ECERs. Vertical dashed line indicates when the 4 kg maximum size was introduced in 2007–08 after which longfin eels 4 kg and over are not recorded on ECERs. Error bars are 95% confidence intervals. Before 2000, 26% of the catch was recorded as EEU (unidentified) and these catches are omitted.



Annual relative exploitation rate for longfin eels in the Auckland (AB). Because some catch of longfin was reported as EEU (unidentified) and has not been allocated to species, the exploitation rate is likely to have beenhigher than shown before 2000.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	A slight decline in CPUE to 2016, with a steep increase in the last two years.
Recent Trend in Fishing intensity or Proxy	The relative exploitation rate has declined since 2013 and in 2018 was below the series mean.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of longfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under current catch levels

Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	For ESA, Soft Limit: Very Unlikely (< 10%) if catch remains at current levels For ESA, Hard Limit: Very Unlikely (< 10%) if catch remains at current levels
Probability of Current Catch or TACC causing Overfishing to continue or to commence	For ESA, Unlikely (< 40%) if catch remains at current levels

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2020	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series and increased escape tube size from 25 mm to 31 mm in 2012–13 • Failure of some fishers to record on ECE returns all legal-sized eels caught, not just those retained • Unrecorded release of > 4 kg eels since 2007–08	

Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series. The proportion of current longfin habitat in Auckland (Statistical Area AB) fished commercially during the period 2009–10 and 2013–14 is estimated at 35% (Table 15). The proportion of virgin habitat impacted by hydro dams, commercial fishing, and other anthropogenic activity was estimated to be 38%.

Fishery Interactions
Bycatch of other species in the commercial Auckland eel fishery includes mainly catfish, with lesser quantities of koi carp, goldfish, kōura, grey mullet, and yellowbelly flounder. Most bycatch species are usually returned alive.

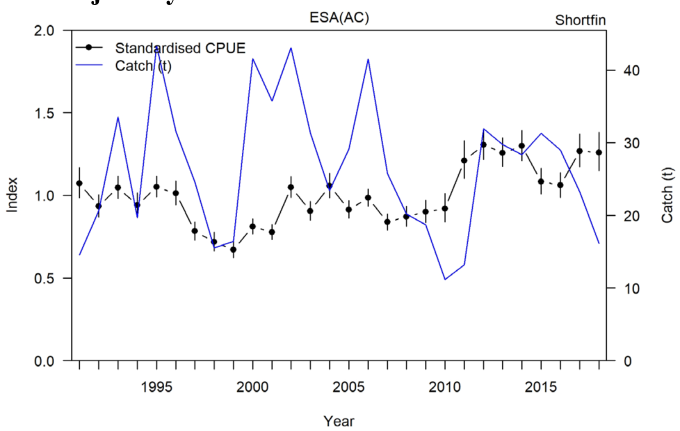
QMA SFE 21 and LFE 21 (includes ESAs AC, AD, AE and AF)

- **Hauraki (AC) shortfin**

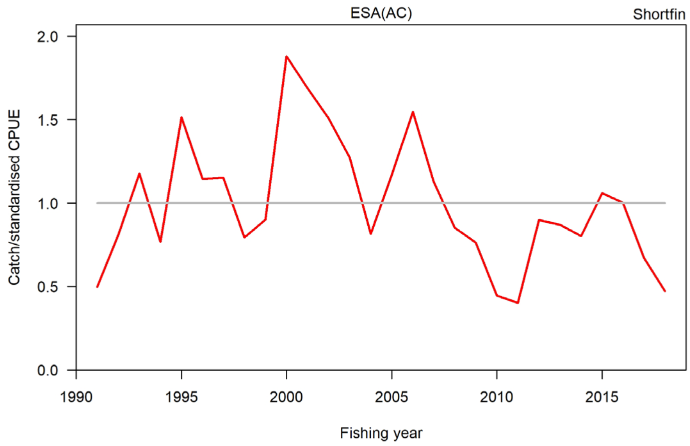
Stock Status	
Most Recent Assessment Plenary Publication Year	2020

Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE on positive catch	
Reference Points	Target: B_{MSY} proxy based on CPUE; not determined Default Soft Limit: 20% B_0 Default Hard Limit: 10% B_0 Overfishing threshold: F_{MSY} proxy based on relative exploitation rate; not determined	
Status in relation to Target	Unknown	
Status in relation to Limits	Soft Limit: Unknown Hard Limit: Unknown	
Status in relation to Overfishing	Unknown	

Historical Stock Status Trajectory and Current Status



Standardised CPUE for shortfin eels in Hauraki (AC) from 1990–91 to 2017–18 (from Beentjes 2020). Also shown is the total estimated core fisher shortfin catch in AC from ECERs. Error bars are 95% confidence intervals. Before 2002, 16% of the catch was recorded as EEU (unidentified) and these catches are omitted.



Annual relative exploitation rate for shortfin eels in the Hauraki (AC). Because some catch of shortfin was reported as EEU (unidentified) and has not been allocated to species, the exploitation rate is likely to have been higher than shown before 2002.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	No trend in CPUE until 2010, after which it has increased
Recent Trend in Fishing intensity or Proxy	The relative exploitation rate has declined since 2006, and in 2018 was below the series mean.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of shortfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2020	Next assessment: 2023
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series and increased escape tube size from 25 mm to 31 mm in 2012–13 • Failure of some fishers to record on ECE returns all legal-size eels caught, not just those retained	

Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series.

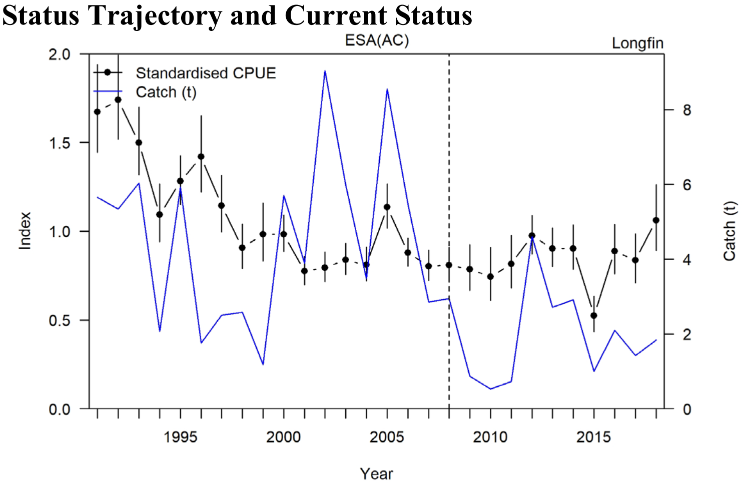
Fishery Interactions
Bycatch of other species in the commercial Hauraki eel fishery includes mainly catfish, with lesser quantities of brown trout, goldfish, koi carp, and kōkopu. Most bycatch species are usually returned alive.

- **Hauraki (AC) longfin**

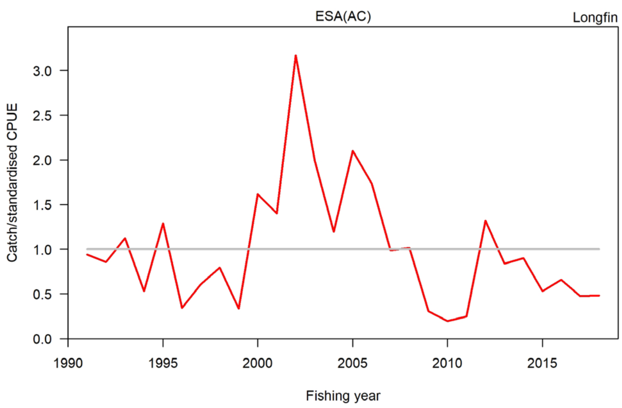
Stock Status		
Most Recent Assessment Plenary Publication Year	2020	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE on positive catch	
Reference Points	For ESA, Interim Target is 40% B_0	

	For commercially fished area, Target is B_{MSY} proxy based on CPUE; not determined Default Soft Limit: 20% B_0 Default Hard Limit: 10% B_0 For ESA, Overfishing threshold is F_{MSY} For commercially fished area, Overfishing threshold is F_{MSY} proxy based on relative exploitation rate; not determined
Status in relation to Target	For total ESA: Likely (> 60%) to be at or above For fished area: Unknown
Status in relation to Limits	For ESA, Soft Limit: Very Unlikely (< 10%) to be below For ESA, Hard Limit: Very Unlikely (< 10%) to be below
Status in relation to Overfishing	For ESA: Unlikely (< 40%) to be overfishing For fished area: Unknown

Historical Stock Status Trajectory and Current Status



Standardised CPUE for longfin eels in Hauraki (AC) from 1990–91 to 2017–18 (from Beentjes 2020). Also shown is the total estimated core fisher longfin catch in AC from ECERs. Vertical dashed line indicates when the 4 kg maximum size was introduced in 2007–08 after which longfin eels 4 kg and over are not recorded on ECERs. Error bars are 95% confidence intervals. Before 2002, 16% of the catch was recorded as EEU (unidentified) and these catches are omitted.



Annual relative exploitation rate for longfin eels in the Hauraki (AC). Because some catch of longfin was reported as EEU (unidentified) and has not been allocated to species, the exploitation rate is likely to have been higher than shown before 2002.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Steep decline in CPUE to 2000–01, and then without trend/stable to 2017–18
Recent Trend in Fishing intensity or Proxy	The relative exploitation rate has declined steeply since 2012 and in 2018 was well below the average for the series.
Other Abundance Indices	-

Trends in Other Relevant Indicators or Variables	Catches of longfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	For ESA, Soft Limit: Very Unlikely (< 10%) if catch remains at current levels For ESA, Hard Limit: Very Unlikely (< 10%) if catch remains at current levels
Probability of Current Catch or TACC causing Overfishing to continue or to commence	For ESA, Unlikely (< 40%) if catch remains at current levels

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2020	Next assessment: 2023
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series and increased escape tube size from 25 mm to 31 mm in 2012–13 • Failure of some fishers to record on ECE returns all legal-size eels caught, not just those retained • Unrecorded release of > 4 kg eels since 2007–08	

Qualifying Comments

Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series.

The proportion of current longfin habitat in Hauraki (Statistical Area AC) fished commercially during the period 2009–10 and 2013–14 is estimated at 50% (Table 15). The proportion of virgin habitat impacted by hydro dams, commercial fishing, and other anthropogenic activity was estimated to be 55%.

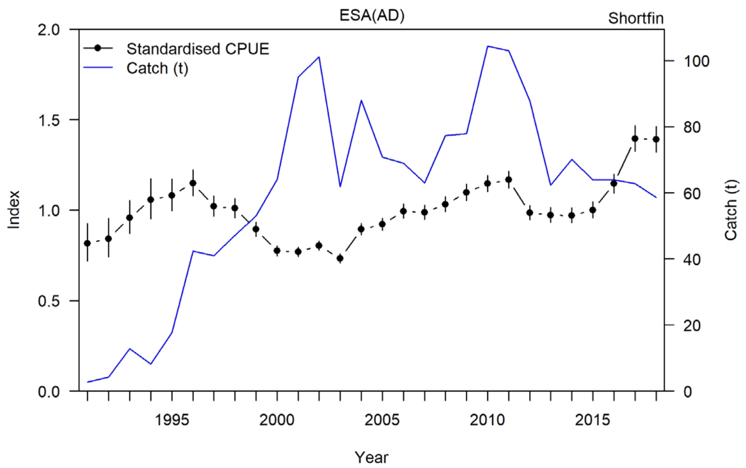
Fishery Interactions

Bycatch of other species in the commercial Hauraki eel fishery includes mainly catfish, with lesser quantities of koi carp, goldfish, kōura, grey mullet, and yellowbelly flounder. Most bycatch species are usually returned alive.

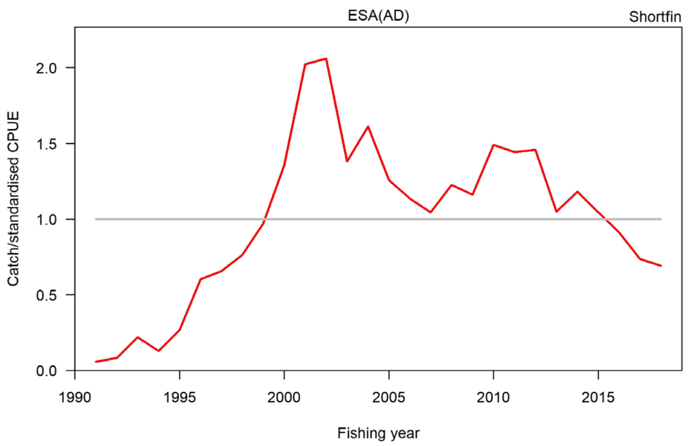
- **Waikato (AD) shortfin**

Stock Status		
Most Recent Assessment Plenary Publication Year	2020	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE on positive catch	
Reference Points	Target: B_{MSY} proxy based on CPUE; not determined Default Soft Limit: 20% B_0 Default Hard Limit: 10% B_0 Overfishing threshold: F_{MSY} proxy based on relative exploitation rate; not determined	
Status in relation to Target	Unknown	
Status in relation to Limits	Soft Limit: Unknown Hard Limit: Unknown	
Status in relation to Overfishing	Unknown	

Historical Stock Status Trajectory and Current Status



Standardised CPUE for shortfin eels in Waikato (AD) from 1990–91 to 2017–18 (from Beentjes 2020). Also shown is the total estimated core fisher shortfin catch in AD from ECERs. Error bars are 95% confidence intervals. Before 2002, 71% of the catch was recorded as EEU (unidentified) and these catches are omitted.



Annual relative exploitation rate for shortfin eels in the Waikato (AD). Because considerable catch of shortfin was reported as EEU (unidentified) and has not been allocated to species, the exploitation rate is likely to have been much higher than shown before 2002.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	No long-term trend in CPUE until 2003, after which it increased, most steeply in the last three years.
Recent Trend in Fishing intensity or Proxy	The relative exploitation rate has declined since 2009 and in 2018 was below the series mean.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of shortfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2020	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series and increased escape tube size from 25 mm to 31 mm in 2012–13 • Failure of some fishers to record on ECE returns all legal-sized eels caught, not just those retained	

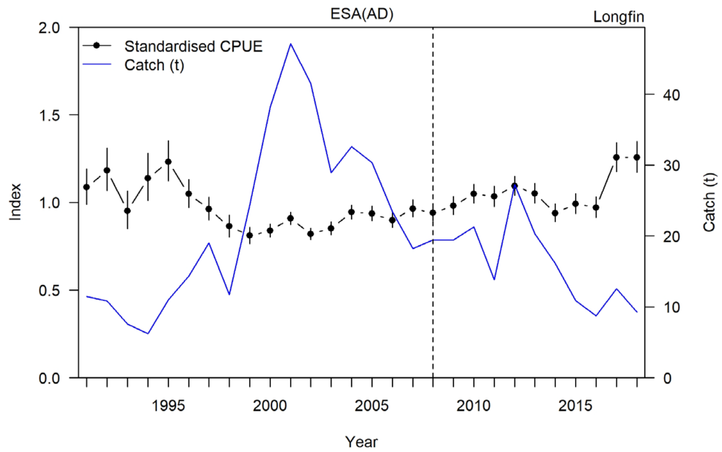
Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series.

Fishery Interactions
Bycatch of other species in the commercial Waikato eel fishery includes large quantities of catfish and koi carp, as well as goldfish, rudd, kōura, brown trout, perch, and kōkopu. Most bycatch species are usually returned alive.

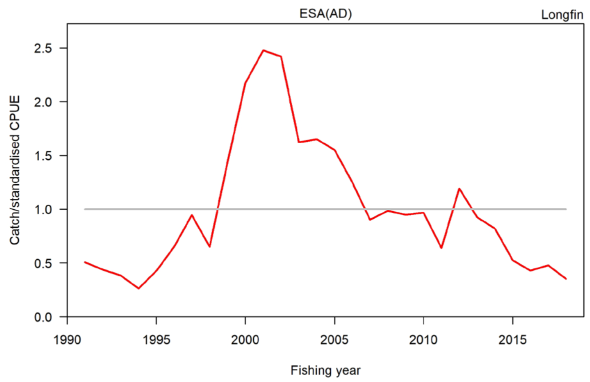
- **Waikato (AD) longfin**

Stock Status		
Most Recent Assessment Plenary Publication Year	2020	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE on positive catch	
Reference Points	For ESA, Interim Target is 40% B_0 For commercially fished area, Target is B_{MSY} proxy based on CPUE; not determined Default Soft Limit: 20% B_0 Default Hard Limit: 10% B_0 For ESA, Overfishing threshold is F_{MSY} For commercially fished area, Overfishing threshold is F_{MSY} proxy based on relative exploitation rate; not determined	
Status in relation to Target	For total ESA: Likely (> 60%) to be at or above For fished area: Unknown	
Status in relation to Limits	For ESA, Soft Limit: Very Unlikely (< 10%) to be below For ESA, Hard Limit: Very Unlikely (< 10%) to be below	
Status in relation to Overfishing	For ESA: Unlikely (< 40%) to be overfishing For fished area: Unknown	

Historical Stock Status Trajectory and Current Status



Standardised CPUE for longfin eels in Waikato (AD) from 1990–91 to 2017–18 (from Beentjes 2020). Also shown is the total estimated core fisher longfin catch in AD from ECERs. Vertical dashed line indicates when the 4 kg maximum size was introduced in 2007–08 after which longfin eels 4 kg and over are not recorded on ECERs. Error bars are 95% confidence intervals. Before 2002, 71% of the catch was recorded as EEU (unidentified) and these catches are omitted.



Annual relative exploitation rate for longfin eels in the Waikato (AD). Because considerable catch of longfin was reported as EEU (unidentified) and has not been allocated to species, the exploitation rate is likely to have been much higher than shown before 2002.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	A moderate decline in CPUE to 1998, and then a gradual increase, steepest in the last two years to around the level of the former peak.
Recent Trend in Fishing intensity or Proxy	The relative exploitation rate has declined steeply since 2002 and in 2018 was well below the series mean.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of longfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	For ESA, Soft Limit: Very Unlikely (< 10%) if catch remains at current levels For ESA, Hard Limit: Very Unlikely (< 10%) if catch remains at current levels
Probability of Current Catch or TACC causing Overfishing to continue or to commence	For ESA, Unlikely (< 40%) if catch remains at current levels

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2020	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series and increased escape tube size from 25 mm to 31 mm in 2012–13 • Failure of some fishers to record on ECE returns all legal-sized eels caught, not just those retained • Unrecorded release of > 4 kg eels since 2007–08	

Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series.

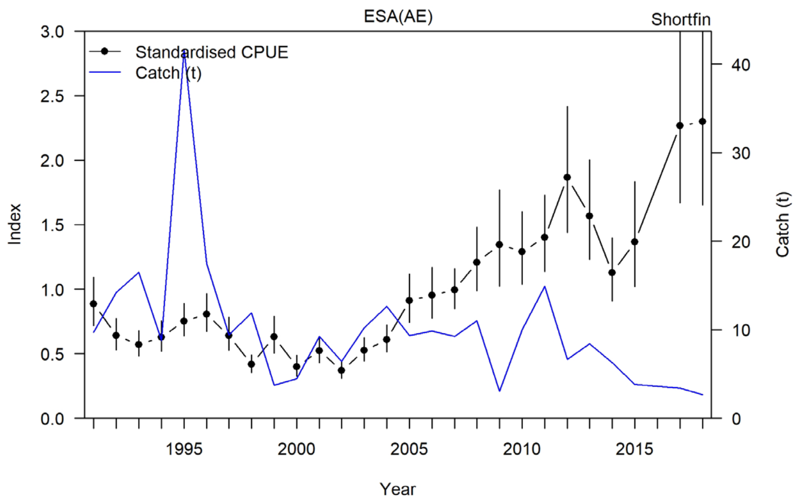
The proportion of current longfin habitat in Waikato (Statistical Area AD) fished commercially during the period 2009–10 and 2013–14 is estimated at 43% (Table 15). The proportion of virgin habitat impacted by hydro dams, commercial fishing, and other anthropogenic activity was estimated to be 56%.

Fishery Interactions
Bycatch of other species in the commercial Waikato eel fishery includes large quantities of catfish and koi carp, as well as goldfish, rudd, kōura, brown trout, perch, and kōkopu. Most bycatch species are usually returned alive.

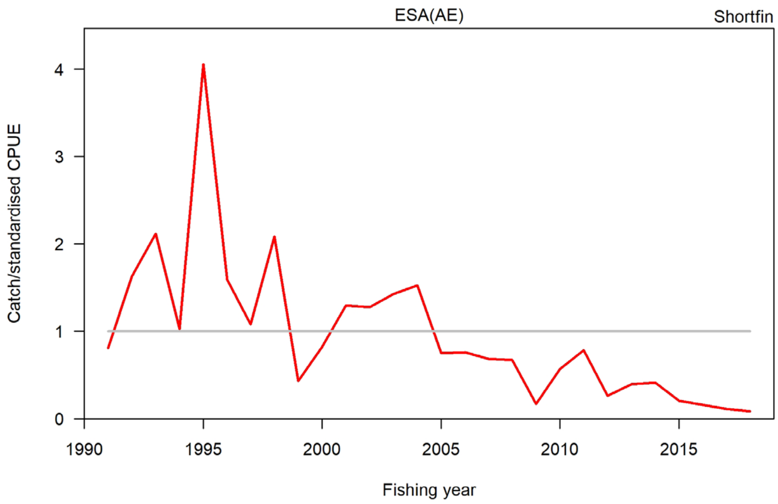
- **Bay of Plenty (AE) shortfin**

Stock Status		
Most Recent Assessment Plenary Publication Year	2020	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE on positive catch	
Reference Points	Target: B_{MSY} proxy based on CPUE; not determined Default Soft Limit: 20% B_0 Default Hard Limit: 10% B_0 Overfishing threshold: F_{MSY} proxy based on relative exploitation rate; not determined	
Status in relation to Target	Unknown	
Status in relation to Limits	Soft Limit: Unknown Hard Limit: Unknown	
Status in relation to Overfishing	Unknown	

Historical Stock Status Trajectory and Current Status



Standardised CPUE for shortfin eels in Bay of Plenty (AE) from 1990–91 to 2017–18 (from Beentjes 2020). Also shown is the total estimated core fisher shortfin catch in AE from ECERs. Error bars are 95% confidence intervals. Before 2000, 13% of the catch was recorded as EEU (unidentified) and these catches are omitted.



Annual relative exploitation rate for shortfin eels in the Bay of Plenty (AE). Because some catch of shortfin was reported as EEU (unidentified) and has not been allocated to species, the exploitation rate is likely to have been higher than shown before 2000.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	No trend in CPUE until 2002, after which it increases steeply to a peak in 2018.
Recent Trend in Fishing intensity or Proxy	Relative exploitation rate has declined since 2002, and in 2018 was well below the series mean.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of shortfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2020	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000	

	• Exclusion of zero catches • Changes in MLS and retention in early parts of the series and increased escape tube size from 25 mm to 31 mm in 2012–13 • Failure of some fishers to record on ECE returns all legal-sized eels caught, not just those retained

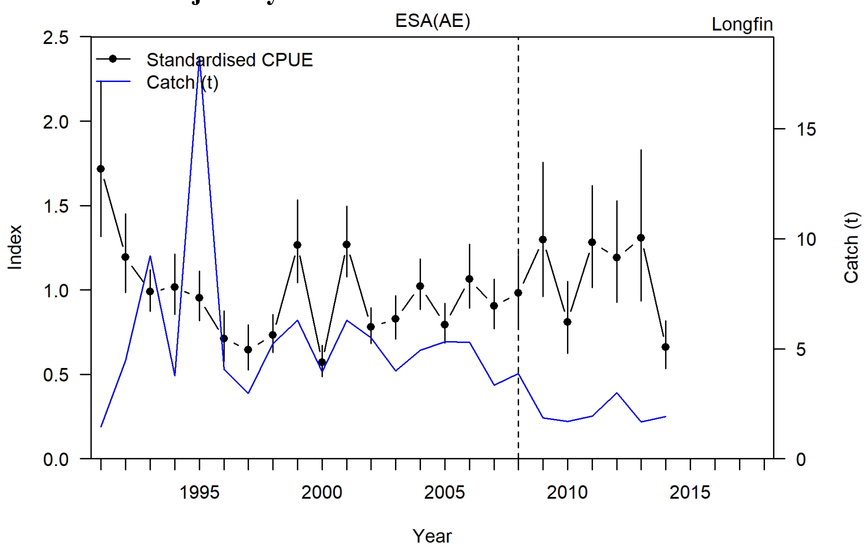
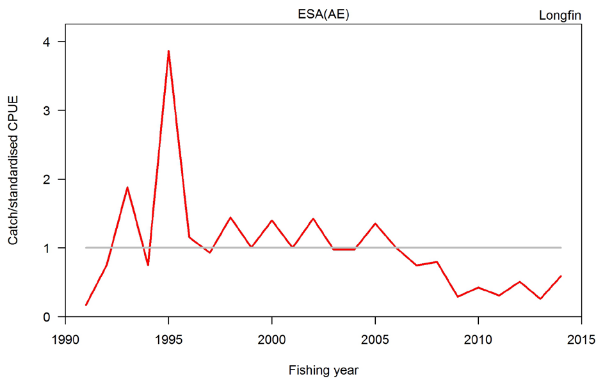
Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series.

Fishery Interactions
Bycatch of other species in the commercial Bay of Plenty eel fishery includes very small quantities of goldfish and bullies. Most bycatch species are usually returned alive.

- **Bay of Plenty (AE) longfin**

Stock Status		
Most Recent Assessment Plenary Publication Year	2020	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE on positive catch	
Reference Points	For ESA, Interim Target is 40% B_0 For commercially fished area, Target is B_{MSY} proxy based on CPUE; not determined Default Soft Limit: 20% B_0 Default Hard Limit: 10% B_0 For ESA, Overfishing threshold is F_{MSY} For commercially fished area, Overfishing threshold is F_{MSY} proxy based on relative exploitation rate; not determined	

Status in relation to Target	For total ESA: Likely (> 60%) to be at or above For fished area: Unknown
Status in relation to Limits	For ESA, Soft Limit: Very Unlikely (< 10%) to be below For ESA, Hard Limit: Very Unlikely (< 10%) to be below
Status in relation to Overfishing	For ESA: Unlikely (< 40%) to be overfishing For fished area: Unknown

Historical Stock Status Trajectory and Current Status

Standardised CPUE for longfin eels in Bay of Plenty (AE) from 1990–91 to 2017–18 (from Beentjes 2020). Also shown is the total estimated core fisher longfin catch in AE from ECERs. Vertical dashed line indicates when the 4 kg maximum size was introduced in 2007–08 after which longfin eels 4 kg and over are not recorded on ECERs. Error bars are 95% confidence intervals. Before 2000, 13% of the catch was recorded as EEU (unidentified) and these catches are omitted.

Annual relative exploitation rate for longfin eels in the Bay of Plenty (AE). Because some catch of longfin was reported as EEU (unidentified) and has not been allocated to species, the exploitation rate is likely to have been higher than shown before 2000.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	A steep decline in CPUE to 2000, and then variable with no clear trend. Insufficient data to produce indices after 2013–14.
Recent Trend in Fishing intensity or Proxy	The relative exploitation rate has declined since 2005, and since 2007 has been below the series mean. Insufficient data to produce exploitation rate after 2013–14.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of longfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	For ESA, Soft Limit: Very Unlikely (< 10%) if catch remains at current levels For ESA, Hard Limit: Very Unlikely (< 10%) if catch remains at current levels

Probability of Current Catch or TACC causing Overfishing to continue or to commence	For ESA, Unlikely (< 40%) if catch remains at current levels

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2020	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series and increased escape tube size from 25 mm to 31 mm in 2012–13 • Failure of some fishers to record on ECE returns all legal-size eels caught, not just those retained • Unrecorded release of > 4 kg eels since 2007–08	

Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series. The proportion of current longfin habitat in Bay of Plenty (Statistical Area AE) fished commercially during the period 2009–10 and 2013–14 is estimated at 17% (Table 15). The proportion of virgin habitat impacted by hydro dams, commercial fishing, and other anthropogenic activity was estimated to be 24%.

Fishery Interactions
Bycatch of other species in the commercial Bay of Plenty eel fishery includes very small quantities of goldfish and bullies. Most bycatch species are usually returned alive.

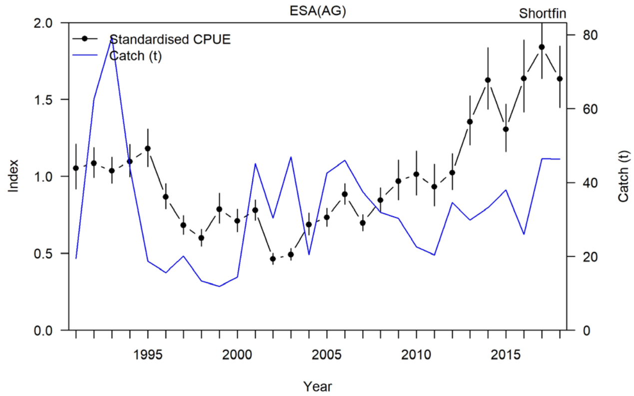
QMA SFE 22 and LFE 22 (includes ESAs AG, AK, AL and AM)

- **Hawke's Bay (AG) shortfin**

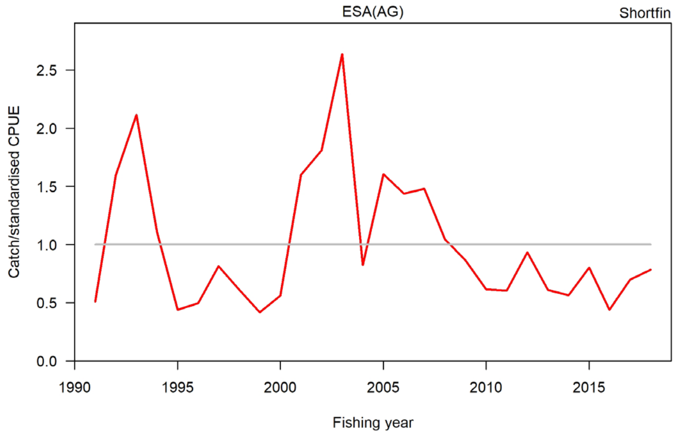
Stock Status		
Most Recent Assessment Plenary Publication Year	2020	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE on positive catch	
Reference Points	Target: B_{MSY} proxy based on CPUE; not determined	

	Default Soft Limit: 20% B_0 Default Hard Limit: 10% B_0 Overfishing threshold: F_{MSY} proxy based on relative exploitation rate; not determined
Status in relation to Target	Unknown
Status in relation to Limits	Soft Limit: Unknown Hard Limit: Unknown
Status in relation to Overfishing	Unknown

Historical Stock Status Trajectory and Current Status



Standardised CPUE for shortfin eels in Hawke's Bay (AG) from 1990–91 to 2017–18 (from Beentjes 2020). Also shown is the total estimated core fisher shortfin catch in AG from ECERs. Error bars are 95% confidence intervals. Before 2001, 5% of the catch was recorded as EEU (unidentified) and these catches are omitted.



Annual relative exploitation rate for shortfin eels in the Hawke's Bay (AG). Because some catch of shortfin was reported as EEU (unidentified) and has not been allocated to species, the exploitation rate is likely to have been higher than shown before 2001.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	CPUE declined until 2002, followed by a steep increase to well above the previous peak in 1995.
Recent Trend in Fishing intensity or Proxy	The relative exploitation rate has declined since 2007 and from 2009 has been below the series mean.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of shortfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under current catch levels

Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2020	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series and increased escape tube size from 25 mm to 31 mm in 2012–13 • Failure of some fishers to record on ECE returns all legal-sized eels caught, not just those retained	

Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series.

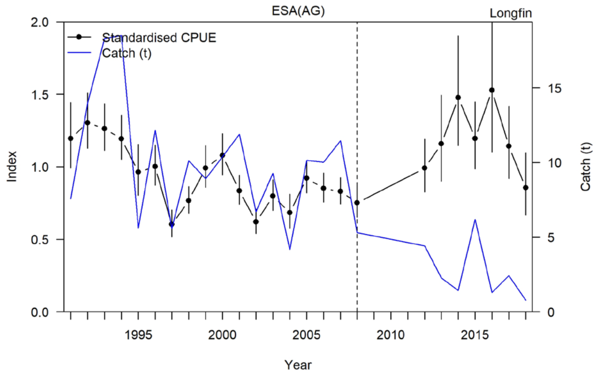
Fishery Interactions
Bycatch of other species in the commercial Hawke's Bay eel fishery includes mostly goldfish and small quantities of brown trout. Most bycatch species are usually returned alive.

- **Hawke's Bay (AG) longfin**

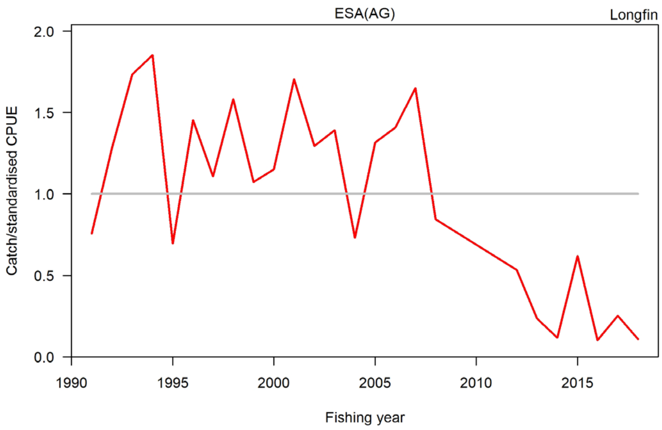
Stock Status		
Most Recent Assessment Plenary Publication Year	2020	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE on positive catch	
Reference Points	For ESA, Interim Target is 40% B_0 For commercially fished area, Target is B_{MSY} proxy based on CPUE; not determined Default Soft Limit: 20% B_0 Default Hard Limit: 10% B_0 For ESA, Overfishing threshold is F_{MSY}	

	For commercially fished area, Overfishing threshold is F_{MSY} proxy based on relative exploitation rate; not determined
Status in relation to Target	For total ESA: Likely (> 60%) to be at or above For fished area: Unknown
Status in relation to Limits	For ESA, Soft Limit: Very Unlikely (< 10%) to be below For ESA, Hard Limit: Very Unlikely (< 10%) to be below
Status in relation to Overfishing	For ESA: Unlikely (< 40%) to be overfishing For fished area: Unknown

Historical Stock Status Trajectory and Current Status



Standardised CPUE for longfin eels in Hawke's Bay (AG) from 1990–91 to 2017–18 (from Beentjes 2020). Also shown is the total estimated core fisher longfin catch in AG from ECERs. Vertical dashed line indicates when the 4 kg maximum size was introduced in 2007–08 after which longfin eels 4 kg and over are not recorded on ECERs. Error bars are 95% confidence intervals. Before 2001, 5% of the catch was recorded as EEU (unidentified) and these catches are omitted.



Annual relative exploitation rate for longfin eels in the Hawke's Bay (AG). Because some catch of longfin was reported as EEU (unidentified) and has not been allocated to species, the exploitation rate is likely to have been higher than shown before 2001.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	CPUE declined until 1997, was stable until 2008 and then increased until 2015–16, declining steeply in the last two years.
Recent Trend in Fishing intensity or Proxy	The relative exploitation rate has declined steeply since 2007, and in 2018 was well below the series mean.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of longfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under

	current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	For ESA, Soft Limit: Very Unlikely (< 10%) if catch remains at current levels For ESA, Hard Limit: Very Unlikely (< 10%) if catch remains at current levels
Probability of Current Catch or TACC causing Overfishing to continue or to commence	For ESA, Unlikely (< 40%) if catch remains at current levels

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2020	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series and increased escape tube size from 25 mm to 31 mm in 2012–13 • Failure of some fishers to record on ECE returns all legal-sized eels caught, not just those retained • Unrecorded release of > 4 kg eels since 2007–08	

Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series. The proportion of current longfin habitat in Hawke's Bay (Statistical Area AG) fished commercially during the period 2009–10 and 2013–14 is estimated at 17% (Table 15). The proportion of virgin habitat impacted by hydro dams, commercial fishing, and other anthropogenic activity was estimated to be 25%.

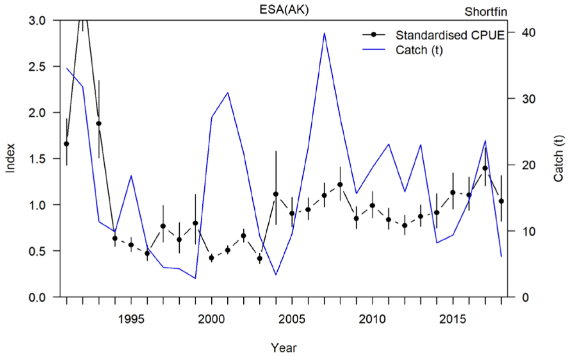
Fishery Interactions
Bycatch of other species in the commercial Hawke's Bay eel fishery includes mostly goldfish and small quantities of brown trout. Most bycatch species are usually returned alive.

- **Manawatu (AK) shortfin**

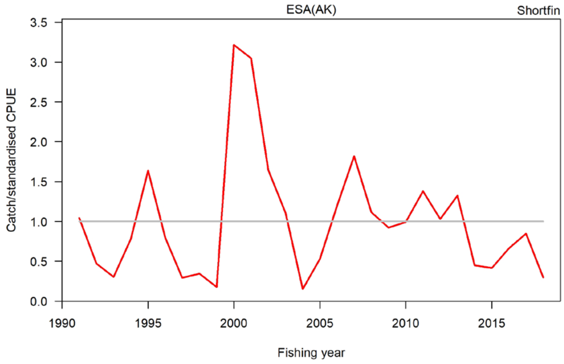
Stock Status	
Most Recent Assessment Plenary Publication Year	2020

Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE on positive catch	
Reference Points	Target: B_{MSY} proxy based on CPUE; not determined Default Soft Limit: 20% B_0 Default Hard Limit: 10% B_0 Overfishing threshold: F_{MSY} proxy based on relative exploitation rate; not determined	
Status in relation to Target	Unknown	
Status in relation to Limits	Soft Limit: Unknown Hard Limit: Unknown	
Status in relation to Overfishing	Unknown	

Historical Stock Status Trajectory and Current Status



Standardised CPUE for shortfin eels in Manawatu (AK) from 1990–91 to 2017–18 (from Beentjes 2020). Also shown is the total estimated core fisher shortfin catch in AK from ECERs. Error bars are 95% confidence intervals. Before 2001, 56% of the catch was recorded as EEU (unidentified) and these catches are omitted.



Annual relative exploitation rate for shortfin eels in the Manawatu (AK). Because some catch of shortfin was reported as EEU (unidentified) and has not been allocated to species, the exploitation rate is likely to have been higher than shown before 2001.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	CPUE dropped markedly from 1992 to 1994, was stable until an increase in 2004, and has since fluctuated without a long-term trend.
Recent Trend in Fishing intensity or Proxy	The relative exploitation rate has declined since 2013, and in 2018 was below the series mean.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of shortfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under

	current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2020	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series and increased escape tube size from 25 mm to 31 mm in 2012–13 • Failure of some fishers to record on ECE returns all legal-sized eels caught, not just those retained	

Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series.

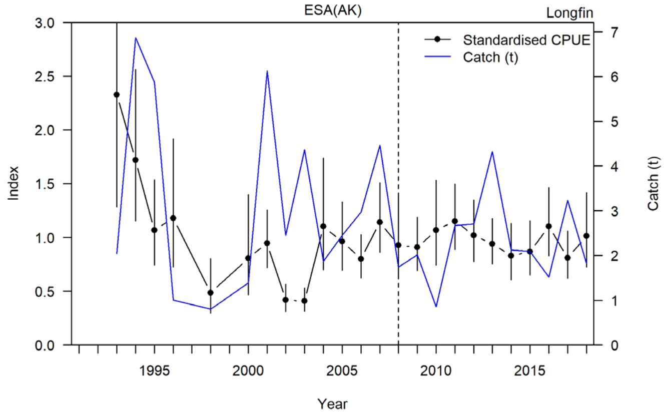
Fishery Interactions
Bycatch in the commercial Manawatu eel fishery include small quantities of koi carp, black flounder, yellowbelly flounder, and perch. Most bycatch species are usually returned alive.

- **Manawatu (AK) longfin**

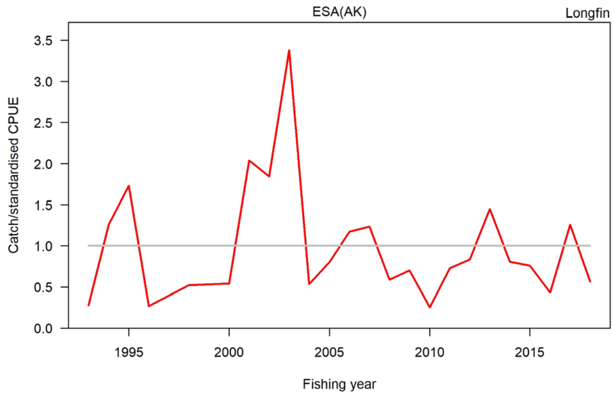
Stock Status		
Most Recent Assessment Plenary Publication Year	2020	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE on positive catch	
Reference Points	For ESA, Interim Target is 40% B_0 For commercially fished area, Target is B_{MSY} proxy based on CPUE; not determined Default Soft Limit: 20% B_0 Default Hard Limit: 10% B_0	

	For ESA, Overfishing threshold is F_{MSY} For commercially fished area, Overfishing threshold is F_{MSY} proxy based on relative exploitation rate; not determined
Status in relation to Target	For total ESA: Likely (> 60%) to be at or above For fished area: Unknown
Status in relation to Limits	For ESA, Soft Limit: Very Unlikely (< 10%) to be below For ESA, Hard Limit: Very Unlikely (< 10%) to be below
Status in relation to Overfishing	For ESA: Unlikely (< 40%) to be overfishing For fished area: Unknown

Historical Stock Status Trajectory and Current Status



Standardised CPUE for longfin eels in Manawatu (AK) from 1990–91 to 2017–18 (from Beentjes 2020). Also shown is the total estimated core fisher longfin catch in AK from ECERs. Vertical dashed line indicates when the 4 kg maximum size was introduced in 2007–08 after which longfin eels 4 kg and over are not recorded on ECERs. Error bars are 95% confidence intervals. Before 2001, 56% of the catch was recorded as EEU (unidentified) and these catches are omitted.



Annual relative exploitation rate for longfin eels in the Manawatu (AK). Because some catch of longfin was reported as EEU (unidentified) and has not been allocated to species, the exploitation rate is likely to have been higher than shown before 2001.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	CPUE declined steeply until 2003, increased in 2004, and has fluctuated without trend since then.
Recent Trend in Fishing intensity or Proxy	The relative exploitation rate has fluctuated around the series mean since 2003 and in 2018 was below the series mean.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of longfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under

	current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	For ESA, Soft Limit: Very Unlikely (< 10%) if catch remains at current levels For ESA, Hard Limit: Very Unlikely (< 10%) if catch remains at current levels
Probability of Current Catch or TACC causing Overfishing to continue or to commence	For ESA, Unlikely (< 40%) if catch remains at current levels

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2020	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series and increased escape tube size from 25 mm to 31 mm in 2012–13 • Failure of some fishers to record on ECE returns all legal-sized eels caught, not just those retained • Unrecorded release of > 4 kg eels since 2007–08	

Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series. The proportion of current longfin habitat in Manawatu (Statistical Area AK) fished commercially during the period 2009–10 and 2013–14 is estimated at 36% (Table 15). The proportion of virgin habitat impacted by hydro dams, commercial fishing, and other anthropogenic activity was estimated to be 41%.

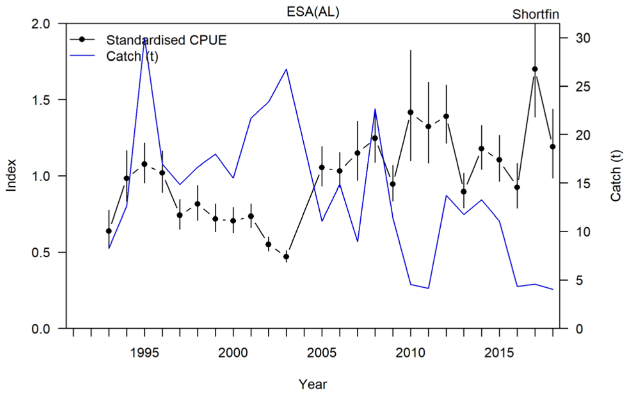
Fishery Interactions
Bycatch in the commercial Manawatu eel fishery include small quantities of koi carp, black flounder, yellowbelly flounder, and perch. Most bycatch species are usually returned alive.

- **Wairarapa (AL) shortfin**

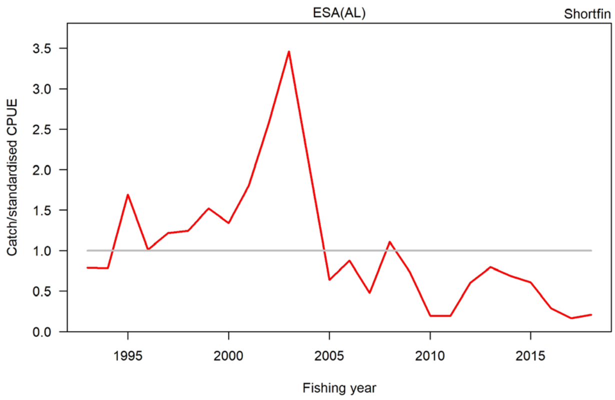
Stock Status	
Most Recent Assessment Plenary Publication Year	2020

Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE on positive catch	
Reference Points	Target: B_{MSY} proxy based on CPUE; not determined Default Soft Limit: 20% B_0 Default Hard Limit: 10% B_0 Overfishing threshold: F_{MSY} proxy based on relative exploitation rate; not determined	
Status in relation to Target	Unknown	
Status in relation to Limits	Soft Limit: Unknown Hard Limit: Unknown	
Status in relation to Overfishing	Unknown	

Historical Stock Status Trajectory and Current Status



Standardised CPUE for shortfin eels in Wairarapa (AL) from 1990–91 to 2017–18 (from Beentjes 2020). Also shown is the total estimated core fisher shortfin catch in AL from ECERs. Error bars are 95% confidence intervals. Before 1999, 33% of the catch was recorded as EEU (unidentified) and these catches are omitted.



Annual relative exploitation rate for shortfin eels in the Wairarapa (AL). Because some catch of shortfin was reported as EEU (unidentified) and has not been allocated to species, the exploitation rate is likely to have been higher than shown before 1999.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	CPUE declined from 1995 to 2003, increased in 2005, and has fluctuated without trend since then.
Recent Trend in Fishing intensity or Proxy	The relative exploitation rate declined steeply after 2003, and has been below the series mean since 2005.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of shortfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2020	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series and increased escape tube size from 25 mm to 31 mm in 2012–13 • Failure of some fishers to record on ECE returns all legal-sized eels caught, not just those retained	

Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series.

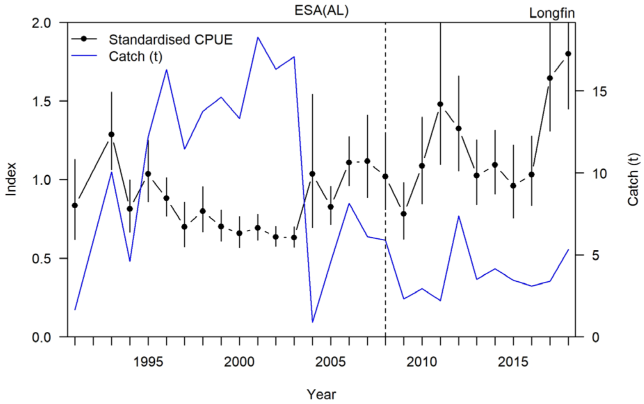
Fishery Interactions
Bycatch in the commercial Wairarapa eel fishery include mostly rudd and perch, with smaller quantities of flatfish and goldfish. Most bycatch species are usually returned alive.

- **Wairarapa (AL) longfin**

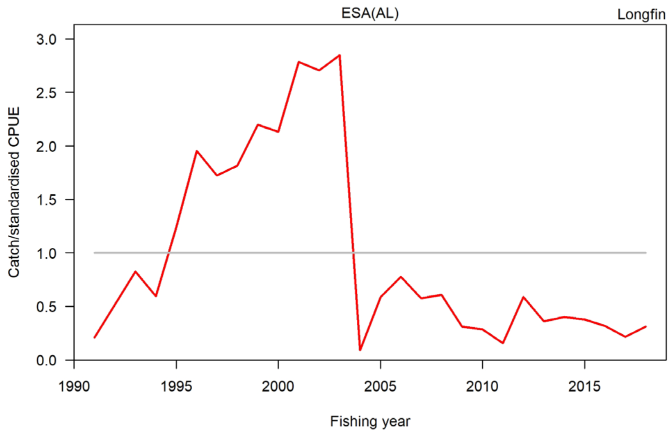
Stock Status		
Most Recent Assessment Plenary Publication Year	2020	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE on positive catch	
Reference Points	For ESA, Interim Target is 40% B_0 For commercially fished area, Target is B_{MSY} proxy based on CPUE; not determined	

	Default Soft Limit: 20% B_0 Default Hard Limit: 10% B_0 For ESA, Overfishing threshold is F_{MSY} For commercially fished area, Overfishing threshold is F_{MSY} proxy based on relative exploitation rate; not determined
Status in relation to Target	For total ESA: Likely (> 60%) to be at or above For fished area: Unknown
Status in relation to Limits	For ESA, Soft Limit: Very Unlikely (< 10%) to be below For ESA, Hard Limit: Very Unlikely (< 10%) to be below
Status in relation to Overfishing	For ESA: Unlikely (< 40%) to be overfishing For fished area: Unknown

Historical Stock Status Trajectory and Current Status



Standardised CPUE for longfin eels in Wairarapa (AL) from 1990–91 to 2017–18 (from Beentjes 2020). Also shown is the total estimated core fisher longfin catch in AL from ECERs. Vertical dashed line indicates when the 4 kg maximum size was introduced in 2007–08 after which longfin eels 4 kg and over are not recorded on ECERs. Error bars are 95% confidence intervals. Before 1999, 33% of the catch was recorded as EEU (unidentified) and these catches are omitted.



Annual relative exploitation rate for longfin eels in the Wairarapa (AL). Because some catch of longfin was reported as EEU (unidentified) and has not been allocated to species, the exploitation rate is likely to have been higher than shown before 1999.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	CPUE declined until 2003, increased in 2004, and fluctuated without trend until the last two years when CPUE increased steeply
Recent Trend in Fishing intensity or Proxy	The relative exploitation rate declined steeply after 2003, and has been below the series mean since 2005.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of longfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data

	begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	For ESA, Soft Limit: Very Unlikely (< 10%) if catch remains at current levels For ESA, Hard Limit: Very Unlikely (< 10%) if catch remains at current levels
Probability of Current Catch or TACC causing Overfishing to continue or to commence	For ESA, Unlikely (< 40%) if catch remains at current levels

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2020	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series and increased escape tube size from 25 mm to 31 mm in 2012–13 • Failure of some fishers to record on ECE returns all legal-sized eels caught, not just those retained • Unrecorded release of > 4 kg eels since 2007–08	

Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series. The proportion of current longfin habitat in Wairarapa (Statistical Area AL) fished commercially during the period 2009–10 and 2013–14 is estimated at 4% (Table 15) (Beentjes et al 2016). The proportion of virgin habitat impacted by hydro dams, commercial fishing, and other anthropogenic activity was estimated to be 5%.

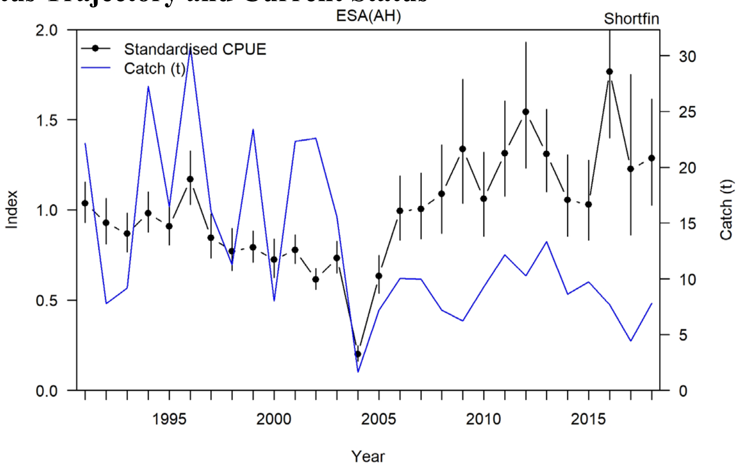
Fishery Interactions
There has been no recorded bycatch in the commercial Wairarapa eel fishery since 2000–01. Most bycatch species are usually returned alive.

QMA SFE 23 and LFE 23 (includes ESAs AH, AJ)

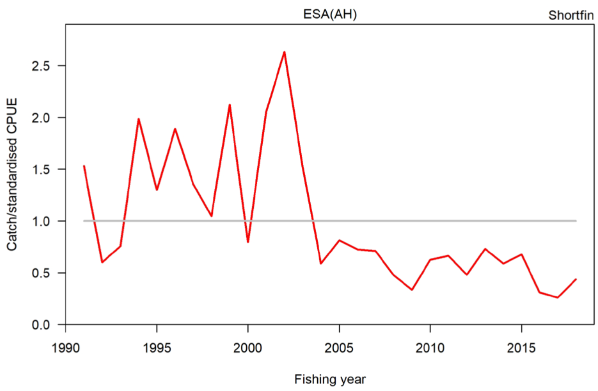
- **Rangitikei-Whanganui (AH) shortfin**

Stock Status		
Most Recent Assessment Plenary Publication Year	2020	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE on positive catch	
Reference Points	Target: B_{MSY} proxy based on CPUE; not determined Default Soft Limit: 20% B_0 Default Hard Limit: 10% B_0 Overfishing threshold: F_{MSY} proxy based on relative exploitation rate; not determined	
Status in relation to Target	Unknown	
Status in relation to Limits	Soft Limit: Unknown Hard Limit: Unknown	
Status in relation to Overfishing	Unknown	

Historical Stock Status Trajectory and Current Status



Standardised CPUE for shortfin eels in Rangitikei-Whanganui (AH) from 1990–91 to 2017–18 (from Beentjes 2020). Also shown is the total estimated core fisher shortfin catch in AH from ECERs. Error bars are 95% confidence intervals. Before 2001, 7% of the catch was recorded as EEU (unidentified) and these catches are omitted.



Annual relative exploitation rate for shortfin eels in the Rangitikei-Whanganui (AH). Because some catch of shortfin was reported as EEU (unidentified) and has not been allocated to species, the exploitation rate is likely to have been higher than shown before 2001.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	CPUE declined gradually until 2005, and then increased to well above the former peak.

Recent Trend in Fishing intensity or Proxy	The relative exploitation rate declined steeply after 2003, and has been below the series mean since 2004.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of shortfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2020	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series and increased escape tube size from 25 mm to 31 mm in 2012–13 • Failure of some fishers to record on ECE returns all legal-sized eels caught, not just those retained	

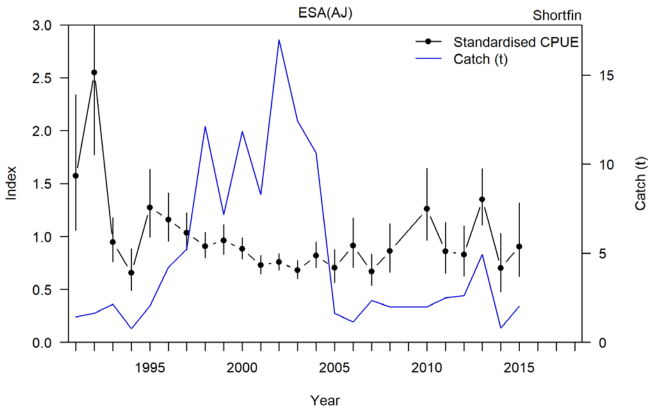
Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series.

Fishery Interactions
The only recorded bycatch in the commercial Rangitikei-Whanganui eel fishery since 2000–01 has been brown trout. Most bycatch species are usually returned alive.

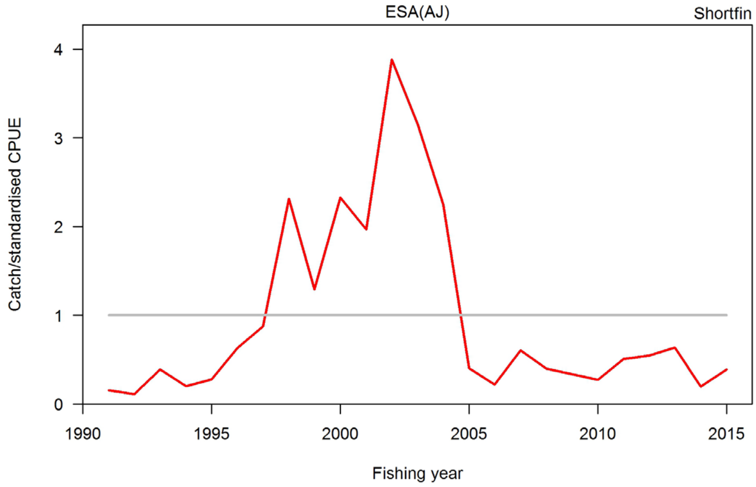
- **Taranaki (AJ) shortfin**

Stock Status		
Most Recent Assessment Plenary Publication Year	2020	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE on positive catch	
Reference Points	Target: B_{MSY} proxy based on CPUE; not determined Default Soft Limit: 20% B_0 Default Hard Limit: 10% B_0 Overfishing threshold: F_{MSY} proxy based on relative exploitation rate; not determined	
Status in relation to Target	Unknown	
Status in relation to Limits	Soft Limit: Unknown Hard Limit: Unknown	
Status in relation to Overfishing	Unknown	

Historical Stock Status Trajectory and Current Status



Standardised CPUE for shortfin eels in Taranaki (AJ) from 1990–91 to 2017–18 (from Beentjes 2020). Also shown is the total estimated core fisher shortfin catch in AJ from ECERs. Error bars are 95% confidence intervals. Before 2001, 16% of the catch was recorded as EEU (unidentified) and these catches are omitted.



Annual relative exploitation rate for shortfin eels in the Taranaki (AJ). Because some catch of shortfin was reported as EEU (unidentified) and has not been allocated to species, the exploitation rate is likely to have been higher than shown before 2001.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	CPUE declined to 2003, and then fluctuated without trend. There were insufficient data to generate indices after 2014–15.

Recent Trend in Fishing intensity or Proxy	Relative exploitation rate declined steeply after 2002, and has been below the series mean since 2005. There were insufficient data to generate relative exploitation rates after 2014–15.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of shortfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2020	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series and increased escape tube size from 25 mm to 31 mm in 2012–13 • Failure of some fishers to record on ECE returns all legal-sized eels caught, not just those retained	

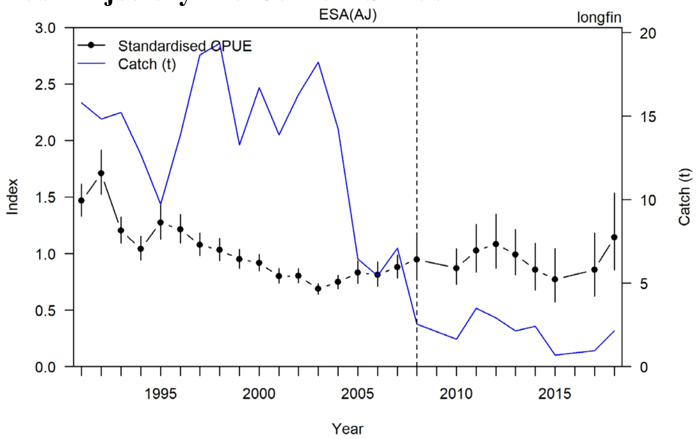
Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series.

Fishery Interactions
There has been no recorded bycatch in the commercial Taranaki eel fishery since 2000–01. Most bycatch species are usually returned alive.

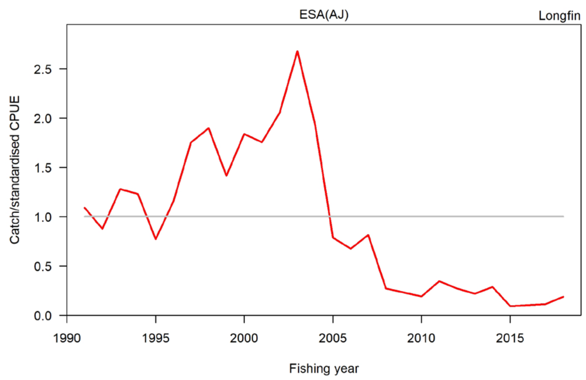
- **Taranaki (AJ) longfin**

Stock Status		
Most Recent Assessment Plenary Publication Year	2020	
Catch in most recent year of assessment	Year: -	Catch: -
Assessment Runs Presented	Standardised CPUE on positive catch	
Reference Points	For ESA, Interim Target is 40% B_0 For commercially fished area, Target is B_{MSY} proxy based on CPUE; not determined Default Soft Limit: 20% B_0 Default Hard Limit: 10% B_0 For ESA, Overfishing threshold is F_{MSY} For commercially fished area, Overfishing threshold is F_{MSY} proxy based on relative exploitation rate; not determined	
Status in relation to Target	For total ESA: Likely (> 60%) to be at or above For fished area: Unknown	
Status in relation to Limits	For ESA, Soft Limit: Very Unlikely (< 10%) to be below For ESA, Hard Limit: Very Unlikely (< 10%) to be below	
Status in relation to Overfishing	For ESA: Unlikely (< 40%) to be overfishing For fished area: Unknown	

Historical Stock Status Trajectory and Current Status



Standardised CPUE for longfin eels in Taranaki (AJ) from 1990–91 to 2017–18 (from Beentjes 2020). Also shown is the total estimated core fisher longfin catch in AJ from ECERs. Vertical dashed line indicates when the 4 kg maximum size was introduced in 2007–08 after which longfin eels 4 kg and over are not recorded on ECERs. Error bars are 95% confidence intervals. Before 2001, 16% of the catch was recorded as EEU (unidentified) and these catches are omitted.



Annual relative exploitation rate for longfin eels in the Taranaki (AJ). Because some catch of longfin was reported as EEU (unidentified) and has not been allocated to species, the exploitation rate is likely to have been higher than shown before 2001.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Moderate decline in CPUE until 2003, then fluctuating without trend.
Recent Trend in Fishing intensity or Proxy	The relative exploitation rate declined steeply after 2003 and in 2018 was well below the series mean.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Catches of longfin elvers at primary monitoring sites have fluctuated without trend since the series of reliable data begins in 1995–96, suggesting no overall trend in recruitment.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline in the medium term under current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	For ESA, Soft Limit: Very Unlikely (< 10%) if catch remains at current levels For ESA, Hard Limit: Very Unlikely (< 10%) if catch remains at current levels
Probability of Current Catch or TACC causing Overfishing to continue or to commence	For ESA, Unlikely (< 40%) if catch remains at current levels

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE based on positive catches from commercial fyke net	
Assessment Dates	Latest assessment Plenary publication year: 2020	Next assessment: 2023
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Standardised CPUE only provides an index of abundance for eels in areas fished by commercial fishers. Other potential issues with the CPUE indices include: • Low numbers of fishers • Uncertainty in target species after 2000 • Exclusion of zero catches • Changes in MLS and retention in early parts of the series and increased escape tube size from 25 mm to 31 mm in 2012–13 • Failure of some fishers to record on ECE returns all legal-sized eels caught, not just those retained • Unrecorded release of > 4 kg eels since 2007–08	

Qualifying Comments
Because the commercial eel fishery has had a long history (beginning in the late 1960s), and indices of abundance are only available from the early 1990s, it is difficult to infer stock status from recent abundance trends, and these should therefore be interpreted with caution. Other sources of mortality, such as habitat alteration (historical and current), have also reduced abundance prior to the CPUE series. The proportion of current longfin habitat in Taranaki (Statistical Area AJ) fished commercially during the period 2009–10 and 2013–14 is estimated at 17% (Table 15). The proportion of virgin habitat impacted by hydro dams, commercial fishing, and other anthropogenic activity was estimated to be 24%.

Fishery Interactions
There has been no recorded bycatch in the commercial Taranaki eel fishery since 2000–01. Most bycatch species are usually returned alive.

6. FOR FURTHER INFORMATION

Beentjes, M P (1998) Enhancement of Lake Hawea eel stocks by transfer of juveniles. *NIWA Technical Report 41*. 15 p.

Beentjes, M P (1999) Size, age, and species composition of South Island commercial eel catches from market sampling (1997–98). *NIWA Technical Report 51*. 51 p.

Beentjes, M P (2005) Monitoring commercial eel fisheries in 2003–04. *New Zealand Fisheries Assessment Report 2005/39*. 57 p.

Beentjes, M P (2008) Monitoring commercial eel fisheries in 2003–04 and 2004–05. *New Zealand Fisheries Assessment Report 2008/19*. 43 p.

Beentjes, M P (2011) Monitoring commercial eel fisheries in 2007–08 and 2008–09. *New Zealand Fisheries Assessment Report 2011/50*.

Beentjes, M P (2013) Monitoring commercial eel fisheries: 2009–10 to 2011–12. *New Zealand Fisheries Assessment Report 2013/47*. 76 p.

Beentjes, M P (2016) Monitoring commercial eel fisheries: 2003–04 to 2014–15. *New Zealand Fisheries Assessment Report 2016/50*. 83 p.

Beentjes, M P (2019) Monitoring commercial eel fisheries: 2015–16 to 2017–18. *New Zealand Fisheries Assessment Report 2019/92*. 83 p.

Beentjes, M P (2020) Catch per unit effort (CPUE) analyses and characterisation of the North Island commercial freshwater eel fishery, 1990–91 to 2017–18. *New Zealand Fisheries Assessment Report2020/24*. 258 p.

Beentjes, M P (2021) Catch per unit effort (CPUE) analyses and characterisation of the South Island commercial freshwater eel fishery, 1990–91 to 2018–19. *New Zealand Fisheries Assessment Report 2021/50.* 193 p.

Beentjes, M P; Boubée, J A T; Jellyman, D J; Graynoth, E (2005) Non-fishing mortality of freshwater eels (*Anguilla* spp.). *New Zealand Fisheries Assessment Report 2005/34*. 38 p.

Beentjes, M P; Bull, B (2002) CPUE analyses of the commercial freshwater eel fishery. *New Zealand Fisheries Assessment Report 2002/18*. 55 p.

Beentjes, M P; Chisnall, B L (1997) Trends in size and species composition and distribution of commercial eel catches. *New Zealand Fisheries Data Report No. 89*. 71 p.

Beentjes, M P; Chisnall, B L (1998) Size, age, and species composition of commercial eel catches from market sampling, 1996–97. *NIWA Technical Report No. 29*. 124 p.

Beentjes, M P; Chisnall, B L; Boubee, J A; Jellyman, D J (1997) Enhancement of the New Zealand eel fishery by elver transfers. *New Zealand Fisheries Technical Report No. 45*. 44 p.

Beentjes, M P; Dunn, A (2003) CPUE analysis of the commercial freshwater eel fishery in selected areas, 1990–91 to 2000–01. *New Zealand Fisheries Assessment Report 2003/54*. 47 p.

Beentjes, M P; Dunn, A (2008) Catch per unit effort (CPUE) analyses of the South Island commercial freshwater eel fishery, 1990–91 to 2005–06. *New Zealand Fisheries Assessment Report 2008/51*. 109 p.

Beentjes, M P; Dunn, A (2010) CPUE analyses of the North Island commercial freshwater eel fishery, 1990–91 to 2006–07. *New Zealand Fisheries Assessment Report 2010/5*. 101 p.

Beentjes, M P; Dunn, A (2013a) Catch per unit effort (CPUE) analyses and characterisation of the South Island commercial freshwater eel fishery, 1990–91 to 2009–10. *New Zealand Fisheries Assessment Report 2013/11*. 211 p.

Beentjes, M P; Dunn, A (2013b) Catch per unit effort (CPUE) analyses and characterisation of the North Island commercial freshwater eel fishery, 1990–91 to 2011–12. *New Zealand Fisheries Assessment Report 2013/62*. 292 p.

Beentjes, M P; Dunn, A (2014) Catch per unit effort (CPUE) analyses and characterisation of Te Waihora commercial freshwater eel fishery, 1990–91 to 2011–12 *New Zealand Fisheries Assessment Report 2014/17.* 46 p.

Beentjes, M P; Dunn, A (2015) Catch per unit effort (CPUE) analyses and characterisation of the South Island commercial freshwater eel fishery, 1990–91 to 2012–13. *New Zealand Fisheries Assessment Report 2015/30*. 177 p.

Beentjes, M P; Jellyman, D J (2002) Evaluation of eel enhancement in Coopers Lagoon, South Canterbury. *New Zealand Fisheries Assessment Report 2002/7.* 18 p.

Beentjes, M P; Jellyman, D J (2003) Enhanced growth of longfin eels, *Anguilla dieffenbachii*, transplanted into Lake Hawea, a high country lake in South Island, New Zealand. *New Zealand Journal of Marine and Freshwater Research 37*: 1–11.

Beentjes, M P; Jellyman, D J (2011) Evaluation of the 1998 transfer of juvenile longfin eels into Lake Hawea from recaptures, and ageing validation based on otolith annual ring deposition. *New Zealand Fisheries Assessment Report 2011/19*. 37 p.

Beentjes, M P; McKenzie, A (2017) Catch per unit effort (CPUE) analyses and characterisation of the North Island commercial freshwater eel fishery, 1990–91 to 2014–15. *New Zealand Fisheries Assessment Report 2017/61*.

Beentjes, M P; Sykes, J; Crow, S K (2016) GIS mapping of the longfin eel commercial fishery throughout New Zealand, and estimates of longfin habitat and proportion fished. *New Zealand Fisheries Assessment Report 2016/32*. 53 p.

Boubée, J; Hudson, N (2009) Assessment of the state of the Rangitaiki River within Ngati Manawa rohe. NIWA client report HAM2009-100. 350 p.

Chisnall, B L (2000) Enhancement of Maori customary eel fisheries in Lakes Taharoa and Harihari by transfer of juveniles. *NIWA Technical Report 91*. 16 p.

Chisnall, B L; Beentjes, M P; Boubee, J A T; West, D W (1998) Enhancement of the New Zealand Eel Fisheries by transfers of elvers, 1996–97. *NIWA Technical Report 37*. 55 p.

Chisnall, B L; Jellyman, D J; Bonnett, M L; Sykes, J R E (2002) Spatial and temporal variability in size of glass eels (*Anguilla* spp.) in New Zealand. *New Zealand Journal of Marine and Freshwater Research 36*: 89–104.

Chisnall, B L; Kalish, J M (1993) Age validation and movement of freshwater eels (*Anguilla dieffenbachii* and *A. australis*) in a New Zealand pastoral stream. *New Zealand Journal of Marine and Freshwater Research 27*: 333–338.

Crow, S; Jellyman, D (2010) Assessment of the eel population in the Pātea River catchment. Final Research Project for Ministry of Fisheries Project EEL2009-04. 38 p. (Unpublished report held by Fisheries New Zealand Wellington.)

Crow, S; Snelder, T; Jellyman, P; Greenwood, M; Dunn, A (2016) Temporal Trends in the Relative Abundance of New Zealand Freshwater Fishes: Analysis of New Zealand Freshwater Fish Database Records. NIWA Client Report CHC2016-049 prepared for the Ministry for the Environment. 71 p.

Crow, S.; Jellyman, P.J.; Martin, M.L.; Bowman, E. (2020). Recruitment of freshwater eels, 1995–2018. *New Zealand Fisheries Assessment Report 2020/36*. 120 p.

Crow, S.K; Lambert, P.W.; Eigan , E.M; Bowman, E.(2023). Recruitment of freshwater eels 1995–2022. *New Zealand Fisheries Assessment Report 2023/52* 94 p.

Davey, A J H; Jellyman, D J (2005) Sex determination in freshwater eels and management options for manipulation of sex. *Reviews in Fish Biology and Fisheries 15*: 37–52.

Dekker, W (2001) Status of the European eel stock and fisheries. Proceedings of the International Symposium, Advances in Eel Biology, University of Tokyo, 28–30 September 2001: 50–52.

Dekker, W; Casselman, J (2014) The 2003 Québec Declaration of Concern About Eel Declines—11 Years Later: Are Eels Climbing Back up the Slippery Slope? *Fisheries 39(12)*: 613–614. DOI: 10.1080/03632415.2014.979342

Dunn, A; Beentjes, M P; Graynoth, E (2009) Preliminary investigations into the feasibility of assessment models for New Zealand longfin eels (*Anguilla dieffenbachii*). *New Zealand Fisheries Assessment Report 2009/30*. 42 p.

Durif, C M F; Knutsen, J A; Johannessen, T; Vollestad, L A (2008) Analysis of European eel (*Anguilla anguilla*) time series from Norway. Report No 8/2008. Institute of Marine Research, Oslo. 22 p.

Fu, D; Beentjes, M P; Dunn, A (2012) Further investigations into the feasibility of assessment models for New Zealand longfin eels (*Anguilla dieffenbachii*). Final Research Report for Project EEL200702. 77 p. (Unpublished report held by Fisheries New Zealand Wellington.)

Graynoth, E; Booker, D J (2009) Biomass of longfin eels in medium to large rivers. *New Zealand Fisheries Assessment Report 2009/44*. 24 p.

Graynoth, E; Jellyman, D J; Bonnett, M (2008) Spawning escapement of female longfin eels. *New Zealand Fisheries Assessment Report 2008/07*. 57 p.

Horn, P L (1996) A review of age and growth data for New Zealand freshwater eels (*Anguilla sp).* New Zealand Fisheries Assessment Research Document 1996/6. 26 p. (Unpublished document held by NIWA library, Wellington.)

Hoyle, S D; Jellyman, D J (2002) Longfin eels need reserves: modelling the effects of commercial harvest on stocks of New Zealand eels. *Marine and Freshwater Research 53*: 887–895.

Jellyman, D J (1993) A review of the fishery for freshwater eels in New Zealand. *New Zealand Freshwater Fisheries Report 10*. 51 p.

Jellyman, D J (1995) Longevity of longfinned eels *Anguilla dieffenbachia* in a New Zealand high country lake. *Ecology of Freshwater Fish 4*: 106–112.

Jellyman, D J; Beentjes, M P (1998) Enhancement of the eel stocks of Coopers Lagoon, Canterbury Bight, by transfer of juvenile eels. *NIWA Technical Report 22*. 18 p.

Jellyman, D J; Booker, D J; Watene, E (2009) Recruitment of glass eels (Anguilla spp.) in the Waikato River, New Zealand. Evidence of declining migrations? *Journal of Fish Biology 74*: 2014–2033.

Jellyman, D J; Bowen, M (2009) Modelling larval migration routes and spawning areas of Anguillid eels of New Zealand and Australia. pp 255–274. *In:* Haro, A J; Smith, K L; Rulifson, R A; Moffitt, C M; Klauda, R J; Dadswell, M J; Cunjak, R A; Cooper, J E; Beal, K L; Avery, T S (eds). Challenges for Diadromous Fishes in a Dynamic Global Environment *American Fisheries Society Symposium 69*. Bethesda, Maryland.

Jellyman, D J; Chisnall, B L; Dijkstra, L H; Boubée, J A T (1996) First record of the Australian longfinned eel, *Anguilla reinhardtii*, in New Zealand. *New Zealand Journal of Marine and Freshwater Research 47*: 1037–1340.

Jellyman, D J; Chisnall, B L; Sykes, J R E; Bonnett, M L (2002) Variability in spatial and temporal abundance of glass eels (*Anguilla* spp.) in New Zealand waterways. *New Zealand Journal of Marine and Freshwater Research 36*: 511–517.

Jellyman, D J; Chisnall, B L; Todd, P R (1995) The status of the eel stocks of Lake Ellesmere. *NIWA science and technology series 26*, 62 p.

Jellyman, D J; Graynoth, E; Francis, R I C C; Chisnall, B L; Beentjes, M P (2000) A review of the evidence for a decline in the abundance of longfinned eels (*Anguilla dieffenbachii*) in New Zealand. Final Research Report, Ministry of Fisheries Research Project EEL9802. 76 p. (Unpublished report held by Fisheries New Zealand Wellington.)

Jellyman, D J; Sykes, J R E (2004) Review of glass eel recruitment, 1996–2002. Final Research Report, Ministry of Fisheries Research Project 13 p. (Unpublished report held by Fisheries New Zealand Wellington.)

Martin, M L; Boubée, J A T; Bowman, E J (2013) Recruitment of freshwater elvers, 1995–2012. *New Zealand Fisheries Assessment Report 2013/50*. 111 p.

Martin, M L; Boubée, J A T; Bowman, E J (2014) Recruitment of freshwater elvers. New Zealand Fisheries Progress Report. Ministry for Primary Industries. Wellington. 32 p. (Unpublished report held by Fisheries New Zealand Wellington.)

Martin, M L; Boubée, J A T; Bowman, E J (2016) Recruitment of freshwater elvers 1995–2015. *New Zealand Fisheries Assessment Report 2016/46* 98 p.

McCleave, J D; Jellyman, D J (2004) Male dominance in the New Zealand longfin eel population of a New Zealand river: Probable causes and implications for management. *North American Journal of Fisheries Management 24*: 490–505.

Ministry of Fisheries (2004) Setting of Sustainability and Other Management Controls for Stocks to be Introduced into the QMS on 1 October 2004: North Island shortfin and longfin eels (SFE, LFE). Final Advice Paper 25 June 2004. 232 p.

Ministry of Fisheries (2007) Review of Sustainability Measures and Other management Controls for 1 October 2007. Volume 1. Final Advice Paper and Summary of Recommendations. 5 September 2007. pp. 210–251.

Moriarty, C; Dekker, W (1997) Management of the European eel. *Fisheries Bulletin (Dublin) 15:* 125 p.

Québec Declaration of Concern (2003) Worldwide decline of eel resources necessitates immediate action. pp 447–449 *In:* Casselman, J M; Cairns, D K (editors.) Eels at the edge: science status and conservation concerns. *American Fisheries Society Symposium 58*, Bethesda, Maryland, USA. 460 p.

Richkus, W A; Whalen, K (2000) Evidence for a decline in the abundance of the American eel, *Anguilla rostrata* (LeSueur), in North America since the early 1980s. *Dana 12*: 83–97.

Speed, S R; Browne, G N; Boyd, R O (2001) Assessment and Monitoring of Commercial Eel Fisheries. Final Research Report for Ministry of Fisheries Research Project EEL9801. 178 p. (Unpublished report held by Fisheries New Zealand Wellington.)

Todd, P R (1980) Size and age of migrating New Zealand freshwater eels (*Anguilla* spp.). *New Zealand Journal of Marine and Freshwater Research 14*: 283–293.

Townsend, A J; de Lange, P J; Duffy, C A J; Miskelly, C M; Molloy, J; Norton, D A (2008) New Zealand Threat Classification System manual. Department of Conservation, Wellington. 35 p.

Vollestad, L A; Jonsson, B (1988) A 13-year study of the population dynamics and growth of the European eel (*Anguilla Anguilla*) in a Norwegian River: evidence for density-dependent mortality, and development of a model for predicting yield. *Journal of Animal Ecology 88*: 983–997.