Setting conservation priorities for Australian freshwater turtles

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ABSTRACT

The Australian freshwater turtle fauna appears to comprise a series of relictual lineages, each of considerable antiquity, possibly stemming from times when climates were moister. Half the extant genera are monotypic and two species, *Carettochelys insculpta* and *Pseudemydura umbrina*, are distinctive at higher taxonomic levels. In this paper, the conservation priorities of several species of concern are assessed against criteria of rarity, distinctiveness, intrinsic vulnerability to population decline, and the level of threat currently faced. In many cases, far too little is known for an unqualified assessment, not only in terms of conservation biology, but indeed at the level of basic alpha taxonomy, which has led to a serious impediment to action on the conservation front. In this context, priorities for research need to focus on both the tactical research needed to support management intervention and on the strategic research needed to bring knowledge of undescribed and recently described forms to a level at which appropriate assessment of their conservation status can be made. Agencies concerned with the conservation of these animals should consider dispensing with normal conventions and include undescribed but well-recognized species in their formal strategies and management plans.

INTRODUCTION

All but one species of Australian freshwater turtle belong to the family of side-necked turtles, the Chelidae. Chelid turtles are also found in South America and New Guinea, and are unknown outside their present range even as fossils (Pritchard and Trebbau 1984). As such, chelids are the only Australian reptiles with unambiguous Gondwanal origins. *Carettochelys insculpta* is the sole surviving member of the family Carettochelydidae, now known only from New Guinea and northern Australia but once widely distributed across the globe. *Carettochelys* is considered to be a recent immigrant to Australia from the north (Cogger and Heatwole 1981).

Australia is a dry place — only Antarctica and Greenland have a lower precipitation. The total annual discharge from Australian rivers and streams is equal only to that of the Missouri, a tributary of the Mississippi, so wetland systems in Australia are certainly less extensive and possibly less diverse than those of the American and Asian continents. Furthermore, many of our extensive wetland systems are seasonally ephemeral or unreliably available over periods ranging from years to decades. It should come as no surprise that the diversity of freshwater turtles in Australia does not compare favourably with that of most other continents.

Australia has not always been arid, and the current climate is the result of progressively increasing aridity beginning in the middle to late Miocene (12–5 Ma). The current Australian turtle fauna appears to comprise a series of distinct lineages, each of considerable antiquity, and possibly relicts of a more diverse fauna that existed when the wetter climes prevailed. Half the extant genera are monotypic, including:

- the Western Swamp Turtle, *Pseudemydura umbrina*, from near Perth in Western Australia;
- the Fitzroy Turtle or White-eyed River Diver, *Rheodytes leukops*, from the Fitzroy River near Rockhampton in Queensland;
- an undescribed monotypic genus (Cann and Legler, submitted), variously called Short-necked Alpha or the Petshop Turtle, from the Mary River near Gympie in Queensland; and
- the Pig-nosed Turtle, *Carettochelys insculpta*, until recently thought to occur only in New Guinea, but now also known from some of the larger rivers of northern Australia.

The remaining fauna comprises:

- the *Emydura*, a genus of short-necked species that are abundant and widespread in southern, eastern and northern Australia.

- *Elseya latisternum* group of four species (only one described) found from the coastal rivers of New South Wales, inland tributaries of the Darling River, and coastal rivers of eastern and northern Australia west to Arnhem Land;
- the *Elseya dentata* group of five species (only one described) found in the coastal rivers of Queensland between Gympie and Cairns and the coastal rivers of northern Australia;
- the *Chelodina*, a genus of long-necked turtles, abundant within extensive ranges in southern, eastern and northern Australia.

The described species of Australian freshwater turtle and undescribed forms considered to be distinct species (Georges and Adams 1992) are listed in Table 1.

In this article, I would like to address the relative priorities for management and research that might be accorded certain species of Australian freshwater turtle from a conservation perspective. Australian freshwater turtles do not often fall in the category of species in conflict with community goals, values and aspirations, nor are they a major economic resource, at least in a non-Aboriginal context. Priorities must instead be based on values that cannot be measured on an economic scale — values that stem from concepts of rarity, distinctiveness, intrinsic vulnerability to population decline, and the level of threat currently faced by a species.

RARITY

In the colloquial sense rarity may relate as much to availability for collection than to actual population densities (Main 1982). A cryptic species that is difficult to obtain may be considered rare in this sense and therefore desirable. *Carettochelys insculpta* was once thought to be one of the rarest turtles in the world, but this reputation was due in large part to the remoteness of its distribution relative to those who sought it, rather than to low population densities (Pritchard 1979). The consequential increase in the aesthetic value of the species may increase public pressure for adequate measures to be taken to ensure the species conservation, a positive consequence perhaps, but this pressure is sometimes not commensurate with the real need for action.

In the biological sense, rarity is a complex concept. Rabinowitz *et al.* (1986) acknowledge the limitations of the English language to describe the various forms of rarity, and classify rarity according to three criteria — geographic distribution, local population size and habitat specificity. Habitat specificity will be considered below under the topic of intrinsic vulnerability, but geographic distribution and local population size are combined to provide a more useful notion of rarity. Widely distributed species with locally abundant populations are not considered rare whereas species with low abundances throughout a restricted range are clearly rare. A third category of species with low abundances throughout an extensive range, while perhaps rare in the colloquial sense, need not necessarily be of concern from a conservation viewpoint. Low abundance is a feature of the biology of many species and may in fact be a strategy to enhance survival. A widely distributed species for which low abundance is typical may well be quite secure. In contrast, rarity involving locally abundant populations within a restricted distribution may have a direct bearing on conservation priorities. An abundant species with a geographically restricted distribution can be quite vulnerable to extinction through habitat destruction, climatic change or disease. Species of Australian freshwater turtle fall into each of these categories.

The species of *Emydura* and *Elseya*, as well as *Chelodina longicollis* and several others are typically widely distributed and abundant. At the other extreme, *Pseudemydura umbrina* has an extremely restricted distribution comprising a single ephemeral swamp and less than 30 animals survive in the wild. *Chelodina expansa* has relatively low numbers throughout extensive ranges and *Chelodina steindachneri* is very patchily distributed over a wide area, but has locally high population densities (Kuchling, pers. comm.). The former is a dietary specialist, the later specializes on ephemeral habitats of the semi-arid zone. *Carettochelys insculpta* and *Rheodytes leukops* are examples of species that may be locally abundant within a restricted range.

DISTINCTIVENESS

Taxonomic and morphological distinctiveness has an important bearing on conservation priorities. Does a particular species have close relatives which may share some or many of its features, or put another way, how much would be lost if the species went extinct? *Carettochelys insculpta* is Australia's most distinctive species, being the sole remaining member of a once globally widespread family (indeed, superfamily, Frair 1985). *Carettochelys* represents all

Table 1. Currently recognized species of Australian freshwater turtle, their distributions and primary sources of information on ecology and management. Refer also to the general accounts of Goode (1967) and Cann (1978).

Species	Distribution	Selected primary sources
Carettochelys insculpta Ramsay, 1886	Distribution unexplicably patchy in coastal rivers of Northern Territory. Present in Victoria R., Daly R., Alligator Rivers region, Goomadeer R.; absent from or rare in Liverpool R., MacArthur, Limmen Bight and Roper R. Extra-limital in New Guinea. Permanent water.	Cogger 1970; Webb *et al.* 1986; Georges and Kennett 1989; Heaphy 1990; Georges and Rose 1994.
Chelodina expansa Gray 1857	Murray-Darling drainage, coastal drainages of Queensland from Brisbane to Rockhampton, Fraser and Moreton Islands. Riverine species.	Goode and Russell 1968; Legler 1978; Chessman 1983, 1988; Georges 1984.
Chelodina longicollis (Shaw, 1794)	Murray-Darling drainage, coastal drainages from Victoria to the Burdekin of Queensland, Fraser and Moreton Islands. Seasonally ephemeral and permanent waters.	Chessman 1984, 1988; Parmenter 1985; Georges *et al.* 1986; Kennett and Georges 1991; Beck 1991.
Chelodina novaeguineae Boulenger, 1888	Coastal drainages of Queensland from the Burdekin, north to Cape York, west through the gulf rivers to the Roper Drainage. Principally ephemeral waters.	Kennett *et al.* 1992.
Chelodina oblonga Gray, 1841	South-west Western Australia. Seasonally ephemeral waters.	Clay 1981; Kuchling 1988.
Chelodina rugosa Ogilby, 1890	Northern Australia from the Kimberley region, the Northern Territory, the Gulf and Cape York Peninsula. Seasonally ephemeral waters.	Grigg *et al.* 1986; Covacevich *et al.* 1990; Kennett *et al.* 1993a,b.
Chelodina steindachneri Siebenrock, 1914	Patchily distributed over a widespread range in semi-arid regions of central coastal and inland Western Australia. Ephemeral waters	Kuchling 1988.
Chelodina sp. aff. *rugosa* (Mann)	Rivers and streams of the Arnhem Land and Kimberley plateaux and escarpments.	—
Elseya dentata (Gray, 1863)	Northern Australia from the Kimberley region to the Gulf, but boundaries to its distribution uncertain. Permanent water.	Coventry and Tanner 1973; Legler 1985.
Elseya sp. aff. *dentata* (Sth Alligator)	South Alligator River, boundaries to distribution unknown.	—
Elseya sp. aff. *dentata* (Burnett) and (Johnstone)	Coastal rivers of Queensland from the Mary to the Johnstone Rivers. Permanent water. Possibly two species.	Goode 1967.
Elseya latisternum Gray, 1867	Coastal rivers from the Richmond River of northern NSW to Cape York, through the Gulf to the rivers draining the Arnhem Land plateau. Permanent and semi-permanent middle and upper reaches and side tributaries of rivers.	Goode 1967; Legler 1985.
Elseya sp. aff. *latisternum* (Bellingen) and (Manning)	A sibling pair of species (morphologically identical but genetically very distinct) in the Bellingen River and the Barnard/Manning drainage respectively. Permanent flowing water in middle to upper reaches.	—
Emydura macquarii (Gray, 1830), *Em. krefftii* (Gray, 1871), *Em. signata* Ahl, 1932	Murray-Darling drainage *(macquarri)*, coastal rivers of Queensland from Mary River to Cooktown (krefftii), coastal rivers of NSW from the Hawkesbury/Nepean to Brisbane *(signata)*. A polytypic species or species complex with distinctive populations also in Cooper Creek and Fraser Island. Permanent water.	Georges 1982, 1983; Chessman 1986, 1988; Cann 1978; Thompson 1983, 1993.
Emydura subglobosa (Krefft, 1876)	Jardine River, Cape York. Extra-limital in New Guinea. Permanent water.	—
Emydura sp. aff. *subglobosa* (Sleisbeck). Formerly *Em. australis* in part.	Coastal rivers of northern Australia from the headwaters of the Daly River to the Gulf. Eastern boundary uncertain. Permanent water.	—
Emydura victoriae Gray, 1842	Coastal rivers of northern Australia from the Fitzroy River in Western Australia to the Daly River in the Northern Territory (eastern boundary uncertain). Permanent water.	Coventry and Tanner 1973

Table 1 — continued

Species	Distribution	Selected Primary Sources
Emydura sp. aff. *victoriae* (Daly Mission). Formerly *Em. australis* in part.	Coastal rivers of northern Australia from the Daly River in the west to the Mitchell River in the east. Permanent water. Sympatric with *Em. victoriae* at Policeman's Crossing, Daly River.	—
Pseudemydura umbrina Siebenrock, 1901	Perth. Winter-wet seasonally ephemeral swamps.	Burbidge 1981; Kuchling and DeJose 1989; Burbidge *et al.* 1990; Kuchling and Bradshaw 1993.
Rheodytes leukops Legler and Cann, 1980	Fitzroy River, Queensland. Permanent water.	Legler and Cann 1980.
Short-necked Alpha	Mary River, Queensland. Permanent water.	Cann and Legler, submitted.

that remains of 40 million years of evolution independent of any other extant lineage (Chen *et al.* 1980). There is little doubt that *Carettochelys* is morphologically distinct, and its biology holds many surprises. Its embryos enter diapause late in their term (Webb *et al.* 1986), hatchling sex depends on incubation temperature (Webb *et al.* 1986; Georges 1992) unlike other Australian freshwater turtles (Bull *et al.* 1985; Thompson 1988; Georges 1988), adults engage in pharangeal and possibly cutaneous respiration (Schultz-Westrum 1963) and it is a highly mobile species with the potential for a complex seasonal pattern of habitat utilization in northern Australia.

Also distinctive is *Pseudemydura umbrina*, a sister taxon to the remaining Australian chelids. Its nearest living relative may be in South America, possibly *Platemys* (Legler 1981) and some consider it distinct enough to elevate it to the monotypic sub-family, Pseudemydurinae (Gaffney 1977; Gaffney and Meylan 1988). It is Australia's most terrestrially adapted species, perhaps the only one that deserves the name tortoise.

The only other species without clear affinities among the Australian chelid fauna are *Rheodytes leukops* and Short-necked Alpha. The electrophoretic studies of Georges and Adams (1992) revealed that both *Rheodytes leukops* and Short-necked Alpha represent distinct lineages which could not be reliably placed within the short-necked *Emydura-Elseya* clade, though their affinities clearly lie there. Their relationship to the remaining short-necks of *Elseya* and *Emydura,* and to each other, is presumably so distant that estimates of similarity are low and dominated by parallelisms to such a degree that clear affinities could not be reliably determined. *Rheodytes* is morphologically distinctive because of its exceptional capacity to extract oxygen from the water in which it lives using well-vascularized "gills" in a well ventilated cloaca (Legler 1981; Legler and Georges 1994). Short-necked Alpha is poorly known because of its relatively recent discovery (Cann and Legler, in prep.)

INTRINSIC VULNERABILITY

In addition to rarity and distinctiveness, we must consider the intrinsic vulnerability of a species to population decline and ultimate extinction when setting priorities for conservation and related research. Are there features of the animal's biology that render it more or less vulnerable to population decline and extinction, quite irrespective of whether it is in decline? Low fecundity, dietary or habitat specialization, naturally low population densities and susceptibility to dizease are examples. In this sense, a species can be vulnerable without being endangered, endangered without being particularly vulnerable, or both vulnerable and endangered (the terms are used here in quite a different way from the IUCN classification, Groombridge 1982).

Pseudemydura umbrina is a good example of a species that is extremely vulnerable by virtue of its biology. It has narrow habitat requirements, specializing on ephemeral swamps which are full principally only during the colder months of the year (Burbidge 1981; Burbidge *et al.* 1990). They have an exceptionally low fecundity, typically producing only one clutch of 3–5 eggs per season (Kuchling and Bradshaw 1993). Compare this with the reproductive output of *Emydura macquarii* which can produce up to three clutches each of 30 eggs annually. *Carettochelys insculpta* is vulnerable by virtue of its large size and palatability, ease of capture and stereotyped nesting behaviour, a vulnerability that is a suspected contributor to decline in areas of New Guinea (Groombridge 1982). It can be argued that one of the greatest threats to populations residing close to the

proposed mine at Coronation Hill on the headwaters of the South Alligator River of northern Australia would have arisen from the increased human population in the region. The associated increase in fishing activities in restricted dry-season refugia, coupled with the turtle's susceptibility to capture on baited lines, would be of great cause for concern. If the peculiar cloacal respiratory apparatus of *Rheodytes leukops* is a reflection on its specialization for well-oxygenated stretches of riffle in streams, then this specialization may make it vulnerable to human activity, particularly to the construction of dams and weirs.

CURRENT THREATS

Finally, the level of current threats to a species existence needs to be considered when assessing the need for some form of action to stem population decline or avert extinction. A distinction is sometimes made between population shifts that result from human-induced as opposed to natural causes, but in terms of outcome, it matters little. A key indicator here is whether it can be demonstrated that populations are in decline, which is difficult with such long-lived animals as turtles. There can be little doubt that populations of *Pseudemydura umbrina* have declined in recent times, both because of documented reduction in availability of suitable habitat through draining of swamps for agricultural, pastoral and residential uses, and because of the documented decline and recent extinction of the Twin Swamps population, one of only two sites to support populations of the species at that time (Kuchling and De Jose 1989; Burbidge *et al.* 1990). *Carettochelys insculpta* is thought to have declined in the South Alligator Rivers region because of the impact of feral buffalo (Archie Carr, personal communication to Pritchard 1979) which trample nesting banks, destroy riparian vegetation upon which the turtles rely for food in the dry-season, and cause dramatic increases in turbidity with consequential changes to aquatic flora and fauna (Georges and Kennett 1989). On the whole, though, we are largely ignorant of trends in population numbers for most Australian species, and will remain so until more work is done to gather baseline data on abundances for species of concern (e.g., *Rheodytes leukops*, Short-necked Alpha, *Elseya* sp. aff. *latisternum* (Gwydir/Bellingen/Manning) and others). Most assessments of whether a species is currently endangered by human activities are based on presumed threats with little or no data in support.

PRIORITIES FOR MANAGEMENT AND RESEARCH

A summary of how each of several species considered to be of concern score against each of the four criteria is provided in Table 2. While it is obviously desirable to rank these species in some linear order of increasing priority, as with the rankings defined by the IUCN (Groombridge 1982), this can be quite difficult. A high score on one criterion may be balanced by a low score on another, and a species which scores high on several criteria in an Australian context may not if its global distribution and abundance are considered (e.g., *Emydura subglobosa*). Balancing these independent considerations necessarily requires value judgements of some sort. The species shown in Table 2 are ranked by my judgement in decreasing order of concern. All listed species are of some concern, but only *Pseudemydura umbrina* is considered endangered (*sensu* IUCN).

The broad generalization drawn from this table is that too little is known of many species to make an unqualified assessment, not only in terms of their conservation biology, but indeed at the level of basic alpha taxonomy. It is a sad testimony to the state of formal taxonomic research on the freshwater turtle fauna that of the 23 species, 10 are yet to be described despite knowledge of their existence dating back to the 1960s (Goode 1967). This results in a taxonomic impediment to action on the conservation front, which Wells and Wellington (1983, 1985) attempted to address in their well-intentioned but, in the view of some, scientifically misguided publication of a revision of the Australian reptile fauna. A revision of the Australian Chelidae is urgently needed, but in the meantime, agencies concerned with the conservation of these animals should consider dispensing with normal conventions and include undescribed but well-recognized species in their formal strategies and management plans.

In this context, priorities for research need to focus both on tactical research to support effective management intervention (for Endangered (E) and Vulnerable (V) species, *sensu* Groombridge 1982) and on strategic research to bring knowledge of undescribed and recently described forms to a level at which an appropriate assessment of their conservation status can be made (for Indeterminate (I) and Insufficiently Known (K) species, *sensu* Groombridge 1982). In the first research category, *Pseudemydura umbrina* ranks highest;

Table 2. Species of Australian freshwater turtle considered to warrrant attention for conservation purposes and the basis for that assessment. Species with extra-limital distributions are considered in an Australian context only. Species are ranked in approximate order of decreasing concern.

Species	Rarity	Distinctiveness	Intrinsic vulnerability	Recent and current threats	Priorities for tactical research/management intervention	Priorities for strategic ecological research
Pseudemydura umbrina	Populations size extremely low; distribution extremely restricted.	Closest living relatives possibly in South America; Australia's most terrestrially adapted turtle.	Low fecundity (one clutch, four eggs, annually); habitat specialist on ephemeral swamps.	Populations in decline. Drainage of swamps has reduced distribution of species to below viable. Foxes. Protected by reserve system.	Establish captive breeding colony and investigate feasibility of rehabilitation and translocation. Continue monitoring wild populations. Inhibit turtle dispersal to unfavourable habitat. Fox control.	Current native habitat is considered marginal. Continue investigation of current distribution (follow up anecdotal reports), ecological requirements and habitat preferences.
Rheodytes leukops	Locally abundant within a single drainage.	Affinities lie with the *Elseya-Emydura* clade, but otherwise uncertain; cloacal respiration most developed of any turtle.	Possibly a specialist on well oxygenated riffle stretches within streams.	Unknown, but riffle is threatened by weirs and dams. Siltation and consequential changes to river fauna is great in the Dawson. Not protected by reserves.	Consider options for reservation of one or more subpopulations and habitat. Environmental Impact Assessments for dam/weir proposals should be required to assess presence of species in affected sites and to assess potential impacts of the development.	Determine population size, distribution within Fitzroy/Dawson drainage, and habitat requirements, especially with regard to reliance on riffle. Seek evidence of declines.
Short-necked Alpha	Locally abundant within a single drainage.	Affinities lie with the *Elseya-Emydura* clade, but otherwise uncertain; morphology almost totally unknown.	Unknown.	Unknown. Foxes prey extensively on nests. Not protected by reserves.	Consider options for reservation of one or more subpopulations and habitat.	Determine population size, distribution within Mary drainage, and ecological requirements, especially with regard to dietary and habitat specialization. Describe taxon.
Carettochelys insculpta (of global concern)	Locally abundant within a restricted distribution in northern Australia, abundant and widespread in southern New Guinea.	Sole surviving member of its family with closest living relatives among the Trionychidae; Australia's only freshwater cryptodire and the most aquatic.	Large size, palatability, ease of capture, and stereotyped nesting make this species attractive for exploitation by native peoples. Temperature determines sex.	Habitat degradation by feral buffalo and stock thought to have impacted dry season refugia and breeding areas. Substantial populations in Kakadu National Park and Arnhem Land Aboriginal Reserves.	Protection of riverine and riparian ecosystems of the Daly drainage required. Control of fishing with baited lines within the reserve system. Special attention to dry season refugia. Feral buffalo control and impact of stock on riparian ecosystems and nesting.	Delineation of current distribution and causes of absence, a high priority for Australian populations. Baseline data on population densities, movements and habitat utilization in both wet and dry seasons.

Table 2 — continued

Species	Rarity	Distinctiveness	Intrinsic vulnerability	Recent and current threats	Priorities for tactical research/management intervention	Priorities for strategic ecological research
Emydura subglobosa	Population size low; distribution restricted to tip of Cape York. Abundant and widely distributed in New Guinea.	Closely related to the several other species in genus *Emydura*.	Not intrinsically vulnerable.	Population status and trends unknown. No threats known. Not protected by reserves.	Insufficient data available to justify action.	Determine population size (and seek evidence of decline), distribution in Cape York drainages and habitat requirements. Compare taxonomically to new Guinea populations.
Elseya spp. aff. *latisternum* (Bellingen) and (Manning)	Each of this sibling pair abundant within single drainages.	Distinctive at the species level. Australia's only clear example of sibling species of turtle.	Unknown, but appears to specialize on flowing middle to upper reaches of clearwater rivers.	Unknown, but increased turbidity of streams may influence local distribution and ultimately population viability. Not protected by reserves.	Insufficient data available to justify action. Consideration in proposed developments involving riverine ecosystems. Consider options for reservation of one or more sub-populations and habitat.	Determine population sizes, distribution within Bellingen and Barnard/ Manning drainages, and ecological requirements, especially reasons for absence from adjacent drainages. Describe taxa.
Elseya spp. aff. *latisternum* (Gwydir)	Abundant at restricted localities in the headwaters of the Qwydir and Namoi.	Distinctive at the species level, but fairly closely related to *Elseya latisternum*.	Unknown.	Poorly known, but some populations seriously affected by eye disease. Not protected by reserves.	Insufficient data available to justify action.	Determine population sizes, distribution within the tributaries of the Darling River system north of the Macquarie Marshes. Determine ecological requirements. Describe taxon.
Chelodina sp. aff. *rugosa* (Mann)	Restricted to streams of the plateaux and adjacent escarpment country of Arnhem Land and the Kimberley region.	Closely related to the lowland species *Chelodina rugosa*.	Unknown.	None known. Some protection afforded by Kakadu National Park and Aboriginal Reserves.	Insufficient data available to justify action.	Determine population sizes, distribution within the rivers of the Arnhem Land and Kimberley plateaux. Determine ecological requirements. Investigate taxonomic boundary between forms from the two disjunct regions. Describe taxon.

in the latter category, Short-necked Alpha (soon to be described as a new genus and species by Cann and Legler, in prep.), ranks highest.

Though their objectives are different and though they differ in urgency, both categories of research are important. What attention is being paid to the needs of Short-necked Alpha, and how will this situation improve without fundamental data on its population status and requirements? What attention has been paid to the sibling species pair of *Elseya* in the relatively populated Bellingen and Barnard/Manning drainages of New South Wales, despite knowledge of their existence that dates back decades? Can we expect this to change unless they are formally described and their specific habitat requirements are determined? Conservation agencies need to consider not only those species demonstrably at risk, but also those that may be at risk but currently receive little attention because of lack of fundamental information on their taxonomy, population status and ecology. Suggested priorities for research are included in Table 2.

In papers of this sort, the focus of attention primarily is on species that are of concern with regard to extinction. Abundant and widespread species are of lesser concern because, in a context where resources are limited, it is important to focus attention where it is most urgently needed (but see Thompson 1983, 1993). Does this imply that species that are abundant and widespread, and not particularly under threat or in decline, do not require attention? To answer this question, we need to consider the objectives of a programme leading to the sound management of Australian freshwater turtles. Appropriate objectives might be:

- To preserve the current Australian freshwater turtle fauna by preventing further extinctions. The loss of *Pseudemydura umbrina* would be a tragedy.
- To preserve current processes leading to speciation among Australian freshwater turtles. Conservation implies that species are preserved in the context in which they evolved and will continue to evolve.

The recent electrophoretic work of Georges and Adams (in prep.) has shown that *Emydura macquarii* from the Murray Darling drainage, *Emydura krefftii* from coastal Queensland and *Emydura signata* from coastal New South Wales share even rare alleles. They appear to be distinctive allopatric populations of a widespread and polytypic species, a conclusion supported by the observation that nowhere do they occur in sympatry. Some of their populations are quite distinctive and deserve attention in their own right (Georges and Legler 1994). The morphological differences and geographic variation in gene frequencies suggest that they are in the process of undergoing allopatric speciation. This speciation process could be retarded or brought to an abrupt halt if, for example, hatchlings from commercial farms were distributed for sale in towns on the east coast of New South Wales and Queensland. Migration is a potent force acting against genetic divergence through genetic drift of allopatric and parapatric populations of a species (Hartl 1980:197). Some genetic models predict that only one successful immigrant between allopatric populations of a species is required per generation to dramatically reduce divergence through drift.

The same problems would not arise with *Chelodina longicollis*, as individuals frequently undertake overland migrations and may move from drainage to drainage. It is genetically and morphologically very similar over the same range as mentioned for the *Emydura* above. There is no reason to prohibit well managed commercial sale and distribution of this abundant species in the southeastern states.

Clearly, to address the second management objective listed above, a far greater knowledge of the systematics and ecology of freshwater turtles is required.

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