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PAST AND PRESENT DISTRIBUTIONS AND TRANSLOCATIONS OF MURRAY COD *MACCULLOCHELLA PEELI* AND TROUT COD *M. MACQUARIENSIS* (PISCES: PERCICHTHYIDAE) IN VICTORIA

By P. L. CADWALLADER AND G. J. GOOLEY

Fisheries and Wildlife Division, Ministry for Conservation, Snobs Creek Freshwater Fisheries Research Station and Hatchery, Private Bag 20, Alexandra, Victoria 3714

ABSTRACT: Details of past and present distributions and translocations of Murray cod and trout cod in Victoria are presented. Because of the similarities between the two species and their overlapping distributions there is a great deal of uncertainty about many of the early records which simply refer to 'cod'. Nevertheless, it is evident that Murray cod have undergone only a marginal reduction in their natural geographical range, but have declined markedly in abundance, whereas trout cod have declined dramatically both in distribution and abundance. Translocations to outside the natural geographical range of Murray cod, particularly in the Wimmera and West Wimmera regions, have expanded the range of this species. However, as in the Murray-Darling system, the stocks in these areas have also declined. Trout cod are now considered endangered and Murray cod vulnerable. It is suggested that any attempts to rectify this situation must include a stocking programme using hatchery-bred fish, together with active habitat management in selected areas.

Victorian tributaries of the Murray River and that part of the Murray River contiguous with Victoria support natural populations of several species of native freshwater sport-fish, but the present distributions of these species differ markedly from their past, natural distributions. Man-made changes in the physico-chemical characteristics of the Murray-Darling system, together with the detrimental effects of overfishing and introduced fish, have caused an overall depletion of native fish stocks to such an extent that some species are now rare or seriously threatened with extinction (Lake 1967, 1971, 1978; Berra 1974; Reynolds 1976; Cadwallader 1977, 1978, 1981; Llewellyn & MacDonald 1980; Pollard *et al.* 1980; Clarke 1981).

As a prerequisite for effective restocking programmes and to assist in the conservation and management of the present stocks of native fish in Victoria, it is necessary to have information on the past and present distributions and translocations of each species. Such data have recently been collated for Macquarie perch (Cadwallader 1981) and in this paper we summarise similar data for two other members of the Percichthyidae, the Murray cod *Maccullochella peeli* (Mitchell 1838) and the trout cod *M. macquariensis* (Cuvier 1829). Both species are endemic to the Murray-Darling River system and have been keenly sought by both commercial and recreational fishermen (Dakin & Kesteven 1938; Berra & Weatherley 1972; Cadwallader 1977; Llewellyn & MacDonald 1980). However, the distribution and abundance of both species have declined since the advent of European man in Australia and Murray cod are now caught infrequently and trout cod very rarely.

METHODS

Information on the distributions of Murray cod and trout cod in Victoria was obtained from the following published works: Wilson (1857), Lake (1971, 1978), Anon. (1973, 1974, 1980, 1981), Berra (1974), Harrington (1974), Cadwallader (1977, 1979, 1981), Tunbridge (1978, 1980), Walker & Hillman (1977), Llewellyn & MacDonald (1980), Pollard *et al.* (1980), Scott *et al.* (1980), Clarke (1981) and Tunbridge & Rogan (1981), and from the records of the Australian Museum, the National Museum of Victoria and the Fisheries and Wildlife Division of the Ministry for Conservation, from Fisheries and Wildlife officers throughout Victoria and from discussions with anglers.

RESULTS

The past and present distributions of Murray cod and trout cod in Victoria (including that part of the Murray River contiguous with Victoria) are shown in Figs 1 and 2, respectively. The present distribution of Murray cod (solid circles and squares in Fig. 1) is similar to its past distribution (solid and open circles in Fig. 1), except for the addition of populations derived from translocated fish in the Wimmera area and the disappearance of natural populations in waters such as Lake Cooper (locality 31) and the upper reaches of the Loddon, Campaspe and Goulburn River systems. In contrast, the present distribution of trout cod (solid circles and squares in Fig. 2) is much more restricted than in the past (solid and open circles in Fig. 2).

Details of known translocations of Murray cod and trout cod in Victoria are listed in Table 1.

Since 1978, Murray cod bred by the Fisheries and Wildlife Division at its Warmwater Fisheries Station Pilot Project at Lake Charlegrark (Cadwallader *et al.* 1979) have been stocked in farm dams throughout the State (crosses in Fig. 1) and in Lake Nillahcootie, Lake Meering, Loch Garry, Taylors Lake, Walpolla Creek and the Wimmera River (Table 1). For several years Murray cod produced at the New South Wales Inland Fisheries Research Station at Narrandera have been pur-

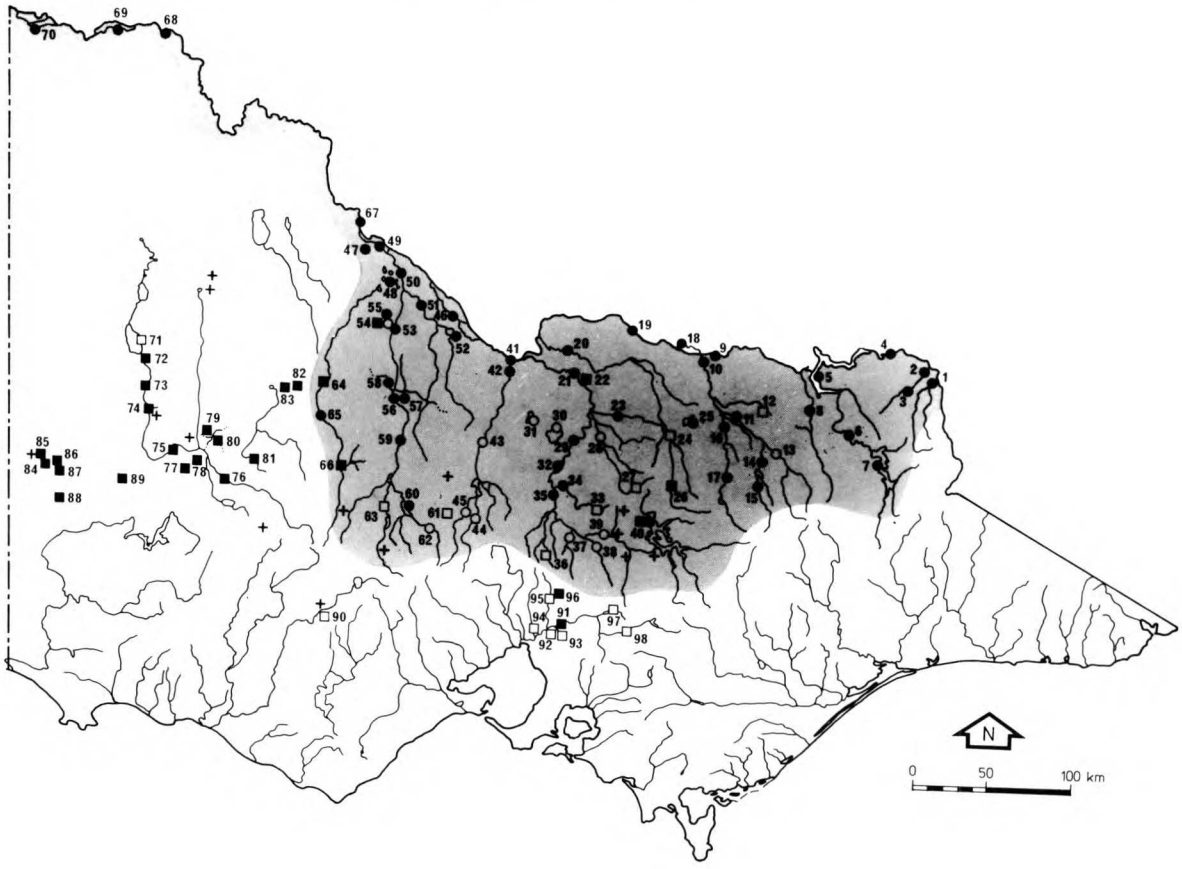

Fig. 1—Past and present distributions of Murray Cod in Victoria. The grey shaded area indicates the presumed past, natural distribution of Murray cod; ●, natural population still present (post 1970); ○, natural population, but no recent records; ■, population derived from introduced fish with post 1970 record(s) and/or post 1970 translocation(s); □, introduced, but no recent records; +, hatchery-bred fish introduced into farm dams, post 1978. Key to locality numbers: 1, Corryong Creek (lower reaches); 2, Cudgewa Creek (lower reaches); 3, Cudgewa Creek (middle to upper reaches); 4, Murray River (Towong Upper to Lake Hume); 5, Lake Hume; 6, Mitta Mitta River (Dartmouth Dam to Lake Hume); 7, Dartmouth Dam and inflowing waters; 8, Kiewa River (lower reaches) and tributaries; 9, Murray River (Hume Weir to Yarrawonga); 10, Ovens River (lower reaches)—Punt Creek; 11, Ovens River (Gapstead to Bundalong); 12, Lake Sambell; 13, Ovens River (Bright to Gapstead); 14, Buffalo River (lower reaches); 15, Buffalo River (upper reaches); 16, King River (lower reaches); 17, King River (Cheshunt to Edi); 18, Lake Mulwala; 19, Murray River (Yarrawonga to Yielima); 20, Broken Creek (lower reaches); 21, Goulburn River (Shepparton to Murray River) and associated irrigation channels; 22, Loch Garry; 23, Broken River (lower reaches); 24, Broken River (Benalla); 25, Lake Mokoan; 26, Lake Nillahcootie; 27, Seven Creeks (upper reaches); 28, Seven Creeks (lower reaches); 29, Goulburn River (Lake Nagambie to Shepparton); 30, Waranga Basin; 31, Lake Cooper; 32, Lake Nagambie-Goulburn Weir; 33, Hughes Creek (Ruffy to Bungle Boori); 34, Hughes Creek (lower reaches); 35, Goulburn River (Seymour to Lake Nagambie); 36, Sunday Creek (Broadford); 37, King Parrot Creek; 38, Yea River; 39, Goulburn River (Lake Eildon to Trawool); 40, Lake Eildon and inflowing waters; 41, Murray River (Yielima to Gunbower); 42, Campaspe River (Rochester to Murray River); 43, Campaspe River (Lake Eppalock to Rochester); 44, Campaspe River (upper reaches); 45, Coliban River; 46, Gunbower Creek; 47, Lake Boga; 48, Kerang Lakes (Kangaroo, Charm, Cullen, Racecourse and the three Reedy Lakes); 49, Little Murray River; 50, Loddon River (Kerang to Murray River); 51, Pyramid Creek; 52, Kow Swamp; 53, Loddon River (Durham Ox to Kerang); 54, Lake Meering; 55, Little Lake Meering; 56, Loddon River (Bridgewater to Durham Ox); 57, Serpentine Creek; 58, Waranga Western Channel; 59, Loddon River (Laanecoorie Reservoir to Bridgewater); 60, Cairn Curran Reservoir; 61, Expedition Pass Reservoir; 62, Loddon River (upper reaches); 63, Deep Creek (=Tullaroop Creek); 64, Avoca River (Charlton); 65, Avoca River (Charlton to Emu); 66, Avoca River (Emu-Bealiba area); 67, Murray River (Gunbower to Tooleybuc); 68, Murray River (Tooleybuc to South Australian border); 69, Walpolla Creek; 70, Lindsay Creek; 71, Lake Hindmarsh; 72, Wimmera River (Jeparit); 73, Wimmera River (Antwerp); 74, Wimmera River (Dimboola); 75, Wimmera River (Horsham); 76, Wimmera River (Glenorchy); 77, Green Lake; 78, Taylors Lake; 79, Marma Lake; 80, Ashens Creek; 81, Richardson River; 82, Wooroonooke Lakes; 83, Lake Jil Jil; 84, Lake Charlegrark; 85, Big Booroopki Swamp; 86, Nowhere Else Swamp; 87, Lake Carpolac; 88, Lake Collins; 89, Miga Lake; 90, Skipton Reservoir; 91, Yarra River (Healesville to Dights Falls); 92, dams, Doncaster; 93, Blackburn Lake; 94, Fish hatchery at Studley Park; 95, Plenty River; 96, Yan Yean Reservoir; 97, Watts River-Maroondah Reservoir; 98, Yarra River (Launching Place).

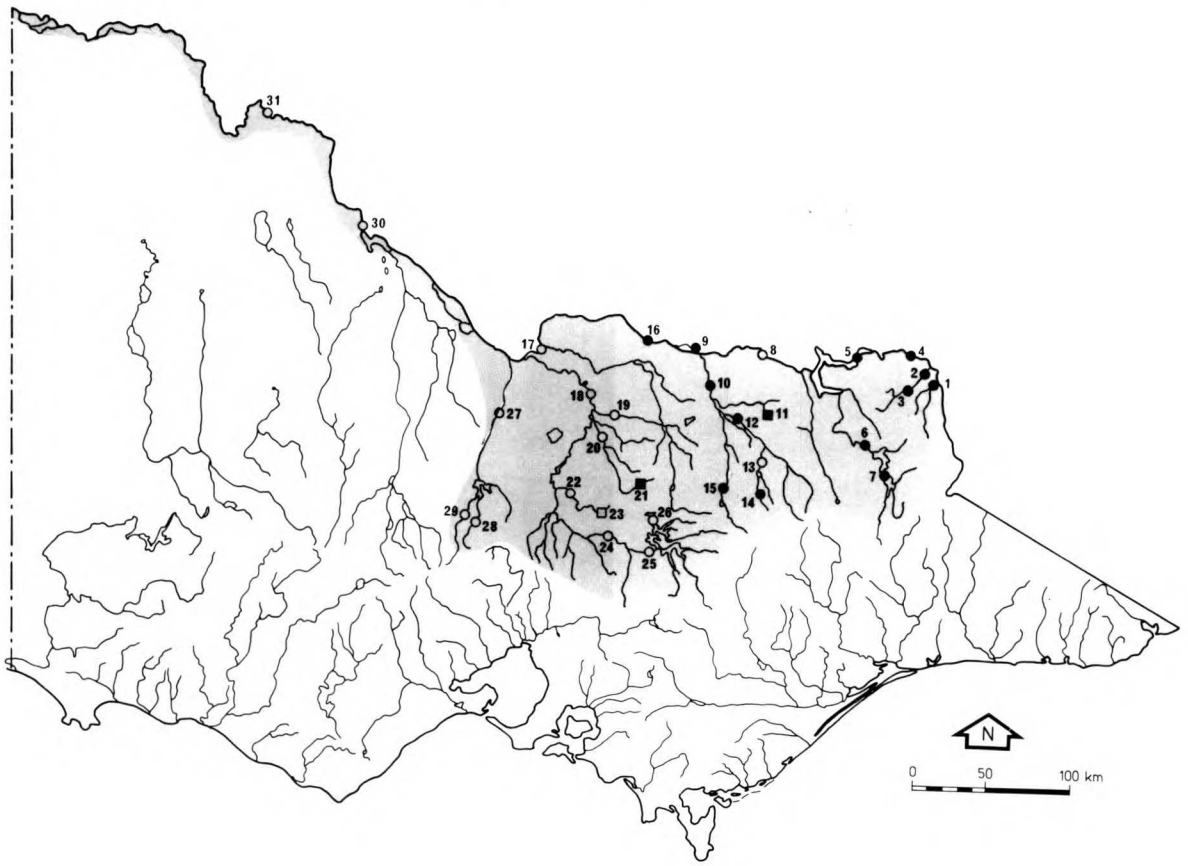

Fig. 2—Past and present distributions of trout cod in Victoria. The grey shaded area indicates the presumed past, natural distribution of trout cod; ●, natural population still present (post 1970); ○, natural population, but no recent records; ■, population derived from introduced fish, still present; □, introduced, but no recent records. Key to locality numbers: 1, Corryong Creek; 2, Cudgewa Creek (lower reaches); 3, Cudgewa Creek (middle to upper reaches); 4, Murray River (Tintaldra to Lake Hume); 5, Lake Hume; 6, Mitta Mitta River (Dartmouth Dam to Mitta Mitta); 7, Dartmouth Dam and inflowing waters; 8, Murray River (Lake Hume to Lake Mulwala); 9, Lake Mulwala; 10, Ovens River (Peechelbar); 11, Lake Sambell; 12, Ovens River (Tarrawingee); 13, Buffalo River (lower reaches); 14, Buffalo River (upper reaches); 15, King River (Cheshunt); 16, Murray River (Lake Mulwala to Strathmerton); 17, Murray River (Barmah Lakes); 18, Goulburn River (Shepparton to Murray River) and associated irrigation channels; 19, Broken River (lower reaches); 20, Seven Creeks (lower reaches); 21, Seven Creeks (upper reaches); 22, Hughes Creek (lower reaches); 23 Hughes Creek (upper reaches); 24, Goulburn River (Cathkin); 25, Goulburn River (Eildon to Thornton); 26, Lake Eildon; 27, Campaspe River (lower reaches); 28, Campaspe River (upper reaches); 29, Coliban River; 30, Murray River (Swan Hill); 31, Murray River (Nyah to South Australian border).

chased privately and released in farm dams in Victoria (crosses in Fig. 1); some have also been purchased by angling clubs and released in public waters such as Lake Meering (Table 1). All public waters stocked in recent years are either located within the natural geographical range of Murray cod or in areas where this species has previously been stocked.

DISCUSSION

Although commercial and recreational fishermen have distinguished between Murray cod and trout cod for quite some time, e.g. see Cadwallader (1977), it is only recently that the trout cod has been scientifically recognised as a distinct species from Murray cod (Berra & Weatherley 1972; Berra 1974; MacDonald 1978). Because of the physical similarities between the two species and their overlapping distributions in the Murray-Darling system there is a great deal of uncertainty about many of the early distributional records which simply refer to 'cod'.

The 50 'Murray cod' transferred from the Ovens River to Lake Sambell in 1928 (Table 1) were probably all or mostly trout cod. The source locality, the upper reaches of the Ovens River near Brookfield, is within the natural range of trout cod and this species of cod has been the only one taken to date in Lake Sambell. Similarly, the 43 'Murray cod' and 57 'cod' taken in the Goulburn River at Cathkin in 1921 and 1922 respectively

TABLE 1
TRANSLOCATIONS OF MURRAY COD AND TROUT COD IN VICTORIA
Parentheses indicate localities outside the natural geographical range of each species; TL, total length

Release locality				Source locality			Remarks
Name of water	Ref. No. (Fig. 1)	Catchment	Date	Name of water	Ref. No. (Fig. 1)	Catchment	
(Ashens Creek	80	Wimmera River)	1972	(Lake Charlegrark	84	West Wimmera)	5-12 June; 50 Murray cod, mean TL 140 mm, range 105-180 mm, from Lake Charlegrark released in Ashens Creek near Lubeck.
Avoca River	64	Avoca River	1972	(Lake Charlegrark	84	West Wimmera)	5-12 June; 100 Murray cod, mean TL 140 mm, range 105-180 mm, from Lake Charlegrark released in Avoca River at Charlton.
Avoca River	65	Avoca River	1972	(Lake Charlegrark	84	West Wimmera)	5-12 June; 400 Murray cod, mean TL 140 mm, range 105-180 mm, from Lake Charlegrark released in Avoca River between Emu and Bealiba.
Broken River	24	Broken River	1915	O'Tooles Dam	–	?	Feb.; 350 cod and perch from O'Tooles Dam released in Broken River at Benalla.
(Lake Carpolac	87	West Wimmera)	1969	(Lake Charlegrark	84	West Wimmera)	1131 Murray cod, TL range 70-150 mm, from Lake Charlegrark released in Lakes Collins, Miga, Green and Carpolac.
(Lake Charlegrark	84	West Wimmera)	1955	Murray River	?	Murray River	51 Murray cod from Murray River released in Lake Charlegrark.
(Lake Collins	88	West Wimmera)	1969	(Lake Charlegrark	84	West Wimmera)	1131 Murray cod, TL range 70-150 mm, from Lake Charlegrark released in Lakes Collins, Miga, Green and Carpolac.
Deep Creek = Tullaroop Creek	63	Loddon River	1935	Murray River	?	Murray River	April, 300 cod from Murray River released in Deep Creek in the Maryborough area.
Lake Eildon	40	Goulburn River	1983	Snobs Creek Hatchery	–	Goulburn River	20-22 April; 34 Murray cod, mean TL 513 mm, range 315-790 mm, mean weight 2132 g, range 300-7330 g, from Snobs Creek Hatchery released into the Delatite arm of Lake Eildon.
Expedition Pass Reservoir	61	Loddon River	?	Not recorded	–	–	No details available.
Loch Garry	22	Goulburn River	1982	(Lake Charlegrark	84	West Wimmera)	1 Dec.; 5000 hatchery-bred Murray cod fry[2], mean TL 12.7 mm, range 12.0-13.5 mm, released in Loch Garry.

(Green Lake	77	Wimmera River)	1969	(Lake Charlegrark	84	West Wimmera)	1131 Murray cod, TL range 70-150 mm, from Lake Charlegrark released in Lakes Collins, Miga, Green and Carpolac.
Hughes Creek	33	Goulburn River	1921	Goulburn Weir	32	Goulburn River	March; 20 Murray cod from Goulburn Weir released in Hughes Creek at Ruffy.
			late 1920s	Seven Creeks	27	Goulburn River	17 trout cod from Seven Creeks released in dam adjacent to Hughes Creek; dam burst, releasing fish in creek between Dropmore and Terip Terip.
(Lake Jil Jil	83	Wimmera River)	1972	(Lake Charlegrark	84	West Wimmera)	5-12 June; 200 Murray cod, mean TL 140 mm, range 105-180 mm, from Lake Charlegrark released in Lake Jil Jil.
(Marma Lake	79	Wimmera River)	1955	Murray River	?	Murray River	8 Murray cod from Murray River released in Marma Lake.
Lake Meering	54	Loddon River	1978	Murrumbidgee River	–	N.S.W.	16 Dec.; 1000 hatchery-bred Murray cod fry[3] released in Lake Meering.
			1982	(Lake Charlegrark)	84	West Wimmera)	17 Dec.; 5000 hatchery-bred Murray cod fry[2], mean TL 12.3 mm, range 11.5-13.5 mm, released in Lake Meering.
(Miga Lake	89	West Wimmera)	1969	(Lake Charlegrark	84	West Wimmera)	1131 Murray cod, TL range 70-150 mm, from Lake Charlegrark released in Lakes Collins, Miga, Green and Carpolac.
Lake Nillahcootie	26	Broken River	1982	(Lake Charlegrark	84	West Wimmera)	14 Dec.; 5000 hatchery-bred Murray cod fry[2], mean TL 16.7 mm, range 15.3-17.8 mm, released in Lake Nillahcootie.
(Nowhere Else Swamp	86	West Wimmera)	1972	(Lake Charlegrark	84	West Wimmera)	June; unknown number of Murray cod from Lake Charlegrark released in Nowhere Else Swamp.
(Plenty River	95	Yarra River)	1857	King Parrot Creek	37	Goulburn River	Murray cod from King Parrot Creek released in Plenty River; 14 on 6 Feb., 27 later in Feb., 25 in March.
(Richardson River	81	Wimmera River)	1972	(Lake Charlegrark	84	West Wimmera)	5-12 June; 200 Murray cod, mean TL 140 mm, range 105-180 mm, from Lake Charlegrark released in Richardson River above Guthries Weir.
Lake Sambell	12	Ovens River	1928	Ovens River	11	Ovens River	50 Murray cod[1], up to 0.9 kg, from Ovens River released in Lake Sambell, Beechworth.
Seven Creeks	27	Goulburn River	1921	Goulburn River	39	Goulburn River	May; 43 Murray cod[1] taken at Cathkin on Goulburn River released in upper reaches of Seven Creeks system.

TABLE 1 (*continued*)

Release locality				Source locality			Remarks
Name of water	Ref. No. (Fig. 1)	Catchment	Date	Name of water	Ref. No. (Fig. 1)	Catchment	
			1921	Seven Creeks	28	Goulburn River	About 50 small cod[1] and Macquarie perch taken in Seven Creeks system below Gooram Falls released upstream near Strathbogie.
			1922	Goulburn River	39	Goulburn River	57 cod[1] taken at Cathkin on Goulburn River released near Strathbogie in the upper reaches of Seven Creeks system.
(Skipton Reservoir	90	Hopkins River)	1920	Not recorded	–	–	Dec.; 3 Murray cod, mean length 230 mm, released in Skipton Reservoir.
Sunday Creek	36	Goulburn River	1917	Not recorded	–	–	Jan.; 18 Murray cod released in Sunday Creek, Broadford.
(Taylors Lake	78	Wimmera River)	1933	Wakool River	–	N.S.W.	April; 88 cod and perch from Wakool River released in Taylors Lake.
			1935	Murray River	67	Murray River	Jan.; 38 cod from Murray River in the Gunbower area released in Taylors Lake.
			1935	Murray River	67	Murray River	April; 500-600 cod from Murray River in the Gunbower area released in Taylors Lake.
			1935	Not recorded	–	–	April; 50 cod and perch, TL range 254-432 mm, released in Taylors Lake.
			1936	N.S.W.	–	?	Jan.; 30 cod, mean length 279 mm, released in Taylors Lake.
			1937	Not recorded	–	–	Jan.-Feb.; 48 cod, mean length 330 m, released in Taylors Lake.
			1981	(Lake Charlegrark	84	West Wimmera)	8-9 Jan.; 6000 hatchery-bred Murray cod fry[2], mean TL 23.2 mm, range 20.8-25.4 mm, mean weight 0.15 g, released in Taylors Lake
			1982	(Lake Charlegrark	84	West Wimmera)	25 Jan.; 4000 hatchery-bred Murray cod fry[2], mean TL 19.2 mm, range 17.5-20.8 mm mean weight 0.08 g, released in Taylors Lake.
Walpolla Creek	69	Mallee	1982	(Lake Charlegrark	84	West Wimmera)	18 Dec.; 5700 hatchery-bred Murray cod fry[2], mean TL 12.1 mm, range 11.0-14.0 mm, released in Walpolla Creek.

(Watts River	97	Yarra River)	1890s	?	–	?	Murray cod released in Watts River during the 1890s; no other details available.
(Wimmera River	72	Wimmera River)	1982	(Lake Charlegrark	84	West Wimmera)	27 Jan.; 1200 hatchery-bred Murray cod fry[2], mean TL 19.2 mm, range 17.5-20.8 mm, mean weight 0.08 g, released in Wimmera River at Jeparit.
			1982	(Lake Charlegrark	84	West Wimmera)	20 Dec.; 2000 hatchery-bred Murray cod fry[2], mean TL 13.5 mm, range 12.6-14.9 mm, released in Wimmera River at Jeparit.
(Wimmera River	74	Wimmera River)	c1950	Murray River	?	Murray River	383 Murray cod from Murray River released in Wimmera River at Dimboola.
			1969	(Lake Charlegrark	84	West Wimmera)	300 yearling Murray cod from Lake Charlegrark released in Wimmera River at Horseshoe Bend.
			1982	(Lake Charlegrark	84	West Wimmera)	29 Nov.-20 Dec.; 2000 hatchery-bred Murray cod fry[2], mean TL 13.2 mm, range 12.1-14.9 mm, released in Wimmera River at Dimboola.
			1983	(Lake Charlegrark	84	West Wimmera)	8 Jan.; 158 hatchery-bred Murray cod yearlings[2], mean TL 120.4 mm, range 62-178 mm, mean weight 26.9 g, range 4.1-76.4 g, released in the Wimmera River at Dimboola.
Wimmera River	75	Wimmera River	1938	Murray River	?	Murray River	April; 38 cod and Macquarie perch from Murray River released in Wimmera River.
			1948	Kyalite River	N.S.W.	Murray River	60 Macquarie perch and Murray cod, mean weight 2.3 kg, released in Wimmera River.
			1949	Murray River	?	Murray River	March; 300 Murray cod, length 102-178 mm, from Murray River released in Wimmera River.
			1982	(Lake Charlegrark	84	West Wimmera)	10 Nov.; 104 hatchery-bred Murray cod yearlings[2], mean TL 77.8 mm, range 40-136 mm, mean weight 9.7 g, range 1.0-39.9 g, released in the Wimmera River at Horsham.
			1982	(Lake Charlegrark	84	West Wimmera)	30 Nov.-20 Dec.; 2000 hatchery-bred Murray cod fry[2], mean TL 13.1 mm, range 12.1-14.9 mm, released in Wimmera River at Horsham.

TABLE 1 (*continued*)

Release locality				Source locality			Remarks
Name of water	Ref. No. (Fig. 1)	Catchment	Date	Name of water	Ref. No. (Fig. 1)	Catchment	
Wimmera River	76	Wimmera River	1972	(Lake Charlegrark	84	West Wimmera)	5-12 June; 100 Murray cod, mean TL 140 mm, range 105-180 mm, from Lake Charlegrark, released in Wimmera River above Glenorchy.
(Wooroonooke Lakes	82	Wimmera River)	1972	(Lake Charlegrark	84	West Wimmera)	5-12 June; 100 Murray cod, mean TL 140 mm, range 105-180 mm, from Lake Charlegrark, released in Wooroonooke Lakes.
(Yan Yean Reservoir	96	Yarra River)	?	?	–	?	No details available.
(Yarra River	91	Yarra River)	1909	Not recorded	–	–	Nov.; 1 cod, length 203 mm, weight 142 g, tagged (No. 72) and released in Yarra River at Studley Park.
			1920	Not recorded	–	–	Dec.; 15 Murray cod, mean length 152 mm, released in Yarra River at Studley Park.
			1960	Not recorded	–	–	Several juvenile cod caught in N.S.W. released in Yarra River. No other details available.
			?	?	–	?	Murray cod released in Yarra River at Launching Place. No details available.
Miscellaneous lakes and ponds in or near Melbourne.							
(Blackburn Lake	93	Yarra River)	1922	Goulburn Weir	32	Goulburn River	11 Feb.; 22 Murray cod, length 152-203 mm, released in Blackburn Lake.
(dams, Doncaster	92	Yarra River)	1920	Not recorded	–	–	Dec.; 16 Murray cod, mean length 230 mm, released in Petty's dams (2), Doncaster.
(Fish Hatchery, Studley Park	94	Yarra River)	1927	Goulburn Weir	32	Goulburn River	24 Nov.; 36 Murray cod from Goulburn Weir sent to Hatchery.

[1] Although some of the original fish may have been Murray cod, recent investigations by the Fisheries and Wildlife Division suggest that most were trout cod.

[2] Produced at the Warmwater Fisheries Station Pilot Project, Lake Charlegrark (Fisheries and Wildlife Division, Victoria).

[3] Produced at the Inland Fisheries Research Station, Narrandera (New South Wales Department of Agriculture).

and translocated to above the Gooram Falls in the upper reaches of the Seven Creeks system (Table 1) were most likely trout cod. Trout cod presently occur in the upper reaches of the Seven Creeks system, whereas Murray cod do not (Cadwallader 1979). In addition to the fish from the Goulburn River, in 1921 a further 50 'cod' were taken from the Seven Creeks system below the Gooram Falls and released above the falls, in the Strathbogie area. Records indicate that 'cod' were being caught in the lower reaches of the Seven Creeks system before 1921 and that Murray cod were present until quite recently. Therefore, it is possible that at the time of the 1921 translocation there were natural populations of both species of cod in the lower reaches of the Seven Creeks system.

Murray Cod

The natural geographical range of Murray cod has not been greatly reduced, but recent records of their occurrence within this range are often anecdotal. Furthermore, these records often mention only a few or single individuals, some of which are very large specimens, suggesting that they may well be members of relict populations.

During the last five years several Murray cod have been taken during Fisheries and Wildlife Division surveys in the Kiewa, lower Delatite, Buffalo, upper Ovens, lower Goulburn and lower Broken Rivers. They have also been taken occasionally by anglers in some of the Kerang lakes, the Goulburn and Big River arms of Lake Eildon, the lower Goulburn, Ovens, Loddon and Campaspe Rivers and in that part of the Murray River contiguous with Victoria (Fig. 1). A single Murray cod has recently been taken in the Mitta Mitta River arm of newly-formed Lake Dartmouth, but the present status of the Murray cod population recorded by Tunbridge (1978) in a now-inundated stretch of river near the dam wall is unknown, although Murray cod are still taken occasionally in the Mitta Mitta River below the dam. It is likely that the present population of Murray cod in the Avoca River consists mainly of translocated fish and their progeny, since the last verified record prior to the release of cod from Lake Charlegrark in 1972 (Table 1) was of a fish angled in 1967. Thus, at present, it appears that there are very few Murray cod in the Avoca, Campaspe, Broken and Kiewa Rivers and only small populations in the Loddon, Goulburn, Ovens and Mitta Mitta Rivers and in the Murray River contiguous with Victoria and associated Victorian anabranches, swamps and lakes such as those at Kerang and Barmah. Reasons for the decline of Murray cod in the Murray system have been discussed elsewhere (Lake 1971; Reynolds 1976; Cadwallader 1978; Pollard *et al.* 1980).

Translocations of Murray cod from the Murray River to the Wimmera River at Horsham in 1938, 1948 and 1949 (Table 1) resulted in Murray cod moving downstream and, in subsequent years, being taken in the river at Dimboola, Antwerp, Jeparit and Lake Hindmarsh (Fig. 1). Despite further translocations of Murray cod from the Murray River to the Wimmera River at Dimboola in about 1950 and from Lake Charlegrark to the Wimmera River above Glenorchy in 1972 (Table 1), it appears that only a relict population remains in the river. Murray cod are now taken infrequently in the Horsham, Dimboola and Antwerp areas.

Initially, the decline of the Murray cod populations in the Wimmera River and Lake Hindmarsh was probably caused by unreliable water flows, low water levels and man-made obstructions on the river. Weirs were constructed at Jeparit, Antwerp, Dimboola and Horsham and water was impounded in several tributaries for domestic and irrigation purposes. In more recent years, the Murray cod populations have declined even further because of problems associated with the destruction of available habitat by so-called 'river improvement' schemes. Water quality has also declined considerably and eutrophication is now an increasing problem in the lower reaches of the river. These problems are compounded by relatively high water temperatures during summer when water flow is most restricted.

The translocation of 51 Murray cod from the Murray River to Lake Charlegrark in the West Wimmera region in 1955 (Table 1) has resulted in the only known, viable, self-propagating population of the species outside its natural geographical range in Victoria. When Lake Charlegrark overflows, Murray cod move through a small drainage creek to Big Booroopki Swamp, where they are also abundant. During 1969 and 1972, several translocations of Murray cod from Lake Charlegrark to various waters in the Wimmera and West Wimmera regions (Table 1) resulted in a population becoming established in Green Lake near Horsham. Of the other waters stocked, Miga Lake, Lake Carpolac and Nowhere Else Swamp have since periodically dried up, and few or no Murray cod have been taken in Lakes Jil Jil, Wooroonooke and Collins or in Ashens Creek and the Richardson River.

Of the other waters outside the natural range which have been stocked with Murray cod (apart from recent releases of hatchery-bred fish), both Taylors Lake near Horsham and the Yarra River between Dights Falls and Warrandyte still support small populations (Table 1). Very low water levels in the late 1960s, together with heavy angling pressure at the time, are thought to have caused the demise of the population in Taylors Lake.

According to local anglers, some Murray cod were included in a shipment of Murray fish released in Marma Lake, Murtoa, in 1955 (Table 1). It is also thought that fish from either Taylors Lake or Ashens Creek moved downstream through the Wimmera-Mallee irrigation system into the lake. A large Murray cod was found dead here in 1981.

The present status of populations of hatchery-bred Murray cod stocked in public waters and farm dams throughout Victoria since 1978 depends very much on the type of water stocked. Fish are known to have perished in many dams, some of which periodically dry up. In other dams, it is suspected that the cod have been eaten by predatory birds. However, some dams continue to support small populations of Murray cod. Several

Murray cod were taken in Lake Meering in 1981 and it is thought that these were hatchery-bred fish released in 1978 by a local angling club. It is not known whether sufficient numbers of fish have survived to form a viable population. The success of releases of hatchery-bred Murray cod fry by the Fisheries and Wildlife Division during 1981 and 1982 has yet to be assessed.

Trout Cod

In recent years, angling reports and Fisheries and Wildlife Division surveys have indicated the presence of trout cod in Lake Mulwala, Lake Hume, Lake Sambell, the Murray River between Strathmerton and Yarrawonga and upstream of Lake Hume, the Ovens, Buffalo, King and Mitta Mitta Rivers, Cudgewa and Corryong Creeks and the Seven Creeks system. Of these localities, it appears that only the Seven Creeks system and the Murray River between Strathmerton and Yarrawonga support viable populations of trout cod. However, further investigations may yet reveal the presence of small, self-propagating populations in the upper reaches of the Ovens and King Rivers and Cudgewa Creek.

According to Berra (1974), trout cod could only be collected consistently in two localities in Victoria: the Seven Creeks system and Lake Sambell. However, the Lake Sambell population was decimated following an unexplained fish kill in 1970 and few trout cod have been taken in the lake since then. Trout cod were recorded by Tunbridge (1978) in the Mitta Mitta River, in an area now inundated by Lake Dartmouth; the present status of this population is unknown. Records indicate that trout cod have disappeared completely from the lower reaches of the Murray River contiguous with Victoria (up to and including the Barmah Lakes), the Murray River between Lake Mulwala and Lake Hume, the Campaspe River system (including the Coliban River) and almost completely from the Goulburn River system (including Lake Eildon, the Broken River and the lower reaches of the Seven Creeks system). It is likely that trout cod also once occurred in the Kiewa River and in most of the major tributaries of the Ovens and Mitta Mitta Rivers; but there are no records to confirm this.

Apart from the effects of overfishing and man-made changes to the environment, trout cod have probably been adversely affected by introduced trout, although there is little substantial evidence to support this view. In the Seven Creeks system, trout cod and trout were found to occupy the same type of habitat (Cadwallader 1979). Furthermore, in aquaria, young trout cod establish well-defined territories similar to those established by trout, so that young trout cod and trout may compete for space on the stream bed. Also, since they take the same types of food and live in similar situations, they may also compete directly for food items. Butcher (1967) also indicated that trout probably eat small trout cod. From what is known about the habitat requirements of trout cod it may be said that in general a 'good trout stream' is also a good trout cod stream. Perhaps it is more than coincidence that the areas formerly occupied by trout cod in north eastern Victoria, from where the species appears to have been almost eliminated, are areas which have been heavily stocked with trout.

CONCLUSIONS

Murray cod have undergone a marginal reduction in their natural geographical range, but have declined markedly in abundance, whereas trout cod have declined dramatically both in distribution and abundance. Consequently, in Victorian waters and the Murray River contiguous with Victoria, using the I.U.C.N. Red Data Book definitions (Holloway 1979) as modified by Ahern (1982), the trout cod must now be considered endangered (i.e. in danger of extinction) and the Murray cod vulnerable (i.e. likely to move into the endangered category in the near future if the factors causing its demise continue operating). Any attempts to rectify this situation must involve the implementation of a stocking programme using hatchery-bred fish of both species, together with active habitat management in selected areas.

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REFERENCES

Ahern, L. D., 1982. Threatened wildlife in Victoria and issues related to its conservation. *Fish. Wildl. Pap., Vic.* 27: 34 pp.

Anon., 1973. Native fish in the Campaspe and Coliban Rivers. *Fish. Wildl. Div., Vic., Freshwat. Fish. Newsl.* 5: 18-19.

Anon., 1974. Endangered native fish. *Fish. Wildl. Div., Vic., Freshwat. Fish. Newsl.* 7: 9-15.

Anon., 1980. Trout management group surveys. *Fish Wildl. Div., Vic., Freshwat. Fish. Newsl.* 13: 11-13.

Anon., 1981. Trout management group surveys. *Fish. Wildl. Div., Vic., Sport Fish. Newsl.* 1: 17-19.

Berra, T. M., 1974. The trout cod, *Maccullochella macquariensis*, a rare freshwater fish of eastern Australia. *Biol. Cons.* 6: 53-56.

Berra, T. M. & Weatherley, A. H., 1972. A systematic study of the Australian freshwater serranid fish genus *Maccullochella*. *Copeia* 1972: 53-64.

BUTCHER, A. D., 1967. A changing aquatic fauna in a changing environment. *Publs. I.U.C.N., New Ser.* 9: 197-218.

CADWALLADER, P. L., 1977. J. O. Langtry's 1949-50 Murray River investigations. *Fish. Wildl. Pap., Vic.* 13: 70 pp.

CADWALLADER, P. L., 1978. Some causes of the decline in range and abundance of native fish in the Murray-Darling River system. *Proc. R. Soc. Vict.* 90: 211-224.

CADWALLADER, P. L., 1979. Distribution of native and introduced fish in the Seven Creeks River system, Victoria. *Aust. J. Ecol.* 4: 361-385.

CADWALLADER, P. L., 1981. Past and present distributions and translocations of Macquarie perch *Macquaria australasica* (Pisces: Percichthyidae), with particular reference to Victoria. *Proc. R. Soc. Vict.* 93: 23-30.

CADWALLADER, P. L., BACKHOUSE, G. N., GOOLEY, G. J. & TURNER, J. A., 1979. New techniques for breeding and raising Murray cod. *Aust. Fish.* 38(9): 9-16.

CLARKE, E. E., 1981. *River in Danger.* The Border Morning Mail, Wodonga, 80 pp.

DAKIN, W. J. & KESTEVEN, G. L., 1938. The Murray cod (*Maccullochella macquariensis* (Cuv. et Val.)). *N.S.W. Chief Sec. Dept., Fish. Res. Bull.* 1: 18 pp.

HARRINGTON, D. J., 1974. Liberations of Murray cod in the Wimmera. *Fish. Wildl. Div., Vic., Freshwat. Fish. Newsl.* 6: 7.

HOLLOWAY, C., 1979. I.U.C.N., the Red Data Book, and some issues of concern to the identification and conservation of threatened species. In *The Status of Endangered Australasian Wildlife*, M. J. Tyler, ed., Royal Zoological Society of South Australia. 1-12.

LAKE, J. S., 1967. Principal fishes of the Murray-Darling River system. In *Australian Inland Waters and their Fauna*, A. H. Weatherley, ed., A.N.U. Press, Canberra. 192-213.

LAKE, J. S., 1971. *Freshwater Fishes and Rivers of Australia.* Nelson, Melbourne. 61 pp.

LAKE, J. S., 1978. *Australian Freshwater Fishes.* Nelson, Melbourne. 160 pp.

LLEWELLYN, L. C. & MACDONALD, M. C., 1980. *Family Percichthyidae.* In *Freshwater Fishes of South-eastern Australia*, R. M. McDowall, ed., Reed, Sydney. 142-149.

MACDONALD, C. M., 1978. Morphological and biochemical systematics of Australian freshwater and estuarine percichthyid fishes. *Aust. J. Mar. Freshwat. Res.* 29: 667-698.

POLLARD, D. A., LLEWELLYN, L. C. & TILZEY, R. D. J., 1980. Management of freshwater fish and fisheries. In *An Ecological Basis for Water Resource Management*, W. D. Williams, ed., A.N.U. Press, Canberra. 227-270.

REYNOLDS, L. F., 1976. Decline of the native fish species in the River Murray. *SAFIC* 8: 19-24.

SCOTT, T. D., GLOVER, C. J. M. & SOUTHCOTT, R. V., 1980. *The Marine and Freshwater Fishes of South Australia* (Reprinted 2nd Edition). Government Printer, South Australia. 392 pp.

TUNBRIDGE, B. R., 1978. A survey of the fish populations in the Mitta Mitta River and tributaries before the construction of Dartmouth Dam. 140 pp. in *Dartmouth Dam Project: Report on Environmental Studies.* S.R.W.S.C., Victoria.

TUNBRIDGE, B. R., 1980. Fish resources of the Yarra River. *Fish. Wildl. Div., Vic., Freshwat. Fish. Newsl.* 12: 7-16.

TUNBRIDGE, B. R. & ROGAN, P. L., 1981. *A Guide to the Inland Angling Waters of Victoria* (3rd Edition). Government Printer, Victoria. 141 pp.

WALKER, K. F. & HILLMAN, T. J., 1977. *Limnological Survey of the River Murray in Relation to Albury-Wodonga, 1973-1976.* Albury-Wodonga Development Corporation. 256 pp.

WILSON, E., 1857. On the Murray River cod, with particulars of experiments instituted for introducing this fish into the River Yarra-Yarra. *Proc. R. Soc. Vict.* 2: 23-34.