INDEPENDENT EXPERT REVIEW OF THE INFORMATION PROVIDED IN THE TRAVESTON CROSSING DAM EIS THAT RELATES TO THE MARY RIVER TURTLE (EPBC Referral 2006/3150)

by

Gerald Kuchling
Chelonia Enterprises (ABN: 45 238 493 419)
154 Bagot Road, Subiaco, WA 6008, Australia

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"*Rivers comprise a variety of lentic (still water) and lotic (flowing water) habitats. Within each of these general categories a variety of physical and biological factors interact to determine the turtle species that occur there. ...A replacement or turnover of some or all species can be expected to accompany changes in external factors. ... Specialist species ... are tied to particular habitats. Rather than adapting to new habitats as environmental conditions change, these species track (follow) their preferred habitat. …*

Damming and sand mining are examples of factors that indirectly damage or destroy populations of river turtles. Direct factors such as human exploitation are typically more obvious causes of population decline and often serve as stimuli to incite conservation action by a concerned public or government. While direct factors typically kill animals outright or at least remove them from the gene pool, indirect factors can surreptitiously reduce their chances of survival by altering habitat or reducing food supplies. As such, they may decimate a population before it becomes obvious that something is wrong. Though less conspicuous than the direct causes, indirect factors are at least of equal importance in determining the ultimate survival of a species."

(D. Moll. and E.O. Moll 2004: The Ecology, Exploitation and Conservation of River Turtles. Oxford University Press)

1. Current Status of the Mary River Turtle *Elusor macrurus*

1.1. Distribution

Elusor macrurus is only found in the Mary River catchment. It occurs primarily in the mainstream Mary River and some major tributaries, including Tinnana Creek and Yabba Creek. It occurs from downstream within the Mary River Barrage near Tiaro up to Kenilworth in the upper Mary (EPA 2007 [EIS Supplementary Report Appendix C15]). The river system has been significantly impacted by sand and gravel extraction, agricultural and urban runoff, erosion, bank instability and currently carries orders of magnitude more sediment than prior to European settlement (EIS 2.2).

The EES (2007) freshwater turtle survey commissioned as part of the EIS provides an extensive and good assessment of the distribution of the species in the wider project area. This is well presented on maps.

1.2. Abundance and Population Status

Elusor macrurus is listed as endangered under the EPBC Act. No rigorously quantitative abundance data are available for *Elusor macrurus*. However, relative abundance of *E. macrurus* in different areas can be estimated from capture and observation data. EPA (2007) summarized the recorded and collected data (from various sources) of a total of 130 *E. macrurus* throughout their known distribution over a ten year period (1997-2006). Most of these turtles (n=112) were collected from 1997 to 1999 at three sites: Gunalda, Woolooga Bridge Crossing and Tiaro (Flakus 2002). Nearly all the additional 18 *E. macrurus* records included in EPA (2007) came from downriver of Gympie, although they also include some data from Kenilworth, Yabba Creek (which flows into the proposed Traveston Crossing Dam inundation area) and from the Mary River just below the proposed Traveston Crossing Dam (TCD) (C. Limpus, pers. communication 27 May 2008). In addition, the EPA has continued to collect nest data since 2002 (in addition to the nest data reported in Flakus 2002) at sandbanks near Tiaro.

The EES (2007) freshwater turtle survey commissioned as part of the EIS used snorkel observation data and was able to record 296 *Elusor macrurus*, including 179 in the proposed TCD inundation area. According to Table 20-9 of the EIS Supplementary Report, the approximate total snorkel survey effort was 8.3 days in the upstream survey reaches (the wider TCD area) and 3.2 days at Gympie, Gundiah and Netherby (in the middle and lower Mary River). In the middle and lower Mary River the survey recorded 21 *E. macrurus* in 3.23 days (~6.6 *E. macrurus*/day), compared to 275 *E. macrurus* in 8.3 days in the upstream survey reaches (~33.1 *E. macrurus*/day).

Appendix 3 in Flakus (2002) details the number of turtles caught per hour at Gunalda, Woolooga Bridge Crossing and Tiaro by different methods from 1997 to 1999, including snorkeling only. By snorkeling only they caught a total of 567 turtles in 122.75 hours. If it is assumed, to make the two studies comparable, that a “snorkel day” in the EES (2007) report corresponds to 12 hours, then Flakus (2002) caught 55.6 turtles/day by snorkeling. Of the total of 789 turtles captured by all methods in Flakus (2002), 112 specimens or 14.2% were *Elusor macrurus*. If it is assumed the same percentages of captured specimens per species applied to snorkel only catches, then ~7.9 *E. macrurus*/day were being caught while snorkeling in the middle and lower Mary River from 1997 to 1999. If a "snorkel day" is (more realistically) assumed to correspond to 10 hours snorkeling, then the catch was ~6.5 *E. macrurus* /day.

These data of Flakus (2002), which are also the main data presented in the EPA (2007) report commissioned by QWI, support the general reliability of the independently commissioned EES (2007) report assumptions regarding the abundance of *Elusor macrurus* in the Mary River including the project area of TCD: despite the methodological limitations of the EES (2007) report, the ~6.6 *E. macrurus*/day being observed while snorkeling in the middle and lower Mary River in 2007 (EES 2007) corresponds well to ~6.5 - 7.9 *E. macrurus*/day being caught while snorkeling in the middle and lower Mary River from 1997 to 1999, the main data on which the EPA (2007) report is based.

Underwater visibility can influence detection rate during snorkeling. The snorkel data of Flakus (2002) were mainly based on snorkel events in 1997 and 1998 (119.5 hrs snorkeling) when water clarity was good and visibility generally 2-3m at the Gunalda site, >5m at the Woolooga Bridge Crossing site and at Tiaro "*usually poor within the deep, slow flowing pools*" but >3m in shallow areas near riffle zones (Flakus 2002 section 2.2.2-2.2.4). In 1999 visibility was "zero" due to floods and only 3 hrs snorkeling occurred with 11 turtles caught (Flakus 2002 Appendix 3). During the EES (2007) snorkel survey visibility was 2-3m in areas upstream of Gympie (wider TCD project area), 1-3m at Gympie and Gundiah, but predominantly 2-3m at Gundiah, and approximately 1m at Netherby (Table 20-9 EIS Supplementary Report). Overall the visibility situation between the Flakus (2002) snorkel data collection and the EES (2007) snorkel data collection shows only minor differences: the visibility during the 1997-1998 snorkel captures in the middle Mary River (Gunalda and Woolooga Bridge Crossing site, Flakus 2002) was similar or slightly superior to the visibility during the 2007 snorkel surveys upstream of Gympie (wider TCD project area) and at Gympie (Table 20-9 EIS Supplementary Report). Visibilities in the lower Mary River ("*usually poor within the deep, slow flowing pools*" at Tiaro in 1997-1998 [Flakus 2002 section 2.2.4] and approximately 1m in pool habitats at Netherby in 2007, but >3m in shallow areas near riffle zones at Tiaro [Flakus 2002 section 2.2.4] and predominantly 2-3m at Gundiah [Table 20-9 EIS Supplementary Report]) also seem to generally correspond well between those studies. In regard to the prevailing water clarity and visibility in the respective areas during the surveys the snorkel data of Flakus (2002) and of EES (2007) are directly comparable.

Thus, all currently available information suggests that today the abundance of *E. macrurus* in the stretch downriver of Moy Pocket in the proposed TCD inundation area + the stretch 7.5 km downriver of the proposed dam (~33.1 *E. macrurus*/day EES [2007] snorkel survey result) is about five times higher than the abundance of *E. macrurus* in the middle and lower Mary River downstream of Gympie (~6.6 *E. macrurus*/day EES [2007] snorkel survey result and ~6.5 - 7.9 *E. macrurus*/day snorkel capture result of Flakus [2002]). The comparatively high abundance of *E. macrurus* in the TCD project area as compared to the middle and lower Mary River clearly is not a methodological artifact of the EES (2007) survey, but is real and supported by the data on which the EPA (2007) report is based.

The EES (2007) freshwater turtle survey commissioned as part of the EIS provides a reasonable estimate of the general abundance of the species in the wider project area, despite the purely observational count of *E. macrurus*. The EIS (9.5.3.5, page 9.50) correctly states that the highest densities of Mary River Turtles were recorded in the stretch of river between the Vic Olson Bridge near Carter's Ridge and Traveston Crossing, an area proposed for inundation by the TCD. The estimated population size in the area affected by the proposed action (within and adjacent to the inundation area) provided by the EIS (8.9.3.1) is between 895 and 3580 individuals. The wide range of the estimate is dictated by the methodological limitations discussed above, but no better estimate is currently available. Clearly, a mark-recapture study of the *E.macrurus* population in the project area would provide much more accurate data.

The EIS Supplementary Report (20.6.1.2) stated (p. 20-48): "*the EIS team concluded that while the EES sampling in the direct area of impact was comprehensive, the very low sampling effort in downstream areas, the lack of sampling near the core downstream nesting banks and the relatively poor visibility in these areas, the historic EPA data from these areas was highly likely to be more indicative of the true situation.*" However, as shown above, when using similar abundance estimates for the EPA (2007) data and the EES (2007) data, the EPA (2007) data from the late 1990s correspond quite well to those of the EES survey from 2007 in the middle and lower reaches of the Mary River, particularly considering the 8-year time span between those surveys. Some changes may have occurred, for example the EES (2007) study found no *E. macrurus* in the Netherby reach (lower Mary River) during the one day of sampling, despite finding there good numbers of the Southern Snapping Turtle *Elseya albagula*. This suggests that the problem was not that turtles could not be seen due to poor visibility, but that there were no *E. macrurus* under the good number of turtles seen. In addition, as shown above, the visibilities in the pools of the lower Mary River at Tiaro in 1997-1998 [Flakus 2002] and at Netherby in 2007 (Table 20-9 EIS Supplementary Report) were quite comparable. Unfortunately neither Flakus (2002) nor EPA (2007) report the number of captured *E. macrurus* during snorkeling in the lower Mary River (Tiaro) compared to the middle Mary River (Gunalda and Woolooga Bridge Crossing sites). Thus it cannot be evaluated if the EES (2007) finding does or does not reflect an actual change of the situation in the lower Mary River between 1997/98 and 2007 (it could be that Flakus [2002] also only caught other turtle species than *E. macrurus* in this general area by snorkeling). However, the results of the EES (2007) study and the EPA (2007) study certainly do not contradict each other.

Furthermore, the suggestion in the EIS Supplementary Report (20.6.1.2) that "historic" data rather than actual data should be used to assess the importance of a particular area or population for a species is inappropriate for an environmental impact statement. The fact that, in the past (1960s), the lower Mary River may have been a stronghold with high abundance of *E. macrurus*, cannot be used to claim that the (relative to the historic situation) smaller population of *E. macrurus* in the TCD area is not significant for the survival of the species today: the historically large population outside the project area has in the mean time crashed by 95%. Today, the abundance of *E. macrurus* in the TCD project area is about five times higher than is known for any other stretch of the Mary River.

The EIS Supplementary Report (20.6.1.3) stated (p. 20-52): "*the EIS recognized that the dam would inundate habitat that is currently suited to Mary River Turtles and the flow regime* *downstream would be modified, most significantly in the reach between the dam and Gympie. It further recognized that the dam wall would impose a barrier to movement of turtles and other species and that the operation of the infrastructure would, without mitigation, cause physical damage to turtles.*"

However, EIS does not present an evaluation of the significance of the project area for persistence and long term survival of *E. macrurus*.

Historically, the relative abundance of *E. macrurus* in the upper *vs* middle/lower Mary River were almost certainly different than they are today. Based on egg and nest data, the breeding population of *Elusor macrurus* in the lower Mary River declined by 95% between the 1960s/ early 1970s and the late 1990s (Flakus 2002, EPA 2007). This suggests that *E. macrurus* in the middle/lower Mary River may have been twenty times more abundant in the 1960s than it is in the same area today and 4 times more abundant than it is today in the TCD project area. On the basis of this information, in the 1960s the *E. macrurus* population in the TCD project area would probably have been considered of marginal importance for the persistence of the species as a whole.

However, with the decline and near crash (95% reduction, EPA [2007]) of the core population of *E. macrurus* in the middle and lower Mary River (probably due to a variety of environmental degradations including the Mary River Barrage and impoundment impacting on juvenile survival, egg harvesting by humans in the 1960s and early 1970s and increased numbers of feral egg predators), the previously marginal population in the TCD project area gained significance for the persistence of the species: it now appears to be the last viable population (probably little or non-depleted with apparently successful recruitment) in the last remaining area which still offers good habitat conditions for *E. macrurus*.

The river stretch which today offers the best habitat and conditions (see section 1.4 below) for *E. macrurus*, supporting the highest densities (five times higher than known for any other area) and the most viable population of Mary River Turtles presently known (successful recruitment, see below), would be inundated and fragmented by the TCD. This would modify, destroy, isolate and decrease the quality of habitat to the extent that *E. macrurus* is likely to decline.

1.3. Threats and recruitment

Threats

An historic threat to *E. macrurus* in the middle and lower Mary River was collection of eggs by humans on sandbanks downstream of Gympie (but mainly downstream of Miva). Eggs were collected to procure turtle hatchlings for the Australian pet market (between 1962-1974). Egg collection largely ceased with the introduction of the Queensland *Fauna Conservation Act* in 1974 (Flakus 2002). EPA (2007 p. 1/57) stated that "*in the 1960s and early 1970s,* E. macrurus *was subjected to a significant population decline due to excessive egg harvest for the pet trade*". Although egg harvest in the lower reaches of the river at that time is undisputed, no evidence or qualified discussion is provided by EPA (2007) to explain the simultaneous and "significant" population decline. *Elusor macrurus* is a very long lived, late maturing turtle: age at sexual maturity is 25+ years for female and 30+ years for males (Tucker 2000).

Given the life history traits of *E. macrurus*, the mean age of breeding females in a normally structured population should, conservatively estimated, be around 35-40 years. Any effect of the historic egg harvest on the adult population, and on the reproductive output of that population, would not be expected to become apparent until the 1990s (when potential hatchlings from the time of the egg harvests would reach sexual maturity). Thus, the egg harvest in the 1960s and early 1970s cannot explain the 95% decline of nesting females by the late 1990s as reported by Flakus (2002) and by EPA (2007).

The population structure of *E. macrurus* in the middle and lower Mary River in the late 1990s showed a lack of large juveniles and a lack of recruitment into the young adult population, which quite likely reflects the egg losses of 1960-70s. However, the structure also showed a lack of medium-aged adults which cannot be explained by the egg harvests that commenced in 1962: according to EPA (2007 p. 17/57), "*the population* (was) *composed mainly of aging adults*". This suggests that by the late 1990s, other factors must already have operated for 1 ½ to 2 decades (but not much longer), impacting on juvenile recruitment into the adult population and causing the *E. macrurus* population to skew towards aged individuals. Notably, the factors preventing recruitment of juveniles to the adult population, did not dramatically increase mortality in the existing adult population (as good numbers of aged individuals remained in the population).

It is generally well known that, despite the tremendous mortality rates of eggs and hatchlings that often takes place on the nesting beaches of river turtles, the protection of larger juveniles and adults and habitat maintenance, are much more important for the maintenance of self-sustaining populations of long-lived river turtles, than the protection of eggs and baby turtles from predation (e.g. Moll, D. & Moll E.O. 2004: *The Ecology, Exploitation, and Conservation of River Turtles*. Oxford Univ. Press).

Diving physiology and behavioural studies indicate that juvenile *E. macrurus* have the greatest requirement for access to water with high dissolved oxygen content (EPA 2007). A main habitat requirement for successful recruitment into *E. macrurus* populations seems to be the dissolved oxygen content of the water. *Elusor macrurus* has a significant reliance on extracting dissolved oxygen from the water using cloacal ventilation. This is undoubtedly the principal factor limiting the distribution of the species to flowing streams and permanent large pools (EPA 2007).

Consequently, *E. macrurus* was identified as one of the turtles at greatest risk from the existing and planned changes to the in-stream habitat and flow regimes from the long past pristine conditions of the Mary River (EPA 2007). The oxygen content is much higher in a flowing river than in impoundments. The construction of the Mary River Barrage and the Tinana Barrage in the early 1980s coincides with the reduction in recruitment of juveniles into the adult *E. macrurus* population in the lower and middle Mary River. These barrages and impoundments are likely a factor that impacted on recruitment into the adult *E. macrurus* populations in those areas. This is consistent with the aging adult *E. macrurus* population as observed by EPA (2007) in the middle and lower Mary River system in the late 1990s.

Tucker (2000, Table 3.3.7) ranked the lower, middle and upper reaches of the Mary, Fitzroy, Kolan and Burnett Rivers according to the observed loss of turtle biodiversity in existing dams *versus* rivers. This study recorded the greatest loss of turtle biodiversity (53.3%) in the middle reaches of the Mary River, thought to be a result of impoundments. In the middle reaches of the Mary River, the species *Emydura krefftii* comprised 44.9% of sampled turtles in the free-flowing sections, but 98.2% in impounded sections (Tucker 2000, Table 3.3.7 + Fig. 3.3.2). This shift in turtle biodiversity in the impounded sections of the middle Mary River was mainly based on declines in the ecological specialists *Elusor macrurus* and *Elseya albagula* (Tucker 2000, Fig. 3.3.3). Overall, of 11754 freshwater turtles sampled in the Mary, Fitzroy, Kolan and Burnett River catchments, the representation of *Elusor macrurus* was 4.8% in unimpounded sections and 0.04% in impoundments (Tucker 2000, Table 3.3.6). Although *E. macrurus* was recorded in impoundments, densities were low compared to free-flowing sections and to other turtle species in the impoundments.

Tucker (2000) recorded two specimens of *Elusor macrurus* in Imbil Weir. It is worth noting that Imbil Weir has an impoundment with a storage capacity of 50 ML, whereas the planned TCD stage 1 storage would be more than 3000 times larger with a capacity of 153,000 ML. In general, large impoundments have a greater impact on turtle biodiversity than smaller impoundments (Tucker 2000). Without providing any details (e.g. number, size), EPA (2007) reports that *Elusor macrurus* has also been captured in the Mary River Barrage impoundment and has been recorded in the Tallegalla Weir impoundment on Tinnana Creek. EIS Supplement p. 20-51 specified: "*The first of the recent studies that included the impounded waters of the Mary River Barrage is S. Flakus MSc thesis at University of Queensland (2002). Flakus recorded nesting at three sites within the barrage impoundment. Van Kampen (2003) also recorded nesting in the barrage weir pool.*" The age of those dams is about the same as the age at maturity of *E. macrurus* (25 years for females and 30 years for males, Tucker 2000). Long-lived species like *E. macrurus* may persist for decades in changed habitats in the face of low or no recruitment, but the low mortality rates of adults cannot compensate for this indefinitely. The occurrence in impoundments of some individuals including gravid or nesting females (EPA 2007) is not in conflict with and does not negate their negative impact on *E. macrurus* populations.

Together, this information and data suggest that, adults would appear to be less common in impoundments (than in free-flowing sections) and that impoundments may play a significant role in reducing the recruitment of juveniles to the adult population. Therefore, through habitat modification, in particular decreased dissolved oxygen concentrations, the planned TCD would have a major negative impact on the *Elusor macrurus* population in the project area.

Another threat to *E macrurus* population is a high loss of eggs at nest banks. Since human exploitation of *E. macrurus* eggs in the middle and lower Mary River ceased in 1974, high level of nest predation by native (goanna) and exotic (fox, feral dog, pig) predators continued. In addition, nesting banks were lost through sand mining and inundation by river impoundments and remaining banks are impacted by cattle (Flakus 2002; EPA 2007). Despite intensive predation the numbers of small juveniles represented in the *E. macrurus* population in the middle and lower Mary River in the late 1990s appeared to be relatively normal (see EPA 2007 Fig. 3.3 p. 24/57). This suggests that the *E. macrurus* life history traits of late maturity, high longevity and iteroparity evolved to compensate for high egg losses at nest banks, a phenomenon well known for many river turtles generally (e.g. Moll and Moll 2004). Egg loss at nest banks is a highly visible threat, but evidently not the most important threat to *E. macrurus* populations.

The EPA (2007) data showed that juveniles represented 35% of the Mary River turtle population in the middle and lower Mary River. These were mostly relatively small juveniles (10-15 cm carapace length), with larger juveniles and subadults being very scarce. This indicates low recruitment into the adult population. Interestingly, the EES (2007) survey found good numbers of juveniles upstream of Gympie but did not find any juvenile *E. macrurus* at Gundiah and Netherby in the middle and lower Mary River. As discussed above this does not seem to reflect visibility variations during the different snorkel surveys. Unfortunately neither Flakus (2002) nor EPA (2007) reported numbers of juvenile *E. macrurus* captured with different techniques in the lower and middle Mary River, e.g. by snorkeling or in traps or by seine netting. If it is assumed that the different capture techniques used by Flakus (2002) and EPA (2007) have equal capture rates of juvenile *E. macrurus*, then it appears that the number of juveniles in the *E. macrurus* population in the lower and middle Mary River has decreased between the late 1990s and 2007, but was high in the upper Mary River (TCD project area) in 2007 (and higher than in the middle and lower Mary River in the late 1990s).

Some eggs certainly have to survive to provide for a healthy age structure in a population and protection of nest banks is a worthwhile action to ensure this. However, as stated earlier for long-lived river turtles generally, the protection of juveniles and adults and habitat maintenance are much more important to maintain self-sustaining populations than the protection of eggs from predation (Moll, D. & Moll E.O. 2004).

The EIS identified repeatedly as main and critical threat to the Mary River Turtle the predation of its eggs by feral and native animals and accidental damage through trampling by cattle (e.g. p3-5; p18-79). This notion which is promoted throughout the EIS - that the only major threat to *Elusor macrurus* populations is loss of eggs - is certainly grossly insufficient. Although these factors can cause problems to a population, they do not seem to be the main reason for the decline of the species and its endangered status (see above).

The serious threat posed by habitat deterioration to *E. macrurus*, particularly through reduced dissolved oxygen concentrations in impoundments on juveniles, is not sufficiently presented and discussed in the EIS.

Recruitment

The problem *E. macrurus* generally seems to have today with recruitment into the adult population is not sufficiently considered by the EIS. In particular, the EIS (20.6.1.2 p. 20-48) suggests that there is no “significant” difference in the juvenile component between the populations in the TCD project area and in the middle and lower Mary River. This is despite the data indicating differences: 35% juveniles found by EPA (2007) in the middle and lower Mary River mainly from 1997-1999; 0% found by EES (2007) in the middle and lower Mary River in 2007; 42.5% were found by EES (2007) in the area proposed for inundation; and 43.7% were found by EES (2007) in the 7.6 km stretch immediately downstream of the proposed dam. To dismiss these differences as “not significant” by simply suggesting they could be sampling artifacts is certainly not consistent with the precautionary principle. Even if the scientific certainty regarding the differences in juvenile proportions in the populations is debatable, the differences shown by the studies cannot simply be dismissed as insignificant and treated as non-existent.

Unfortunately the EES (2007) freshwater turtle study did not report size - frequency distributions (and, therefore, cannot show if large juveniles and subadults are depleted). It does however, present regional differences in the occurrence of juveniles and adult males and females. Juveniles comprise 42.5% in the area proposed for inundation and 43.7% in the stretch immediately downstream of the proposed dam: in the 7.6 km downstream of the proposed dam the density of juveniles is the highest of any of the surveyed areas in the Mary River. The proportion of juveniles, together with the overall density of *E. macrurus* in this area (about five times higher than in the middle and lower Mary River, see above), suggests that the TCD project area is currently important for successful recruitment of *E. macrurus*.

Although the EES (2007) freshwater turtle survey commissioned as part of the EIS provides data on the relative occurrence of *E. macrurus* juveniles, females and males in the project area and beyond, these data are not rigorous. In particular, no size distribution is provided since the turtles were not measured. This means a precise analysis of the population structure is not possible. The designation of *E. macrurus* as juveniles and females based on visual observation only and without handling most turtles is probably not very precise (*E. macrurus* adult males are easier to correctly identify due to the very long tail). Nonetheless, the assessment that the wider TCD project area is currently the most successful recruitment area of *E. macrurus* remaining in the Mary River, is not too sensitive to this imprecision, since it would not affect the combined female/juvenile pool recorded from the survey.

Clearly, a study involving measurement of the size of individuals and mark-recapture of the *E. macrurus* population in the project area would provide much more accurate data on the population structure and recruitment patterns. This would be very important for a more precise and rigorous evaluation of the significance of the TCD project area for the species as a whole.

The EIS (20.6.1.2 p. 20-48) discussed at length personal communications from Limpus that other turtle populations in other rivers also (sometimes or often) show low juvenile segments in the observed population structures. It is suggested that "*the relatively good figures reported for Mary River turtle may reflect some success related to nest protection at the main nesting banks near Tiaro*". If this assumption is used to explain the good number of juveniles in the wider TCD project area it would require large scale upriver movements of hatchlings or juveniles from Tiaro for >100km. This appears to be unlikely since the TCD project area today also supports the highest density of adult *E. macrurus* in the Mary River and since long distance (e.g. 100km) nesting movements of adults have not been recorded by radio-tracking (Tucker 2000, Flakus 2002). A more likely scenario is that the relatively good number of juvenile *E. macrurus* in the TCD project area reflects good juvenile survival and recruitment of a resident population due to the high quality of the current habitat (as suggested by EES [2007] which accordingly considers the TCD project area to represent critical habitat for *E. macrurus*). .

On the other hand, the biology of the Mary River Turtle is still insufficiently known. Some other river turtles, including their hatchlings/juveniles, are known to migrate up to several hundred kilometers from nesting areas to feeding and growing areas (e.g. *Podocnemis expansa* in the Amazon and Orinoco Rivers: Moll and Moll 2004). The EIS goes to great length to play down the significance of the TCD area for *E. macrurus* breeding,. For example, EIS Supplement page 20-26 states: ”*with respect to nesting habitat, it is firstly noted that the limited nesting observed in the inundation area is in accord with historic observations that nesting is sparse throughout the range but most concentrated in areas well downstream, particularly around Tiaro*”. From this speculative basis the much higher proportion of juveniles and the five times higher abundance of *E. macrurus* in the TCD project area as compared to the lower and middle Mary River (suggested by the combined EES [2007] and EPA [2007] data) could only be explained by (until now unrecorded) long distance upriver movements of hatchlings or juveniles from the lower Mary River (Tiaro) to the upper Mary River (the proposed TCD project area). Should such large scale movements of juveniles take place, the construction of the Traveston Crossing dam would even be more devastating for the persistence of *E. macrurus* than if only resident populations would be affected: the dam would essentially cut off and separate the most important nesting area (Tiaro as speculated by the EIS Supplement) from the most important juvenile nursery area (the wider TCD project area as demonstrated by EES [2007]).

Thus, no matter which scenario holds true (either the TCD project area harbours a significant breeding and nesting population and represents critical habitat for *E. macrurus* as suggested by EES [2007] and their data, or it is not a significant nesting area as speculated by the EIS Supplement [which then would require large scale upriver movements of hatchlings or juveniles]), the Traveston Crossing Dam would impact on reproduction and recruitment of *E. macrurus* and reduce the long term survival prospects of the Mary River Turtle. The overall assessment in the EIS that the TCD project area today has, compared to areas in the middle and lower Mary River, no particular significance for the conservation and survival of *E. macrurus* is an inaccurate and inappropriate judgment.

Summary

In regard to threat assessment the major shortcoming in the EIS is that recruitment problems of *Elusor macrurus* are only considered and discussed in regard to the egg stage and the heavy losses that occur during this life phase at nest banks. However, high egg losses at nesting banks are common and normal in river turtles generally and the EPA (2007) data do not suggest that this currently constitutes the main or major threat to the species. The EPA (2007) data strongly indicate that reduced or missing recruitment of large juveniles/ subadults into the adult population is currently the main threat to *E. macrurus* in the middle and lower Mary River. This life stage is temporally separated from the egg stage by about 15-30 years. Problems caused by losses in the large juveniles/ subadult stage cannot or can only be marginally compensated for by reducing the loss of eggs at nest banks.

How the main threat to *E. macrurus* is defined obviously determines which conclusions can be drawn and which solutions can be found. Therefore, the threat of reduced recruitment of large juveniles/ subadults into the adult population of *E. macrurus* has to be identified and assessed separately from that of egg losses. The combination of EPA (2007) data with the EES (2007) survey data supports and is consistent with the following interpretations and conclusions:

- in the lower and middle Mary River *Elusor macrurus* juvenile survival seems to be low and recruitment into the adult population is largely missing. Due to the apparent disappearance of large juveniles and subadults from the population (probably due to environmental degradation including impoundment of previously flowing river sections) the Mary River downriver of Gympie may today constitute a population sink for *E. macrurus* (net loss of turtles higher than recruitment). This assessment is supported by the 95% decline of nesting females in this area between the 1960s and the 1990s of which, due to the life history traits of the species, only a minor part of the decline can be attributed to egg harvests from 1962 to 1974.

- At present the wider TCD project area seems to include the major and most important recruitment area of *Elusor macrurus* in the whole Mary River (highest density of females of all survey stretches, high density of juveniles).

- The most critical threat to the survival of *Elusor macrurus* is the loss of larger juveniles and sub-adults from the overall population. In the lower Mary River this seems to be related to habitat degradation and habitat loss which may expose this age group to increased mortality (e.g. predation: turtles may have to surface more frequently due to decreased dissolved oxygen in the water, exposing them more frequently to predation). The timing of the cessation of recruitment into the adult population and of the beginning of the 95% population crash in the middle and lower Mary River coincided with the construction of the Mary River Barrage.

- Egg loss on nesting banks through predation by feral and native animals and accidental damage through trampling by cattle is an additional threat to the species.

1.4. Habitat

Habitat needs of *Elusor macrurus* encompass aquatic and terrestrial (nesting) habitat. In general the aquatic and terrestrial (nesting) habitat of *E. macrurus* is accurately and sufficiently described in the EIS. Potential nesting habitats (sand banks) have been mapped.

Elusor macrurus occurs in flowing, well oxygenated sections of streams. Its principal habitat is relatively deep (~1-5m) river pools with high dissolved oxygen concentrations, alternating with riffles and shallow stretches. Habitat parameters which are important for the species, in addition to high dissolved oxygen concentration and depth of the water, include macrophytes, underwater shelter, submerged logs, and basking logs and rocks (EIS 9.5.3.5 p. 8-49).

The EIS (20.6.1.3 p. 20-52) states in regard to *E. macrurus*: "*While the inundation area represents currently suitable habitat, it does not represent critical habitat*". This statement is based on the calculation that TCD will only impound 4% of the total length of the river and about 10% of current probable Mary River turtle habitat. This statement does not take into account the following important factors: the 95% reduction in the population downstream of Gympie over the last 3-4 decades (about one generation span of *E. macrurus*); the lack of successful recruitment into the adult population in this area (EPA 2007); and the high proportion of juveniles and the high population densities currently present in the TCD project area. All available data (EPA 2007, EES 2007) show that no habitat stretch has been identified in the Mary River which today could have a higher significance and importance for the recruitment and persistence of *E. macrurus* than the TCD project area.

The EIS repeatedly tries to downplay the significance of high dissolved oxygen content in the water as an important habitat parameter, in particular for juveniles. It has to be stressed that the records of a few adult individuals in some parts of some impoundments and even some evidence of breeding (various pers. comm. of Limpus in EIS 20.6.1.3), in no way indicate that viable populations of *E. macrurus* can persist in impoundments. The longevity of individuals (unknown, but presumably >5 decades and probably much longer) and the long generation turnover time (35-40 years as a minimum) suggests that individuals may persist for many decades under suboptimal environmental conditions and may also show some breeding activity, without leading to successful recruitment into the adult population. The data presented in EPA (2007) suggest that this scenario currently operates in the lower Mary River including the Tiaro area.

The observation that individuals of other cloacal breathing turtle species can be found in impoundments in other rivers (EIS Supplement 50-53) also does not indicate that *E. macrurus* populations can thrive in impoundments: *E. macrurus* is the most specialized "river turtle" (aquatic swimmer of the open water) in the whole Chelidae family. For example, *Rheodytes leucops* in the Fitzroy River catchment is a specialized "bottom walker" and *Elseya albagula* is not a specialist of deep river pools, but prefers more shallow water than *E. macrurus* and is much more widespread. Although all three species are cloacal breathers and able to take up oxygen directly from the water, their other ecological requirements are quite different. The use of extrapolations from observations of species like *Rheodytes leucops* and *Elseya albagula* to conclude that *E. macrurus* populations may do well in impoundments is inappropriate and not supported by any data.

The EIS 20.6.1.3 (pp. 20-52, 20-53, 20-54) regularly makes statements on the suitability of impoundment habitat based on Limpus (pers. comm.) referring to "the species" (evidently meaning cloacal breathing species). However, most of these statements are not based on, and have no relevance to, *E. macrurus* and the suitability of impoundments as its habitat. This includes discussions of "*historical presumed relationship of some turtle species and riffles*" (p. 20-53). However, in the original description of *Elusor macrurus* and its natural habitat (Cann and Legler 1994) the word "riffle" was not even mentioned. *Elusor macrurus* was never described as, or suggested to be, a shallow water riffle specialist - as opposed to *Rheodytes leucops*, see original description in Legler and Cann (1980). "Historically" *E. macrurus* was described as living in relatively deep pools of flowing river sections. Also EES (2007) did not describe *E. macrurus* as a riffle zone specialist, but noted that the highest numbers of juveniles were found in relatively deep pools just below riffle zones. The extensive discussion of riffle zone specialists has no relevance to *E. macrurus*. However, what is relevant is that *E. macrurus*, in particular juveniles, require water of appropriate depth and with high dissolved oxygen content, an environment that often occurs in pools just below riffle zones and generally not in impoundments.

Examples of the overly simplistic concept of the habitat needs of a functioning *E. macrurus* population which is used throughout the EIS include (EIS Supplement p. 20-53): "*The EPA conclusion was "These species appear to be functioning well in shallow, slowly flowing* *impoundment habitats". This most recent information was noted as contradicting the earlier observations (of Tucker) and required further investigation; "The occurrence of persistent populations in some of the water infrastructure impoundments in the Mary River warrant a priority for investigation". One reason the results of Tucker appear contradictory to more recent data is that the sampling undertaken in dams to support this report relied on sampling in the deeper parts of storages near the walls, not in the upper parts of storages where survival and breeding has now been observed*" However, according to EIS Supplement page 20-51 "*Imbil weir nesting by Mary River turtle was recorded by Dr Tony Tucker during the 1997-1999 EPA study of impacts of dams and weirs on turtles*". Tucker himself recorded nesting of *E. macrurus* in a weir and, despite this, clearly did not contradict himself by concluding that *E. macrurus* is detrimentally affected by impoundments. It is simplistic and simply wrong to claim in regard to *E. macrurus* "persistent populations" and "species appear to be functioning well ... in impoundment habitats" based on some limited nesting observations. Tucker (2000) seems to have perfectly understood that the ability of some old individuals to survive in impoundments and even to lay eggs does not indicate functioning populations that can persist in the long term. A population can only persist and a species can only function well if recruitment is successful and the whole life cycle can be completed.

In regard to *E. macrurus* juveniles the EIS Supplement recognizes later (p. 20-60): "*Limpus et al (2007) suggest they have a higher requirement for oxygen… Hence, juveniles may not be as suited to the impoundment as adults*." This statement in the EIS Supplement is the most crucial insight in regard to *E. macrurus* presented in the EIS. However, throughout the document EIS does not draw the logical conclusion out of this realization and insight: that the flooding of the existing habitat by the Traveston Crossing dam would not only reduce the number of *E. macrurus* in this area, but eliminate the majority of what appears to be today the best and the most important *E. macrurus* juvenile growing and recruitment area in the whole Mary River.

An important terrestrial habitat component is sparsely vegetated nesting sand banks above the water level which are used from mid-October throughout November for nesting. For eggs to hatch successfully they have to stay non-inundated for about 50 days after nesting. Hatchlings emerge after an incubation period of ~50days from December-February (EIS 9.5.3.5 p. 8-49).

The EIS repeatedly tries to downplay the importance of the TCD project area for nesting of *E. macrurus*. For example, the EIS (20.6.1.2 p. 20-49) states: "*Flakus records the former egg collector as saying that while occasional nests were found upstream of Gympie, he concentrated his efforts on the banks near Tiaro and downstream as these consistently recorded much higher numbers of nests*". This distorts what Flakus recorded the former egg collector as saying. Word for word Flakus (2002, Appendix 1, p. 106) stated: "*Because they never found nests around Gympie, John never looked for nests further upstream*". Thus, the former egg collector *never looked* for nests upstream of Gympie. He did not know if, nor how many, nests there were upriver of Gympie and he never compared the nest numbers upstream and downstream of Gympie.

The EIS (20.6.1.2 p. 20-51) further states: "*While Mary River Turtles probably nest within the dam area, it is certainly not to the extent observed over many years in the Tiaro area so of itself this observation would not designate the area as critical; the Tiaro area better suits this* *classification*". The suggestion that historically high numbers of nests in downstream areas diminishes the present significance or critical nature of the nesting banks utilized by Mary River turtle in the TCD project area (for the persistence of the species) is inappropriate. Evidence suggests the significance of the Tiaro area as nesting habitat for *E. macrurus* is today dramatically reduced and recruitment in this area is heavily compromised (see EPA 2007 Fig. 3.3 p. 24/57). According to all available data (EPA 2007, EES 2007) the TCD area may today be the only area with successful recruitment of *E. macrurus* in the whole Mary River (see above) and thus, may act as the main source population for the species. For this reason the present nesting activity of *E. macrurus* in the TCD area is highly significant not only for the local population, but may be critical for the persistence of the species.

The overall EIS conclusion is (EIS Supplement 20-61) "*QWI is very confident that significant use of the storage area will be made by the turtle* (= Mary River Turtle), *including potential use for breeding*". If the intended time frame for this statement is a few decades and if the definition of "breeding" is limited to nesting and egg deposition, then this statement is appropriate and in agreement with the results of Tucker (2000): the species is very long lived and given the presently high density of *E. macrurus* in this stretch of the river some specimens would probably remain and survive in the impoundment area and some might also lay eggs. However, since the storage would not be suitable for juveniles (EIS Supplement p. 20-60), juvenile survival would most probably be close to zero and recruitment into the adult population would be non-existent. Thus, again in agreement with Tucker's (2000) conclusions, *E. macrurus* would slowly be lost in the TCD impoundment area over a few decades due to the increasingly old age of the then surviving individuals.

In Summary

- *Elusor macrurus*, in particular juveniles, require water of appropriate depth and with high dissolved oxygen content, a situation which often occurs in pools just below riffle zones.

- The TCD area appears to offer today the largest habitat stretch with successful recruitment of *Elusor macrurus* in the Mary River and thus, may act as the main source population for the species. For this reason the present nesting activity of *E. macrurus* in the TCD area is highly significant and may be critical for the persistence of the species.

2. Impacts of the proposed Traveston Crossing Dam on *Elusor macrurus*

The major impact of the TCD on the *E. macrurus* populations would be through:

- the extensive loss of deep water areas (1-5m) with high dissolved oxygen concentration through flooding of the stretch upstream of the TCD, the best quality habitat known for *E. macrurus*;
- the loss of important nesting sand banks of *E. macrurus*;
- the loss of the majority of the remaining good *E. macrurus* juvenile recruitment areas in the Mary River;
- the fragmentation of the habitat stretch which today contains the highest density *E. macrurus* population through the dam construction.

There is a real chance that these impacts would (as detailed above):

- lead to a long-term decrease in the size of the *E. macrurus* population in the project area;
- fragment the existing *E. macrurus* population in the project area;
- adversely affect habitat critical to the survival of *E. macrurus*;
- (partially) disrupt the breeding cycle of an *E. macrurus* population. According to EIS (20.6.1.3 p. 20-58), 32 of 66 mapped potential *E. macrurus* nesting sites in the immediate area of the dam (48.5%) will be totally inundated by the storage and another 3 (4.5%) will be partially inundated. This will likely cause a disruption of the breeding cycle of about 50% of the population in that area.

In addition, there is a possibility that these impacts would:

- Modify, destroy, remove, isolate and decrease the availability and quality of habitat to the extent that *E. macrurus* is likely to decline. According to the current knowledge of *E. macrurus* populations, any decline of the population in the TCD area through impacts on its habitat will quite likely also lead to a decline in the species.

The EIS (p 18-79) states: "*Of the aquatic fauna, the project will have the most impact on the Mary River Turtle*" and EIS supplement (p. 20-61) states correctly "*The footprint of the storage will impact upon approximately 10% of the available habitat for Mary River Turtle*". The EIS (e.g., 20.6.1.3) assessed and discussed impacts on *E. macrurus* with respect to habitat, nesting, movements, and physical damage caused by infrastructure. However, these impacts are ever only evaluated and discussed in conjunction with the proposed mitigation measures. An evaluation or discussion of actual impacts without reliance on the hypothetical functionality of the proposed mitigation measures is not provided.

3. Mitigation and offset measures proposed for *Elusor macrurus*

The mitigation measures proposed are generally those designed for all freshwater turtle species that occur in the TCD area, rather than specific to *E. macrurus* (EIS 8.10). Exceptions are the captive breeding and head-starting in the proposed Freshwater Species Conservation Centre (FSCC) as well catch and carry of turtles (across the dam) and eggs (to more secure habitat) which could be specifically targeting *E. macrurus*. In addition, water release and environmental flow regimes of the dam could in theory be managed to improve habitat of *E. macrurus*, particularly for juveniles, in the stretch downstream of the dam.

The mitigation and offset measures proposed in the EIS addressing impacts on turtles at the population level (habitat, nesting and movements) include:

- improvements of habitat structures in the impoundment;
- water release and environmental flow regime;
- egg protection and translocation;
- provision of a turtle ramp;
- catch and carry if required.

Impacts on individual turtles are proposed to be mitigated through:

- management measures during the construction phase;
- design adjustments of water take-off structures and the spillway.

Proposed mitigation and offset measures that can be tailored specifically for *E. macrurus* include:
- captive breeding
- head-starting
- water release and environmental flow regime;
- catch and carry of turtles and eggs

The FSCC is partly proposed as an offset to the loss and deterioration of *E. macrurus* habitat (it also seeks to offset impacts on the endangered Mary River Cod and the vulnerable Lungfish). The EIS (p 3-4) proposes to provide for the conservation of the Mary River Turtle through habitat management and any other management practices determined through research by the FSCC. The proponents propose to fund the FSCC for 10 years ($35 000 000).

In general, most of the proposed mitigation actions at the TCD for turtles are well thought through, based on inputs of experts like Colin Limpus and will likely be beneficial for turtle species whose habitat requirements are met by impoundment lakes (mainly generalist species). As such they are commendable. Having said this, most of the proposed actions are speculative, untested, not presented in detail, and without a firm commitment for implementation. They are interesting ideas, but not much more. These include the turtle ramp, spillway design, nest bank translocations and screen designs of the water take off structures. Furthermore, the Mary River turtle is not a generalist species, but a flowing water specialist. For this reason *E. macrurus* is the least likely of the six turtle species in the Mary River drainage to benefit from the proposed mitigation actions of the TCD.

In regard to habitat improvement measures proposed for the impoundment for *E. macrurus*, there is a general lack of appreciation and consideration in the EIS for the requirement for high dissolved oxygen concentrations, in particular for juvenile *E. macrurus*. Other important habitat factors like water depth, macrophytes, food sources, snags, basking logs, cover and temperature are exhaustively presented and discussed, but those factors are always treated in isolation. The EIS does not acknowledge that without high oxygen concentrations, the provision of other individual habitat factors would be ineffective, in particular for juvenile *E. macrurus* (but the measures may still be beneficial for other turtle species). Oxygen levels are only discussed in terms of the likely occurrence of anoxic conditions in the impoundment. Although anoxic conditions are definitely bad for *E. macrurus*, there is also a wide range of oxygen concentrations (other than anoxia/hypoxia) which are likely to be suboptimal, particularly for growing juveniles. Such sub-optimal oxygen levels may prevent successful recruitment into the adult population in the long term.

An example of an especially simplistic view presented in regard to *E. macrurus* habitat requirements is (EIS, p. 20-54): "*One submission used extreme examples from laboratory based experiments to support their contention that the impoundment would not provide suitable habitat, particularly for juveniles…. Oxygen levels in the shallow edge environment of the dam or in the river and tributary entry points are unlikely to experience hypoxia any more often than the current pool environments in which turtles are commonly found*".

Suitable habitat conditions for juvenile *E, macrurus* cannot be defined as 'not being anoxic/hypoxic', they have to be defined as 'requiring high dissolved oxygen content'. Mean values of oxygen saturation in water of the Mary, Fitzroy and Burnett/Kolan Rivers were consitantly lower in impounded than unimpounded habitats for maximum and minimum temperatures in all seasons (Tucker 2000, Fig. 3.3.3.). It is notable that the EIS dismisses one of the few scientific studies (and data) regarding environmental requirements of juvenile *E. macrurus* as "extreme" in favour of unsubstantiated speculations and opinions. In addition and apart from oxygen, the shallow edge environment of the dam may be unsuitable for juvenile *E. macrurus* which are typically found in deep pools (behind riffle zones) and river and tributary entry points would only constitute a tiny proportion of the vast impoundment.

The judgments in regard to mitigation measures for nesting habitat of *E. macrurus* in the TCD area are generally sound and adequate, although a large part of the nesting population would probably be lost through drowning of their aquatic habitats. Even if those mitigation measures (including translocation of nest banks, feral predator control, egg protection and translocation) would be implemented, the major, long-term threat to the *E. macrurus* population in the wider TCD area would not be where to lay the eggs. Rather, the concern would be what habitat would remain to successfully support hatchlings and juveniles for 25-30 years before they recruit to the adult population. The EIS (p.20-60) admits: "*the suitability of the inundation area for juveniles is less certain*". This is quite an understatement.

Incidentally, this problem could not be mitigated or offset by headstarting and/or captive breeding of *E. macrurus* in the proposed FSCC. Firstly, the juvenile phase of *E. macrurus* is 25+ years for females and 30+ years for males (EPA 2007), whereas the FSCC would only be funded for 10 years. If the last known major successful juvenile recruitment area of the Mary River (the wider TCD area as it is now) would have been largely lost through inundation and fragmentation, headstarting and captive breeding would be a largely futile exercise if successful recruitment into the adult population and a long-term self-sustaining wild population of *E. macrurus* is the goal.

If the FSCC did produce and release some juveniles that would be able to establish (e.g. potentially at some river or tributary entry points in the impoundment) and would grow at normal rates, they would not have reached maturity nor recruited into the adult breeding population should Stage 2 of TCD proceed (around 2035). This would potentially flood their habitat and home ranges. The notion that the FSCC could "*provide for the conservation of the Mary River Turtle through habitat management*" (EIS p 3-4) is highly unlikely given the best remaining habitat known for the species would first have to be destroyed.

The 7.6 km river stretch directly downstream of the proposed TCD currently has a high density of *E. macrurus* and a high proportion (43.7%) of juveniles. At present this good habitat stretch is continuous with the good 48.1 km habitat stretch in the proposed TCD inundation area which has a juvenile proportion of 42.5% and which connects to the 1.3 km area upstream of the proposed inundation area with a juvenile proportion of 53.3% (EES 2007). The downstream stretch which the TDC would separate represents 13.3% of the presently continuous good habitat area. Regarding environmental flows this would be the stretch most impacted by the TCD in the whole Mary River below the dam. Throughout the year the median daily flow would basically remain at the level it now shows during the low water season from July to December (EIS Fig. 6.21). The seasonal variability will thus be largely lost, with the exception of flushing flows (flows >2m) which will only be reduced from 5.4% to 4.7% of the time. The part of the flow regime most impacted in this stretch would be low flows between 20-30 cm above cease-to-flow (<100ML/day). Modelling also shows an increase in the length of the longest no flow period from 6 days to 42 days (EIS Supplement 15.1.3.2.).

This changed flow regime would potentially most impact on juvenile *E. macrurus* through temporary reductions in dissolved oxygen concentrations in the deeper pools. As a mitigation the EIS proposed a Preliminary Optimisation Scenario of EFOs that QWI would manage in this reach for the maximum benefit of EVR species, including Mary River turtles. A Preliminary Optimisation - Flow Duration Curve for Dagun Pocket (directly below the dam, EIS Supplement Fig. 15-7) suggests that the worst impacts would be alleviated. However, the predicted Compliance with Environmental Flow Objectives is only presented for the generally less impacted Fisherman's Pocket 35km downstream of the dam (EIS Supplement Table 15-3), but not for the stretch up to 7.6 km downstream of the dam with good *E. macrurus* habitat and density which will be the worst impacted area. This environmental flow regime could in particular improve the flow durations of 30 cm above cease to flow at Fisherman Pocket. However, apart from the scheme being preliminary, all flow allocations which would improve the situation are non-mandatory targets. This optimization scheme generally seems to be a good idea, but is hypothetical, depends on the good will of QWI and certainly cannot be enforced in cases of drought etc.

Another questionable assumption in the EIS is that the turtle ramp (no design or location provided) or catch and carry (of juveniles and adult males) could address the identified need for genetic interchange between the *E. macrurus* population fragments up and downstream of the TCD (EIS 20.6.1.3 p. 20-63-66). The turtle ramp or by-pass channel would most likely simulate a small stream. However, *E. macrurus* is not a turtle that enters small side streams. Compared to other species, they are only found in the main river channel and large tributaries. Thus, of the six turtle species known to occur in the Mary River catchment, *E. macrurus* would be the least likely species to utilize this structure (which is un-designed and un-tested).

The assumption that catch and carry of juveniles and adult males would be an effective contingency, is also questionable. Turtles generally show strong site fidelity and, after relocation, tend to return as quickly as they can to their former home range. The radio-tracking data of *E. macrurus* (Tucker 2000 and Flakus 2002) suggest that *E. macrurus* has well defined home ranges and will do exactly this. Translocated Western Swamp Tortoises *Pseudemydura umbrina* for example return to their previous home ranges even after intermittent periods in captivity of up to 15 years (Wisolith, A. 2006, BSc Thesis, UWA). Thus, if wild *E. macrurus* juveniles and/or adult males would be caught at the base of the dam or downriver of it and carried into the impoundment (or no matter how far upriver), they would most likely immediately try to return back to their home range. This could result in them approaching the spillway or the water take off structures of the dam, where they could be injured or killed. Furthermore, the assertion (EIS p.20-66) that "*relocation of mature males has the highest probability of achieving immediate genetic mixing*" is unsubstantiated and speculative: in *Pseudemydura umbrina*, translocated adult males return back to their former home ranges even faster than females (Wisolith, A. 2006, BSc Thesis, UWA).

In Summary

- The proposed nesting beach mitigation and egg protection measures are sound and would likely lead to a better survival ratio of eggs. However, the overall nesting population and the total egg production in the TCD area would still be likely to decrease due to changes in the aquatic habitat and drowning of nesting beaches in the impoundment. The usefulness of the relocation of nesting beaches is unknown.

- The proposed idea that QWI would manage flow and habitat downstream of the TCD (a reach with currently a high density of *E. macrurus* including a high density of juveniles) for the maximum benefit of EVR species, including *E. macrurus* (EIS p. 20-62), has the potential to maintain the habitat quality for the species or even improve some of its aspects (e.g. avoidance of flooding events of nesting beaches during the time of egg incubation). However, the fragmentation of this sub-population from the upstream stretch might in itself cause problems.

- The majority of other proposed mitigation measures for the TCD will be beneficial to the more generalist and wide-spread turtle species in the Mary River, but not helpful to mitigate impacts on the endemic flowing-river specialist *Elusor macrurus*.

- The general focus in the EIS on short-term, reactive mitigation and management techniques distracts from the most critical issue - the maintenance of natural habitat and the provision of an environment in which the long-lived, late-maturing Mary River Turtle *Elusor macrurus* can sustain and complete its entire life cycle.

4. Remaining impacts on the population (= impact - mitigation/offsets)

- None of the proposed mitigation measures would ensure that the area of the impoundment could remain the significant breeding and juvenile recruitment area of *E. macrurus* it represents today.

- The isolated 7.6 km stretch downstream of the TCD could theoretically remain breeding and juvenile habitat if the water release from the dam is managed appropriately, but this fragment would only represent 13.3% of the presently continuous good habitat area. However, the proposed flow optimization scheme is not mandatory and there is no certainty that it would be implemented.

- The net outcome of captive breeding and headstarting programs for *E. macrurus* in the planned FSCC (an offset) would unlikely be beneficial for the conservation status of *E. macrurus* in the wild since it would dependent on the construction of the TCD which would heavily impact on the best remaining *E. macrurus* population and which would eliminate the majority of the best remaining juvenile habitat in the Mary River.

5. Summary of likely impact of TCD on the *Elusor macrurus* population

- The river stretch with the highest densities of Mary River Turtles currently known (five times higher than known for any other area), which today seems to offers the best habitat conditions for *Elusor macrurus*, would be inundated and fragmented by the TCD. This would lead to a long-term decrease in the size of the *E. macrurus* population in the project area

- The TCD would adversely affect habitat critical to the survival of *Elusor macrurus*. The TCD area appears today to be the only area with successful recruitment of juveniles into the adult population of *Elusor macrurus* in the Mary River and thus, may act as the main source population for the species.

- The TCD would (partially) disrupt the breeding cycle of an *Elusor macrurus* population. According to EIS (20.6.1.3 p. 20-58), 32 of 66 mapped potential *E. macrurus* nesting sites in the immediate area of the dam (48.5%) would be totally inundated by the storage and another 3 (4.5%) would be partially inundated. This would likely cause a disruption of the breeding cycle of about 50% of the population in the area. Mitigation measures like nesting bank relocations are unlikely to fully compensate for this loss. Since the TCD area may today be the only area with successful recruitment of *E. macrurus*, the present nesting activity in the TCD area is highly significant and appears to be critical for the persistence of the species.

- The TCD would modify, destroy, remove, isolate and decrease the availability and quality of habitat to the extent that *Elusor macrurus* would be likely to decline. All available data indicate that the *E. macrurus* populations downriver of Gympie dramatically declined by 95% over the last decades and that there is currently little successful recruitment into the adult population in that area (EPA 2007). All available data indicate that the current population in the TCD project area has the highest density of individuals of any *E. macrurus* population in the world and has a high proportion of juveniles (EES 2007). According to the current knowledge of *E. macrurus* populations, any decline of the population in the TCD area through impacts on its habitat will quite likely also lead to a decline of the *E. macrurus* population.