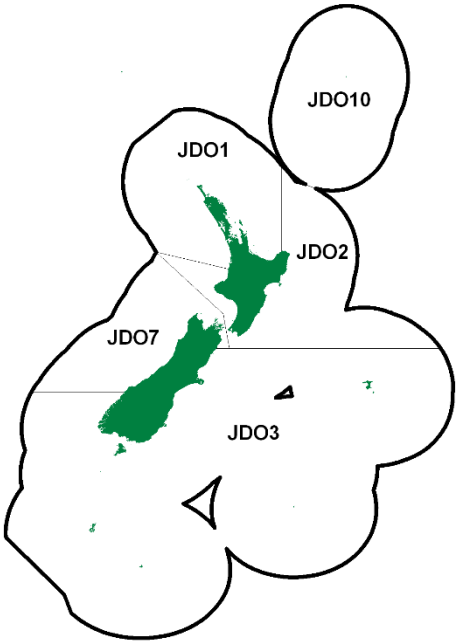
JOHN DORY (JDO)

(*Zeus faber*)
Kuparu



1. FISHERY SUMMARY

John dory was introduced into the QMS on 1 October 1986; current allowances, TACCs, and TACs are summarised in Table 1. The TACCs for JDO 1, JDO 2, and JDO 3 were increased gradually during the late 1980s and early 1990s, but have remained unchanged since 1994–95. The TACC for JDO 7 was increased from 131 to 150 t in October 2012, and to 190 t on 1 October 2016. The TACC for JDO 10 has remained unchanged since 1986.

Table 1: TACs, TACCs, and allowances (t) for John dory for fishing year 2019–20.

Fishstock	Recreational allowance	Customary non–commercial allowance	Other mortality	TACC	TAC
JDO 1	–	–	–	704	704
JDO 2	–	–	–	269.5	269.5
JDO 3	–	–	–	31.9	31.9
JDO 7	4	2	11	230	247
JDO 10	–	–	–	10	10

1.1 Commercial fisheries

John dory are taken mainly as a bycatch of the trawl and Danish seine fisheries. In recent years, around 50–65% of the total reported catch has been taken in JDO 1, and around 20% taken in JDO 2. Reported landings for the main QMAs from 1931 to 1982 are given in Table 2. Recent reported landings by Fishstock are given in Table 3, and the historical landings and TACC values for the three main JDO stocks are depicted in Figure 1.

The increase in JDO 1 landings after 1986–87 is largely attributed to increased targeting of John dory by trawl and Danish seine. Annual catches reached a peak during 1994–95 to 1996–97, at about the level of the TACC of 704 t. There was a general decline in annual landings over the subsequent years. In recent years (2009–10 to 2017–18), landings were maintained at about 350 t per annum, but in 2018–19 landings dropped below 300 t for the first time since 1975. Most of the decline in John dory catch occurred in the Hauraki Gulf-East Northland fishery. Annual catches from the west coast (FMA 9) have been maintained at about 80–140 t over the last 25 years (from 1990–91), predominantly as a bycatch of the snapper, red gurnard, and trevally trawl fisheries. Annual catches from the Bay of Plenty fishery (trawl and Danish seine) were about 80–120 t during the same period.

Annual landings in JDO 2 have never exceeded the TACC and, in the mid-90s, were around 50% of the TACC in each year (Figure 1). From 1999–00 to 2002–03 landings were above 200 t, but in recent years landings have decreased, being below 150 t since 2006–07. Landings from JDO 2 are considered to be approximately equally split between FMAs 2 and 8. Substantial proportions of John dory landings are taken as bycatch in target trawl fisheries for jack mackerels in FMA 8, and as tarakihi and red gurnard bycatch in FMA 2.

Landings from JDO 7 increased markedly after 1999–2000, as a result of increasing abundance. JDO 7 is taken largely as a bycatch of FMA 7 trawl fisheries. The JDO 7 TACC has been increased four times since 2003–04 and is currently 190 t (Table 3). Nevertheless, landings in 2017–18 and 2018–19 exceeded the TACC, by 13 t and 7 t respectively.

Table 2: Reported landings (t) for the main QMAs from 1931 to 1982.

Year	JDO 1	JDO 2	JDO 3	JDO 7	Year	JDO 1	JDO 2	JDO 3	JDO 7
1931–32	70	0	0	0	1957	110	37	0	20
1932–33	60	0	0	0	1958	132	54	0	40
1933–34	57	0	0	0	1959	157	64	0	50
1934–35	42	0	0	0	1960	158	81	0	53
1935–36	92	0	0	0	1961	156	76	0	52
1936–37	105	4	0	1	1962	150	87	0	38
1937–38	80	3	0	0	1963	114	96	0	44
1938–39	78	3	1	0	1964	112	85	1	30
1939–40	40	5	0	0	1965	111	101	0	32
1940–41	0	2	1	1	1966	148	110	0	37
1941–42	0	7	1	3	1967	162	102	0	41
1942–43	3	4	3	3	1968	203	83	0	36
1943–44	12	4	3	3	1969	189	96	0	19
1944	11	7	2	5	1970	259	137	0	24
1945	12	6	0	1	1971	234	141	1	38
1946	27	7	0	3	1972	213	122	0	34
1947	23	12	2	12	1973	259	99	0	30
1948	21	20	1	1	1974	340	101	0	28
1949	22	79	0	4	1975	261	92	0	22
1950	17	65	0	6	1976	362	135	0	55
1951	5	38	0	2	1977	315	141	0	73
1952	34	50	0	5	1978	392	119	0	24
1953	163	62	0	7	1979	503	121	0	29
1954	181	52	0	25	1980	563	173	0	26
1955	162	50	0	24	1981	646	186	0	38
1956	175	46	0	24	1982	577	162	0	28

Notes:

1. The 1931–1943 years are April–March but from 1944 onwards are calendar years.
2. Data up to 1985 are from fishing returns: data from 1986 to 1990 are from Quota Management Reports.
3. Data for the period 1931 to 1982 are based on reported landings by harbour and are likely to be underestimated as a result of under-reporting and discarding practices. Data includes both foreign and domestic landings. Data were aggregated to FMA using methods and assumptions described by Francis & Paul (2013).

Table 3: Reported landings (t) of John dory by Fishstock from 1983–84 to present and actual TACCs (t) for 1986–87 to present. QMS data from 1986–present.

Fishstock	JDO 1		JDO 2		JDO 3		JDO 7	
FMA (s)	1 & 9		2 & 8		3, 4, 5 & 6		7	
	Landings	TACC	Landings	TAC	Landings	TACC	Landings	TACC
1983–84*	659	–	131	–	1	–	35	–
1984–85*	620	–	110	–	0	–	36	–
1985–86*	531	–	158	–	1	–	45	–
1986–87	409	510	168	240	3	30	57	70
1987–88	476	633	192	246	1	30	89	75
1988–89	480	662	151	253	6	30	47	82
1989–90	494	704	152	262	1	30	54	88
1990–91	505	704	171	269	1	31	53	88
1991–92	562	704	214	269	1	31	60	88
1992–93	578	704	217	269	8	31	50	91
1993–94	640	704	186	269	2	32	37	91
1994–95	721	704	140	270	3	32	30	91
1995–96	696	704	139	270	< 1	32	42	91

Table 3 [Continued]

Fishstock	JDO 1		JDO 2		JDO 3		JDO 7	
FMA (s)	1 & 9		2 & 8		3, 4, 5 & 6		7	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1996–97	689	704	140	270	< 1	32	35	91
1997–98	651	704	134	270	< 1	32	26	91
1998–99	672	704	182	270	< 1	32	34	91
1999–00	519	704	235	270	< 1	32	71	91
2000–01	497	704	217	270	1	32	104	91
2001–02	453	704	240	270	4	32	124	91
2002–03	440	704	239	270	2	32	114	91
2003–04	492	704	184	270	< 1	32	155	91
2004–05	561	704	182	270	1	32	133	114
2005–06	549	704	159	270	1	32	124	114
2006–07	544	704	143	270	1	32	127	114
2007–08	482	704	133	270	< 1	32	110	114
2008–09	411	704	136	270	< 1	32	116	114
2009–10	359	704	152	270	< 1	32	109	125
2010–11	386	704	138	270	< 1	32	112	125
2011–12	351	704	131	270	< 1	32	126	125
2012–13	365	704	138	270	< 1	32	128	150
2013–14	349	704	142	270	< 1	32	151	150
2014–15	354	704	147	270	< 1	32	150	150
2015–16	342	704	129	270	< 1	32	151	190
2016–17	361	704	139	270	1	32	177	190
2017–18	322	704	135	270	1	32	203	190
2018–19	279	354	135	270	1	32	197	209
2019–20	255	354	124	270	1	32	178	230

Fishstock	JDO 10			
FMA (s)	10		Total	
	Landings	TACC	Landings	TACC
1983–84*	0	–	826	–
1984–85*	0	–	766	–
1985–86*	0	–	735	–
1986–87	< 1	10	638	860
1987–88	0	10	758	994
1988–89	0	10	684	1 037
1989–90	0	10	701	1 094
1990–91	0	10	730	1 102
1991–92	0	10	837	1 102
1992–93	0	10	853	1 105
1993–94	0	10	865	1 106
1994–95	0	10	894	1 107
1995–96	0	10	877	1 107
1996–97	0	10	864	1 107
1997–98	0	10	811	1 107
1998–99	0	10	889	1 107
1999–00	0	10	826	1 107
2000–01	0	10	819	1 107
2001–02	0	10	819	1 107
2002–03	0	10	795	1 107
2003–04	0	10	832	1 107
2004–05	0	10	877	1 129
2005–06	0	10	833	1 129
2006–07	0	10	815	1 129
2007–08	0	10	725	1 129
2008–09	0	10	663	1 129
2009–10	0	10	620	1 140
2010–11	0	10	637	1 140
2011–12	0	10	609	1 140
2012–13	0	10	633	1 165
2013–14	0	10	642	1 165
2014–15	0	10	652	1 165
2015–16	0	10	622	1 205
2016–17	0	10	678	1 205
2017–18	0	10	661	1 205
2018–19	0	10	612	874
2019–20	0	10	558	895

* FSU data.

Overall the majority of John dory catch is reported from the snapper bottom trawl fishery (16%), followed by the John dory bottom trawl (14%), and the tarakihi bottom trawl fisheries (14%). Danish seine accounts for the second largest John dory catch across fishing methods (Figure 2).

Catches of John dory in JDO 1 are predominantly taken by bottom trawl in the snapper (23%), John dory (19%), and trevally (10%) target fisheries. Danish seine, bottom pair trawl, and bottom longline comprise the remaining John dory catch by fishing method (Figure 3). John dory in JDO 2 are taken predominantly by bottom trawl targeting tarakihi (30%) and gurnard (25%), with midwater and set net fishing methods comprising the remainder of the catch (Figure 4). John dory in JDO 7 is predominantly caught by bottom trawl targeting flatfish (25%), barracouta (23%), and tarakihi (18%) (Figure 5). Throughout the North Island, the trawl and Danish seine fisheries targeting John dory take the majority of their catch targeting snapper (33%) followed by the John dory target fishery (23%) (Figure 6). No data were available for JDO set net fisheries in the South Island.

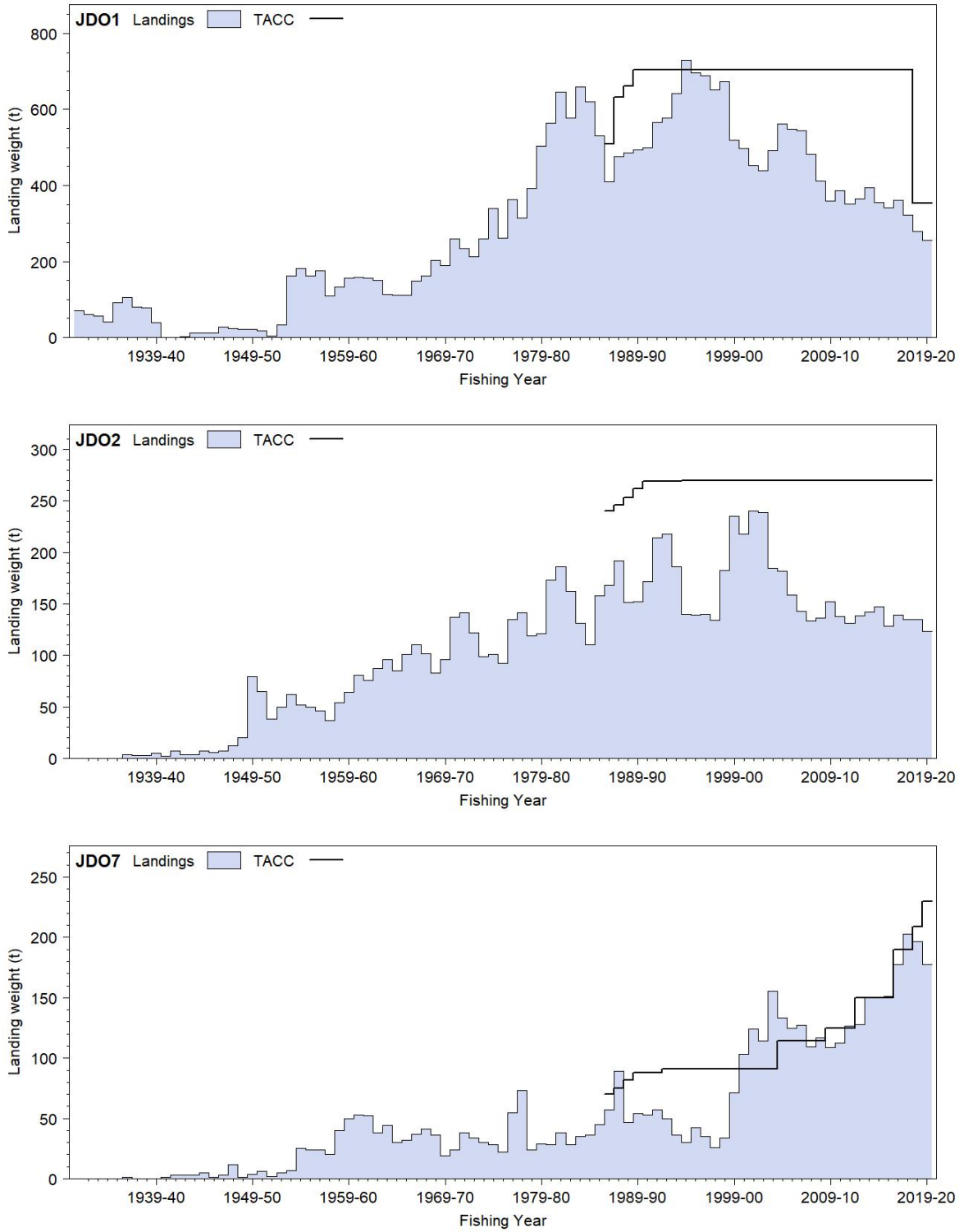


Figure 1: Reported commercial landings and TACC for the three main JDO stocks. JDO 1 (Auckland East), JDO 2 (Central East), and JDO 7 (Challenger).

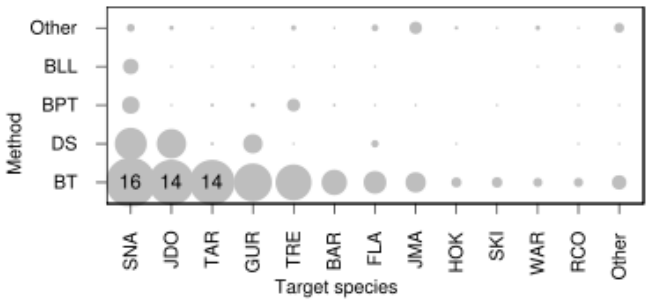


Figure 2: A summary of the proportion of landings of John dory (all QMAs) taken by each target fishery and fishing method. The area of each circle is proportional to the percentage of landings taken using each combination of fishing method and target species. The number in the bubble is the percentage. BT = bottom trawl, DS = Danish seine, BPT = bottom pair trawl, BLL = bottom longline (Bentley et al 2012).

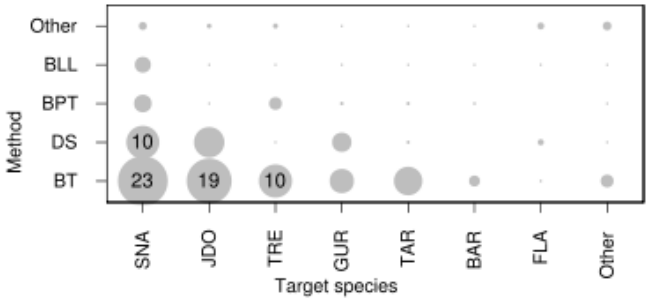


Figure 3: A summary of the proportion of landings of JDO 1 taken by each target fishery and fishing method. The area of each circle is proportional to the percentage of landings taken using each combination of fishing method and target species. The number in the bubble is the percentage. BT = bottom trawl, DS = Danish seine, BPT = bottom pair trawl, BLL = bottom longline (Bentley et al 2012).

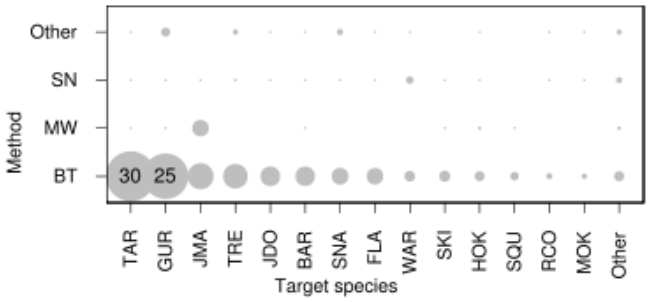


Figure 4: A summary of the proportion of landings of JDO 2 taken by each target fishery and fishing method. The area of each circle is proportional to the percentage of landings taken using each combination of fishing method and target species. The number in the bubble is the percentage. BT = bottom trawl, MW = mid-water, SN = setnet (Bentley et al 2012).

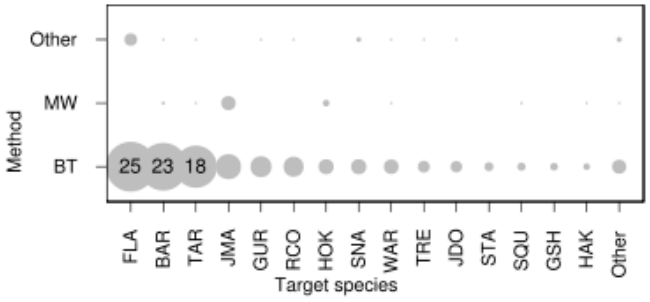


Figure 5: A summary of the proportion of landings of JDO 7 taken by each target fishery and fishing method. The area of each circle is proportional to the percentage of landings taken using each combination of fishing method and target species. The number in the bubble is the percentage. BT = bottom trawl, MW = mid-water (Bentley et al 2012).

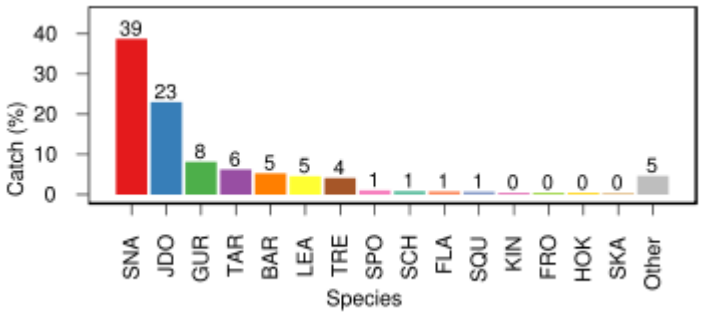


Figure 6: A summary of species composition of the reported trawl and Danish seine catch in trips targeting John dory off the North Island. Catch is expressed as the percentage by weight of each species calculated for all trawl and Danish seine trips (Bentley et al 2012).

1.2 Recreational fisheries

John dory is an important recreational species in the north of New Zealand. They are caught using line fishing methods, predominantly on rod and reel with some longline catch.

1.2.1 Management controls

The main method used to manage recreational harvests of John dory is daily bag limits. Fishers can take up to 20 John dory as part of their combined daily bag limit in the Auckland and Kermadec, Central, and Challenger Fishery Management Areas.

1.2.2 Estimates of recreational harvest

There are two broad approaches to estimating recreational fisheries harvest: the use of onsite or access point methods where fishers are surveyed or counted at the point of fishing or access to their fishing activity; and, offsite methods where some form of post-event interview and/or diary are used to collect data from fishers.

The first estimates of recreational harvest for John dory were calculated using an offsite approach, the offsite regional telephone and diary survey approach. Estimates for 1996 came from a national telephone and diary survey (Bradford 1998). Another national telephone and diary survey was carried out in 2000 (Boyd & Reilly 2002). The harvest estimates provided by these telephone diary surveys (Table 4) are no longer considered reliable.

In response to the cost and scale challenges associated with onsite methods, in particular the difficulties in sampling other than trailer boat fisheries, offsite approaches to estimating recreational fisheries harvest have been revisited. This led to the development and implementation of a national panel survey for the 2011–12 fishing year (Wynne-Jones et al 2014). The panel survey used face-to-face interviews of a random sample of New Zealand households to recruit a panel of fishers and non-fishers for a full year. The panel members were contacted regularly about their fishing activities and catch information collected in standardised phone interviews. The national panel survey was repeated during the 2017–18 fishing year using very similar methods to produce directly comparable results (Wynne-Jones et al 2019). Recreational catch estimates from the two national panel surveys are given in Table 4. Note that national panel survey estimates do not include recreational harvest taken under s111 general approvals.

1.3 Customary non-commercial fisheries

No quantitative information is available on the current level of Māori customary non-commercial catch.

1.4 Illegal catch

No quantitative information is available.

1.5 Other sources of mortality

No quantitative information is available.

Table 4: Recreational harvest estimates for John dory stocks. The telephone/diary surveys ran from December to November but are denoted by the January calendar year. National panel surveys ran through the October to September fishing year but are denoted by the January calendar year. Mean fish weights were obtained from boat ramp surveys (see Hartill & Davey 2015, Davey et al 2019, for panel survey mean weights).

Stock	Year	Method	Number of fish	Total weight (t)	CV
JDO 1	1996	Telephone/diary	49 000	87	0.09
	2000	Telephone/diary	129 000	227	0.23
	2012	Panel survey	28 863	36	0.13
	2018	Panel survey	22 595	26	0.20
JDO 2	2000	Telephone/diary	9 000	16	0.43
	2012	Panel survey	2 000	3	0.33
	2018	Panel survey	2 587	3	0.34
JDO 3	2012	Panel survey	88	< 1	1.00
	2018	Panel survey	183	< 1	1.00
JDO 7	2012	Panel survey	1 351	2	0.52
	2018	Panel survey	699	1	0.47

2. BIOLOGY

John dory are widespread, being found in the eastern Atlantic Ocean, the Mediterranean Sea, and around New Zealand, Australia, and Japan. They are common in the inshore coastal waters of northern New Zealand, and to a lesser extent in Tasman Bay, to depths of 50 m. In the Hauraki Gulf, adults move to deeper waters during summer, and occasional feeding aggregations occur during winter.

John dory are serial spawners (spawning more than once in a season). There appears to be substantial variation in the time of spawning in New Zealand, with spawning occurring between December and April on the northeast coast. The eggs are large and pelagic, taking 12–14 days to hatch. Initially John dory grow rapidly with both males and females reaching 12 to 18 cm standard length (SL) after the first year. From the second year onwards females grow faster than males and reach a greater maximum length. Females mature at a size of 29 to 35 cm SL and in general, larger females mature earlier in the season and are more fecund. Males mature at 23 to 29 cm SL.

M was estimated using the equation $M = \log_e 100/\text{maximum age}$, where maximum age is the age to which 1% of the population survives in an unexploited stock. Using a maximum observed age of 12 years, M was estimated to equal 0.38. Biological parameters relevant to the stock assessment are shown in Table 5.

Table 5: Estimates of biological parameters of John dory.

Fishstock	Estimate						Source
1. Weight = a (length)^b (Weight in g, length in cm total length)							
Combined sexes	a	b					
JDO 1	0.048	2.7					from *Ikatere* 2003
2. von Bertalanffy growth parameters							
	Females			Males			
	K	t_0	$L\infty$	K	t_0	$L\infty$	
JDO 1	0.425	-0.223	41.13	0.48	-0.251	36.4	Hore (1982)

3. STOCKS AND AREAS

In 2012 the stock structure of John dory was reviewed (Dunn & Jones 2013). The approach evaluated patterns in the distribution of catch and CPUE, research survey biomass trends, location of spawning and nursery grounds, size and age compositions, and anecdotal information from the fishery.

John dory have been caught around most of the North Island and the northern South Island, indicating that the QMA boundaries are not biologically appropriate. The analysis suggested five stocks around New Zealand: (1) Hauraki Gulf and east Northland; (2) Bay of Plenty; (3) west coast North Island; (4) southeast North Island; and (5) northern South Island.

Spawning fish and nursery grounds are found in all five stocks. In addition, on the east coast North Island, CPUE analyses support the separation of the Hauraki Gulf, Bay of Plenty, and Hawkes Bay fisheries, and research trawl survey biomass estimates had different trends in Hauraki Gulf and the Bay of Plenty. Very few John dory are found south of Hawkes Bay on the southeast North Island, providing a gap between the east and west coast components of JDO 2. There is relatively strong evidence to separate the northeast and northwest coasts of JDO 1, including fishery CPUE analyses, length and age compositions, and research trawl survey biomass trends. The distribution of John dory off the west coast North Island is continuous between JDO 1 and the northern part of the west coast JDO 2, and the combination of these areas is also supported by CPUE analyses. There is evidence to separate the northern South Island from stocks to the north including the occurrence of unusually large fish on the northern South Island, and CPUE analyses. John dory appear to reach the southern limit of their range off the north and northwest coasts of the South Island.

4. STOCK ASSESSMENT

4.1 Estimates of fishery parameters and abundance

An investigation into the stock structure of New Zealand John dory (Dunn & Jones 2013) supported five biological stocks: (1) Hauraki Gulf and east Northland, (2) Bay of Plenty, (3) West coast North Island, (4) Southeast North Island, and (5) Northern South Island. The first three stocks are found within JDO 1, the fourth consists of the east coast portion of JDO 2, and the fifth of JDO 7 and the portion of JDO 2 located on the south and east coast of the North Island.

JDO 1

Relative abundance indices have been obtained from trawl surveys of the Bay of Plenty, west coast North Island, and Hauraki Gulf within the JDO 1 Fishstock (Table 6). However, there was a change in the configuration of the trawl gear following the 1988 trawl survey. Modifications to the trawl gear may have resulted in a change in the catchability of John dory part way through the time series. Therefore, surveys conducted between 1982 and 1988 and from 1989 onwards should be considered separately for comparisons of biomass indices to be valid.

In 2018, the CPUE indices for the three sub-areas within JDO 1 (Hauraki Gulf and east Northland, Bay of Plenty, and west coast North Island) were updated to 2016–17. The catch and effort data set included individual bottom trawl records from trawl targeting a range of inshore finfish species (BAR, TAR, TRE, GUR, SNA, and JDO). The landed catch of John dory from a trip was allocated to the individual trawl records in proportion to the estimated catch. The analyses used a delta-lognormal CPUE model incorporating positive catch (lognormal) and presence/absence (binomial) components. For a number of analyses, different trends were apparent between the lognormal and binomial CPUE models. Further investigation indicated that the differences may have been attributable to changes in the recording of smaller John dory catches over the time period. Potential biases introduced by changes in catch reporting are likely to be adequately accounted for by applying the delta-lognormal approach.

Table 6: Estimates of John dory biomass (t) from *Kaharoa* trawl surveys.

Year	Trip Code	Biomass	CV (%)
Bay of Plenty			
1983	KAH8303	113	24
1985	KAH8506	128	12
1987	KAH8711	155	38
1990	KAH9004	157	16
1992	KAH9202	236	12
1996	KAH9601	193	44
1999	KAH9902	176	14
North Island east coast			
1993	KAH9304	265	17
1994	KAH9402	268	31
1995	KAH9502	170	18
1996	KAH9605	172	48
North Island west coast (FMA 8)			
1989	KAH8918	68	25
1991	KAH9111	142	62
1994	KAH9410	33	47
1996	KAH9615	19	38
North Island west coast (FMA 9)			
1986	KAH8612	155	35
1987	KAH8715	160	16
1989	KAH8918	148	16
1991	KAH9111	216	37
1994	KAH9410	102	47
1996	KAH9615	147	15
1999	KAH9915 (FMAs 8 & 9)	374	9
Hauraki Gulf			
1984	KAH8421	292	22
1985	KAH8517	245	20
1986	KAH8613	211	25
1987	KAH8716	181	12
1988	KAH8810	477	32
1989	KAH8917	250	22
1990	KAH9016	322	13
1992	KAH9212	227	35
1993	KAH9311	374	24
1994	KAH9411	288	17
1997	KAH9720	387	18
2000	KAH0012	260	26
West coast South Island			
1992	KAH9204	102	29
1994	KAH9404	59	26
1995	KAH9504	27	36
1997	KAH9701	17	31
2000	KAH0004	141	16
2003	KAH0304	288	19
2005	KAH0503	222	14
2007	KAH0704	174	26
2009	KAH0904	269	23
2011	KAH1104	378	18
2013	KAH1305	231	21
2015	KAH1503	486	16
2017	KAH1703	431	12
2019	KAH1902	274	31

Hauraki Gulf and east Northland (part of JDO 1)

In Hauraki Gulf and east Northland, the standardised CPUE indices fluctuated during the 1990s and 2000s and then steadily declined from 2004–05 to 2012–13 and then increased relatively slowly during 2013–14 to 2016–17 (Figure 7).

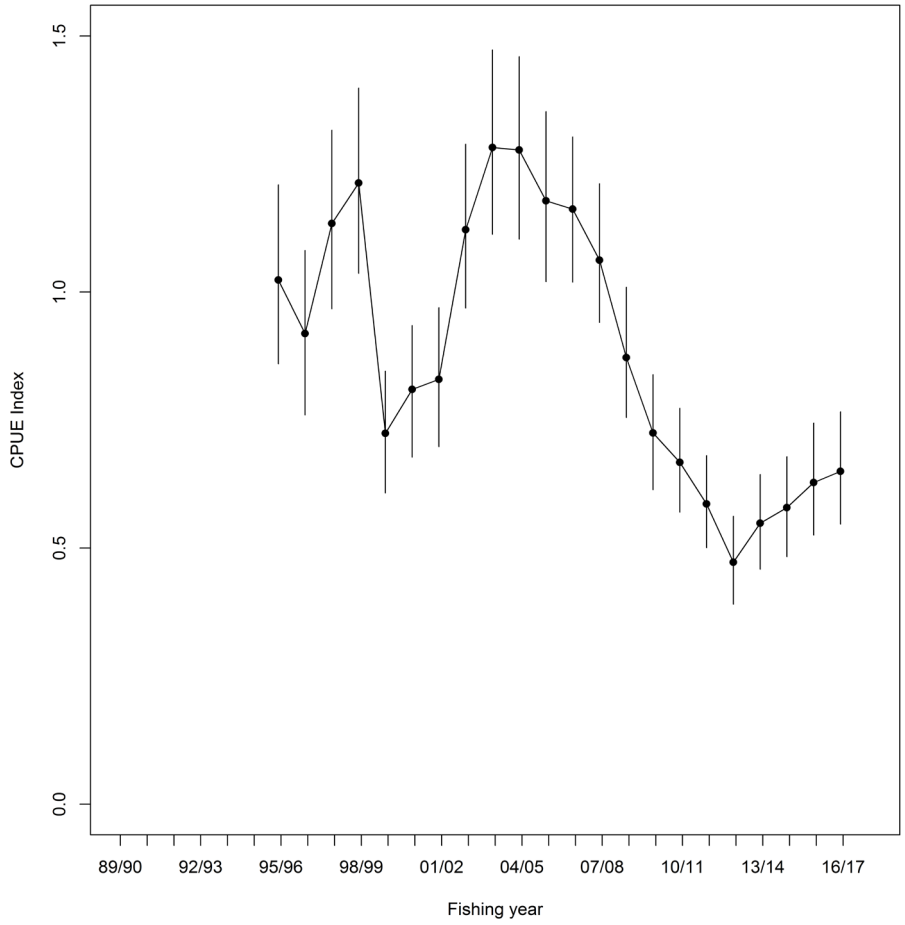


Figure 7: CPUE indices of abundance for Hauraki Gulf and east Northland (part of JDO 1) (combined model of catch rates in mixed species bottom trawl tows). Vertical lines show the 95% confidence intervals.

Bay of Plenty (part of JDO 1)

The standardised CPUE series declined during the late 1990s, remained relatively stable during the 2000s, dropped in 2012–13 to 2013–14 and then increased from 2015–16 to 2016–17 to just below the series mean (Figure 8).

West coast North Island (western JDO 1 and western JDO 2)

The standardised CPUE series suggests that biomass has fluctuated over the study period. CPUE indices were at a high level in 2010–11 to 2012–13 and declined over the subsequent four years (to 2016–17) to below the series mean (Figure 9).

Establishing B_{MSY} compatible reference points for JDO 1

In 2012, the Working Group accepted mean standardised bottom trawl CPUE for the period 1994–95 to 2010–11 as B_{MSY}-compatible proxies for each of the three JDO 1 sub-stocks. All three series were based on combined positive catch and probability of capture models derived from event scale fishing events (i.e., tow). JDO abundance tends to fluctuate in cycles, according to recruitment, and the period chosen included two periods of high abundance and high catch. The Working Group accepted the default Harvest Strategy Standard definitions that the Soft and Hard Limits would be one half and one quarter the target for each sub-stock, respectively.

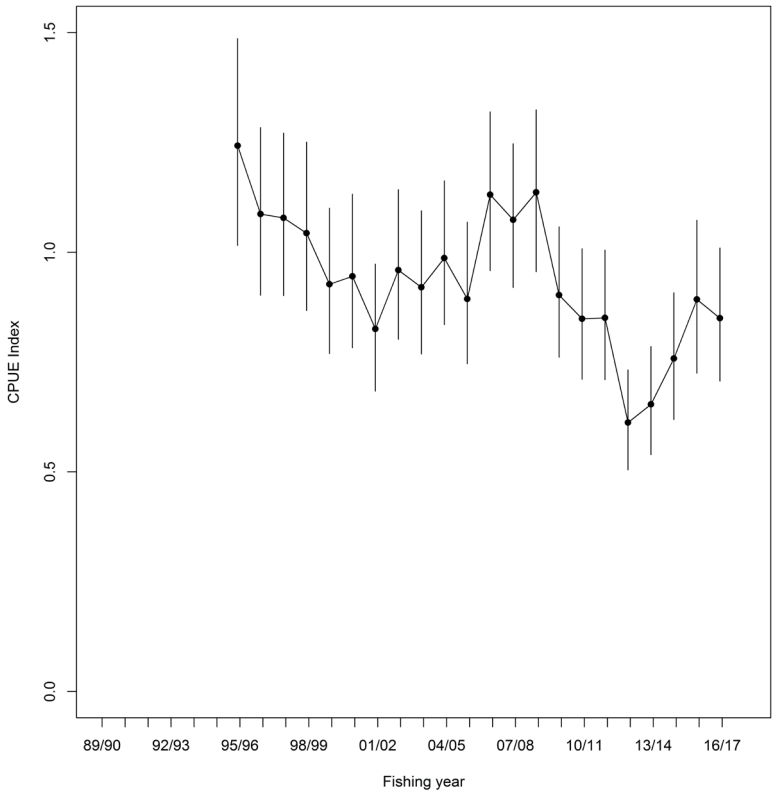


Figure 8: CPUE indices of abundance for the Bay of Plenty (part of JDO 1) (combined model of catch rates in mixed species bottom trawl tows). Vertical lines show the 95% confidence intervals.

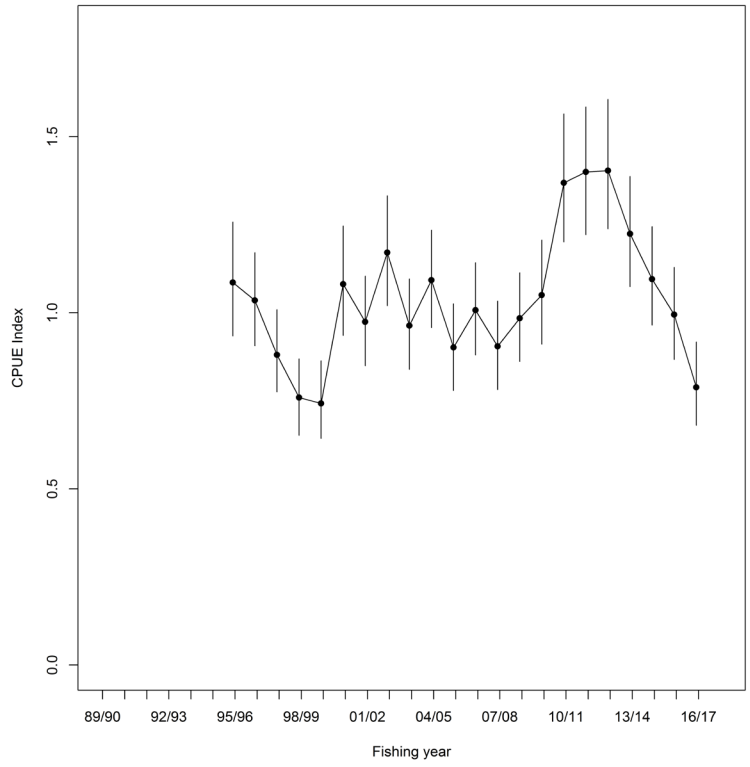


Figure 9: CPUE indices of abundance for the West coast North Island (western JDO 1 and western JDO 2) (combined model of catch rates in mixed species bottom trawl tows). Vertical lines show 95% confidence intervals.

Southeast North Island (part of JDO 2)

The standardised CPUE series suggests an increase in abundance from a low in the mid-1990s to a peak in 2000–01, followed by a steady decline to a series low in 2010–11 (Figure 10).

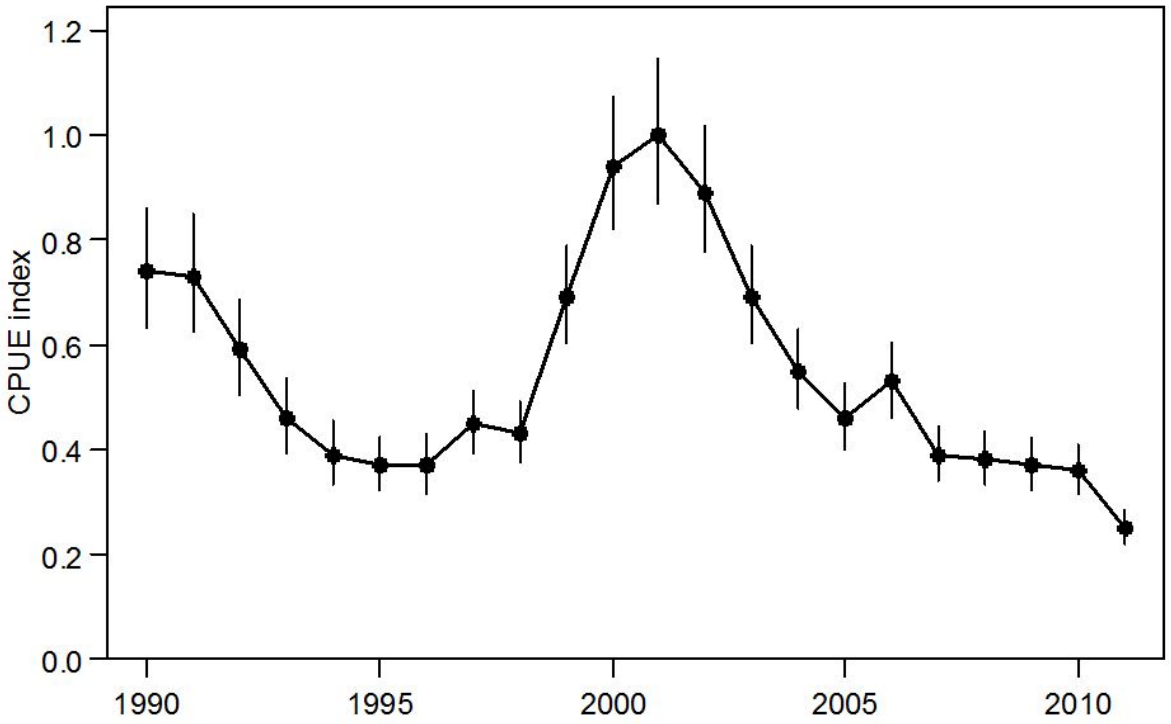


Figure 10: CPUE indices of abundance for the Southeast North Island (part of JDO 2), combined model of catch rates in mixed species bottom trawl tows (Dunn & Jones 2013). Vertical lines show the 95% credible intervals. Years labeled as year-ending (i.e., 1990 is 1989–90).

Northern South Island (JDO 7, and part of JDO 2)

In 2014, the CPUE indices for the Northern South Island zone (JDO 7, and part of JDO 2) were revised and updated to include data to 2012–13 (Langley 2014). The CPUE index was based on JDO bycatch from the following bottom trawl targets: BAR, FLA, GUR, JDO, JMA, RCO, and TAR, in Statistical Areas 033–039.

The Southern Inshore Working Group agreed that the west coast South Island (WCSI) trawl survey series appears to monitor trends in abundance of John dory, particularly recruited biomass (defined as fish of at least 25 cm TL) (Figure 11). Length frequency trends for the John dory survey catch from the west coast South Island and Tasman Bay/Golden Bay are presented in Figure 12. Smaller (20–35 cm) fish tend to be caught in the latter survey region. The 2017 1+ cohort (21–32 cm) is the strongest in the time series. Biomass levels were low before 2003, with recruited biomass increasing two to three fold since then.

Trawl surveys from 2011–2017 estimated the recruited biomass of John dory in the WCSI area to be at the highest level of the entire time series (Figure 11). However, the strong 1+ cohort visible in length frequencies from the 2017 survey doesn't appear to have translated into 3+ fish in 2019. The 2019 biomass has decreased from 2017 and is more similar to the long term mean.

The standardised CPUE series shows a similar trend to the trawl survey biomass index, with a large increase in biomass between the late 1990s and early 2000s, which has persisted to 2013 (Figure 13).

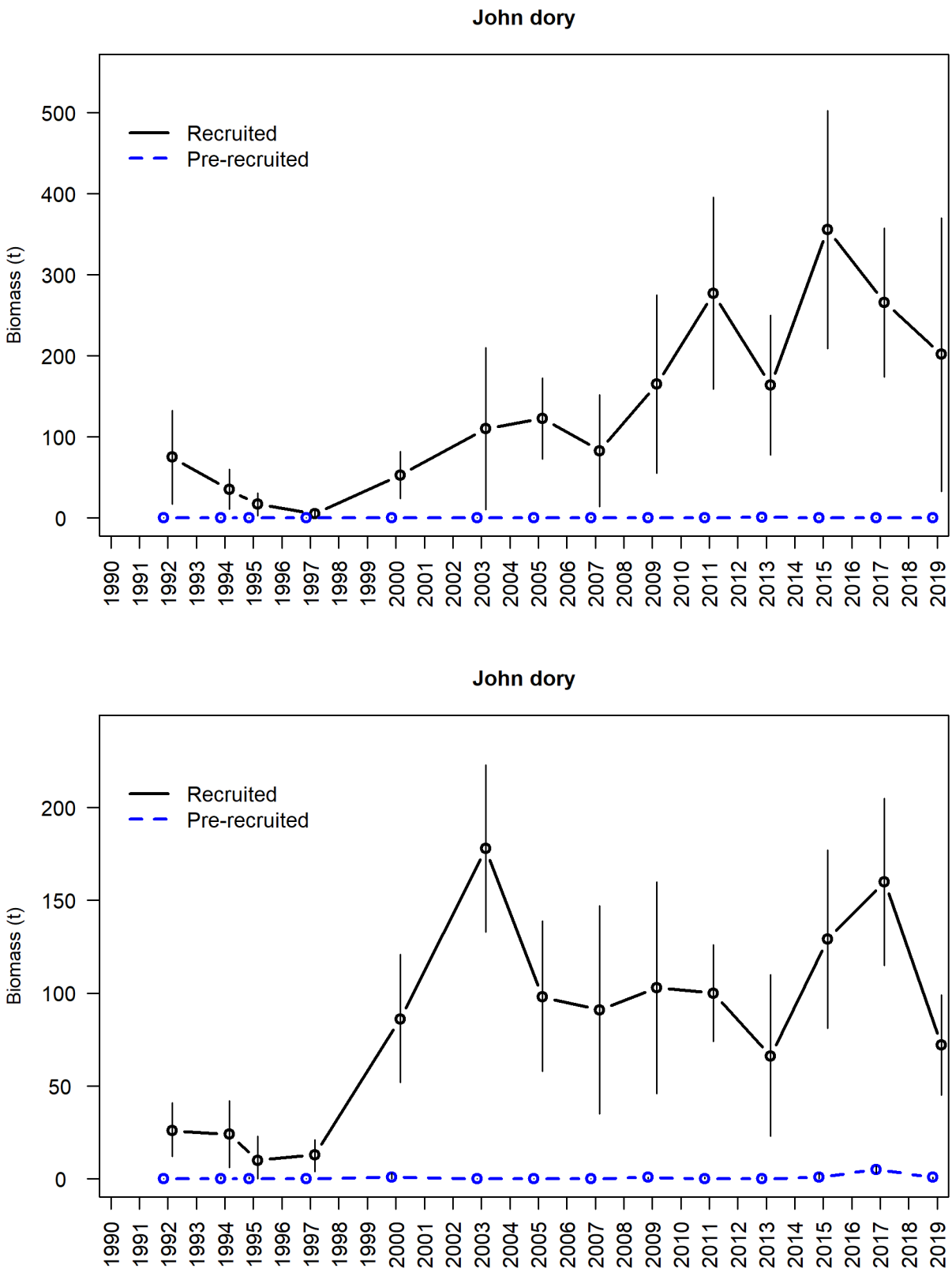


Figure 11: **WCSI trawl survey biomass estimates of recruited and pre-recruit John dory for the west coast South Island strata (top plot) and Tasman Bay/Golden Bay (bottom plot). Error bars are ± two standard deviations. John dory are assumed to recruit to the commercial fishery at 25 cm TL.**

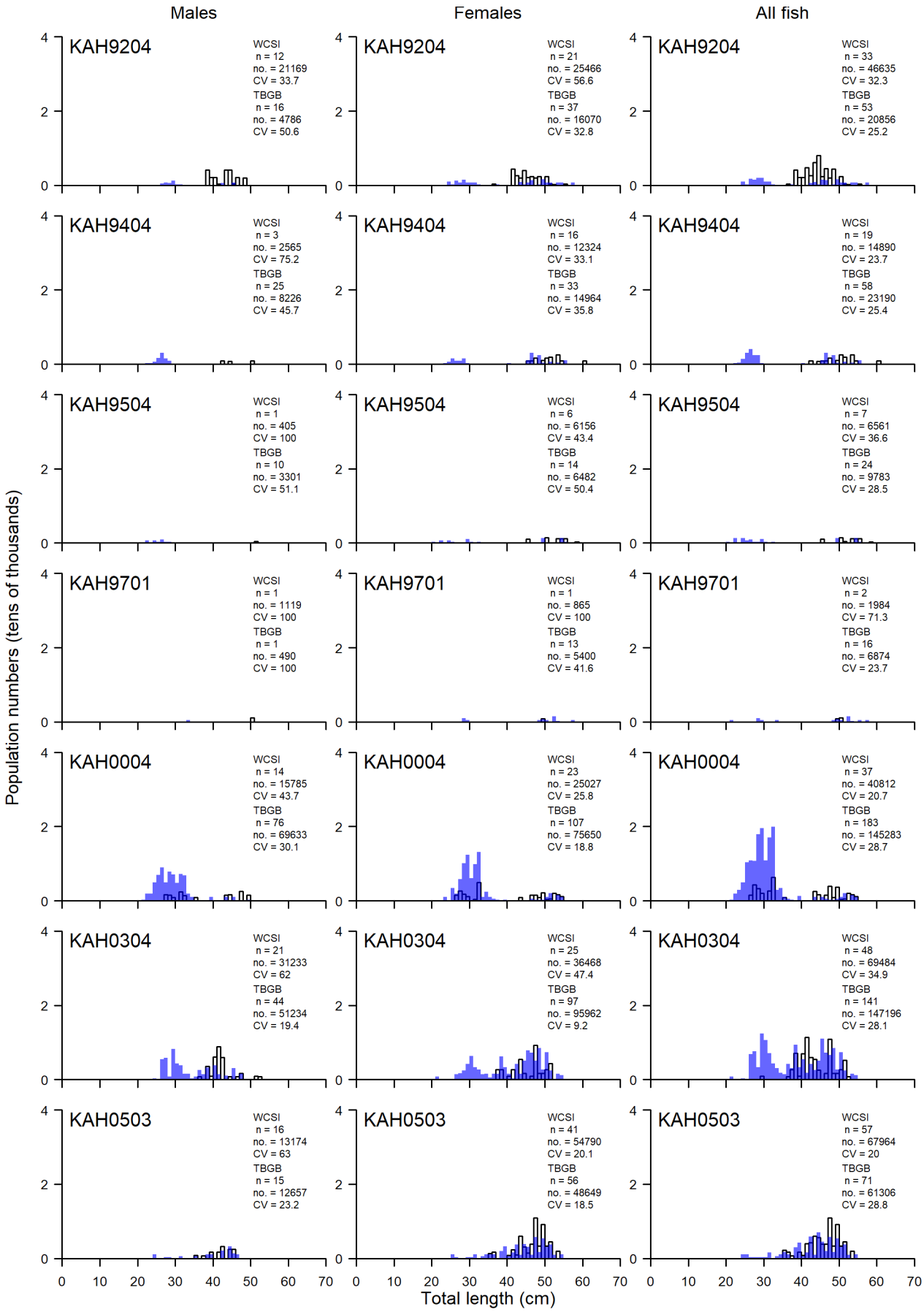


Figure 12: Scaled population length frequency distributions for John dory in 30–400 m for west coast (white bars) and Tasman Bay/Golden Bay (blue bars), from WCSI surveys. n = number of fish measured, no. = scaled population number, CV = coefficient of variation (%). [Continued on next page]

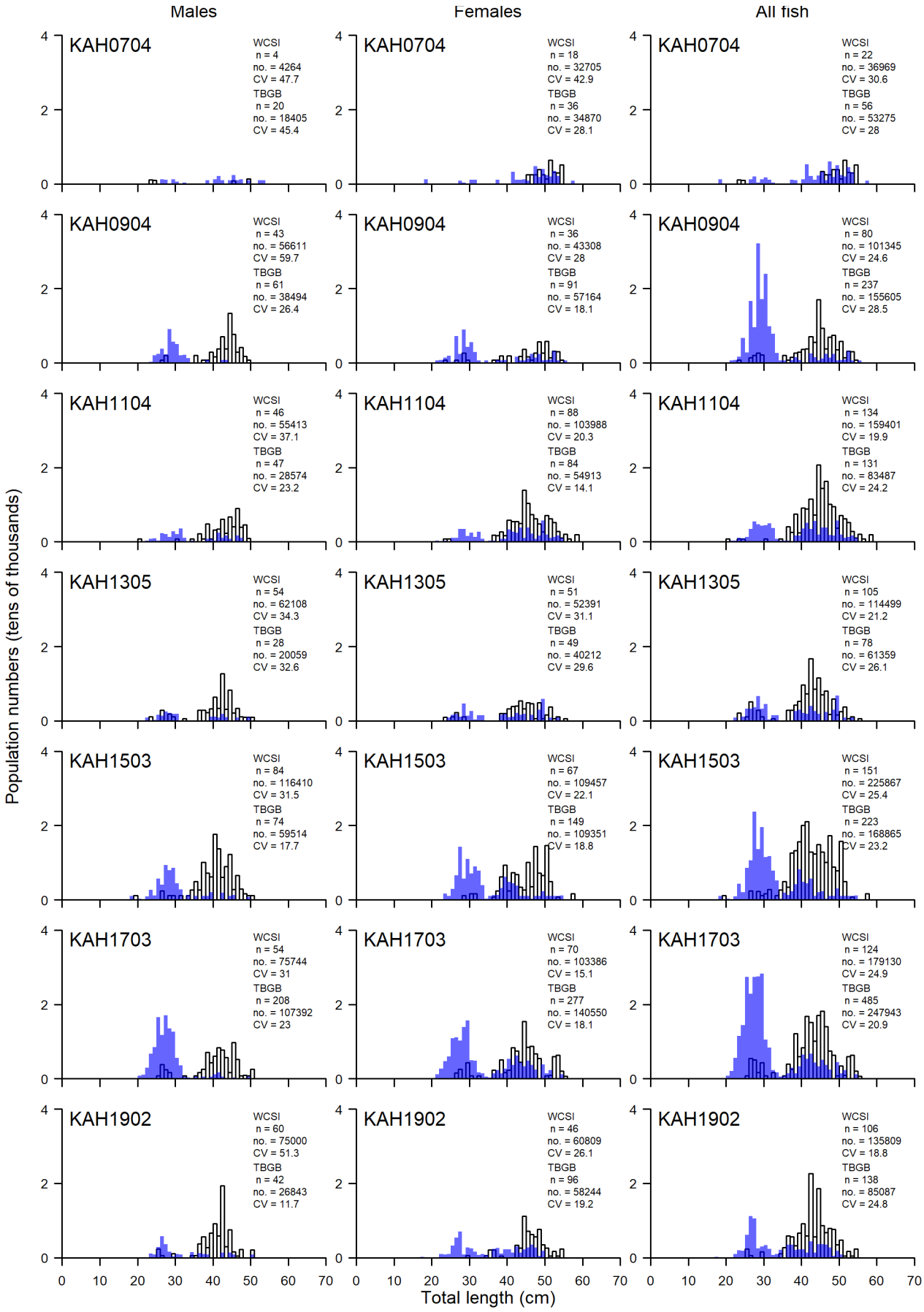


Figure 12 [Continued]

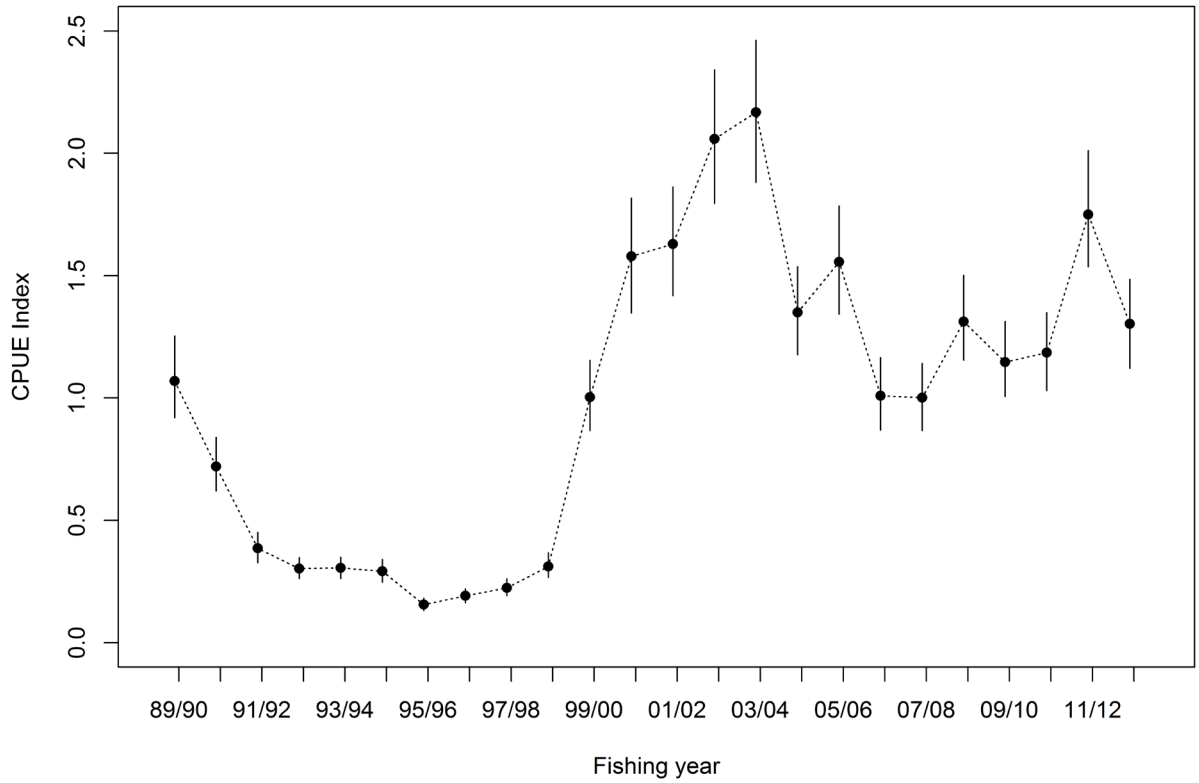


Figure 13: CPUE indices of abundance for the northern South Island (JDO 7 and part of JDO 2), combined model of catch rates in mixed species bottom trawl tows (Langley 2014). Vertical lines show the 95% credible intervals.

4.2 Biomass estimates

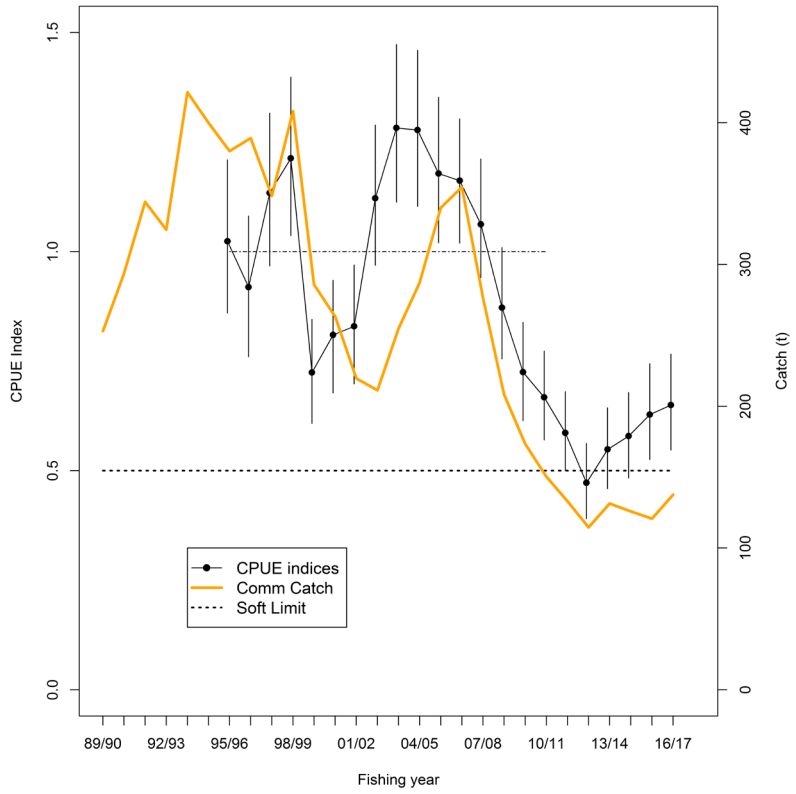
Estimates of absolute reference and current biomass are not available.

5. STATUS OF THE STOCKS

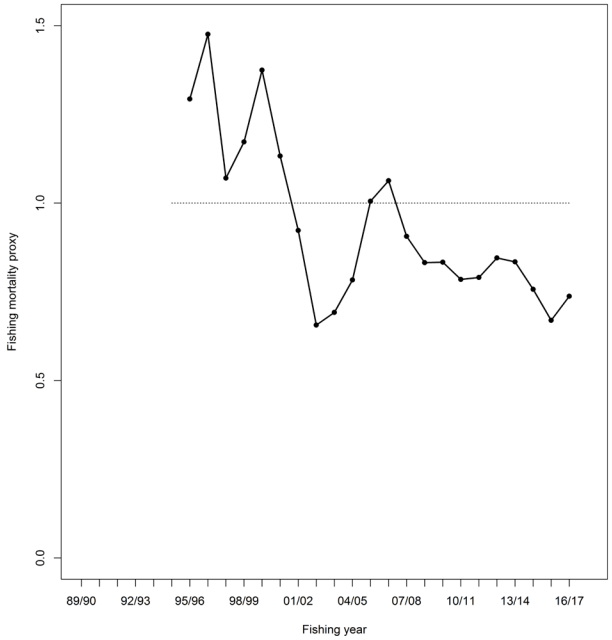
- **JDO 1 (Hauraki Gulf and east Northland)**

Stock Status	
Year of Most Recent Assessment	2018
Assessment Runs Presented	Standardised CPUE
Reference Points	Interim Target: Mean of the CPUE indices for John dory in Hauraki Gulf and east Northland from combined binomial and lognormal models from 1995–96 to 2010–11 Soft Limit: 50% of target Hard Limit: 25% of target Overfishing threshold: F_{MSY}
Status in relation to Target	Very Unlikely (< 10%) to be at or above the target
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	Unlikely (< 40%) that overfishing is occurring

Historical Stock Status Trajectory and Current Status



Standardised CPUE indices for John dory in Hauraki Gulf and east Northland from combined binomial and lognormal models of catch rate in bottom trawl tows in a mixed target fishery. Broken horizontal lines indicate the target and soft limit. The commercial catch from the area is also presented. Vertical lines show the 95% confidence intervals.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	The CPUE indices steadily declined from the mid-2000s to approximate the soft limit in 2012–13. The CPUE indices have increased over the last four years and the 2016–17 index is 65% of the target CPUE level.
Recent Trend in Fishing Intensity or Proxy	 **Relative fishing mortality proxy derived from total area catch divided by CPUE indices from the recent CPUE analysis (black points). The horizontal line represents the average fishing mortality in the period used to define the reference points.**

	The fishing mortality proxy indicates that fishing mortality has been lower in the recent period as total catch from the fishery has declined more than the decline in CPUE and catches have remained low during the last four years, while CPUE increased. The absolute level of fishing mortality that corresponds to the target biomass level is unknown.
Other Abundance Indices	The trend in Danish seine CPUE indices from the Hauraki Gulf fishery is comparable to the BT CPUE index (to 2013–14).
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Annual catches and fishing mortality have been relatively low over the last five years. There has been a modest increase in the CPUE indices over the last 4 years indicating the stock is rebuilding slowly. It is likely that recruitment had been low during the preceding period. The continued rebuilding of the stock to the target biomass level will depend on future levels of recruitment.
Probability of Current Catch or TAC causing Biomass to remain below or to decline below Limits	Soft Limit: Unlikely (< 40%) at the current catch levels (which are the lowest of the time-series) Hard Limit: Very Unlikely (< 10%) over the next five years at current catch levels
Probability of Current Catch or TAC causing Overfishing to continue or to commence	Current catch is Unlikely (< 40%) to cause overfishing

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE	
Assessment Dates	Latest assessment: 2018	Next assessment: 2021
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	- Lack of information on incoming recruitment	

Qualifying Comments
As CPUE is at a relatively low level the stock status should be routinely monitored. It is intended to update the CPUE analysis in 2021.

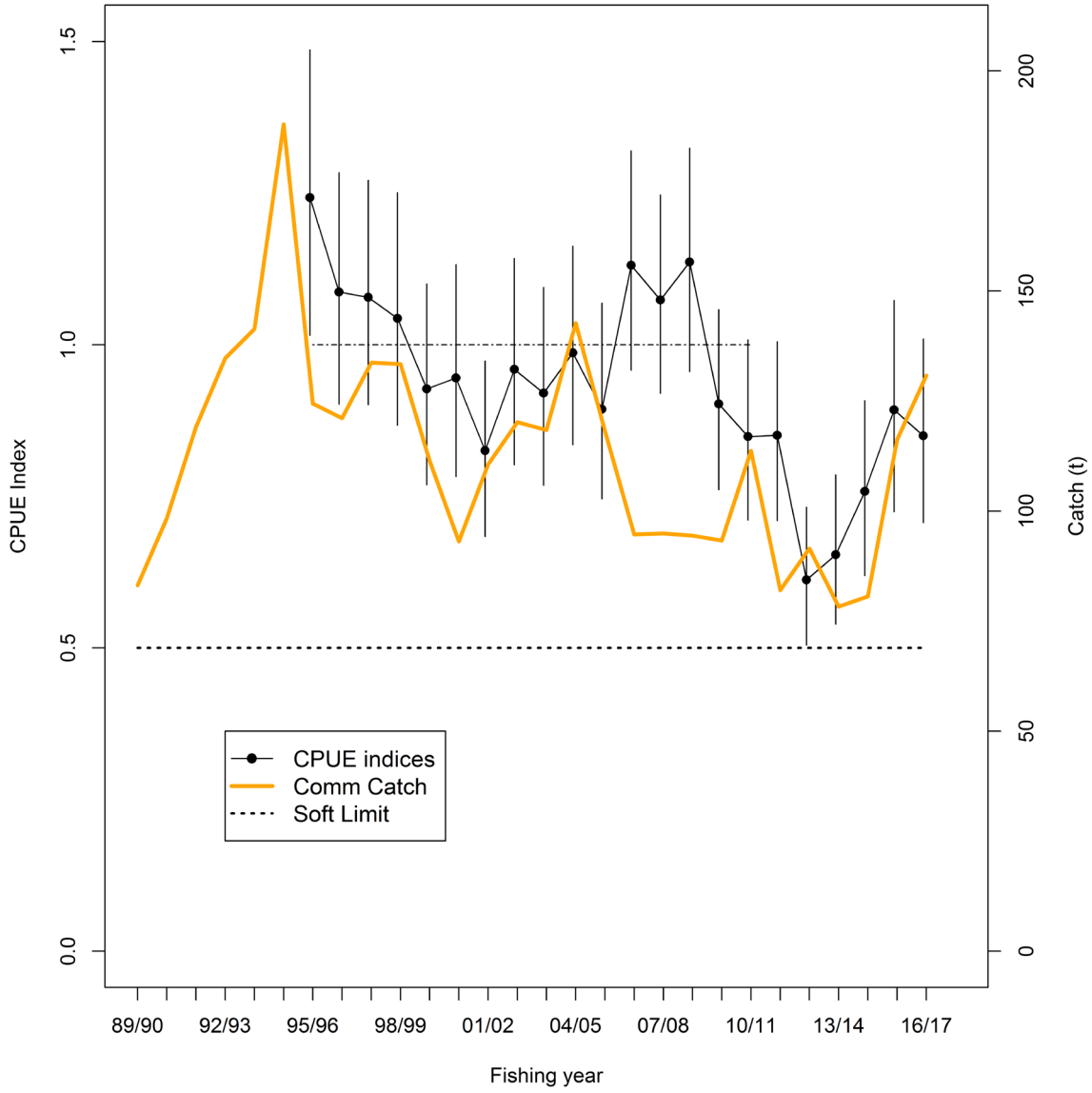
Fishery Interactions
John dory is taken on the east coast by bottom trawl and Danish seine targeted at John dory and snapper. Interactions with other species are currently being characterised.

- **JDO 1 (Bay of Plenty)**

Stock Status	
Year of Most Recent Assessment	2018
Assessment Runs Presented	Standardised CPUE
Reference Points	Interim Target: Mean of the CPUE indices for John dory in Bay of Plenty from combined binomial and lognormal models from 1994–95 to 2010–11 Soft Limit: 50% of target Hard Limit: 25% of target

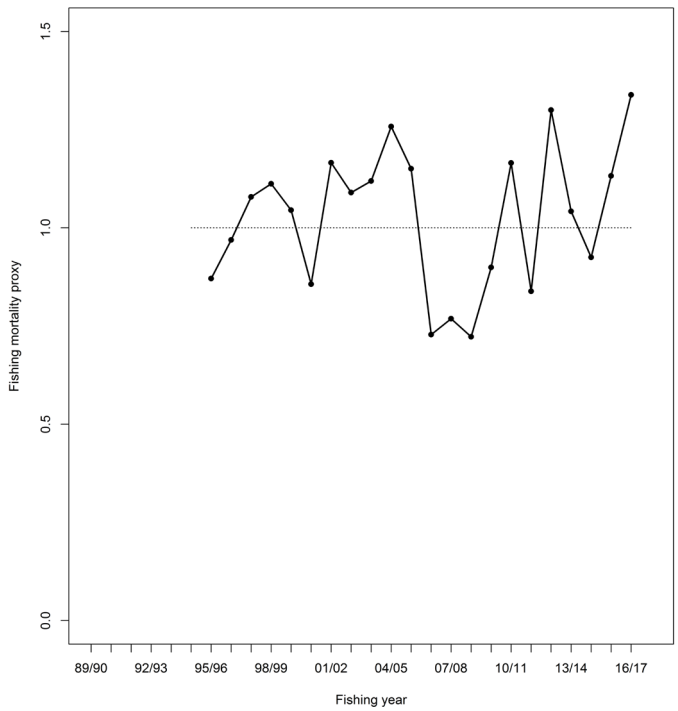
	Overfishing threshold F_{MSY}
Status in relation to Target	Unlikely (< 40%) to be at or above the target
Status in relation to Limits	Soft Limit: Very Unlikely (< 10%) to be below Hard Limit: Very Unlikely (< 10%) to be below
Status in relation to Overfishing	Likely (> 60%) that overfishing is occurring

Historical Stock Status Trajectory and Current Status



Standardised CPUE indices for John dory in Bay of Plenty from combined binomial and lognormal models of catch rate in bottom trawl tows in a mixed target fishery. Broken horizontal lines indicate the target and soft limit. The total catch from the area is also presented. Vertical lines show the 95% confidence intervals.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	The CPUE indices fluctuated over the time-series and reached the lowest level in 2012–13. The CPUE indices increased in subsequent years and the 2016–17 index was at 85% of the target biomass level.

Recent Trend in Fishing Mortality or Proxy	 **Relative fishing mortality proxy derived from total area catch divided by CPUE indices from the recent CPUE analysis (black points). The horizontal line represents the average fishing mortality in the period used to define the reference points.** The fishing mortality proxy has increased since 2008–09 and in 2016–17 was 34% higher than the reference (F_{MSY} proxy) level.
Other Abundance Indices	The general trend in Danish seine CPUE indices from the Bay of Plenty fishery is comparable to the BT CPUE index (to 2013–14).
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Annual catches have increased considerably over the last three years following the increase in abundance (as indexed by CPUE). There has been an increasing trend in fishing mortality over the last 8 years and fishing mortality in 2016–17 was the highest in the series and considerably higher than the reference level. The current (higher) level of the fishing mortality may cause the stock to begin to decline.
Probability of Current Catch or TAC causing Biomass to remain below or to decline below Limits	Soft Limit: Unlikely (< 40%) at current catch levels Hard Limit: Very Unlikely (< 10%) at current catch levels
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Likely (> 60%) at the current level of catch

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Fishery characterisation and standardised CPUE	
Assessment Dates	Latest assessment: 2018	Next assessment: 2021
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- 2018 CPUE analysis	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	-	

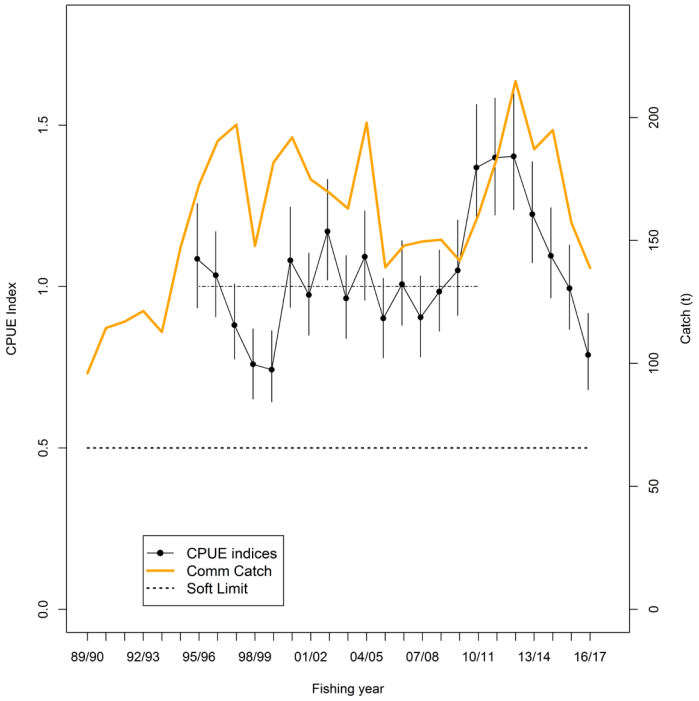
Qualifying Comments
Stock biomass is variable, probably in response to recruitment variation, and the stock abundance had increased in recent years This makes it difficult to predict future trends without recruitment information. Total fishing effort by the Danish seine fleet increased in 2015–16 to 2016–17, while effective effort in the trawl fishery also increased in the same period.

Fishery Interactions
John dory is taken in the Bay of Plenty by bottom trawl targeted at John dory, snapper, trevally, tarakihi and gurnard; and by Danish seine targeted at snapper and gurnard. Interactions with other species are currently being characterised.

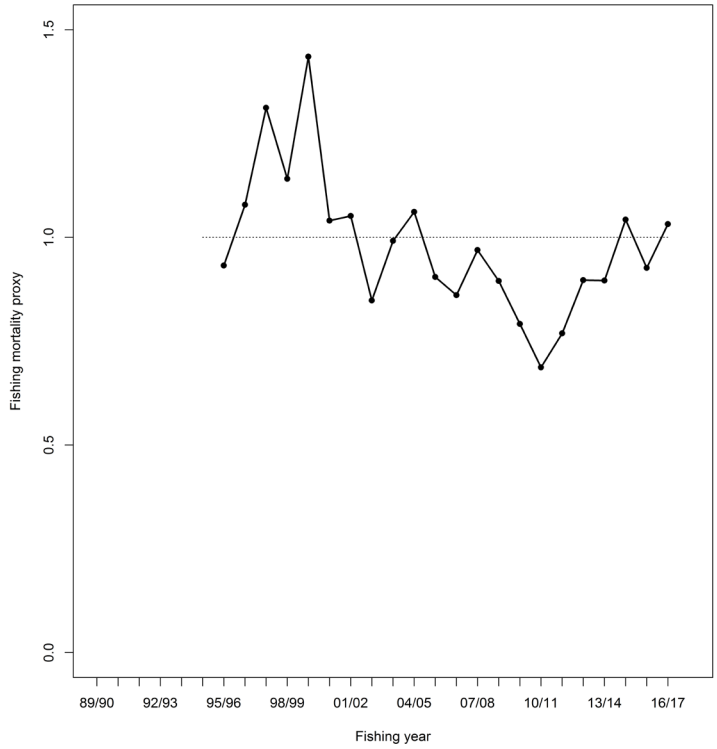
- **JDO 1 (West Coast North Island)**

Stock Status	
Year of Most Recent Assessment	2018
Assessment Runs Presented	Standardised CPUE
Reference Points	Interim Target: Mean of the CPUE indices for John dory on West Coast North Island from combined binomial and lognormal models from 1994–95 to 2010–11 Soft Limit: 50% of target Hard Limit: 25% of target Overfishing threshold: F_{MSY}
Status in relation to Target	Unlikely (< 40%) to be at or above the target
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	About as Likely as Not (40–60%) to be occurring

Historical Stock Status Trajectory and Current Status



Standardised CPUE indices for John dory in West Coast North Island from combined binomial and lognormal models of catch rate in bottom trawl tows in a mixed target fishery. Broken horizontal lines indicate the target and soft limit. Vertical lines show the 95% confidence intervals. Commercial catch represents the catch from this area.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	CPUE indices have fluctuated over the time series. CPUE indices were at the highest level in 2010–11 to 2012–13 and declined over the next four years. The 2016–17 CPUE index is at 79% of the target biomass level.
Recent Trend in Fishing Intensity or Proxy	 **Relative fishing mortality proxy derived from total area catch divided by CPUE indices from the recent CPUE analysis (black points). The horizontal line represents the average fishing mortality in the period used to define the reference points.** Fishing mortality was at a relatively low level in 2010–11 to 2012–13 (corresponding to the high CPUE indices). Fishing mortality has been maintained at about the reference level during 2014–15 to 2016–17.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Likely to fluctuate above the soft limit.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unlikely (< 40%) at current catch levels Hard Limit: Very Unlikely (< 10%) at current catch levels
Probability of Current Catch or TACC causing Overfishing to continue or to commence	About as Likely as Not (40 – 60%%) at current catch levels

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Fishery characterisation and standardised CPUE	
Assessment Dates	Latest assessment: 2018	Next assessment: 2021
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	2018 CPUE analysis	1 – High Quality
Data not used (rank)	N/A	

Changes to Model Structure and Assumptions	-
Major Sources of Uncertainty	- The stock relationship between JDO 1 and JDO 2

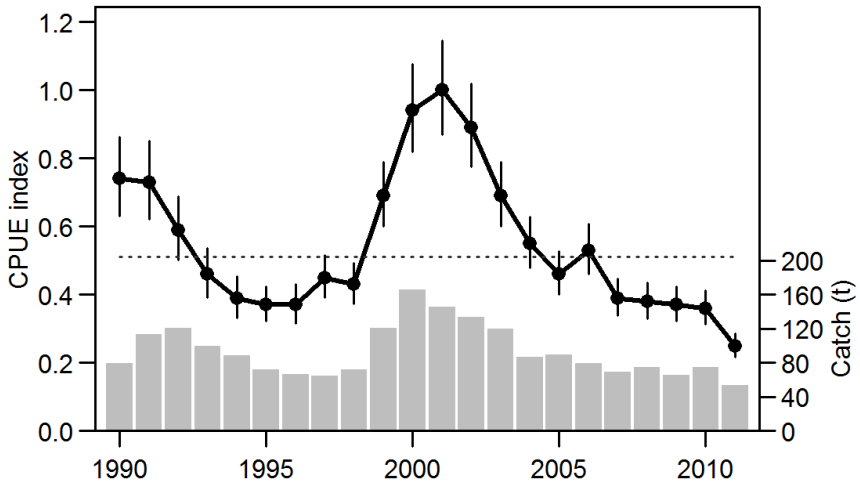
Qualifying Comments
-

Fishery Interactions
John dory is taken on the west coast by bottom trawl targeted at snapper trevally, gurnard and tarakihi. Interactions with other species are currently being characterised.

- **JDO 2 (Southeast North Island)**

Stock Status	
Year of Most Recent Assessment	2013
Assessment Runs Presented	Standardised CPUE
Reference Points	Interim Target: Mean of the CPUE indices for John dory in South East coast of the North Island from combined binomial and lognormal models from 1989–90 to 2010–11 Soft Limit: 50% of target Hard Limit: 25%of target Overfishing threshold F_{MSY}
Status in relation to Target	Unlikely (< 40%) to be at or above the target
Status in relation to Limits	Soft Limit: About as Likely as Not (40–60%) to be below Hard Limit: Unlikely (< 10%) to be below
Status in relation to Overfishing	Unknown

Historical Stock Status Trajectory and Current Status



Standardised CPUE indices for John dory in Southeast North Island from combined binomial and lognormal models of catch rate in bottom trawl trips in a mixed target fishery (Dunn & Jones 2013). Broken horizontal line indicates the mean from 1989–90 to 2010–11; Bars represent catch from this area.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	The CPUE series has fluctuated with a cyclical trend. The data points since 2006–07 have been below the long-term mean. 2010–11 is the lowest in the series.
Recent Trend in Fishing Intensity or Proxy	Unknown
Other Abundance Indices	-

Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Without information on recruitment, it is not possible to predict how the stock will respond in the next few years.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Likely (> 60%) Hard Limit: About as Likely as Not (40–60%)
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	Fishery characterisation and standardised CPUE	
Assessment Dates	Latest assessment: 2013	Next assessment: Unknown
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	- The stock relationship between JDO 1 and JDO 2 - Lack of information on incoming recruitment	

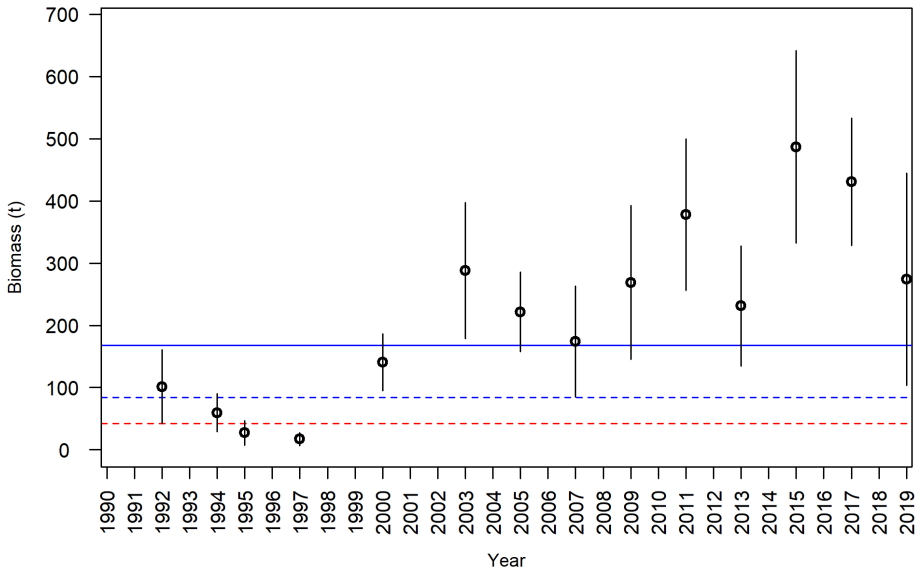
Qualifying Comments
As the John dory fishery in FMAs 1 and 9 has a long history, it is not possible to infer stock status from abundance trends from only the last 22 years. This sub-stock appears to be cyclical, probably in response to recruitment variation. This makes it difficult to predict future trends without recruitment information.

Fishery Interactions
John dory is taken on the east coast by bottom trawl targeted primarily at tarakihi and red gurnard. Interactions with other species are currently being characterised.

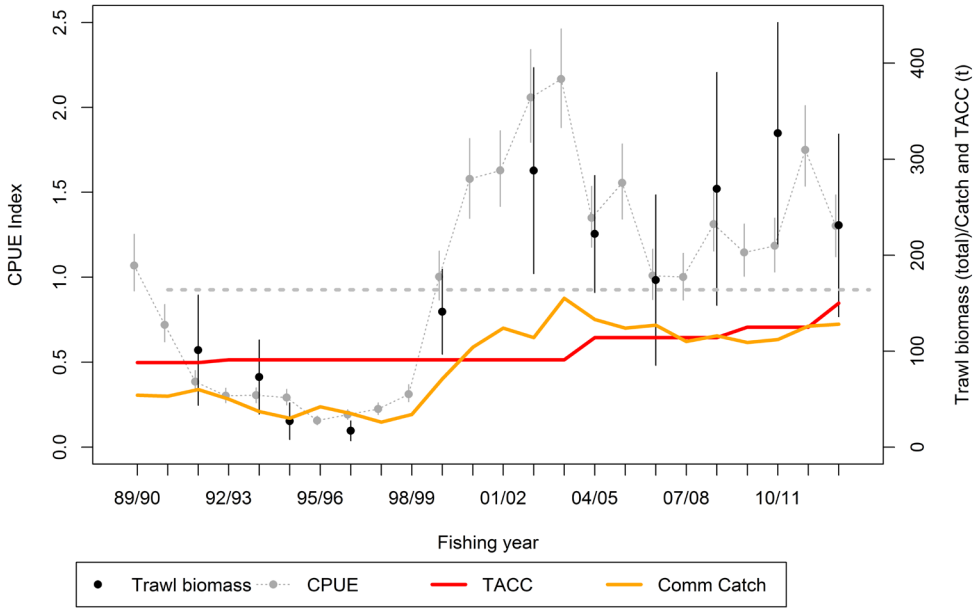
- **JDO 7 (Northern South Island)**

Stock Status	
Year of Most Recent Assessment	2018
Assessment Runs Presented	Trawl survey biomass index (2017) and standardised CPUE (2014)
Reference Points	Interim Target: Mean total biomass from the West Coast South Island trawl survey (WCSI and TBGB) from 1992 to 2011 Soft Limit: 50% of target Hard Limit: 25% of target Overfishing threshold F_{MSY}
Status in relation to Target	Very Likely (> 90%) to be at or above the target
Status in relation to Limits	Soft Limit: Very Unlikely (< 10%) to be below Hard Limit: Very Unlikely (< 10%) to be below
Status in relation to Overfishing	Overfishing is Very Unlikely (< 10%) to be occurring

Historical Stock Status Trajectory and Current Status



Biomass trends from the west coast South Island inshore trawl survey time series. Error bars are ± two standard deviations. The solid blue line represents the interim target and dashed blue and red lines the soft and hard limits, respectively.



A comparison of trends in trawl survey biomass estimates (total biomass, WCSI), CPUE indices and the commercial catch relative to the TACC. The dashed line represents the interim target biomass level relative to the trawl survey biomass indices.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	The trawl survey series declined through the 1990s then increased between 1997–98 and 2003–04. The 2019 estimate is down from the 2017 estimate and is more similar to the trend since 2003. The series has been above the long term mean since 2000–01. Trends in CPUE are comparable to trawl survey biomass trends.
Recent Trend in Fishing Intensity or Proxy	The commercial catch trends generally followed those of the trawl survey biomass estimates up to 2006–07. Since then, the annual catch has been maintained at about the annual TACC level, while trawl survey biomass has increased.
Other Abundance Indices	-

Trends in Other Relevant Indicators or Variables	Length frequency analysis from the West Coast South Island trawl survey showed very good recruitment in 2000, 2003 and 2009 and these are probably supporting the high biomass at this time. Recruitment from the 2011 and 2013 surveys was more modest but was again high in 2015 and 2017. Recruitment appears to be modest again in 2019.

Projections and Prognosis	
Stock Projections or Prognosis	The stock is currently at a relatively high level, above the interim target biomass level, and previous high catches appear to have been sustained by intermittent high recruitment. The strong 1+ year class seen in 2017 is likely to sustain biomass levels, at least in the short term.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unlikely (< 40%) Hard Limit: Very Unlikely (< 10%)
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Very Unlikely (< 10%), for TACC and current catch. Non target species so that even if abundance declines considerably the exploitation rates are unlikely to substantially increase.

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Evaluation of survey biomass and length frequencies. Standardised CPUE	
Assessment Dates	Latest assessment: 2018 (Survey) 2014 (CPUE)	Next assessment: 2021 (survey)
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- West Coast South Island trawl survey - Survey length frequency - CPUE	1 – High Quality 1 – High Quality 1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	- More complete data set obtained for CPUE analysis	
Major Sources of Uncertainty	- The stock relationship between JDO 7 and JDO 2	

Qualifying Comments
-

Fishery Interactions
John dory are primarily taken in conjunction with the following QMS species: barracouta, red cod, stargazer, red gurnard and tarakihi in the Northern South Island bottom trawl fishery. Interactions with other species are currently being characterised.

6. FOR FURTHER INFORMATION

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