



FLORA AND FAUNA GUARANTEE - SCIENTIFIC ADVISORY COMMITTEE
FINAL RECOMMENDATION ON A NOMINATION FOR LISTING

Alteration to the natural temperature regimes of rivers and streams.
(Potentially Threatening Process)

Date of receipt of the nomination: 29 January 1992
Date of preliminary recommendation: 10 March 1992
Date of final recommendation: 21 May 1992

File No.: 92/1702

Validity:

The nomination is for a valid item and the prescribed information was provided. The nominated process was adequately defined and described.

The nominated process encompasses the alteration of the thermal regimes of many rivers. Artificial lowering of water temperatures is caused by hydro-electric, irrigation, and water conservation schemes (Cadwallader 1978, McDowall 1980, OCE 1988). Most impoundments used for these schemes in Victoria utilise only bottom outlets, which release cold water from the lower levels of the water column leading to a drop in natural stream temperatures for many kilometres downstream of the dam structure (Merrick & Schmida 1984, Mitchell 1990, Koehn & O'Connor 1990a, LCC 1991). The artificial raising of water temperatures is caused mainly by the discharge back into rivers, streams or impoundments of water used for cooling purposes in electricity-generating power stations (Harasymiw 1983, Cadwallader & Backhouse 1983). Water temperatures may also be raised artificially by removal of riparian vegetation.

All native fish and invertebrate species are adapted to and are dependent on the natural ambient temperature regimes of Victoria's rivers and streams (Hellawell 1986, OWR 1990). Many have seasonal temperature requirements for particular life cycle processes such as reproduction, and are subject to critical lethal temperatures (Hall 1991).

The process has occurred and is continuing to occur in most Victorian river catchments. There are currently about 70 major water storages in Victoria, most of which are committed to irrigation and domestic use, and about 248 storages (dams and weirs) on natural waterways (Koehn 1985). Riparian vegetation removal is widespread in Victoria especially in lowland and agricultural streams.

The range of flora or fauna affected or potentially affected was adequately stated in the nomination.

Significance of the threat which the potentially threatening process poses or has the potential to pose was adequately stated in the nomination.

Eligibility for listing as a potentially threatening process under the Flora and Fauna Guarantee

The nominated item satisfies at least one criterion of the set of criteria prepared and maintained under Section 11 of the *Flora and Fauna Guarantee Act 1988*, and stated in Schedule 1 of the *Flora and Fauna Guarantee Regulations 1990*.

Evidence that criteria are satisfied:

Criterion 5.1 *The potentially threatening process, in the absence of appropriate management, poses or has the potential to pose a significant threat to the survival of a range of flora or fauna.*

Evidence:

Cold water discharges, particularly those for irrigation purposes during summer, often prevent water reaching temperature levels critical for the spawning of many native fishes (Cadwallader & Backhouse 1983, Merrick & Schmida 1984, Koehn 1985, Tunbridge 1988, Koehn & O'Connor 1990a, 1990b, LCC 1991) and the subsequent survival of eggs and larvae (Cadwallader 1978). Many native fishes spawn in late spring and summer when water temperatures are normally higher. If spawning does not occur, recruitment is reduced, and a species, over a number of years, may disappear from a stretch of stream altogether.

Fish species cannot survive in water temperatures above their specific temperature tolerance level (Koehn & O'Connor 1990a; 1990b; OWR 1990) e.g. the lethal critical temperatures for several native fishes is around 27°C to 29°C (Macey & Potter 1978, Harasyniw 1983, Koehn & O'Connor unpub. data).

Sub-criterion 5.1.1 *The potentially threatening process poses or has the potential to pose a significant threat to the survival of two or more taxa.*

Evidence:

Species of native freshwater fish which are dependent on rising water temperatures to spawn, and have undergone decline in either range or abundance, partly or wholly as a result of changing temperature regimes:

Macquaria australasica (Macquarie Perch) - Ministry for Conservation (1983)

Maccullochella peeli (Murray Cod) - Cadwallader & Backhouse (1983), OCE (1988);

Gadopsis marmoratus (Freshwater Blackfish) - Ministry for Conservation (1983);

Tandanus tandanus (Freshwater Catfish) - Koehn & Morison (1990), Llewellyn & Pollard (1980)

Maccullochella macquariensis (Trout Cod) - Ministry for Conservation (1983);

Macquaria ambigua (Golden Perch) - Lake (1967), OCE (1988)

Bidyanus bidyanus (Silver Perch) - OCE (1988), Cadwallader & Lawrence (1990).

Prototroctes maraena (Australian Grayling) is dependent on low water temperatures to spawn (Jackson & Koehn 1988; Tunbridge 1988).

Species whose eggs or young are killed by high (i.e. 29°C) water temperatures:

Geotria australis (Pouched Lamprey) - Macey & Potter (1978)

Galaxias brevipinnis (Broad-finned Galaxias) - O'Connor & Koehn (unpubl. data)

Galaxias truttaceus (Spotted Galaxias) - O'Connor & Koehn (unpubl. data)

Galaxias olidus (Mountain Galaxias) - O'Connor & Koehn (unpubl. data)

Other rare or restricted species which may be affected by reduced temperatures for spawning include *Gadopsis bispinosus* (Two-spined Blackfish), *Gobiomorphus australis* (Striped Gudgeon), *Gobiomorphus coxii* (Cox's Gudgeon), *Craterocephalus stercusmuscarum* (Freshwater Hardyhead), *Melanotaenia fluviatilis* (Crimson-spotted Rainbowfish) and *Nematalosa erebi* (Bony Bream).

Criterion 5.2 *The potentially threatening process, in the absence of appropriate management, poses or has the potential to pose a significant threat to the evolutionary development of a range of flora or fauna.*

Evidence:

As temperature affects all physiological processes of aquatic biota, departures from the normal temperature pattern, particularly sudden or aseasonal changes, could disturb these processes and cause accelerated, or retarded, growth and abnormal timing of life cycles (Hellawell 1986, Tunbridge 1988, OWR 1990, Hall 1991), such that the growth and development of aquatic insects may be so slow that they fail to complete their life cycles (Office of Water Resources 1990). Fish may also suffer adverse effects such as stress, reduced feeding and decreased resistance to disease (Koehn & O'Connor 1990b).

Background Information:

- Macquarie Perch, Australian Grayling, Murray Cod, Trout Cod, Yarra Pygmy Perch, Ewens Pygmy Perch and Agassiz's Chanda Perch have been listed on Schedule 2 of the FFG Act.
- Other species potentially threatened by the nominated process are have been categorised as rare and threatened in Victoria by Koehn & Morison (1990):
 - Vulnerable - Freshwater Catfish, Silver Perch;
 - Indeterminate - Freshwater Blackfish, Striped Gudgeon, Cox's Gudgeon, Freshwater Hardyhead, Mountain Galaxias;
 - Potentially threatened - Golden Perch, Pouched Lamprey, Broad-finned Galaxias, Spotted Galaxias;
 - Restricted - Two-spined Blackfish, Crimson-spotted Rainbowfish, Bony Bream.
- For some species, temperature accompanied by another environmental cue, e.g. rising water levels, acts to encourage or trigger spawning. Even if the other environmental stimulus does occur, if the appropriate temperatures are not reached spawning may not take place.
- Galaxiids (*G. truttaceus*, *G. brevipinnis*) tend to spawn when water temperatures are decreasing in winter down to 9° or 10°. *G. olidus* spawns at 8°-12°, as water temperatures are starting to rise. Within a certain temperature window, the rate of change of water temperatures is probably the trigger for spawning.
- In conditions of rather higher than normal water temperatures, salmonids show egg abnormalities. This phenomenon is well documented in the USA.
- The threat posed by the nominated process has been formally recognised by the Victorian Government in the State Conservation Strategy which states that it will ". . . maintain water quality sufficient to protect ecosystems downstream of all new on-stream dams, particularly with respect to temperature and oxygen levels" (Government of Victoria 1987).

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- Hall, D.N. (1991) Management plan for freshwater fishes in major Gippsland rivers: water resource requirements. *Arthur Rylah Inst. Env. Res. Tech. Rep. Ser. No. 107*. Department of Conservation and Environment, Melbourne.
- Hall, D.N. & Harrington, D.J. (1989) Observations on the spawning and early life history of Australian Grayling *Prototroctes maraena* Gunther, in the Barwon River, Victoria. *Arthur Rylah Inst. Env. Res. Tech. Rep. Ser. No. 84*. 31 pp. Department of Conservation, Forests and Lands, Melbourne.
- Harasymiw, B.J. (1983) Effects of temperature on life stages of La Trobe River fish species. Planning and Investigations Department. La Trobe Valley Water Resources Biological Studies, Vol. VI, 84 pp.
- Hellawell, J.M. (1986) *Biological Indicators of Freshwater Pollution and Environmental Management*. Elsevier Applied Science Publishers: London 546 pp.
- Hubbs, C. (1972) Some thermal consequences of environmental manipulations of water. *Biol. Cons.* 4(3): 185-188.
- Jackson, P.D. & Koehn, J.D. (1988) A review of biological information, distribution and status of the Australian Grayling *Prototroctes maraena* Gunther in Victoria. *Arthur Rylah Inst. Env. Res. Tech. Rep. Ser. No. 52*. 20 pp. Department of Conservation, Forests and Lands, Melbourne.
- Koehn, J.D. (1985). Environmental problems and approaches to determining habitat requirements for freshwater native fish in Victoria, in *Proceedings of the River Management Association*. Offices of the Rural Water Commission, Armadale.
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- Koehn, J.D. & O'Connor, W.G. (1990a) *Biological Information for the Management of Native Freshwater Fishes in Victoria*. Department of Conservation and Environment. Government Printer, Melbourne.
- Koehn, J.D. & O'Connor, W.G. (1990b) Threats to Victorian native freshwater fish. *Vict. Nat.* 107: 5-12.
- Lake, J.S. (1967) Rearing experiments with five species of Australian freshwater fishes. I. Inducement to spawning. *Aust. J. Mar. Freshw. Res.* 18: 137-153.
- LCC (1991) *Rivers and Streams Special Investigation - Final Recommendations*. Land Conservation Council, Melbourne. 208 pp.
- Llewellyn, L.C. (1971) Breeding studies on the freshwater forage fish of the Murray-Darling River System. *Fisherman* (N.S.W.) 3(13): 1-12.
- Llewellyn, L.C. (1979) Some observations on the spawning and development of the Mitchellian freshwater hardyhead *Craterocephalus fluviatilis* McCulloch from inland waters in New South Wales. *Aust. Zool.* 20: 269-288.
- McCarragher, D.B. & McKenzie, J.A. (1986) Observations on the distribution, growth, spawning and diet of estuary perch (*Macquaria colonorum*) in Victorian waters. *Arthur Rylah Inst. Env. Res. Tech. Rep. Ser. No. 42*. 21 pp. Department of Conservation, Forests and Lands, Melbourne.
- McDowall, R.M. (ed.) 1980c. *Freshwater Fishes in South-Eastern Australia*. Reed. 208 pp.
- Macey, D.J. & Potter, I.C. (1978) Lethal temperatures of ammocoetes of the Southern Hemisphere lamprey, *Geotria australis* Gray. *Environ. Biol. Fishes* 3: 241-243.

Advertisement for public comment

In accordance with the requirements of Section 14 of the *Flora and Fauna Guarantee Act 1988*, the preliminary recommendation was advertised for public comment for a period of at least 30 days.

The preliminary recommendation was advertised in:

"The Age" - on 8 April 1992

"The Weekly Times" - on 8 April 1992

Government Gazette - on 8 April 1992

Submissions closed on 15 May 1992.

Further evidence provided:

No public comments were received by the Scientific Advisory Committee.

No evidence was provided to warrant a review of the Scientific Advisory Committee's preliminary recommendation that the potentially threatening process is eligible for listing.

Documentation

The published information and research data provided to the SAC have been assessed. To the best of their knowledge, the SAC believes that the data presented are not the subject of scientific dispute and the inferences drawn are reasonable and well supported.

Final Recommendation of the Scientific Advisory Committee

The Scientific Advisory Committee concludes that on the evidence available the nominated item is eligible for listing in accordance with Section 11 of the Act because primary criteria 5.1 and 5.2 are satisfied.

The SAC also concludes that sub-criterion 5.1.1 has been satisfied and that no evidence exists to suggest that primary criterion 5.1 cannot be satisfied as a consequence of sub-criterion 5.1.1 being satisfied.

The Scientific Advisory Committee recommends that the nominated item be supported for listing on Schedule 3 of the *Flora and Fauna Guarantee Act 1988*.

Selected references:

Backhouse, G.N. and Frusher, D.J. (1980) The Crimson-spotted Rainbowfish, *Melanotaenia fluviatilis* (Castelnau 1878). *Vic. Nat.* **97**: 144-148.

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. Vic.* **90**: 211-224.

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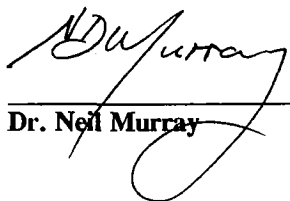
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- Tunbridge, B.R. (1988) Environmental flows and fish populations of waters in the south-western region of Victoria. *Arthur Rylah Inst. Env. Res. Tech. Rep. Ser. No. . 21 pp.* Department of Conservation, Forests and Lands, Melbourne.
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- Wharton, J.C.F. (1968) Spawning areas of the Macquarie perch *Macquaria australasica* above the Eildon Lake (Victoria). *Aust. Soc. Limnol. Newsl.* 6: 11-13.

Endorsement by the Convenor of the Scientific Advisory Committee

Date


Dr. Neil Murray

18 June 1992