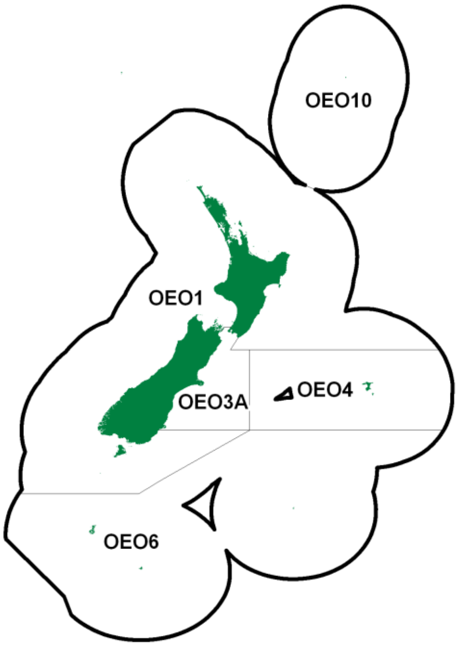
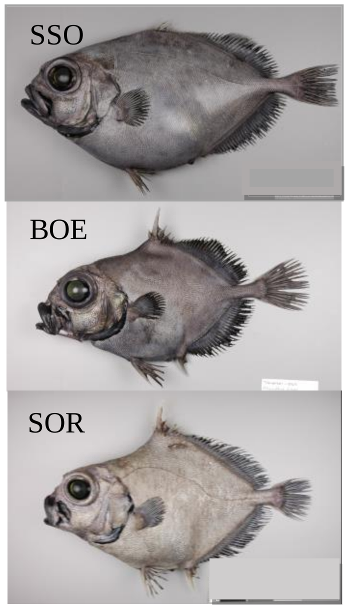
OREOS (OEO)

(*Allocyttus niger*, *Allocyttus verucosus*, *Neocyttus rhomboidalis* and *Pseudocyttus maculatus*)





1. INTRODUCTION

The main black oreo and smooth oreo fisheries have been assessed separately and individual reports produced for each as follows:

1. OEO 3A black oreo and smooth oreo
2. OEO 4 black oreo and smooth oreo
3. OEO 1 and OEO 6 black oreo and smooth oreo

2. BIOLOGY

2.1 Black oreo

Black oreo have been found within a 600 m to 1300 m depth range. The geographical distribution south of about 45° S is not well known. It is a southern species and is abundant on the south Chatham Rise, along the east coast of the South Island, the north and east slope of Pukaki Rise, the Bounty Platform, the Snares slope, Puysegur Bank and the northern end of the Macquarie Ridge. They most likely occur all around the slope of the Campbell Plateau.

Spawning occurs from late October to at least December and is widespread on the south Chatham Rise. Mean length at maturity for females, estimated from Chatham Rise trawl surveys (1986–87, 1990, 1991–93) using macroscopic gonad staging, is 34 cm TL.

They appear to have a pelagic juvenile phase, but little is known about this phase because only about 12 fish less than 21 cm TL have ever been caught. The pelagic phase may last for 4–5 years with lengths of up to 21–26 cm TL.

Unvalidated age estimates were obtained for Chatham Rise and Puysegur-Snares samples in 1995 and 1997 respectively using counts of the zones (assumed to be annual) observed in thin sections of otoliths. These estimates indicate that black oreo is slow growing and long lived. The maximum estimated age was 153 years (45.5 cm TL fish). Australian workers used the same methods, i.e., sections of otoliths,

and reported similar results A von Bertalanffy growth curve was fitted to the Puysegur samples only (Table 1). Estimated age at maturity for females was 27 years.
A first estimate of natural mortality (*M*), 0.044 (yr^{-1}), was made in 1997 using the Puysegur growth data only. This estimate is uncertain because it appeared that the otolith samples were taken from a well fished part of the Puysegur area.

Black oreo appear to settle over a wide range of depths on the south Chatham Rise, but appear to prefer to live in the depth interval 600–800 m that is often dominated by individuals with a modal size of 28 cm TL.

2.2 Smooth oreo

Smooth oreo occur from 650 m to about 1500 m depth. The geographical distribution south of about 45° S is not well known. It is a southern species and is abundant on the south Chatham Rise, along the east coast of the South Island, the north and east slope of Pukaki Rise, the Bounty Platform, the Snares slope, Puysegur Bank and the northern end of the Macquarie Ridge. They most likely occur all around the slope of the Campbell Plateau.

Spawning occurs from late October to at least December and is widespread on the south Chatham Rise in small aggregations. Mean length at maturity for females, estimated from Chatham Rise trawl surveys (1986–87, 1990, 1991–93) using macroscopic gonad staging, is 40 cm TL.

They appear to have a pelagic juvenile phase, but little is known about this phase because only about six fish less than 16 cm TL have ever been caught. The pelagic phase may last for 5–6 years with lengths of up to 16–19 cm TL.

Unvalidated age estimates were obtained for Chatham Rise and Puysegur-Snares fish in 1995 and 1997 respectively using counts of the zones (assumed to be annual) observed in thin sections of otoliths. These estimates indicate that smooth oreo is slow growing and long lived. The maximum estimated age was 86 years (51.3 cm TL fish). Australian workers used the same methods, i.e., sections of otoliths, and reported similar results. A von Bertalanffy growth curve was fitted to the age estimates from Chatham Rise and Puysegur-Snares fish combined and the parameters estimated for the growth curve are in Table 1. Estimated age at maturity for females was 31 years.

An estimate of natural mortality, 0.063 (yr^{-1}), was made in 1997. The estimate was from a moderately exploited population of fish from the Puysegur region. The Puysegur fishery started in 1989–90 and by August–September 1992 (when the otoliths were sampled) about 24% of the smooth oreo catch from 1989–90 to 1995–96 had been taken. Future estimates of *M* should, if possible, be made from an unexploited population.

There are concentrations of recently settled smooth oreo south and south west of Chatham Island, although small individuals (16–19 cm TL) occur widely over the south Chatham Rise at depths of 650–800 m.

Table 1: Biological parameters used for black oreo and smooth oreo stock assessments. Values not estimated are indicated by (-). [Continued on next page].

Fishstock			Estimate
1. Natural Mortality - *M* (yr^{1})			
	Females	Males	Unsexed
Black oreo	0.044	0.044	0.044
Smooth oreo	0.063	0.063	
2. Age at recruitment - A_r (yr)			
Black oreo	-	-	-
Smooth oreo	21	21	
3. Age at maturity A_M (yr)			
Black oreo	27	-	-
Smooth oreo	31	-	

Table 1 [Continued].

Fishstock									Estimate
4. von Bertalanffy parameters									
			Females			Males			Unsexed
	$L_{\infty(cm, TL)}$	$k(yr^{1})$	t_0 (yr)	$L_{\infty(cm, TL)}$	$k(yr^{1})$	t_0 (yr)	$L_{\infty(cm, TL)}$	$k(yr^{1})$	t_0 (yr)
Black oreo	39.9	0.043	-17.6	37.2	0.056	-16.4	38.2	0.05	-17.0
Smooth oreo	50.8	0.047	-2.9	43.6	0.067	-1.6			
5. Length-weight parameters (Weight = a(length)^b (Weight in g, length in cm fork length))									
			Females			Males			Unsexed
	a		b	a		b	a		b
Black oreo	0.008		3.28	0.016		3.06	0.0078		3.27
Smooth oreo	0.029		2.90	0.032		2.87			
6. Length at recruitment (cm, TL)									
			Females			Males			Unsexed
Black oreo			-			-			-
Smooth oreo			34			-			
7. Length at maturity (cm, TL)									
Black oreo			34			-			-
Smooth oreo			40			-			-
8. Recruitment variability (σ_R)									
Black oreo			0.65			0.65			0.65
Smooth oreo			0.65			0.65			
9. Recruitment seeepness									
Black oreo			0.75			0.75			0.75
Smooth oreo			0.75			0.75			
10. Fishing mortality (F_{max} (yr^{-1}))									
Black oreo			0.9			0.9			-
Smooth oreo			0.9			0.9			
11. Max exploitation (E_{max} (yr^{-1}))									
Black oreo			-			-			0.67

3. STOCKS AND AREAS

3.1 Black oreo

Stock structure of Australian and New Zealand samples was examined using genetic (allozyme and mitochondrial DNA) and morphological counts (fin rays, etc.). It was concluded that the New Zealand samples constituted a stock distinct from the Australian sample based on "small but significant difference in mtDNA haplotype frequencies (with no detected allozyme differences), supported by differences in pyloric caeca and lateral line counts". The genetic methods used may not be suitable tools for stock discrimination around New Zealand.

A New Zealand pilot study examined stock relationships using samples from four management areas (OEO 1, OEO 3A, OEO 4 and OEO 6) of the New Zealand EEZ. Techniques used included genetic (nuclear and mitochondrial DNA), lateral line scale counts, settlement zone counts, parasites, otolith microchemistry, and otolith shape. Lateral line scale and pyloric caeca counts were different between samples from OEO 6 and the other three areas. The relative abundance of three parasites differed significantly between all areas. Otolith shape from OEO 3A samples was different to that from OEO 1 and OEO 4, but OEO 1, OEO 4 and OEO 6 otolith samples were not morphologically different. Genetic, otolith microchemistry, and settlement zone analyses showed no regional differences.

3.2 Smooth oreo

Stock structure of Australian and New Zealand samples was examined using genetic (allozyme and mitochondrial DNA) and morphological counts (fin rays, etc.). No differences between New Zealand and Australian samples were found using the above techniques. A broad scale stock is suggested by these results but this seems unlikely given the large distances between New Zealand and Australia. The genetic methods used may not be suitable tools for stock discrimination around New Zealand.

A New Zealand pilot study examined stock relationships using samples from four management areas (OEO 1, OEO 3A, OEO 4 and OEO 6) of the New Zealand EEZ. Techniques used included genetic (nuclear and mitochondrial DNA), lateral line scale counts, settlement zone counts, parasites, otolith microchemistry, and otolith shape. Otolith shape from OEO 1 and OEO 6 was different to that from OEO 3A and OEO 4 samples. Weak evidence from parasite data, one gene locus and otolith microchemistry suggested that northern OEO 3A samples were different from other areas. Lateral line scale and otolith settlement zone counts showed no differences between areas.

These data suggest that the stock boundaries given in previous assessment documents should be retained until more definitive evidence for stock relationships is obtained, i.e., retain the areas OEO 1, OEO 3A, OEO 4, and OEO 6 (see the figure on the first page of the Oreos assessment report above).

The four species of oreos (black oreo, smooth oreo, spiky oreo, and warty oreo) are managed with separate catch limits for black and smooth in some areas. Each species could be managed separately. They have different depth and geographical distributions, different stock sizes, rates of growth, and productivity.

4. FISHERY SUMMARY

4.1 Commercial fisheries

Commercial fisheries occur for black oreo (BOE) and smooth oreo (SSO). Oreos are managed as a species group, which also includes spiky oreo (SOR). The Chatham Rise (OEO 3A and OEO 4) is the main fishing area, but other fisheries occur off Southland on the east coast of the South Island (OEO 1/OEO 3A), and on the Pukaki Rise, Macquarie Ridge, and Bounty Plateau (OEO 6). In the past oreo catch has been taken as bycatch of the more valuable orange roughy fisheries but target fisheries are now much more common in most areas for smooth or black oreo.

Total reported landings of oreos and TACs are shown in Table 2, while Figure 1 depicts the historical landings and TACC values for the main OEO stocks. OEO 3A and OEO 4 were introduced into the QMS in 1982–83, while OEO 1 and OEO 6 were introduced later in 1986–87. Total oreo catch from OEO 4 exceeded the TAC from 1991–92 to 1994–95 and was close to the TAC from 1995–96 to 2000–01 (Table 2). Catch remained high in OEO 4 while the orange roughy fishery has declined. The OEO 4 TAC was reduced from 7000 to 5460 t in 2001–02 but was restored to 7000 t in 2003–04. The oreo catch from OEO 3A was less than the TAC from 1992–93 to 1995–96, substantially so in 1994–95 and 1995–96. The OEO 3A TAC was reduced from 10 106 to 6600 t in 1996–97. A voluntary agreement between the fishing industry and the Minister of Fisheries to limit catch of smooth oreo from OEO 3A to 1400 t of the total oreo TAC of 6600 t was implemented in 1998–99. Subsequently the total OEO 3A TAC was reduced to 5900 t in 1999–00, 4400 in 2000–01, 4095 in 2001–02 and 3100 t in 2002–03. Catch from the Sub-Antarctic area (OEO 6) increased substantially in 1994–95 and exceeded the TAC in 1995–96. The OEO 6 TAC was increased from 3000 to 6000 t in 1996–97. There was also a voluntary agreement not to fish for oreos in the Puysegur area which started in 1998–99. OEO 1 was fished under the adaptive management programme up to the end of 1997–98. The OEO 1 TAC reverted back to pre-adaptive management levels from 1998–99.Catches have declined since then, and from 1 October 2007 the TACC was reduced to 2500 t, and other sources of mortality were allocated 168 t.

Reported estimated catches by species from tow by tow data recorded in catch and effort logbooks (Deepwater, TCEPR, and CELR) and the ratio of estimated to landed catch reported are given in Table 3.

Table 2: Total reported landings (t) for all oreo species combined by Fishstock from 1978–79 to 2013–14 and TACs (t) from 1982–83 to 2013–14.

Fishing	OEO 1		OEO 3A		OEO 4		OEO 6		Totals	
year	Landings	TAC	Landings	TAC	Landings	TAC	Landings	TAC	Landings	TAC
1978–79*	2 808	-	1 366	-	8 041	-	17	-	12 231	-
1979–80*	143	-	10 958	-	680	-	18	-	11 791	-
1981–82*	21	-	12 750	-	9 296	-	4 380	-	25 851	-
1982–83*	162	-	8 576	10 000	3 927	6 750	765	-	26 514	-
1983–83#	39	-	4 409	#	3 209	#	354	-	13 680	17 000
1983–84†	3 241	-	9 190	10 000	6 104	6 750	3 568	-	8 015	#
1984–85†	1480	-	8 284	10 000	6 390	6 750	2 044	-	22 111	17 000
1985–86†	5 390	-	5 331	10 000	5 883	6 750	126	-	18 204	17 000
1986–87†	532	4 000	7 222	10 000	6 830	6 750	0	3 000	16 820	17 000
1987–88†	1 193	4 000	9 049	10 000	8 674	7 000	197	3 000	15 093	24 000
1988–89†	432	4 233	10 191	10 000	8 447	7 000	7	3 000	19 159	24 000
1989–90†	2 069	5 033	9 286	10 106	7 348	7 000	0	3 000	19 077	24 233
1990–91†	4 563	5 033	9 827	10 106	6 936	7 000	288	3 000	18 703	25 139
1991–92†	4 156	5 033	10 072	10 106	7 457	7 000	33	3 000	21 614	25 139
1992–93†	5 739	6 044	9 290	10 106	7 976	7 000	815	3 000	21 718	25 139
1993–94†	4 910	6 044	9 106	10 106	8 319	7 000	983	3 000	23 820	26 160
1994–95†	1 483	6 044	6 600	10 106	7 680	7 000	2 528	3 000	23 318	26 160
1995–96†	4 783	6 044	7 786	10 106	6 806	7 000	4 435	3 000	18 291	26 160
1996–97†	5 181	6 044	6 991	6 600	6 962	7 000	5 645	6 000	23 810	26 160
1997–98†	2 681	6 044	6 336	6 600	7 010	7 000	5 222	6 000	24 779	25 644
1998–99†	4 102	5 033	5 763	6 600	6 931	7 000	5 287	6 000	21 249	25 644
1999–00†	3 711	5 033	5 859	5 900	7 034	7 000	5 914	6 000	22 083	24 633
2000–01†	4 852	5 033	4 577	4 400	7 358	7 000	5 932	6 000	22 518	23 933
2001–02†	4 197	5 033	3 923	4 095	4 864	5 460	5 737	6 000	22 719	22 433
2002–03†	3 034	5 033	3 070	3 100	5 402	5 460	6 115	6 000	18 721	20 588
2003–04†	1 703	5 033	2 856	3 100	6 735	7 000	5 811	6 000	17 621	19 593
2004–05†	1 025	5 033	3 061	3 100	7 390	7 000	5 744	6 000	17 105	21 133
2005–06†	850	5 033	3 333	3 100	6 829	7 000	6 463	6 000	17 220	21 133
2006–07†	903	5 033	3 073	3 100	7 211	7 000	5 926	6 000	17 475	21 133
2007–08†	947	2 500	3 092	3 100	7 038	7 000	5 902	6 000	17 113	21 133
2008–09†	582	2 500	2 848	3 100	6 907	7 000	5 540	6 000	16 979	18 600
2009–10†	464	2 500	3 550	3 350	7 047	7 000	5 730	6 000	15 877	18 600
2010–11†	381	2 500	3 370	3 350	7 061	7 000	3 610	6 000	16 791	18 850
2011–12†	581	2 500	3 324	3 350	6 858	7 000	2 325	6 000	14 422	18 860
2012–13	652	2 500	3 245	3 350	6 944	7 000	136	6 000	13 088	18 860
2013-14	386	2 500	3 473	3 350	7 024	7 000	367	6 000	11 251	18 860

Source: FSU from 1978–79 to 1987–88; QMS/MFish/MPI from 1988–89 to 2013–14. *, 1 April to 31 March. #, 1 April to 30 September. Interim TACs applied. †, 1 October to 30 September. Data prior to 1983 were adjusted up due to a conversion factor change

Table 3: Reported estimated catch (t) by species (smooth oreo (SSO), black oreo (BOE) by Fishstock from 1978–79 to 2007–08 and the ratio (percentage) of the total estimated SSO plus BOE, to the total reported landings (from Table 2. -, less than 1. No catch split available for 2008–09.

				SSO				BOE	Total estimated	Estimated landings (%)
Year	OEO 1	OEO 3A	OEO 4	OEO 6	OEO 1	OEO 3A	OEO 4	OEO 6		
1978–79*	0	0	0	0	9	0	0	0	9	-
1979–80*	16	5 075	114	0	118	5 588	566	18	11 495	98
1980–81*	1	1 522	849	2	66	8 758	5 224	215	16 637	64
1981–82*	21	1 283	3 352	2	0	11 419	5 641	4 378	26 096	98
1982–83*	28	2 138	2 796	60	6	6 438	1 088	705	13 259	97
1983–83#	9	713	1 861	0	1	3 693	1 340	354	7 971	100
1983–84†	1 246	3 594	4 871	1 315	1 751	5 524	1 214	2 254	21 769	99
1984–85†	828	4 311	4 729	472	544	3 897	1 651	1 572	18 004	99
1985–86†	4 257	3 135	4 921	72	1 060	2 184	961	54	16 644	99
1986–87†	326	3 186	5 670	0	163	4 026	1 160	0	14 531	96
1987–88†	1 050	5 897	7 771	197	114	3 140	903	0	19 072	100
1988–89†	261	5 864	6 427	-	86	2 719	1 087	0	16 444	86
1989–90†	1 141	5 355	5 320	-	872	2 344	439	-	15 471	83
1990–91†	1 437	4 422	5 262	81	2 314	4 177	793	222	18 708	87
1991–92†	1 008	6 096	4 797	2	2 384	3 176	1 702	15	19 180	88
1992–93†	1 716	3 461	3 814	529	3 768	3 957	1 326	69	18 640	78
1993–94†	2 000	4 767	4 805	808	2 615	4 016	1 553	35	20 599	88
1994–95†	835	3 589	5 272	1 811	385	2 052	545	230	14 719	81
1995–96†	2 517	3 591	5 236	2 562	1 296	3 361	364	1 166	20 093	84
1996–97†	2 203	3 063	5 390	2 492	2 578	3 549	530	1 950	21 755	88
1997–98†	1 510	4 790	5 868	2 531	1 027	1 623	811	1 982	20 142	95
1998–99†	2 958	2367	5 613	3 462	820	3 147	844	1 231	20 442	93
1999–00†	2 533	1 733	5 985	4 306	970	3 943	628	1 043	21 142	94

Table 3 [Continued]:

Year	OEO 1	OEO 3A	OEO 4	SSO OEO 6	OEO 1	OEO 3A	OEO 4	BOE OEO 6	Total estimated	Estimated landings (%)
2001–02†	2 973	1 769	3 806	4 470	697	2 378	515	983	17 591	94
2002–03†	2 521	1 395	4 105	3 941	481	1 636	868	1 640	16 587	94
2003–04†	1 046	1 244	5 082	3 767	458	1 590	973	1 496	15 656	92
2004–05†	665	1 447	5 848	3 840	234	1 594	851	1 580	16 059	93
2005–06†	529	1 354	5 145	3 289	265	1 770	763	2 616	15 731	90
2006–07†	530	1 220	5 863	2 214	263	1 651	795	3 071	15 607	91
2007–08†	407	1 482	6 150	2 182	429	1 521	592	3 022	15 785	93

Source: FSU from 1978–79 to 1987–88 and MFish from 1988–89 to 2006–07 * 1 April to 31 March. #, 1 April to 30 September. †, 1 October to 30 September.

Descriptive analyses of the main New Zealand oreo fisheries were updated with data from 2006–07 in 2008. Standardised CPUE analyses of black and smooth oreo have been updated as follows:

- smooth oreo in OEO 3A in 2009;
- black oreo in OEO 4 in 2009;
- black oreo in OEO 6 (Pukaki) in 2009;
- smooth oreo OEO 6 (Bounty) in 2008;
- black oreo in OEO 3A in 2008;
- smooth oreo in OEO 4 in 2007;
- smooth oreo in Southland (OEO 1 and OEO 3A)in 2007;
- smooth oreo OEO 6 (Pukaki) in 2006.

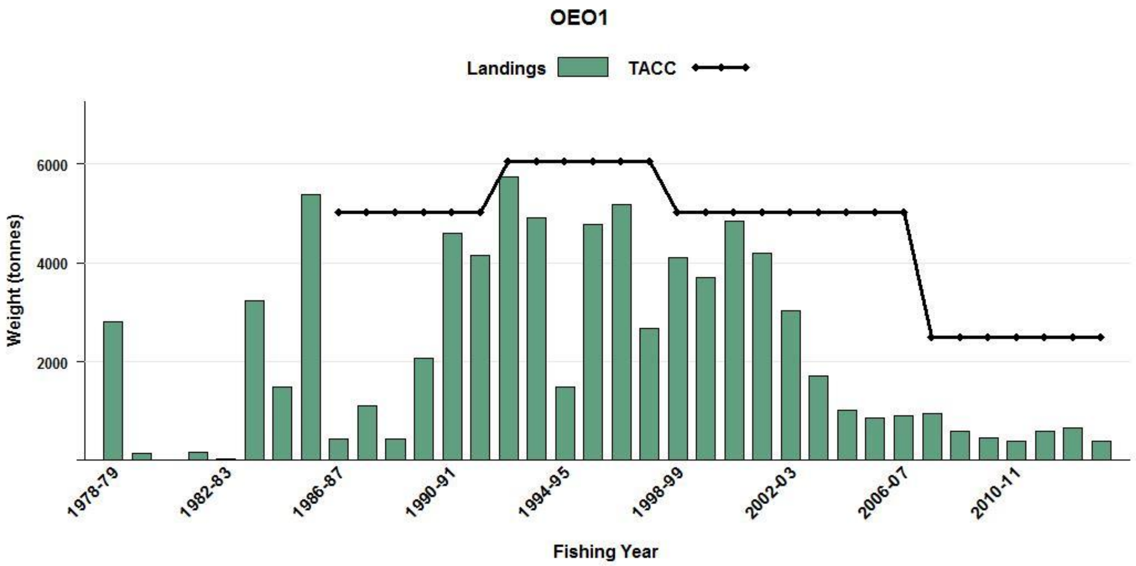


Figure 1: Reported commercial landings and TACC for the four main OEO stocks. OEO 1 (Central East - Wairarapa, Auckland, Central Egmont, Challenger, Southland, South East Catlin Coast). [Continued on next page].

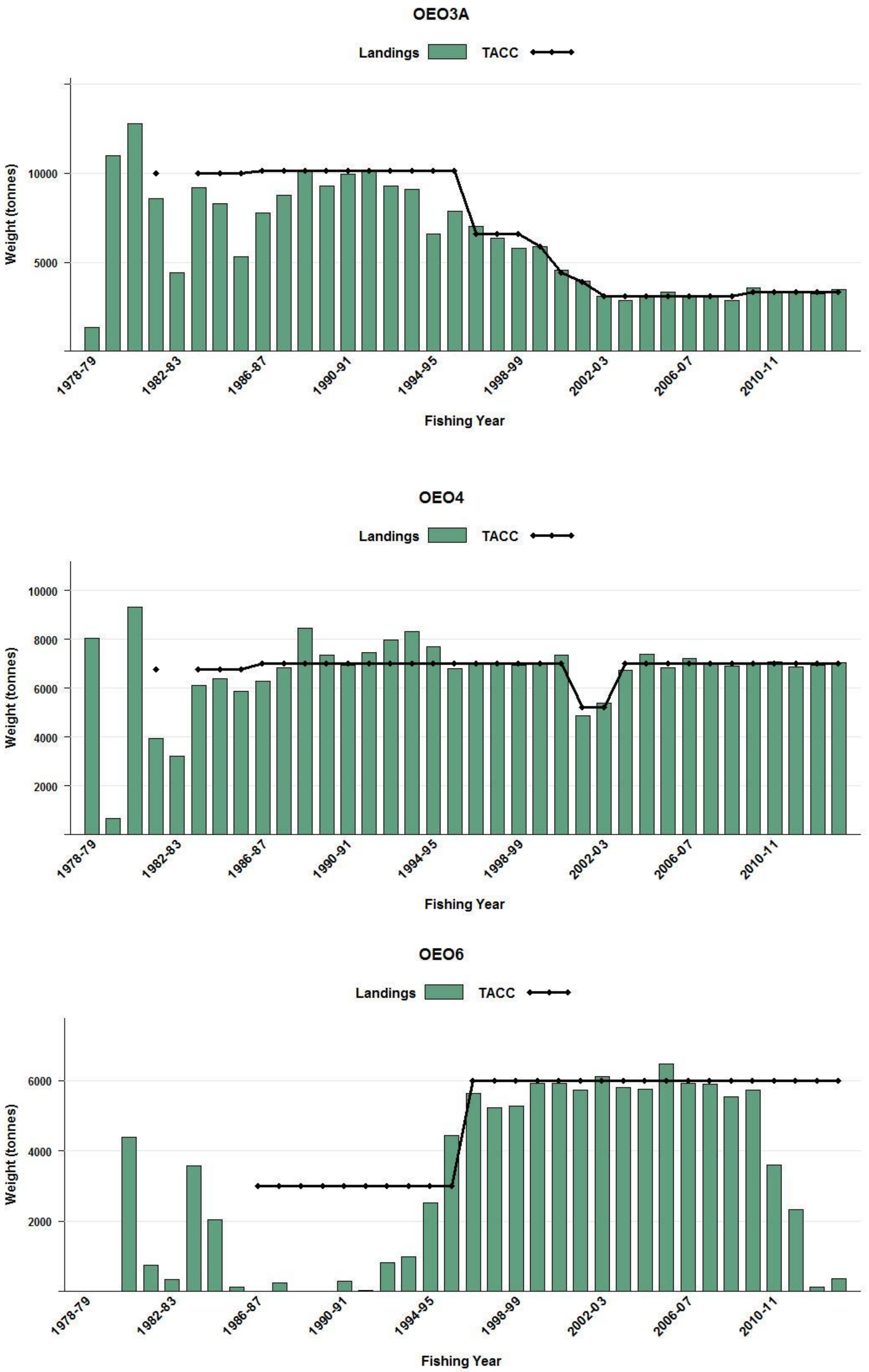


Figure 1 [Continued]: Figure 1: Reported commercial landings and TACC for the four main OEO stocks. From top to bottom: OEO 3A (South East Cook Strait/Kaikoura/Strathallan), OEO 4 (South East Chatham Rise), and OEO 6 (Sub-Antarctic).

4.2 Recreational fisheries
There are no known recreational fisheries for black oreo and smooth oreo.

4.3 Customary non-commercial fisheries
There is no known customary non-commercial fishing for black oreo and smooth oreo.

4.4 Illegal catch
Estimates of illegal catch are not available.

4.5 Other sources of mortality
Dumping of unwanted or small fish and accidental loss of fish (lost codends, ripped codends, etc.) were features of oreo fisheries in the early years. These sources of mortality were probably substantial in those early years but are now thought to be relatively small. No estimate of mortality from these sources has been made because of the lack of hard data and because mortality now appears to be small. Estimates of discards of oreos were made for 1994–95 and 1995–96 from MFish observer data. This involved calculating the ratio of discarded oreo catch to retained oreo catch and then multiplying the annual total oreo catch from the New Zealand EEZ by this ratio. Estimates were 207 and 270 t for 1994–95 and 1995–96 respectively.

5. ENVIRONMENTAL AND ECOSYSTEM CONSIDERATIONS

This section was updated for the 2013 Fishery Assessment Plenary after review by the Aquatic Environment Working Group. An issue-by-issue analysis is available in the 2012 Aquatic Environment and Biodiversity Annual Review (www.mpi.govt.nz/Default.aspx?TabId=126&id=1644).

5.1 Role in the ecosystem
Smooth and black oreo dominate trawl survey relative abundance estimates of demersal fish species at 650–1200 m on the south and southwest slope of the Chatham Rise (e.g., Hart & McMillan 1998). They are probably also dominant at those depths on the southeast slope of the South Island and other southern New Zealand slope areas including Bounty Plateau, and Pukaki Rise. They are replaced at depths of about 700–1200 m on the east and northern slope of Chatham Rise by orange roughy. The south Chatham Rise oreo fisheries are relatively long-standing, dating from Soviet fishing in the 1970s but the effects of extracting approximately 6000 t per year of smooth oreo from the south Chatham Rise (OEO 4) ecosystem between 1983–84 and 2012–13 are unknown.

5.1.1 Trophic interactions
Smooth oreo feed mainly on salps (80%), molluscs (9%, of which 8% are squids but also including octopods), and teleosts (5%) (percentage frequency of occurrence in stomachs with food, Stevens et al 2011). Black oreo feed on teleosts (48%), crustaceans (36%), salps (24%), and cephalopods (mainly squid, 6%) (Stevens et al 2011). Diet varies with fish size but salps remained the main prey for smooth oreo in the largest fish with small numbers of Scyphozoa, fish and squids. Salps were the main prey for smaller black oreo but amphipods and natant decapod crustaceans were important for intermediate sized fish (Clark et al 1989). Smooth oreo and black oreo occur with orange roughy at times. Orange roughy diet was mainly crustaceans (58%), teleosts (41%), and molluscs (10%, particularly squids) (frequency of occurrence, Stevens et al 2011) suggesting little overlap with the salp-dominated diet of smooth oreo. Where they co-occur, orange roughy and black oreo may compete for teleost and crustacean prey.

Predators of oreos probably change with fish size. Larger smooth oreo, black oreo and orange roughy were observed with healed soft flesh wounds, typically in the dorso-posterior region. Wound shape and size suggest they may be caused by one of the deepwater dogfishes (Dunn et al 2010).

5.1.2 Ecosystem indicators

Tuck et al. (2009) used data from the Sub-Antarctic and Chatham Rise middle-depth trawl surveys to derive indicators of fish diversity, size, and trophic level. However, fishing for oreos occurs mostly deeper than the depth range of these surveys and is only a small component of fishing in the areas considered by Tuck et al. (2009).

5.2 Incidental catch (fish and invertebrates)

Anderson (2011) summarised the bycatch of oreo trawl fisheries from 1990–91 to 2008–09. Since 2002, oreo species (mainly smooth oreo and black oreo) accounted for about 92% of the total estimated catch from all observed trawls targeting oreos. Orange roughy (3.5%) was the main bycatch species, with no other species or group of species accounting for more than 0.6% of the total catch. Hoki were the next most common bycatch species, followed by rattails, deepwater dogfishes, especially Baxter's dogfish (*Etmopterus baxteri*) and seal shark (*Dalatias licha*), slickheads, and basketwork eel (*Diastobranchus capensis*), all of which were usually discarded. Ling were also frequently caught, but only comprised about 0.3% of the total catch. In total, over 250 species or species groups were identified by observers in the target fishery. Total annual fish bycatch in the oreo fishery since 1990–91 ranged from about 270 t to 2200 t and, apart from some higher levels in the late 1990s, did not show any obvious trends. Bycatch was split almost evenly between commercial and non-commercial species although, since 2002, about 60% of the bycatch was of commercial species.

The main invertebrate bycatch includes corals (almost 0.4% of the total catch, Anderson 2011), squids and octopuses, king crabs, and echinoderms. Tracey et al (2011) analysed the distribution of nine groups of protected corals based on bycatch records from observed trawl effort from 2007–08 to 2009–10, primarily from 800–1000 m depth. For the oreo target fishery, the highest catches were reported from the north and south slopes of the Chatham Rise, east of the Pukaki Rise, and on the Macquarie Ridge.

5.3 Incidental catch (seabirds, mammals, and protected fish)

For protected species, capture estimates presented here *include* all animals recovered to the deck of fishing vessels (alive, injured or dead), but do not include any cryptic mortality (e.g., a seabird struck by a warp but not brought on board the vessel, Middleton & Abraham 2007, Brothers et al 2010). Ramm (2011, 2012a, 2012b) summarised observer data for combined bottom trawl fisheries for orange roughy, oreos, cardinalfish and listed annual captures of seabirds, and mammals from 2008–09 to 2010–11.

5.3.1 Marine mammal interactions

There have been no observed incidental captures of New Zealand sea lions by trawlers targeting oreos from 2002–03 to date, but occasional captures of New Zealand fur seals are observed (which were classified as "Not Threatened" under the New Zealand Threat Classification System in 2010, Baker et al 2010). Between 2002–03 and 2012–13, there were 8 observed captures of New Zealand fur seals in oreo trawl fisheries, all prior to 2008–09. In the 2011–12 fishing year there were no observed captures (Table 4) but there were 2 (95% c.i. 0–10) estimated captures, with the estimates made using a statistical model (Thompson et al 2013). All observed fur seal captures occurred in the Sub-Antarctic region. The average rate of capture for the last ten years was less than 0.00 per 100 tows (range 0–0.38). This is a very low rate compared with that in the hoki fishery (1.28–5.63 per 100 tows

Table 4: Number of tows by fishing year and observed and model-estimated total New Zealand fur seal captures in oreo trawl fisheries, 2002–03 to 2012–13. No. obs, number of observed tows; % obs, percentage of tows observed; Rate, number of captures per 100 observed tows, % inc, percentage of total effort included in the statistical model. Estimates are based on methods described in Thompson et al (2013) and available via http://www.fish.govt.nz/en-nz/Environmental/Seabirds/. Data for 2002–03 to 2011–12 are based on data version 20130304 and preliminary data for 2012–13 are based on data version 20140131.

		Observed				Estimated		
	Tows	No.obs	%obs	Captures	Rate	Captures	95%c.i.	%inc.
2002–03	2 834	302	10.7	0	0.00	3	0 – 14	100.0
2003–04	2 542	372	14.6	1	0.27	4	0 – 16	100.0
2004–05	2 571	495	19.3	1	0.20	11	0 – 61	96.3
2005–06	2 306	365	15.8	1	0.27	7	1 – 28	100.0
2006–07	2 255	1 079	47.8	1	0.09	2	1 – 5	100.0
2007–08	2 499	1 050	42.0	4	0.38	6	4 – 15	96.8
2008–09	2 167	893	41.2	0	0.00	2	0 – 11	96.2
2009–10	2 541	964	37.9	0	0.00	2	0 – 10	96.8
2010–11	1 899	612	32.2	0	0.00	2	0 – 12	100.0
2011–12†	1 660	428	25.8	0	0.00	2	0 – 10	100.0
2012–13†	1 278	157	12.3	0	0.00	-	-	-

† Provisional data, no model estimates available.

5.3.2 Seabird interactions

Annual observed seabird capture rates ranged from 0.1 to 3.5 per 100 tows in the combined orange roughy, oreo, and cardinalfish trawl fisheries between 1998–99 and 2007–08 (Baird 2001, 2004 a,b,c, 2005, Abraham et al 2009, Abraham & Thompson 2011). However, in the oreo trawl fisheries only, capture rates have not been above 1 bird per 100 tows since 2005–06 and have fluctuated without obvious trend at this low level (Table 5). In the 2011–12 fishing year there was 1 observed bird capture in the oreo trawl fisheries, a rate of 0.23 birds per 100 observed tows with estimated captures of 8 (3-16) per 100 tows (Abraham et al 2013, Table 5). The average capture rate in the oreo trawl fisheries over the last ten years was only 0.34 birds per 100 tows, a low rate relative to trawl fisheries for squid (13.78), scampi (5.57) and hoki (2.16), birds per 100 tows over the same period.

Table 5: Number of tows by fishing year and observed seabird captures in orange roughy, oreo, and cardinalfish trawl fisheries, 2002–03 to 2012–13. No. obs, number of observed tows; % obs, percentage of tows observed; Rate, number of captures per 100 observed tows. Estimates are based on methods described in Abraham et al (2013) and available via http://www.fish.govt.nz/en-nz/Environmental/Seabirds/. Data for 2002–03 to 2011–12 are based on data version 20130304 and preliminary data for 2012–13 are based on data version 20140131.

			Fishing effort	Observed captures				Estimated captures
	Tows	No. obs	% obs	Captures	Rate	Mean	95% c.i.	% included
2002–03	2 834	302	10.7	0	0.00	13	4–27	100.0
2003–04	2 542	372	14.6	0	0.00	13	4–27	100.0
2004–05	2 571	495	19.3	1	0.20	24	94–53	96.3
2005–06	2 306	365	15.8	5	1.37	20	10–38	100.0
2006–07	2 255	1 079	47.8	0	0.00	7	2–18	100.0
2007–08	2 499	1 050	42.0	3	0.29	11	4–21	96.8
2008–09	2 167	893	41.2	2	0.22	8	3–17	96.2
2009–10	2 541	964	37.9	6	0.62	11	5–20	96.8
2010–11	1 899	612	32.2	4	0.65	15	8–26	100.0
2011–12	1 660	428	25.8	1	0.23	8	3–16	100.0
2012 –13†	1 278	157	12.3	0	0.00	-	-	-

† Provisional data, no model estimates available.

Table 6: Number of observed seabird captures in oreo trawl fisheries, 2002–03 to 2012–13, by species and area. The risk ratio is an estimate of aggregate potential fatalities across trawl and longline fisheries relative to the Potential Biological Removals, PBR (from Richard & Abraham 2013 where full details of the risk assessment approach can be found). It is not an estimate of the risk posed by fishing for oreo. Other data, version 20130304.

Species	Risk Ratio	Chatham Rise	East Coast South Island	Subantarctic	Stewart-Snares Shelf	West Coast South Island	Total
Salvin's albatross	Very high	3	3	3	0	0	9
Chatham Island albatross	Very high	3	0	1	0	0	4
Total albatrosses	**N/A**	**6**	**3**	**4**	**0**	**0**	**13**
Cape petrel	High	0	1	0	0	0	1
White chinned petrel	Medium	0	1	0	0	0	1
Grey petrel	Medium	0	0	1	0	0	1
Sooty shearwater	Very low	0	3	0	1	0	4
NZ White-faced storm petrel	-	1	0	0	0	0	1
Total other birds	N/A	**1**	**5**	**1**	**1**	**0**	**8**

Salvin's albatross was the most frequently captured albatross (46% of observed albatross captures) but only two different species have been observed captured since 2002–03 (Table 6). Sooty shearwaters were the most frequently captured other taxon (50%, Table 6). Seabird captures in the oreo trawl fisheries were observed mostly off the east coast South Island. These numbers should be regarded as only a general guide on the distribution of captures because the observer coverage may not be representative.

Mitigation methods such as streamer (tori) lines, Brady bird bafflers, warp deflectors, and offal management are used in the orange roughy, oreo, and cardinalfish trawl fisheries. Warp mitigation was voluntarily introduced from about 2004 and made mandatory in April 2006 (Department of Internal Affairs 2006). The 2006 notice mandated that all trawlers over 28 m in length use a seabird scaring device while trawling (being "paired streamer lines", "bird baffler" or "warp deflector" as defined in the Notice).

5.4 Benthic interactions

Orange roughy, oreos, and cardinalfish are taken using bottom trawls and accounted for about 14% of all tows reported on TCEPR forms to have been fished on or close to the bottom between 1989–90 and 2004–05 (Baird et al 2011). Black et al (2013) estimated that, between 2006–07 and 2010–11, 97% of oreo catch was reported on TCEPR forms. Tows are located in Benthic Optimised Marine Environment Classification (BOMEC, Leathwick et al 2009) classes J, K (mid-slope), M (mid-lower slope), N, and O (lower slope and deeper waters) (Baird & Wood 2012), and 94% were between 700 and 1 200 m depth (Baird et al 2011). Deepsea corals in the New Zealand region are abundant and diverse and, because of their fragility, are at risk from anthropogenic activities such as bottom trawling (Clark & O'Driscoll 2003, Clark & Rowden 2009, Williams et al 2010). All deepwater hard corals are protected under Schedule 7A of the Wildlife Act 1953. Baird et al (2012) mapped the likely coral distributions using predictive models, and concluded that the fisheries that pose the most risk to protected corals are these deepwater trawl fisheries.

Trawling for orange roughy, oreo, and cardinalfish, like trawling for other species, is likely to have effects on benthic community structure and function (e.g., Rice 2006) and there may be consequences for benthic productivity (e.g., Jennings 2001, Hermsen et al 2003, Hiddink et al 2006, Reiss et al 2009). These consequences are not considered in detail here but are discussed in the Aquatic Environment and Biodiversity Annual Review (Ministry for Primary Industries 2012).

The New Zealand EEZ contains 17 Benthic Protection Areas (BPAs) that are closed to bottom trawl fishing and include about 52% of all seamounts over 1500 m elevation and 88% of identified hydrothermal vents.

5.5 Other considerations

5.5.1 Spawning disruption

Fishing during spawning may disrupt spawning activity or success. Morgan et al (1999) concluded that Atlantic cod (*Gadus morhua*) "exposed to a chronic stressor are able to spawn successfully, but there appears to be a negative impact of this stress on their reproductive output, particularly through the production of abnormal larvae". Morgan et al (1997) also reported that "Following passage of the trawl, a 300-m-wide "hole" in the [cod spawning] aggregation spanned the trawl track. Disturbance was detected for 77 min after passage of the trawl." There is no research on the disruption of spawning smooth oreo and black oreo by fishing in New Zealand, but spawning of both species appears to be over a protracted period (October to February) and over a wide area (O'Driscoll et al 2003). Fishing continues during the spawning period, possibly because localised spawning schools of smooth oreo, in particular, may provide good catch rates.

5.5.2 Genetic effects

Fishing, environmental changes, including those caused by climate change or pollution, could alter the genetic composition or diversity of a species. There are no known studies of the genetic diversity of smooth or black oreo from New Zealand. Genetic studies for stock discrimination are reported under "stocks and areas".

5.5.3 Habitat of particular significance to fisheries management

Habitat of particular significance for fisheries management does not have a policy definition currently although work is currently underway to generate one. O'Driscoll et al. (2003) identified the south Chatham Rise as important for smooth oreo spawning, and the north, east and south slope as important for juveniles. The south Chatham Rise is also important for black oreo spawning and juveniles. Deepsea corals such as the reef-forming scleractinian corals and gorgonian sea fan corals are thought to provide prey and refuge for deep-sea fish (Fosså et al 2002, Stone 2006, Mortensen et al 2008). Large aggregations of deepwater species like orange roughy, oreos, and cardinalfish occur above seamounts with high densities of such "reef-like" taxa, but it is not known if there are any direct linkages between the fish and corals. Bottom trawling for orange roughy, oreos, and cardinalifish has the potential to affect features of the habitat that could qualify as habitat of particular significance to fisheries management.

6. FOR FURTHER INFORMATION

Abraham, E.R.; Thompson, F.N. (2009). Capture of protected species in New Zealand trawl and longline fisheries, 1998–99 to 2006–07. *New Zealand Aquatic Environment and Biodiversity Report No. 32*. 197 p.

Abraham, E R; Thompson, F N (2011) Summary of the capture of seabirds, marine mammals, and turtles in New Zealand commercial fisheries, 1998–99 to 2008–09. *New Zealand Aquatic Environment and Biodiversity Report No. 80*.

Abraham, E R; Thompson, F N; Berkenbusch, K (2013) Estimated capture of seabirds in New Zealand trawl and longline fisheries, 2002–03 to 2010–11. Final Research Report for Ministry for Primary Industries project PRO2010-01 (Unpublished report held by Ministry for Primary Industries, Wellington).

Anderson, O F (2011) Fish and invertebrate bycatch and discards in orange roughy and oreo fisheries from 1990–91 until 2008–09. *New Zealand Aquatic Environment and Biodiversity Report No. 67*. 61 p.

Baird, S J (2001) Estimation of the incidental capture of seabird and marine mammal species in commercial fisheries in New Zealand waters, 1998–99. *New Zealand Fisheries Assessment Report 2001/14*.43 p.

Baird, S J (2004a) Estimation of the incidental capture of seabird and marine mammal species in commercial fisheries in New Zealand waters, 1999–2000. *New Zealand Fisheries Assessment Report 2004/41*. 56 p.

Baird, S J (2004b) Incidental capture of seabird species in commercial fisheries in New Zealand waters, 2000–01. *New Zealand Fisheries Assessment Report 2004/58*. 63 p.

Baird, S J (2004c) Incidental capture of seabird species in commercial fisheries in New Zealand waters, 2001–02. *New Zealand Fisheries Assessment Report 2004/60*. 51 p.

Baird, S J (2005) Incidental capture of seabird species in commercial fisheries in New Zealand waters, 2002–03. *New Zealand Fisheries Assessment Report 2005/2*. 50 p.

Baird, S J; Smith, M H (2007) Incidental capture of New Zealand fur seals (*Arctocephalus forsteri*) in commercial fisheries in New Zealand waters, 2003–04 to 2004–05. *New Zealand Aquatic Environment and Biodiversity Report No. 14*. 98 p.

Baird, S J; Wood, B A (2012) Extent of coverage of 15 environmental classes within the New Zealand EEZ by commercial trawling with seafloor contact. *New Zealand Aquatic Environment and Biodiversity Report 89*. 43 p.

Baird, S J; Wood, B A; Bagley, N W (2011) Nature and extent of commercial fishing effort on or near the seafloor within the New Zealand 200 n. mile Exclusive Economic Zone, 1989–90 to 2004–05. *New Zealand Aquatic Environmental and Biodiversity Report No. 73*. 48 p.

Baker, C S; Chilvers, B L; Constantine, R; DuFresne, S; Mattlin, R H; van Helden, A; Hitchmough, R (2010) Conservation status of New Zealand marine mammals (suborders Cetacea and Pinnipedia), 2009. *New Zealand Journal of Marine and Freshwater Research 44*: 101–115.

Ballara, S L; Anderson, O F (2009) Fish discards and non-target fish catch in the trawl fisheries for arrow squid and scampi in New Zealand waters. *New Zealand Aquatic Environment and Biodiversity Report No. 38*. 102 p.

Black, J; Wood, R; Berthelsen, T; Tilney, R (2013) Monitoring New Zealand's trawl footprint for deepwater fisheries: 1989–1990 to 2009–2010. *New Zealand Aquatic Environment and Biodiversity Report No. 110*. 57 p.

Clark, M R; Anderson, O F; Gilbert, D J (2000) Discards in trawl fisheries for southern blue whiting, orange roughy, hoki, and oreos in waters around New Zealand. *NIWA Technical Report 71*. 73 p.

Clark, M R; King, K J; McMillan, P J (1989) The food and feeding relationships of black oreo, *Allocyttus niger*, smooth oreo, *Pseudocyttus maculatus*, and eight other fish species from the continental slope of the south-west Chatham Rise, New Zealand. *Journal of Fish Biology* 35: 465–484.

Clark, M; O'Driscoll, R (2003) Deepwater fisheries and aspects of their impact on seamount habitat in New Zealand. *Journal of Northwest Atlantic Fishery Science 31*: 441–458.

Clark, M R; Rowden, A A (2009) Effect of deepwater trawling on the macro-invertebrate assemblages of seamounts on the Chatham Rise, New Zealand. *Deep Sea Research I 56*: 1540–1554.

Coburn, R P; McMillan, P J (2006) Descriptions of the black oreo and smooth oreo fisheries in OEO 1, OEO 3A, OEO 4, and OEO 6 from 1977–78 to the 2004–05 fishing years. *New Zealand Fisheries Assessment Report 2006/60*. 70 p.

Coburn, R P; McMillian, P J; Gilbert, D J (2007) Inputs for a stock assessment of smooth oreo, Pukaki Rise (part of OEO 6). *New Zealand Fisheries Assessment Report 2007/23*. 32 p.

Department of Internal Affairs. (2006) Seabird Scaring Devices – Circular Issued Under Authority of the Fisheries (Commercial Fishing) Amendment Regulations 2006 (No. F361). *New Zealand Gazette 6 April 2006* : 842–846.

Doonan, I J; McMillan, P J; Hart, A C (1997) Revision of smooth oreo life history parameters. New Zealand Fisheries Assessment Research Document 1997/9. 11 p. (Unpublished document held in NIWA library, Wellington.)

Doonan, I J; McMillian, P J; Hart, A C (2008) Ageing of smooth oreo otoliths for stock assessment. *New Zealand Fisheries Assessment Report 2008/08*. 29 p.

Doonan, I J; McMillan, P J; Kalish, J M; Hart, A C (1995) Age estimates for black oreo and smooth oreo. New Zealand Fisheries Assessment Research Document. 1995/14. 26 p. (Unpublished document held in NIWA library, Wellington.)

Dunn, M R; Szabo, A; McVeagh, M S; Smith, P J (2010) The diet of deepwater sharks and the benefits of using DNA identification of prey. *Deep-Sea Research I 57* 923–930.

Fosså J H; Mortensen P B; Furevik D M (2002) The deep-water coral *Lophelia pertusa* in Norwegian waters: distribution and fishery impacts. *Hydrobiologia* 471: 1–12.

Hart, A C; McMillan, P J (1998) Trawl survey of oreos and orange roughy on the south Chatham Rise, October–November 1995 (TAN9511). *NIWA Technical Report 27*. 48 p.

Hart, A C; McMillan, P J (2006) A summary of observer biological information on the New Zealand black oreo and smooth oreo fisheries from 1979–80 to 2004–05. *New Zealand Fisheries Assessment Report 2006/55*. 39 p.

Hermsen, J M; Collie, J S; Valentine, P C (2003) Mobile fishing gear reduces benthic megafaunal production on Georges Bank. *Marine Ecology Progress Series 260*: 97–108.

Hiddink, J G; Jennings, S; Kaiser, M J; Queiros, A M; Duplisea, D E; Piet, G J (2006) Cumulative impacts of seabed trawl disturbance on benthic biomass, production, and species richness in different habitats. *Canadian Journal of Fisheries and Aquatic Sciences 63*: 721–36.

Jennings, S; Dinmore, T A; Duplisea, D E; Warr, K J; Lancaster, J E (2001) Trawling disturbance can modify benthic production processes. *Journal of Animal Ecology 70*: 459–475.

Leathwick, J R; Rowden, A; Nodder, S; Gorman, R; Bardsley, S; Pinkerton, M; Baird, S J; Hadfield, M; Currie, K; Goh, A (2009) Benthic-optimised marine environment classification for New Zealand waters. Final Research Report for Ministry of Fisheries project BEN2006/01. 52 p. (Unpublished report held by Ministry for Primary Industries, Wellington.)

McKenzie, A (2007) Stock assessment for east Pukaki Rise smooth oreo (part of OEO 6). *New Zealand Fisheries Assessment Report 2007/34*. 27 p.

McMillan, P J; Doonan, I J; Hart, A C (1997) Revision of black oreo life history parameters. New Zealand Fisheries Assessment Research Document 1997/8. 13 p. (Unpublished document held in NIWA library, Wellington.)

Middleton, D A J; Abraham, E R (2007) The efficacy of warp strike mitigation devices: Trials in the 2006 squid fishery. Final Research Report for research project IPA2006/02. (Unpublished report held by Ministry for Primary Industries, Wellington).

Ministry for Primary Industries (2012) Aquatic Environment and Biodiversity Annual Review 2012. Compiled by the Fisheries Management Science Team, Ministry for Primary Industries, Wellington, New Zealand. 390 p.

Morgan, M J; Deblois, E M; Rose, G A (1997) An observation on the reaction of Atlantic cod (*Gadus morhua*) in a spawning shoal to bottom trawling. *Symposium on the Biology and Ecology of Northwest Atlantic Cod, St. John's, NF (Canada)*, 24–28 Oct 1994.

Morgan, M J; Wilson, C E; Crim, L W (1999) The effect of stress on reproduction in Atlantic cod. *Journal of Fish Biology 54*: 477–488.

Mortensen, P B; Buhl-Mortensen, L; Gebruk, A V; Krylova, E M (2008) Occurrence of deep-water corals on the Mid-Atlantic Ridge based on MAR-ECO data. *Deep Sea Research Part II: Topical Studies in Oceanography 55*: 142–152.

O'Driscoll, R L; Booth, J D; Bagley, N W; Anderson, O F; Griggs, L H; Stevenson, M L; Francis, M P (2003) Areas of importance for spawning, pupping or egg-laying, and juveniles of New Zealand deepwater fish, pelagic fish, and invertebrates. *NIWA Technical Report 119*. 377 p.

Ramm, K C (2011) Conservation Services Programme Observer Report for the period 1 July 2008 to 30 June 2009. Available at: www.doc.govt.nz/documents/science-and-technical/2008-09-csp-observer-report.pdf

Ramm, K (2012a) Conservation Services Programme Observer Report: 1 July 2009 to 30 June 2010. Department of Conservation, Wellington. 130 p.

Ramm, K (2012b) Conservation Services Programme Observer Report: 1 July 2010 to 30 June 2011. Department of Conservation, Wellington. 121 p.

Reiss, H; Greenstreet, S P R; Siebe, K; Ehrich, S; Piet, G J; Quirijns, F; Robinson, L; Wolff, W J; Kronke, I (2009) Effects of fishing disturbance on benthic communities and secondary production within an intensively fished area. *Marine Ecology Progress Series 394*: 201–213.

Rice, J (2006) Impacts of Mobile Bottom Gears on Seafloor Habitats, Species, and Communities: A Review and Synthesis of Selected International Reviews. Canadian Science Advisory Secretariat Research Document 2006/057. 35 p. (available from http://www.dfo-mpo.gc.ca/CSAS/Csas/DocREC/2006/RES2006_057_e.pdf).

Richard, Y; Abraham, E R (2013) Risk of commercial fisheries to New Zealand seabird populations. *New Zealand Aquatic Environment and Biodiversity Report No. 109*. 62 p.

Richard, Y; Abraham, E R; Filippi, D (2011) Assessment of the risk to seabird populations from New Zealand commercial fisheries. Final Research Report for Ministry of Fisheries research projects IPA2009-19 and IPA2009-20. (Unpublished report held by Ministry for Primary Industries, Wellington.). 66 p.

Smith, P; McMillan, P; Proctor, C; Robertson, S; Knuckey, I; Diggles, B; Bull, B (1999) Stock relationships of smooth oreo in New Zealand waters. Final Research Report for Ministry of Fisheries Research Project DEE9801. 76 p.

Smith, P; Proctor, C; Robertson, S; McMillan, P; Bull, B; Diggles, B (2000) Stock relationships of black oreo in New Zealand waters. Final Research Report for Ministry of Fisheries Research Project DEE9801. Objective 1 (Part two). 79 p.

Stevens, D W; Hurst, R J; Bagley, N W (2011) Feeding habits of New Zealand fishes: a literature review and summary of research trawl database records 1960 to 2000. *New Zealand Aquatic Environment and Biodiversity Report No. 85*. 218 p.

Stewart, B D; Smith, D C (1994) Development of methods to age commercially important dories and oreos. Final Report to the Fisheries Research and Development Corporation.

Stone, R P (2006) Coral habitat in the Aleutian Islands of Alaska: depth distribution, fine-scale species associations, and fisheries interactions. *Coral Reefs 25*: 229–238.

Thompson, F N; Berkenbusch, K; Abraham, E R (2013) Marine mammal bycatch in New Zealand trawl fisheries, 1995–96 to 2010–11. *New Zealand Aquatic Environment and Biodiversity Report No. 105*. 73p.

Tracey, D M; Rowden, A A; Mackay, K A; Compton, T (2011) Habitat-forming cold-water corals show affinity for seamounts in the New Zealand region. *Marine Ecology Progress Series 430*: 1–22.

Tuck, I; Cole, R; Devine, J (2009) Ecosystem indicators for New Zealand fisheries. *New Zealand Aquatic Environment and Biodiversity Report No. 42*. 188 p.

Ward, R D; Elliot, N G; Yearsley, G K; Last, P R (1996) Species and stock delineation in Australasian oreos (Oreosomatidae). Final Report to Fisheries Research and Development Corporation. 144 p.

Williams, A; Schlacher, T A; Rowden, A A; Althaus, F; Clark, M R; Bowden, D A; Stewart, R; Bax, N J; Consalvey, M; Kloser, R J (2010) Seamount megabenthic assemblages fail to recover from trawling impacts. *Marine Ecology 31 (Suppl. 1)*: 183–199.