Advice to the Minister for Sustainability, Environment, Water, Population and Communities from the Threatened Species Scientific Committee (the Committee) on Amendment to the list of Threatened Species under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

1. Name

Craterocephalus fluviatilis

The species is commonly known as the Murray hardyhead. It is in the Family Atherinidae and the subfamily Atherininae.

2. Reason for Conservation Assessment by the Committee

The Murray hardyhead was originally listed as vulnerable under the EPBC Act's predecessor, the *Endangered Species Protection Act 1992*, and its vulnerable status was retained when the EPBC Act came into force. This advice follows assessment of new information provided to the Department via a public nomination to change the listing category to critically endangered. This is the Committee's first consideration of the species under the EPBC Act.

3. Summary of Conclusion

The Committee judges that the species has been demonstrated to have met sufficient elements of Criterion 1 to make it eligible for listing as **endangered**.

The Committee judges that the species has been demonstrated to have met sufficient elements of Criterion 2 to make it eligible for listing as **endangered**.

The highest category for which the species is eligible to be listed is **endangered**.

4. Taxonomy

The species is conventionally accepted as *Craterocephalus fluviatilis* (Murray hardyhead) McCulloch, 1912.

There was much confusion with hardyhead species in the Murray-Darling system before a taxonomic review in 1990 (Crowley and Ivantsoff, 1990). This limits the value of historical records, as they may reflect erroneous identifications.

5. Description

Murray hardyhead are a small highly mobile schooling fish that attain about 76 mm in length (Ivantsoff and Crowley, 1996; Ebner and Raadik, 2001; Ellis, 2005). They are moderately deep-bodied, with a small protrusible mouth which projects forward as a tube when open (Crowley and Ivantsoff, 1990; Ellis, 2005). The colour varies from silver or silvery-green to dark golden dorsally, with a silvery-black (sometimes golden or reddish) mid-lateral stripe running along the body, and a pale abdomen with a silvery iridescent sheen (Crowley and Ivantsoff, 1990; Ellis, 2005; Hammer and Wedderburn, 2008). The body and fins may develop an orange sheen during the spawning period (Ebner and Raadik, 2001; Ellis, 2005).

6. National Context

Murray hardyheads are endemic to the lowland reaches of the Murray and Murrumbidgee rivers and associated tributaries, billabongs, lakes and wetlands. In past decades the species was abundant and was collected as far upstream as Yarrawonga and as far downstream as the Lower Lakes on the Murray River, and as far upstream as Narrandera on the Murrumbidgee River (Ivantsoff and Crowley, 1996; Hammer et al., 2002; Ellis, 2005). Murray hardyheads have now suffered a severe reduction in range and abundance. The species is considered extinct in NSW in the Murrumbidgee system and is now found in only a handful of saline lakes and wetlands in Victoria and South Australia, in the middle and lower reaches of the Murray River, and some areas of the Lower Lakes (Ebner et al., 2003; Ellis, 2005; Hammer et al., 2007).

The Murray hardyhead is currently:

- listed as vulnerable under the Commonwealth EPBC Act
- listed as critically endangered under the New South Wales *Fisheries Management Act 1994*
- listed as threatened under the Victorian *Flora and Fauna Guarantee Act 1988* and ranked as critically endangered for management purposes (VIC DSE, 2007)
- listed as critically endangered under draft threatened species schedules under the South Australian *National Parks and Wildlife Act 1972*.

The species is found in the North Central, Mallee and South Australian Murray-Darling Basin (SA MDB) NRM Regions.

7. Relevant Biology/Ecology

The Atherinidae includes 60 species from marine, estuarine and freshwater habitats, mostly in the Indo-West Pacific region (Wedderburn et al., 2008). Atherinids are small, short-lived, fast-swimming, schooling fish commonly known as ‘silversides’ or as ‘hardyheads’. The Murray-Darling Basin supports four hardyhead species including the Murray hardyhead, *Craterocephalus amniculus* (Darling River hardyhead), restricted to but relatively common in the upper reaches of the Darling River catchment, *Craterocephalus stercusmuscarum fulvus* (unspecked hardyhead), abundant in the middle and lower Murray River sub-catchment, and *Atherinosoma microstoma* (small-mouthed hardyhead), restricted to the region of the Murray Mouth and the Coorong.

Wedderburn et al. (2007) observed Murray hardyhead using two habitat types:

- shallow (<0.5 m), saline (3–20 ppt) waters that are completely or partially isolated from the main river channel, with scant woody debris and a few submergent macrophyte (aquatic plant) species, predominantly the salt-tolerant widgeon grass (*Ruppia* spp.). This habitat is typified by deflation basin lakes and off-river wetlands along the middle reaches of the Murray River.
- shallow (<0.5 m), slightly saline waters (0.4–1 ppt) that are partially or fully connected to the channel, and dominated by the submergent macrophyte *Myriophyllum* spp. (water milfoil). This habitat is found along the lower reaches of the Murray River and some areas of the Lower Lakes.

Murray hardyheads tolerate salinities up to 85 parts per thousand (ppt) (sea water is approximately 35 ppt) and thrive in saline lakes and wetlands. It is not clear if these are a preferred habitat or refugia (Wedderburn et al., 2008; Wedderburn and Walker, 2008). These habitats are rarely occupied by other native or alien fish species, and may therefore provide a refuge from competition or predation.

Wedderburn (2008; also Adams et al., 2011) employed enzyme (allozymes) and mitochondrial DNA analyses to identify five genetic management units for Murray hardyhead:

Elizabeth Lake unit (now extinct)

Round Lake unit

Woorinen North Lake unit

'Middle Murray' unit – including Cardross Lake, Lake Hawthorn (now extinct in the wild), Disher Creek evaporation basin and Berri evaporation basin sub-populations

'Lower Murray' unit – including Murray Bridge, Lake Albert and Lake Alexandrina sub-populations.

The 'Lower Murray' unit is genetically the most diverse and is a logical priority for conservation. Wedderburn (2008; also Adams et al., 2011) also reported low levels of reciprocal introgression (genetic evidence of interbreeding) with the Darling River hardyhead (*C. amniculus*) in the Lower Murray unit. He suggested that this is evidence of greater movement in both species before river regulation, and indicates that Murray hardyhead originally had a more continuous distribution in a wider range of habitats.

Murray hardyheads reach sexual maturity in six to seven months (Sharpe et al., 2003; Ellis, 2005). The breeding/recruitment season spans September to March (Ellis, 2005; Stoessel, 2008), when water levels in lakes and wetlands should be high enough to ensure submergence of widgeon grass beds and connectivity with areas of emergent vegetation, both of which provide spawning substrates (Ellis, 2005). The salinity tolerances of eggs and larvae are not known, but probably are substantially less than that of adults.

The lifespan is approximately 18 months in the wild (Ellis, 2006). There is 60–90 percent mortality in wild adults after spawning, and all adults die after 18 months (Bice and Ye, 2006, 2007; Ellis, 2006). The generation length of the species therefore is less than two years.

In saline lakes, larger Murray hardyhead consume items such as dipteran (fly) pupae, fish eggs and larger zooplankton, while smaller individuals are restricted by gape ("mouth") size to smaller food items such as copepod nauplii (larvae) and rotifers. There is some seasonal variation in diet (Ellis, 2005).

8. Description of Threats

Little is known of the Murray hardyhead's original distribution, or the timing and causes of its decline. It appears that the species once had a more continuous distribution along the lower Murrumbidgee and Murray Rivers, and occurred in a wider range of off-river habitats as well as along the river margins. The range contraction to saline lakes and off-stream wetlands appears to have occurred in recent decades.

Murray hardyhead declined sharply in the 1950s, 1960s and 1970s, as agriculture, river regulation and water extractions intensified (Maheshwari et al., 1995; Ebner et al., 2003; Ellis, 2005; Hammer et al., 2007) and several alien fish species invaded these reaches of the Murray-Darling system: the medium-sized, predatory redfin perch (*Perca fluviatilis*), the small, aggressive, fin-nipping gambusia (*Gambusia holbrooki*) and the large, omnivorous, sediment-grubbing carp (*Cyprinus carpio*), with the latter two species becoming dominant in lowland reaches of the system (Cadwallader, 1977; Rhodes, 1999; Rowland, 2005; Lintermans, 2007). Wedderburn et al. (2008) remarked on the Murray hardyhead's apparent inability to co-habit with other fish, including other hardyhead species, unless submergent macrophytes were present. This is noteworthy as it is now recognised that the invasion of carp caused extensive losses of submergent macrophytes in the Murray-Darling system (Roberts et al., 1995; Roberts and Sainty, 1996; Rhodes, 1999; Potter et al., 2002; Copeland et al., 2003).

In the Murrumbidgee River catchment, Gilligan (2005) noted that the small native fish assemblage of Murray hardyhead, *Ambassis agassizii* (olive perchlet), *Mogurnda adspersa* (purple-spotted gudgeon) and *Nannoperca australis* (southern pygmy perch) were common and secure in the Narrandera region between 1965 and 1970, but were not recorded after invasion of the catchment by carp in 1972 (with the exception of a single Murray hardyhead recorded in 1995). Gilligan (2005: p.83) stated that "*Despite the fact that many factors would have impacted on these four taxa, the invasion of carp is most closely related to the point in time when populations of these species changed from being relatively common to disappearing from the catchment."*

By the 1990s, the Murray hardyhead was effectively extinct in the Murrumbidgee system and largely restricted to scattered saline lakes and wetlands along the middle and lower Murray River (Ebner et al., 2003; Ellis, 2005; Hammer et al., 2007). The primary drivers for the species' decline since it has been restricted to these saline refugial habitats has been increasing river regulation and water abstraction, exacerbated by drought and associated effects (Ebner et al., 2003; Ellis, 2005; Hammer et al., 2007).

Increasing river regulation and water abstraction, exacerbated by widespread drought in 2001–2009, reduced connectivity between wetland habitats and caused many to dry out. Ten Murray hardyhead populations were lost during the protracted drought, when there would have been physiological stresses and lack of recruitment associated with extreme salinity levels, nutrients and pH, variable oxygen levels and algal blooms in wetland habitats (Ellis 2005; Dixon et al., 2005; Hammer et al., 2007; Stoessel, 2007, 2008, unpubl. data, 2009). Many saline wetlands are maintained partially by irrigation run-off, but inflows have been reduced by increased water efficiency by irrigators (Backhouse et al., 2008; Stoessel, unpubl. data, 2009). Other threats include pesticide contamination in irrigation run-off, siltation, barriers to movement and continued competition and predation by alien fish species, particularly carp and gambusia (Ebner et al, 2003; Stoessel, 2007, 2008, unpubl. data, 2009; Wedderburn et al., 2007, 2008).

Alien fish parasites are an emerging threat. Murray hardyhead populations with high levels of parasitic worm infestations have been recorded in Victoria and South Australia (Hammer and Wedderburn, 2008; Ellis, unpubl. data, 2011). These are suspected to be the Asian fish tapeworm (*Bothriocephalus acheilognathi*), brought to Australia with importations of carp and now present throughout the Murray-Darling system (Dove and Fletcher, 2000). The parasite is vectored primarily by carp, and to a lesser extent by gambusia (Dove and Fletcher, 2000). It lodges in the intestine, and can cause heavy mortalities of small or juvenile fish and impaired health and growth in larger fish (Scott and Grizzle, 1979). It has caused mortalities in a native carp gudgeon (*Hypseleotris* sp.) in the ACT (Lintermans, 2007). The effects of this parasite on Murray hardyhead are not yet known.

9. Public Consultation

The information used in this assessment was made available for public exhibition and comment for 30 business days from late October to early December. No comments were received.

10. How judged by the Committee in relation to the criteria of the EPBC Act and Regulations

The Committee judges that the species is **eligible** for listing as **endangered** under the EPBC Act. The assessment against the criteria is as follows:

Criterion 1: It has undergone, is suspected to have undergone or is likely to undergo in the immediate future a very severe, severe or substantial reduction in numbers

Once widespread and abundant in the Murray and Murrumbidgee river systems in southern NSW and northern Victoria, Murray hardyhead are now limited to a few populations (Ebner et al., 2003; Ellis, 2005; Hammer et al., 2007). In addition, 10 of 19 known Murray hardyhead populations in Victoria and South Australia were lost during the 2000–2009 drought (e.g. Hardie, 2000; Lyon et al., 2005; Dixon et al., 2005; Ellis 2005; Hammer et al., 2007; Stoessel, 2007, 2008, unpubl. data, 2009). Most of the remaining populations are too widely separated for natural recolonisation to occur, and the decline probably can be countered only by translocations or by restocking of hatchery-bred fish. The Committee therefore considers this decline to be severe. The Committee notes that the number of populations lost would be greater if environmental water allocations had not been used to sustain some habitats i.e. Cardross Lakes (Basin 1 East), Round Lake, Woorinen North Lake (Stoessel, unpubl. data, 2009). Therefore, the species has been demonstrated to have met the relevant elements of Criterion 1 to make it **eligible** for listing as **endangered**.

Criterion 2: Its geographic distribution is precarious for the survival of the species and is very restricted, restricted or limited

Nine populations of Murray hardyhead are known from the lower Murray-Darling Basin and their distribution is patchy and highly fragmented (Lloyd and Walker 1986; Ellis, 2005, Wedderburn et al 2007). Stoessel (unpubl. data, 2009) identified the known locations in Victoria as Cardross Lake Basin 1 East, Round Lake and Woorinen North Lake, providing suitable habitat totalling about 1.1 km^2. In South Australia, known populations include those in Berri Evaporation Basin, Disher Creek and the Lower Lakes (Lake Alexandrina, Goolwa Channel, Finniss River and Lake Albert), providing habitat totalling about 65 km^2. Stoessel (unpubl. data, 2009) estimated the total area of occupancy for the species across South Australia and Victoria in early 2008 to be 66.1 km^2.

The Committee is aware that the Murray hardyhead's area of occupancy may have increased slightly since this estimation and the cessation of drought in 2010, particularly in the Lower Lakes region. Nevertheless, the Committee accepts the area of occupancy estimate of 66.1 km^2 as representative of the species' current geographic distribution and judges it to be restricted. The Committee further judges this geographic distribution to be precarious for the survival of the species, as it represents a severely fragmented range and the species is known to have undergone a substantial decline in area of occupancy and extent. The species' habitats also limit its ability to repopulate because of river regulation, the effects of pesticide and nutrient contamination in irrigation run-off, siltation, barriers to movement and competition from alien fish species. Therefore, the species has been demonstrated to have met the relevant elements of Criterion 2 to make it **eligible** for listing as **endangered**.

Criterion 3: The estimated total number of mature individuals is limited to a particular degree; and either

(a) evidence suggests that the number will continue to decline at a particular rate; or

(b) the number is likely to continue to decline and its geographic distribution is precarious for its survival

There are no estimates available for the total number of mature Murray hardyhead. Adults of the species are small, fast-moving and short-lived, and so numbers are difficult to estimate. Data show that the species has declined sharply over the last 10 years (incorporating the 2000–2009 drought), but there are no data available to indicate whether the total number of mature individuals is very low, low, limited, or not limited. Therefore, as the species has not been demonstrated to have met this element of Criterion 3, it is **not eligible** for listing in any category under this criterion.

Criterion 4: The estimated total number of mature individuals is extremely low, very low or low

No estimates are available for the total number of mature Murray hardyhead. Nevertheless, considering that this is a small, schooling species found in only nine locations, the total number of mature individuals is very likely to exceed 1,000. The Committee does not consider that the total number of mature individuals of the species is extremely low, very low or low. Therefore, as the species has not been demonstrated to have met Criterion 4, it is **not eligible** for listing in any category under this criterion.

Criterion 5: Probability of extinction in the wild that is at least

(a) 50% in the immediate future; or

(b) 20% in the near future; or

(c) 10% in the medium-term future

There are no data available to estimate a probability of extinction of the species in the wild over a relevant timeframe. Therefore, as the species has not been demonstrated to have met the relevant elements of Criterion 5, it is **not eligible** for listing in any category under this criterion.

11. Conclusion

Conservation Status

Craterocephalus fluviatilis (Murray hardyhead) was nominated for transferring from the vulnerable to the critically endangered category of the list of threatened species referred to in section 178 of the EPBC Act.

The Committee accepts that the Murray hardyhead has undergone a severe reduction in numbers in the last 10 years. Therefore, the species has been demonstrated to have met the relevant elements of Criterion 1 to make it **eligible** for listing as **endangered**.

The Committee notes the Murray hardyhead's area of occupancy might have increased slightly since 2010, but accepts the estimated area of occupancy of 66.1 km^2 as representative of the species' geographic distribution, and judges it to be restricted and precarious for the species' survival. Therefore, the species has been demonstrated to have met the relevant elements of Criterion 2 to make it **eligible** for listing as **endangered**.

The highest category for which the species is eligible to be listed is **endangered**.

Recovery Plan

The species already is subject to a Recovery Plan, commencing in 2008 (Backhouse et al., 2008).

12. Recommendations

(i) The Committee recommends that the list referred to in section 178 of the EPBC Act be amended by **transferring** from the vulnerable category to the endangered category:

Craterocephalus fluviatilis

(ii) The Committee recommends that the species continue to be the subject of a Recovery Plan.

Threatened Species Scientific Committee
11 July 2011

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