Yabby Farming

— frequently asked questions

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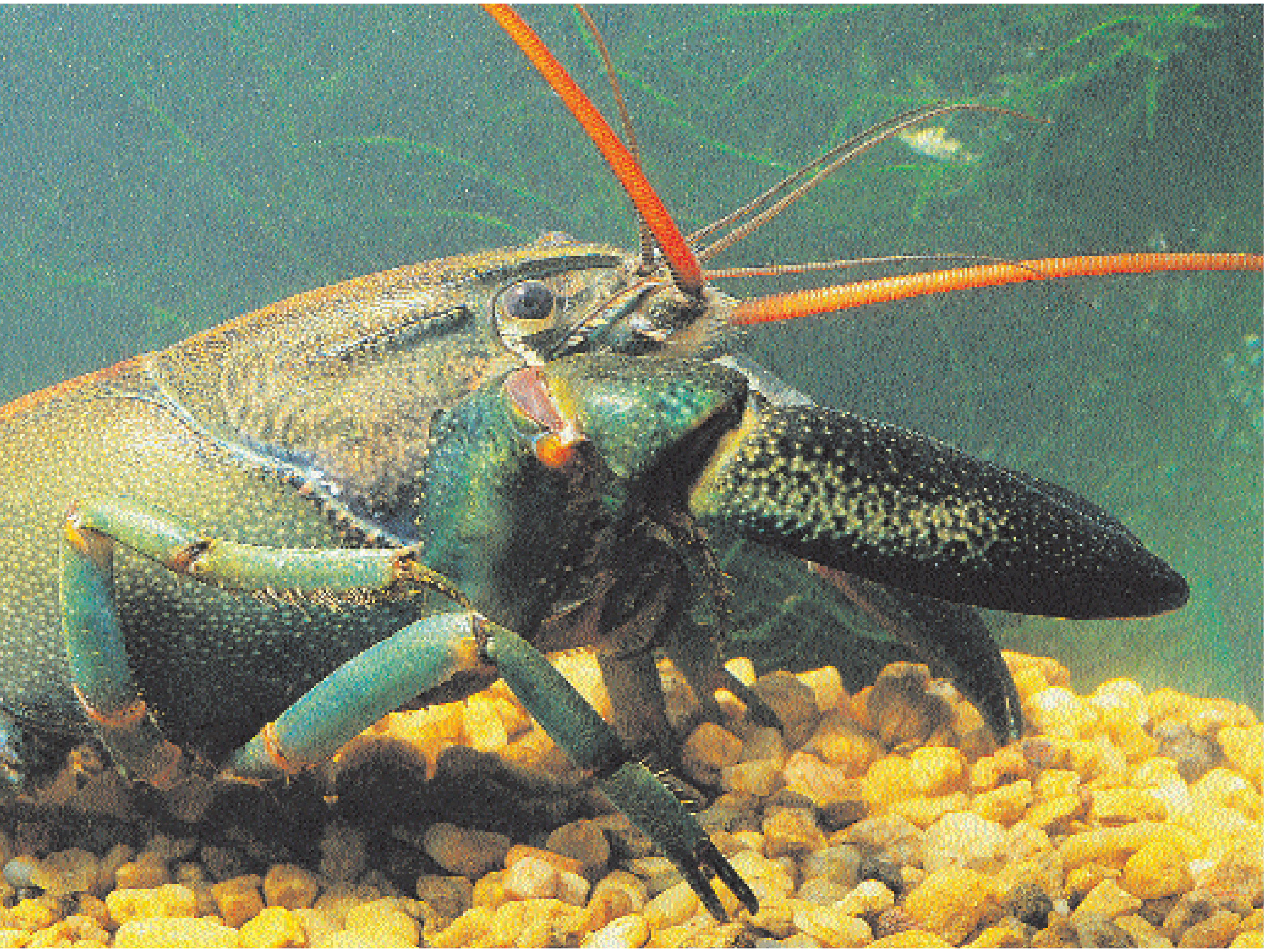
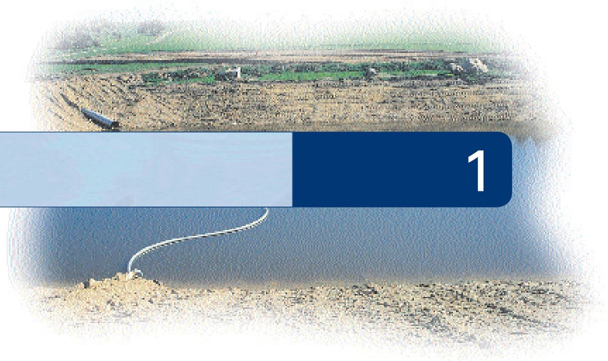
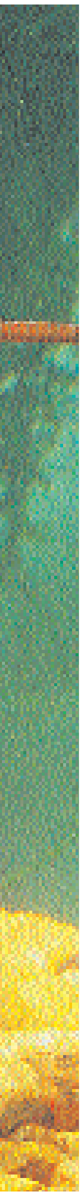




Introduction 1



Yabbies are indigenous to central and eastern Australia and have created considerable aquaculture interest. Although some yabbies are produced in ponds on purpose-built farms, the vast majority of commercial aquaculture yabby production in Australia comes from trapping yabbies in farmers' dams. This use of existing farm dams originally built to water stock has enabled rapid expansion of the industry due to low entry costs. The yabby industry currently harvests around 4,000 farm dams, with most spread throughout Western Australia's 750,000 km^2 wheatbelt region.

Australian yabbies are in demand internationally due to several characteristics, including:

- high quality;
- being larger than crayfish produced by overseas competitors;
- freedom from major diseases, and;
- ability to be landed alive in major international markets.
- Local processors and exporters have developed processing techniques to ensure premium quality product can be exported to international markets.

The aim of Fisheries Western Australia in providing this information is to assist farmers already engaged in this interesting and unusual new industry, and to encourage more people to become involved. Much of the information contained in this publication is the result of a research program jointly supported by Fisheries WA, FRDC (Fisheries Research and Development Corporation) Aquaculture Development Fund (WA), the WA yabby industry, Agriculture WA and The University of Western Australia, Animal Science Group, Faculty of Agriculture. This document replaces Yabby Questions and Answers (1995) by N Morrissy, *Aquainfo* #1, Fisheries Department of WA.

A reading list is provided at the end of this book. However, two other major volumes that complement this publication are Lawrence, C.S., Morrissy, N.M., Bellanger, J. and Cheng, Y.W. 1998. Final Report FRDC Project 94/075: Enhancement of commercial yabby production from Western Australian farm dams. *Fisheries Research Report* No. 112. Fisheries WA, 134pp and 'Yabby Code of Practice', video and book available from:

Simon Bennison, ACWA,
PO Box 55, Mt Hawthorn, WA 6016.

For the latest information on yabby farming, consult the Fisheries WA web site (http://www.wa.gov.au/westfish/) and the Australian Crayfish Aquaculture e-group (http://www.egroups.com/subscribe/AustralianCrayfishAquaculture).

Why is there a boundary to licensing, stopping yabby farming in the higher rainfall areas in south-west WA?

Yabbies are not a species native to WA. They were introduced from western Victoria in 1932 to the Narembeen area and then spread widely throughout the wheatbelt region.

The boundary to yabby farming (formerly Albany Highway and now nearer to the State forests) is intended to separate yabbies from habitats of the native marron, koonacs and gilgies, which occur mainly in natural waters in the wetter forested part of south-west WA.

This policy of separating yabby and marron farming regions is designed to protect native freshwater crayfish. Yabby harvesting is best suited to the muddy clay dams of the inland agricultural region, where most of the large number of existing dams are still not harvested.

Why do we need any licensing in the yabby industry?

Licences are required to ensure that the activities being carried out are unlikely to:

- affect other fish or the aquatic environment;
- are in the interests of the aquaculture industry, and;
- have been approved by relevant authorities.

In WA, all licence holders are required to submit production returns, and from this information, production statistics are compiled and the value of the industry estimated. Fisheries WA has a statutory requirement to report to Parliament on the progress of the industry and uses these production returns to assist industry management, research programs and development strategies.

Why are more yabbies farmed in dams than in tanks or ponds?

Because the more intensive methods of farming crayfish in tanks and ponds are economically unproven for yabbies (despite many attempts), and are much more difficult than simply harvesting farm dams. Tanks and ponds also need a lot of capital investment. If you have a farm with dams containing yabbies, only a small amount of money needs to be spent on some traps to get started.

The message is, "make the most of the yabbies

What is the easiest way to start selling my yabbies?

You can let a commercial harvester (who holds an aquaculture licence that authorises them to trap yabbies from properties other than their own) harvest your dams; the harvester will pay you for each kilogram of your yabbies, according to their size and condition.

Regulations vary between states, so contact your local Fisheries office for local rules and regulations that apply to yabby harvesting in your region.

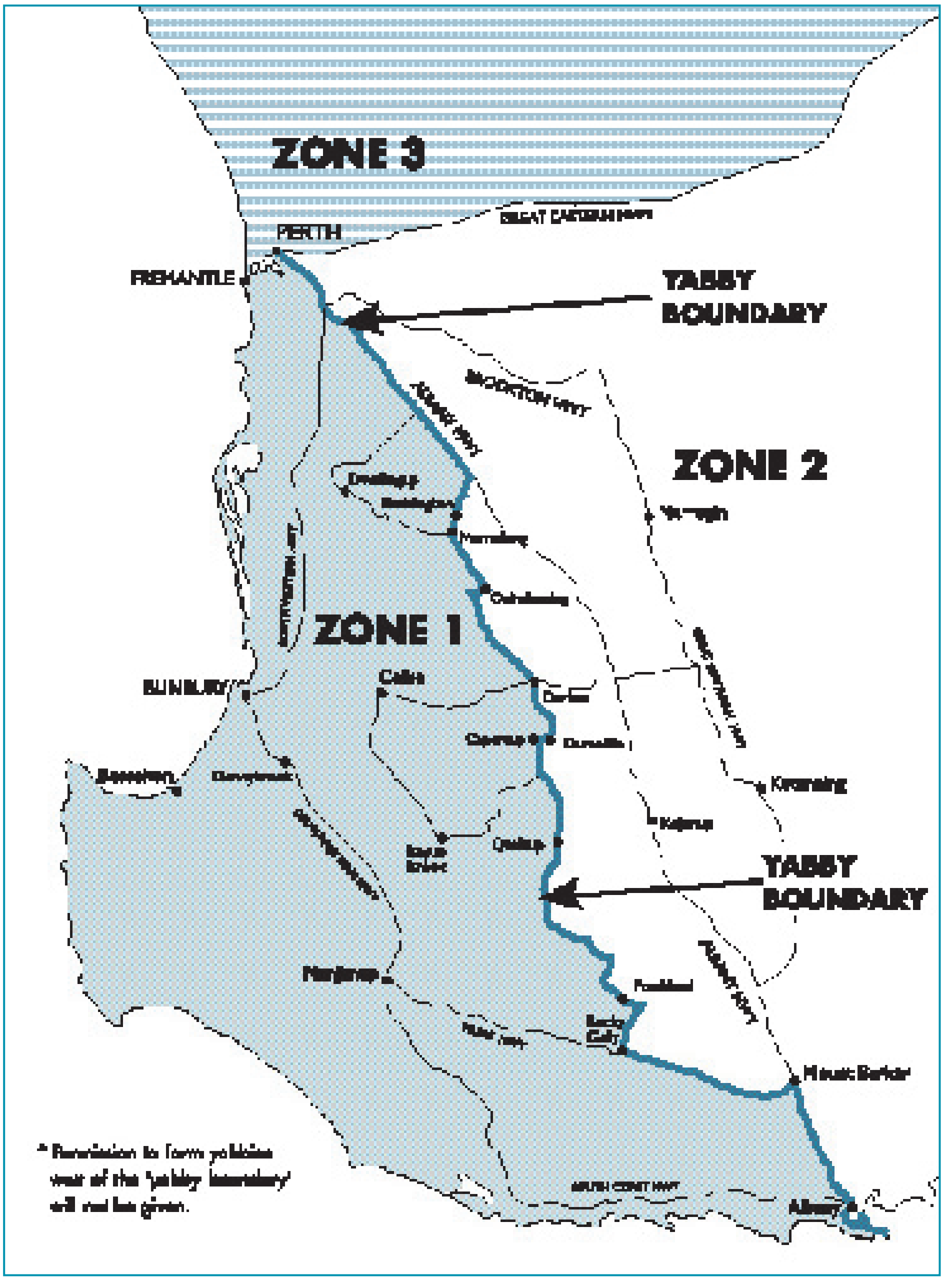
What if I want to do my own trapping? Do I need a licence?

One of the major reasons for the success and growth of the yabby industry is the marketing of a purged, clean, high quality product.

In WA, if you sell yabbies that you've trapped from your farm to a person who is authorised by an aquaculture licence to purchase the yabbies, you don't need a licence (usually you deliver the yabbies to a processor's purging/packing shed or collection depot).

If you want to sell your yabbies directly to a

Figure 1: Map of Western Australia showing yabby boundary. Yabbies can only be farmed east of this boundary.



retail fish shop or restaurant, you'll need to get an aquaculture licence from Fisheries WA (see Thorne, 2000). This type of farmer usually has a shed, with holding tanks, to purge and pack a high quality, graded, live product for delivery to the retail outlet.

As regulations vary between states, contact your local Fisheries office for rules and regulations that apply to yabby farming and harvesting in your region.

How do I find out who can harvest and/or process yabbies in my area or apply for a yabby licence?

Most people who have the licences required to harvest other farmers' dams and/or process yabbies are listed in the phone book. Alternatively, talk to your neighbours. In many cases they can provide you with a contact number for your local processor or harvester. For information on obtaining your own licence, contact your local Fisheries office.

I have koonacs/gilgies in my wheatbelt dams in Western Australia; what about them?

You've almost certainly got yabbies; people have been wrongly using the common names of 'koonacs' (*Cherax plebejus* and *C. glaber*) and 'gilgies' (*Cherax quinquecarinatus* and *C. crassimanus*) for the introduced yabbies (*C. albidus*). Koonacs and gilgies are quite different freshwater crayfish species, and are native to WA. A free brochure on identifying freshwater crayfish in WA, with coloured photos and descriptions of marron, koonacs, gilgies and yabbies, is available from Fisheries WA.

(six head, eight thorax). The first pairs of appendages are the sensory feelers for smell and touch called antennae and antennules, followed by various, small mouthparts used for feeding (maxillae, maxillipeds, mandibles). Protected under the large plate-like sides (branchiostegites) of the shell cover (carapace), are the external aquatic gills (branchiae) in a water-filled gill (branchial) chamber. Inside the chamber, a special plate-like appendage (scaphognaphite) circulates water forward through the gills. The first, large pair of legs (chelipeds) have big, powerful claws or chelae, which grow disproportionately larger in adult males and are used for threatening other yabbies, if not for actual fighting. The second and third legs are walking legs and have tiny, sensitive (touch and taste) chelae that are used to feed on minute organic particles.

The rear part (abdomen) of a yabby is basically six articulated segments. The last segment has an articulated extension (telson), which is the centre flap of the tail fan; the two other flaps (uropods) are the last pairs of appendages. The abdominal flesh, which we like to eat, is muscle used to flap the tail fan to swim backwards when escaping. The upper part (tergum) of each segment of the abdominal shell extends down the sides, and these side plates (pleura) are disproportionately enlarged in adult females to protect the eggs carried under the abdomen.

Under the abdomen (sternum), four segments have pairs of biramous swimmerets or pleopods. At spawning, the female glues her fertilised eggs to one branch of each pleopod (exopodite); in adult females this branch is broader and flatter with long fine hairs or setae; the other branch (endopodite) helps to oar a flow of well-oxygenated water over the incubating eggs. After the eggs hatch, the baby yabbies hang head down from the pleopodal setae, using special snap-hooks found at these attached stages on their most posterior (back) two pairs of legs. Interestingly, all northern hemisphere baby crayfish hang tail down, using the claws on their first pair of legs.

What are the most noticeable internal parts?

It is cruel to break open a live yabby and a messy way to investigate its internals. Take a cooked (boiled) yabby in the usual eating grasp with both hands and flex it open at the join between the cephalo-thorax and abdomen, without breaking it in two. Lift the carapace back towards the head. If you have a mature female, the first thing seen on top, is the red-orange, bi-lobed ovaries. In the uncooked state, these are dark green.

In males, the white testes are harder to find but can be traced along the highly coiled spermatophore tubes (*vasa deferentia*) leading

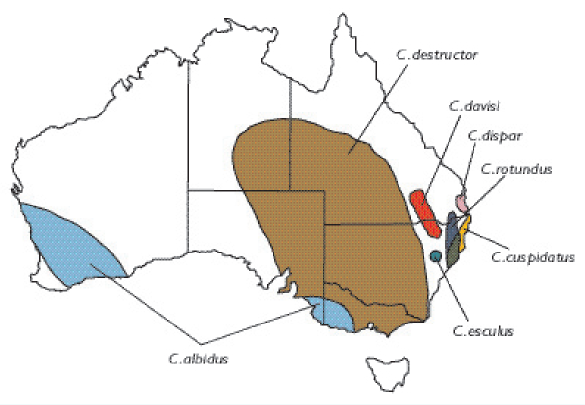


Figure 2: Distribution of Yabbies according to Reik (1969).

What is a yabby?

A yabby is a freshwater crayfish. They are decapod (10-legged) crustaceans along with marron, rock lobsters and prawns. Crustaceans belong to the very large group of jointed leg animals without backbones (arthropods) which includes insects, spiders and scorpions. These animals are peculiar as their skeleton is on the outside of their soft body, as a hard calcified shell or exoskeleton.

Where do yabbies come from originally?

Australia and southern Papua New Guinea (PNG) have a rich freshwater crayfish fauna of over 100 different species and there are a few similar species in New Zealand, South America and Madagascar. These are a different family (the *Parastacidae*) from freshwater crayfish in the northern hemisphere (the *Astacidae* in Europe and the *Cambaridae* in North America and eastern Asia). All these crayfish evolved from ancient marine lobsters.

It is now believed that the move to freshwater happened separately in the two hemispheres more than 100 million years ago when Australia, India, Africa and Australia-New Zealand were joined together and attached to Antarctica as the giant southern continent called Gondwanaland. India and Africa broke off first to drift north before freshwater crayfish could spread from the original freshwater site (south-east Australia, which was invaded from the sea), so no native freshwater crayfish are found in these countries. A few crayfish spread to South America, New Zealand and Madagascar before these countries split off and drifted north. As Australia drifted north later to ultimately collide with Asia, the climate changed, from cold to hot and wet to dry.

Although WA is now separated from eastern Australia by a desert barrier, at one time it was linked by a giant inland lake. The genus most adaptable to these changes was *Cherax*, which evolved and spread to the west to give the marron (*Cherax tenuimanus*), northwards to become the red claw (*Cherax quadricarinatus*) in sub-tropical Queensland and over Torres Strait (dry at one time) to evolve into more than a dozen *Cherax* species now found in Australia, Torres Strait Islands and southern Papua New Guinea.

Undoubtedly, the most adaptable species of *Cherax* is the common eastern states yabby, or *Cherax destructor*. It is found in a very wide range of habitats, from hot waterholes in central Australia, to cold lakes and permanent streams near Mt Kosciusko in the Great Dividing Ranges, and from southern Victoria and South Australia to southern Northern Territory and south east Queensland. It has a number of closely related sister species of yabbies, such as our white yabby (*Cherax albidus*). Some taxonomists are arguing whether or not our yabby is really a different species. In any case, yabbies are remarkable animals!

What is our yabby's true name; I've heard that there are lots of different species of yabbies?

The everyday, or common, name yabby (from the Aboriginal word yabber) is loosely used for to a large population number before the surface water disappears again.

Females are very fecund (large number of eggs per spawning) and can spawn several times in succession between spring and autumn. Baby yabbies grow rapidly and sexual maturity occurs in females at a relatively small size and in their first year. Yabby population explosions ensure a very large number of offspring, so that when the water eventually dries up, some will survive the impending drought.

What happens when yabbies are put in a farm dam that doesn't dry up?

They go through the same population explosion as in the wild and reach very high numbers, particularly juveniles, in a year or two. In crayfish, and many other animals and plants, growth is closely related to their density (number per unit area) or degree of crowding. As density increases, growth slows dramatically and survival at moulting (see next section) is poor, so the throughput to larger and marketable sizes is low. However, breeding does not seem to slow. This overpopulation, or crowding, is currently seen as the central problem to be overcome in yabby farming, so as to increase production of larger-sized yabbies in a dam.

With a hard shell, how do yabbies grow?

The general process of growth is called moulting and involves a cycle of moult stages (A-E), which has to be repeated many times through their life. Periodically, they make a new soft shell under the old hard one (stage D). Then, laying on its side, the yabby breaks out of the old shell at the join on top between head and tail – an involved contortion called ecdysis or moulting (stage E). Amazingly, this involves all parts of the external shell, and some fore and rear gut lining as well as eyes, gills and legs.

The new exposed soft shell is expanded quickly by drinking water (note: land insects take in air) (stage A), and then hardens so the yabby can get mobile (stage B). During the subsequent intermoult (stage C) the yabby feeds and replaces the water with soft body growth. In early stage C, the yabby is hungriest and most readily caught in a baited trap.

Yabbies often lose legs by fighting. However, gradually through three or four moult cycles. they can completely replace a leg.

Do they often die during moulting?

Yabbies are very vulnerable during moulting. Most crayfish deaths occur while they are sluggish – just before, during or after moulting. They get stuck trying to emerge from the old shell or they are attacked by other crayfish, or a predator while they are soft and defenceless. A yabby on its side in shallow water is usually moulting. Sometimes what you see is the old empty shell. If not, wait a few minutes and the 'new' yabby will emerge. Don't disturb or handle a moulting yabby; they can't breathe at this stage and any delay means they run out of breath before finishing. Small crayfish ecdyse in a few minutes but very big ones can take 20 minutes, or longer.

several species of small freshwater crayfish in eastern Australia. The most widely used scientific name for our yabby species in WA is *Cherax albidus*. The first name is the group, or genus, of rather similar crayfish to which yabbies belong (over 30 species in Australia and PNG, including marron, koonacs and gilgies in WA). The generic name, *Cherax*, is thought to be a misspelling of the Greek word Charax, meaning a pointed stake – a thing that scratches. The second name (no capital letter) is the particular species, the white yabby which was first named as *Cherax albidus* by a Victorian museum taxonomist, Dr Ellen Clark, in 1936. It is understood that these yabbies were first introduced to WA from Merwyn swamp, near Nihil in the Wimmera farming district, in western Victoria.

Interesting coincidence?

The species name for WA yabbies is derived from the same Latin word ('albus' = white) which is used to describe the reflection of sunlight from our white clay dams ('albido'), where white yabbies are so successful.

Why do some yabbies differ in colour?

Yabbies can vary considerably in overall colour and in the intensity of their shell colour patterns. Some of this variation is due to age, but it is mostly camouflage to match the colour of their background. It is believed that the shell and the female's deep green eggs are coloured by pigments obtained by eating plants.

Juvenile yabbies from muddy dams are normally very bland in appearance (the white yabby), while older yabbies are olive-greenish and more strongly marked. Darker, dirtier yabbies are ones that are not growing well (i.e. not making a new shell frequently); very clean, pale, often pink, juveniles have just cast off their old shell. Yabbies from clear, very clean waters tend to be blue; those from green water, quite green; and those from tannin-coloured water, brown.

Are yabbies different to other crayfish?

Biologically, yabbies have adapted to ensure that some survive an extreme drought to start a new population when surface water returns. They burrow down to the water table when surface water dries up. Drought for a crayfish usually means the regular annual cycle of drying-out surface water in swamps, pools and small creeks after winter. Our native species of koonacs and gilgies live in these temporary, or what biologists call ephemeral habitats. They breed in their burrows in late summer and emerge to feed and grow during winter and early spring. The famous American red swamp crawfish, *Procambarus clarkii*, in Louisiana has the same lifecycle.

Yabbies are different, however, as they breed during spring and summer, and grow best during summer and little during winter. Yabbies seem to be adapted to the long-term drought of the outback lasting several years. When rain does fall (often as summer cyclonic downpours), surface water lasts for several years. The few surviving yabbies are biologically adapted to start the rapid build up

large diameter plate. These plates thicken with
stored calcium extracted from the outside shell (exoskeleton) through moult stage D leading up to moulting. After moulting, through stages B and early C, the white buttons (gastroliths) are used up to calcify the new exoskeleton. (These indigestible crayfish buttons are
often found on banks and under trees near clearwater crayfish habitats when shag predation is prevalent.)

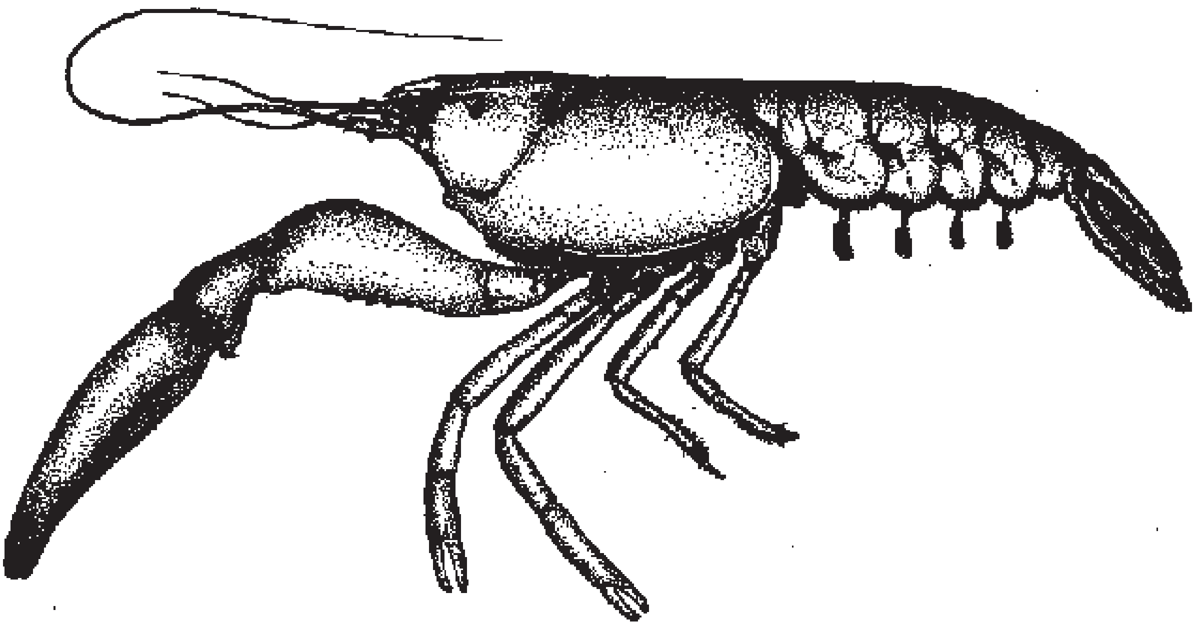
If you now crack and remove the tail shell in the usual way, the thinner top layer of abdominal flesh can be peeled back. If you've boiled up a freshly caught yabby, the hind
gut will then be obvious as a black strip, usually incorrectly called the vein. Most people like to tediously remove this rather offensive looking (faecal) piece of gut before eating the tail meat (muscle). An important part of yabby processing before marketing is to purge out the dark food waste from the gut by starving the yabbies in clean water for several days.

What is the yellow material in the head?

This is the hepatopancreas or mid-gut gland. It ranges in colour from bright yellow to mustard to light brown, depending on the animal's condition, where it lives and what it has been eating. In many countries, this is consumed and regarded as a delicacy.

What is the vein in the tail?

This black strip is not a vein but actually the hind gut of the yabby which joins the anus to the stomach. In freshly caught yabbies from the dam, it often appears dark due to faecal material, but in



How do I tell a moult from a dead yabby?

Farmers often see yabby shells on the side of their dam and think the animals are dying. But if you look closely you will often see that these yabby shells do not have eyes nor do they have meat inside the body. They are the moults left after the animals have shed their external skeleton in order to grow. On the other hand, a dead yabby still has eyes and if it has been dead for a while, the smell will leave you in no doubt as to whether it is a moult or a dead animal!

Are yabbies cold-blooded? If so, how does this affect growth?

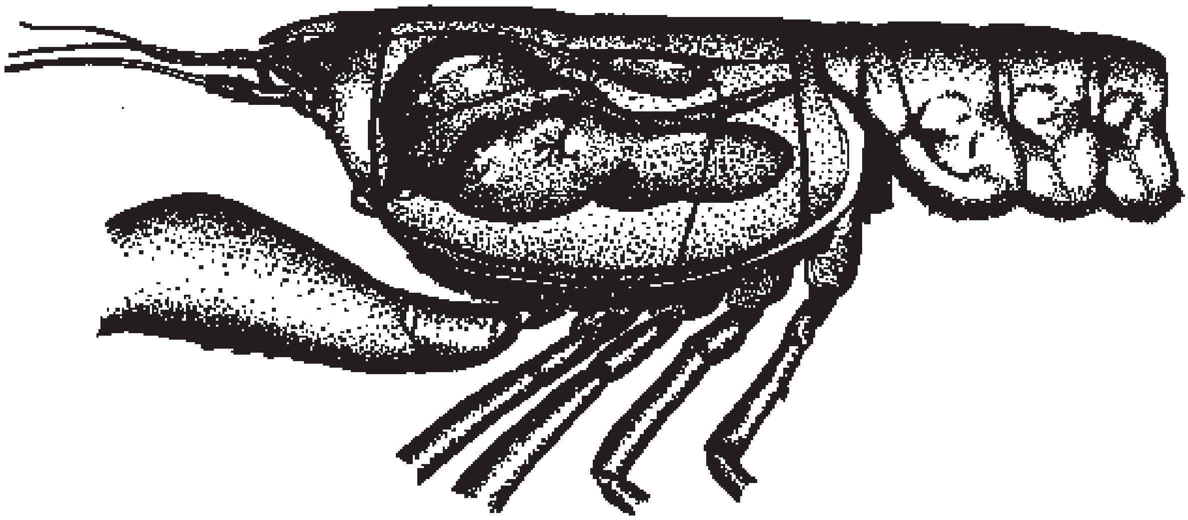
Yes. Their feeding activity and therefore growth are very dependent on the water temperature. They are called poikilotherms because their body temperature varies with the temperature of their environment (humans are homeotherms, with a constant, high, body temperature). The annual season for yabby growth starts in September and ends in May. The yabby harvesting season with baited traps follows the same annual pattern because capture is dependent upon the feeding activity of the yabby. Temperature values favouring growth are given in another answer (see Table 1).

So you want to know more…

What are the names of the different outside body parts of yabbies?

Yabbies and other arthropods evolved from marine worm-like animals with a simpler, more uniform body of 20 similar, articulated segments, each with a pair of double-branched legs (biramous appendages). Inside, these worms had a gut and nerve cord running from the mouth to the tail end. At the mouth end, the nerve cord was barely enlarged and housed the primitive head-brain. In yabbies, these segments and appendages can still be identified, but many segments are highly modified and fused and different pairs of appendages are also highly modified for particular purposes. Some of the scientific names for body parts and their purposes or functions, which you may care to know to understand this animal, are mentioned in the following brief description.

The front half of a yabby is called the cephalothorax (head-chest) with 14 segments



from the insides of the bases of the last pair of legs. Underneath the gonads (lift and cut them out with tweezers and scissors) is a large organ called the hepatopancreas (or mid-gut gland), which is joined to the gut. This is the yabby's liver and is usually mustard-coloured. People in other countries don't waste the head part of tiny crayfish like we do, opting to suck out this so-called 'mustard'.

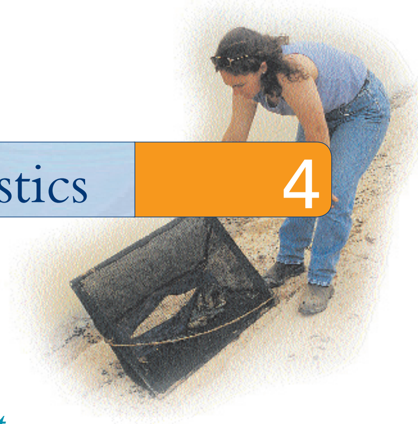
The other major organ, nearer the mouth, is the large round dark stomach, usually filled with fine particles. It contains hard grinding teeth called the gastric mill (these teeth and the inside lining of the gut in front of them are shed during moulting along with the outer shell).

On either side of the stomach wall is a

Table 1: A Summary of the Biological Characteristics of Western Australian Yabbies *Cherax albidus.*

ATTRIBUTE	ESTIMATE	Reference
Maximum size	290 g	Lawrence, unpublished data
Maximum growth rate	0.6 g/day	Lawrence, unpublished data
Temperature		
Lower limit for growth	15°C	Morrissy, Evans and Huner, 1990
Upper limit for survival	36°C	Morrissy, Evans and Huner, 1990
Optimum for growth	28°C	Morrissy, Evans and Huner, 1990
Salinity		
Upper limit for survival	22 ppt	Morrissy, Evans and Huner, 1990
Upper limit for growth	6 – 8 ppt	Morrissy, Evans and Huner, 1990
Broods per year	1 – 5	Morrissy, Evans and Huner, 1990
Egg incubation period	19 – 40 days	Morrissy, Evans and Huner, 1990
Spawning season	Spring – Autumn	Morrissy, Evans and Huner, 1990
Temperature for breeding	18 – 20°C	Morrissy, Evans and Huner, 1990
Day length for breeding	14 – 16 hours	Morrissy, Evans and Huner, 1990
Size of female at first spawning	10 g	Lawrence, unpublished data
Total edible flesh (tail and claw flesh)	22 – 23%	Morrissy, Evans and Huner 1990
Tail flesh	15 – 20%	Morrissy, Evans and Huner 1990

Water Quality and Farm Dam Characteristics



What are the best dams for growing yabbies?

The most profitable dams face the prevailing winds, have low banks and are low in the catchment. Dams with a broad mouth that spreads out across the catchment are also very good.

Yabby dam in wheat paddock.

What limits yabby productivity in dams?

The major factors limiting yabby growth are lack of food and high densities. Yabby production is also limited by lack of aeration (hence dams facing the prevailing winds with low banks are more productive), lack of water in some regions and size of dams. Water chemistry can also limit production. In particular, water that has a high zinc or copper content produces fewer yabbies.

What is the best temperature for yabby growth?

Yabbies grow most rapidly when the water temperature is 28°C. Below 20°C growth slows down, and stops completely when temperatures drop below 15°C.

When I've swum in a dam during summer, why is the water warm at the surface but much colder lower down?

Water is a poor conductor of heat, and heat from the sun travels slowly down from the surface. In deep, still, clear water, the temperature decreases gradually with depth. Some metres down, the temperature decreases rather more rapidly, most rapidly through a layer called the thermocline, and then changes little towards the bottom. In contrast, most of the sunlight heat is absorbed, or reflected, very close to the surface in muddy farm dams by the suspended clay particles. The thermocline is usually less than a metre down from the surface.

Why doesn't the hot surface water mix with the cold bottom water?

Hot water is lighter or less dense than cold water so the water layers on either side of the thermocline mix very little, and heat is transferred slowly by diffusion and not by convection-circulation. This so-called temperature stratification during the daytime is very stable and hard to mix.

When does the water mix?

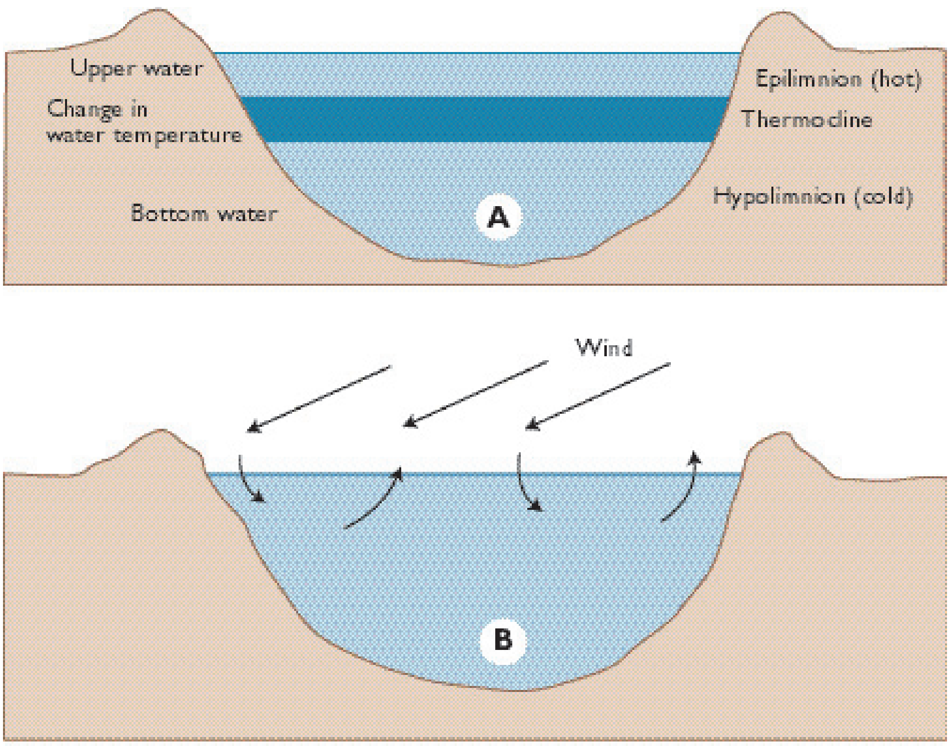
Mixing occurs regularly during the cold, windy winter and to a lesser extent in the warmer, calmer spring and autumn. During the day in summer, only the winds of cyclonic storms are strong enough to mix the water layers. The stronger the wind, the deeper the mixing, so the deepest bottom water, down to 3-4 metres in the centre of a dam, mixes very infrequently. Mixing can also occur before sunrise if the night is cool enough to bring the surface water down to the same temperature and density as the deeper water. Some wind may then mix the dam.

A rare cold, summer night can cool the surface water to a lower temperature than the deeper water. The density layers are then unstable and the surface topples over without much wind help. This is what farmers and scientists mean when they say that a dam 'overturns'. The problem with natural re-aeration of bottom water, by early morning mixing with surface water, is that algae at the surface may have already removed most of the oxygen in surface water overnight.

How much of this colder water, cut off from the surface, is there?

About two-thirds of a dam volume is under the thermocline. There is, of course, more cold stagnant water in a muddier or deeper dam. It is likely that the wall area above the thermocline is the most favourable for yabbies.

Water stratification in typical farm dam.



A = Stratification
B = Mixed

survive at extremely low, if not zero oxygen levels, they can't be active, trapped, feed, moult, mate and spawn under such extreme dam conditions.

What else do the yabbies do in response to low dissolved oxygen?

We know that marron in these dams are forced into shallower water during summer. Although yabbies are more tolerant of low oxygen, they seem to favour the warmer, well oxygenated, shallow water. The negative effects of this crowding onto a smaller area of the dam bed are reduced survival and growth, since these production factors are very much influenced by density (crowding) of crayfish.

What can I do to aerate my dams?

A lot of people have thought about this problem, which is currently being researched. There are two related aspects. Firstly, if you spend money on an aerator and its maintenance, the cost has to be offset, at least, by increased production of yabbies for your yabby farming to stay profitable. Secondly, the amount of energy needed to mix a dam is quite high, so it seems that a powerful, and therefore costly, aerator is needed. Aeration is more likely to be a feature of purpose built ponds using higher stocking densities and feed rates if these prove to be profitable.

Another method of aerating farm dams is to use calcium nitrate. Calcium nitrate increases the dissolved oxygen levels in ponds at the bottom where yabbies live by oxidising the otherwise anaerobic pond sediments. Although we have shown in research ponds that this technique works, it is still highly experimental.

What types of aerators have been considered?

In one of our shallow, purpose built marron ponds (1,000 m^2 surface area), a paddlewheel aerator is run briefly three times a day on mains power. This aeration is necessary to offset the oxygen demand of a high rate of daily feeding and allows crayfish production at about five times that of a farm dam. Farm dams don't have mains power, so use of wind and solar power are obvious possibilities. The problem with windmills supplying power directly (no battery storage) is lack of wind when you need the power to mix dams during summer.

Is there any way of improving the natural aeration of dams?

Although muddy dams are an advantage for yabby farming (as explained further on), many are too muddy with clay. The depth of the thermocline and therefore the area of favourable dam-bed could be increased by somewhat reducing the muddiness. We know how to do this in theory (by liming, as explained further on) but the technique needs to be researched on dams for fine tuning. It has other benefits too, such as providing additional calcium, which yabbies require for moulting.

How can I recognise harmful mud conditions?

Pick a clear dam when dams are low and look at the bottom mud near the bank. You'll see that the very top layer of mud is light brown, but if you scratch it, underneath it's black. If you can grab a handful of the black stuff, it smells of rotten eggs

What does this temperature stratification mean for yabbies?

The temperature of the deeper water in dams is not favourable for yabbies. The water under the thermocline is usually about 14°C at the start of hotter spring weather and warms to only 19°C by the end of summer. However, these patterns vary in different parts of Australia. Above the thermocline, the water heats and cools daily in the range 20°C to over 30°C (they can tolerate temperatures up to 36°C). Consequently, there is only a relatively small area of the bed of a dam under shallow water around its edges that is likely to have the most favourable temperatures for growth of yabbies during summer.

Is the stagnancy of the deeper water bad too?

The oxygen concentration of the mixed surface water above the thermocline is usually close to 100 per cent during the daytime; it may even be supersaturated (>100 per cent) right at the surface due to algae, even in a muddy dam. However, the oxygen declines rapidly through the thermocline to well below 50 per cent, and frequently close to zero, in the deeper water. One hundred per cent is the maximum amount of oxygen that can be readily dissolved in water at a given temperature. Supersaturation occurs if algae release very fine bubbles of oxygen during the daytime.

Unfortunately, however, algae and plants consume oxygen at night, so a large algae bloom or a lot of plants can often result in very low oxygen conditions at night. When this occurs, farmers visiting their ponds early in the morning often see the yabbies crowded around the edges of their dam or pond trying to get more oxygen. In severe cases, the yabbies may even walk out of the pond or dam in search of better aerated water.

What causes the low oxygen in deeper water?

Low oxygen is caused by a combination of the removal of oxygen by rotting organic matter in the water and on the bed of the dam, and lack of circulation of this water to the surface where natural aeration occurs. Bacteria in the black organic matter at the bottom of ponds and dams consume oxygen during both the day and night.

How well do yabbies cope with low oxygen levels?

Yabbies can survive for much longer times at lower oxygen levels than many other crayfish, such as marron. At zero oxygen, they can change their metabolism to a form which doesn't need oxygen, although this can't go on indefinitely and they must be inactive. They can survive and prosper relatively well in nutrient rich dams where the winter clay turbidity is replaced by algal blooms at the start of summer.

In contrast, marron often die in these dams. One observation by farmers is that dams with algal blooms give fewer problems with excessive reproduction and overcrowding. This is probably because the eggs and hatched young attached under females' tails are less tolerant of low oxygen. Therefore, the fewer surviving juveniles are less crowded and consequently grow faster. However, it needs to be remembered that while yabbies can or hydrogen sulphide. Exposed to air, the black colour will change to brown. The brown top layer is well aerated with oxygen, or is aerobic, and the black mud is anaerobic.

How can I remove the black mud?

Our research has shown that calcium nitrate can be used to oxidise the anaerobic black mud in the bottom of dams and turn it into rich brown aerobic mud. This oxidised brown mud does not smell as the anaerobic bacteria prefer poorly oxygenated sediments. However, it remains to be seen if it can be used profitably in yabby farming.

Why do yabbies do so well in muddy dams?

Crayfish have a great instinctive fear of bird predators (e.g. shags or cormorants), and the clay turbidity in muddy dams provides shelter for the yabbies from these predators. During daylight hours, crayfish in clear water are very vulnerable to shags and are inactive in hiding places. However, the muddy water in most dams provides 24 hour night-time light conditions on the bed of a dam, so shags can't see to hunt, and crayfish are active during the daytime.

Crayfish don't need to see to feed; they can do it by touch, smell and taste. Underwater darkness in muddy dams is the reason why yabbies can be harvested so readily with baited traps during the daytime. In addition, muddy dams have lower salinity than clear dams and yabbies grow faster when the salinity is low. There is some debate as to whether white clay or red clay dams are better. In either case, it is clear that muddy dams are good for farming yabbies.

Why are some dams muddier than others?

Clay turbidity, as muddy water is called, is due to small particles of clay suspended in the water. These colloidal particles have electrical (negative) charges so they repel each other (like the same poles of two magnets) and don't settle out by clumping together. Some clays are finer than others; red montmorillinite gives much more turbid dams than white kaolin.

However, the major factor controlling clay turbidity is salinity. The more saline the water, the clearer the dam water will be. The suspended clay particles are neutralised by the positively charged salt ions dissolved in the water, and this is why dams towards the salinised bottoms of valleys in the wheatbelt tend to be clearer. Muddy dams will usually go clear over about 1,000 mg/L salinity.

Why are some dams muddy in winter and clearer in summer?

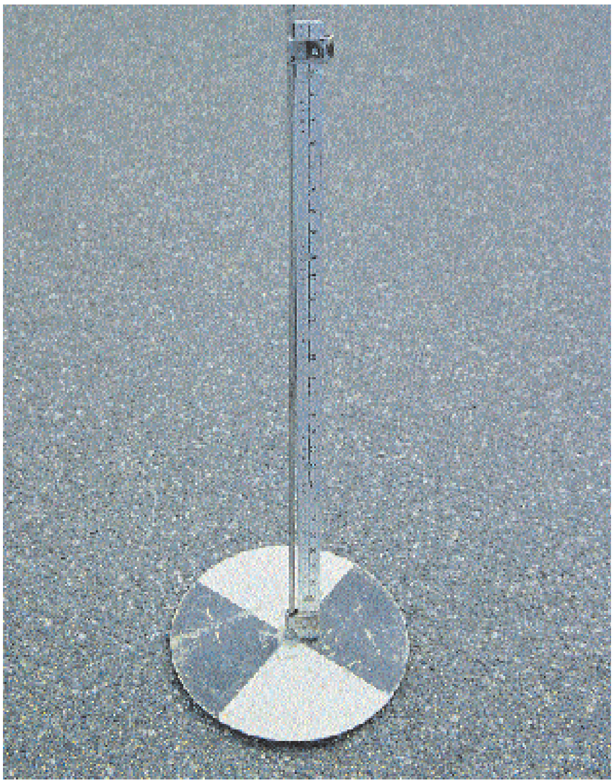
The salinity of all dams increases over summer as the water evaporates into a gas (water vapour), leaving behind the dissolved salts (in contrast, stock drinking and seepage removes both water and salts). Increasing salinity drops out (flocculates) the clay turbidity. When the dams overflow in winter, salts are diluted and flushed out by lower salinity inflow so the dam salinity drops - to the inflow salinity if the dam overflows for long enough - and the dam goes turbid again.

If I wanted to keep a record of the turbidity of my yabby dams, how would I measure it?

A simple, but scientific, measurer is called a Secchi disc. Cut out a 30 cm diameter tin disc, mark it out in four quadrants of the circle and paint alternate sectors with flat white and black paint. Screw the disc at its centre to one end of a one metre long pole that is marked at one centimetre intervals. The Secchi depth, as a measure of turbidity, is the water depth where the disc just disappears from view as you lower it, or just reappears as you raise it (take the average of the two readings).

Monthly recording is often adequate. Very muddy red clay dams may have a Secchi depth of 5 cm (the depth of penetration of most of the sunlight).

(See recommended reading section for details on the construction and use of a Secchi disc).



Secchi disc and pole

What is salinity?

Salinity is the quantity of all the salts dissolved in water. The major salt in the south-west of WA is table salt (sodium chloride = NaCl). In the dissolved state, this salt splits (dissociates) into ions, the positively charged sodium (Na^{+}) cation and the negatively charged chloride anion (Cl^{-}). Other salts give the cations, potassium (K^{+}), magnesium (Mg^{++}) and calcium (Ca^{++}) and the anions, bicarbonate (HCO_3^{-}) and sulphate (SO_4^{--}). The south-west waters are rather unusual amongst world fresh waters in having a very high proportion of sodium and chloride due to their accumulation in the wheatbelt groundwater from seawater spray carried inland by rain. The other salts are low because of the ancient, leached-out south-west catchments.

How much salinity can yabbies take?

Yabbies can survive up to about 22 ppt, but as a group they become unsociable over 12 ppt and growth slows over around 6 ppt. Further research is needed on yabby eggs and hatched young, which appear to be less tolerant of high salinity. Salinity tolerance is not really an issue when farming yabbies, because yabbies do well, and you can trap them in muddy dams. Scientists have shown that muddy dams will usually go clear over about 1 ppt salinity. A good rule of thumb is, if the dam is muddy, it is below 1 ppt, and is therefore not too salty for farming yabbies. However, if the dam is clear, have the water tested to check the salinity is not too high.

In addition, while we have shown good relationships between yabby production and water chemistry, the ideal levels have not yet been determined.

Table 3 shows the range of water chemistry recorded from farm dams in WA. The water chemistry analyses shows that on average, levels of zinc, nitrate, iron and copper in WA farm dams are above those recommended for continuous exposure, while maximum levels of manganese are greater than those recommended for continuous exposure. In addition, the maximum levels recorded for alkalinity, iron, hardness and zinc exceed those previously associated with fish kills.

Table 2 : Salinity Conversion Table

µS/cm	mS/cm	MS/m	mg/L or ppm	ppt	gpg	comments
500	0.50	50	275	0.275	19	Very fresh water.
1,000	1.00	100	550	0.550	38	Marginally fresh.
1,500	1.50	150	825	0.825	58	
2,000	2.00	200	1,100	1.100	77	Dam water starts to go clear.
3,000	3.00	300	1,650	1.650	116	
4,000	4.00	400	2,200	2.200	154	
5,000	5.00	500	2,750	2.750	192	
6,000	6.00	600	3,300	3.300	231	
7,000	7.00	700	3,850	3.850	270	
8,000	8.00	800	4,450	4.450	308	
9,000	9.00	900	4,950	4.950	346	
10,000	10.00	1000	5,500	5.500	385	
15,000	15.00	1500	8,250	8.250	578	Brackish.
20,000	20.00	2000	11,000	11.00	770	
30,000	30.00	3000	16,500	16.50	1,155	Estuarine water.
40,000	40.00	4000	22,000	22.00	1,540	
50,000	50.00	5000	27,500	27.50	1,925	
60,000	60.00	6000	33,000	33.00	2,310	
65,000	65.00	6500	35,750	35.75	2,502	Sea water.

When measuring salinity, what is the difference between mg/L, mS/cm, gpg etc?

These are different units for measuring salinity. Farmers have traditionally used gpg (grains per gallon), marine biologists often use ppt (parts per thousand) while many others use mS/cm (milli Seimens per centimetre). The following formulae can be used to convert salinity between different units

- Divide µS/cm by 1,000 to get mS/cm.
- Multiply mS/cm by 100 to get mS/m.
- Multiply mS/m by 5.5 to get mg/L (ppm).
- Divide mg/L (ppm) by 1,000 to get ppt.
- Divide mg/L (ppm) by 14.25 to get grains per gallon.

Below is a table you can use as a guide for converting salinity measurements from one scale to another.

I've got a water analysis report which is hard to understand; what does it all mean?

Salinity may be reported as total dissolved salts (TDS) or total soluble salts (TSS), and will be given as a concentration (a total weight of all the dissolved salts present per unit volume of water). The old British units of concentration were grains per gallon (gpg); the metric units are milligrams per litre (mg/L) which can also be called parts per million (ppm).

To convert gpg to mg/L, multiply by 14.25. These units are used for low freshwater salinities, which in the south-west range from 100 mg/L to 500 mg/L for uncleared (non-salinised) catchments. Most farm dams are in the range 300-1,500 mg/L. You can start to taste salt in water at 2,000-3,000 mg/L (brackish) and seawater is about 35,000 mg/L. Higher salinities are given as grams per litre (g/L) or parts per thousand (ppt or ‰), or with the symbol S ‰ (1,000 mg/L = 1 g/L = 1 ppt). All the salts in water are difficult and expensive to measure individually. However, salinity can be measured quickly with an electrical conductivity meter; the more salts, the more current is passed.

OK – I understand the units, but what is high and what is low?

While the toxicity of chemicals to fish species varies considerably according to species, age, stress and environmental variables, which are in many cases unknown for yabbies, the levels associated with fish kills and acceptable continuous exposure provide a basis for evaluating water quality (Langdon, 1988).

Table 3 : Summary of Water Chemistry (mean, min and max) Recorded During Summer and Winter from 27 WA Farm Dams Currently Harvested for Yabbies

(Most lethal and acceptable water quality criteria are not available for yabbies, so values for fish have been used instead.)

Parameter	Unit	Mean	Min	Max	Levels associated with fish kills	Acceptable continuous exposure levels for fish
Alkalinity	mg/L	139	16	450	>200	20-200
CO_3 (Carbonate)	mg/L	3	<2	45		
Ca (Calcium)	mg/L	14	2	44		
Cl (Chloride)	mg/L	117	15	560		
Cu (Copper)	mg/L	0.02	<0.02	0.05	>0.03-0.07 soft water >0.6-6.4 hard water	<0.006
Econd (Electrical conductivity)	mS/m	68	16	234		
Salinity	mg/L	375	90	1287	22,000	<12,000
Fe (Iron)	mg/L	0.47	0.05	7.10	>0.5	<0.1
HCO_3 (Hydrogen Carbonate)	mg/L	168	19	450		
Hardness	mg/L	95	16	270	>200	20-200
K (Potassium)	mg/L	13	5	35		
Mn (Manganese)	mg/L	0.02	<0.02	0.05	>75	<0.01
NO_3_N (Nitrogen, expressed as nitrate)	mg/L	4	0.02	46	>100	<1.0
Na (Sodium)	mg/L	107	20	469		
P_SR (Phosphorous, soluble reactive)	mg/L	0.30	0.01	5.90		
SO_4_S (Sulphate, expressed as sulphur)	mg/L	24	4	81		
Zn (Zinc)	mg/L	0.06	0.02	0.68	>0.4 -1.76	<0.005
Secchi disc depth	cm	13.4	2.5	100		
pH	-	7.71	5.00	8.60	<4-5, >9-10	6.7-8.6

Do I need to be concerned about any particular salt ions in my dam water?

One element known to influence freshwater crayfish production in WA is calcium, and many south-west soils are deficient in calcium. Since crayfish use a lot of calcium to make their hard shells, they are good at extracting calcium from low levels in water. When changing their shells to grow, crayfish conserve calcium as the hard white buttons or gastroliths stored in their heads.

However, processors occasionally notice deliveries of lighter/softer shelled yabbies from particular farms and dams. Some dams have very low levels of dissolved calcium and may develop even lower levels because a large proportion of the dam's calcium is removed in harvested yabbies. Also, overseas studies show that alkaline waters (pH greater than 7.0) richer in calcium, have more productive natural food chains. Waters with:

- 0-10 mg/L of calcium are regarded as calcium poor;
- 10-20 mg/L are medium range; and
- 20-30 mg/L or more are rich.

Calcium is not a threshold survival factor; crayfish occur naturally in the purest south-west stream water and elsewhere at salinities of less than 100 mg/L with calcium at 1 - 2 mg/L (though, don't try them in distilled or rain water). However, calcium concentration may be a limiting growth factor, as farm dams low in calcium produce less yabbies.

How do I know whether I've got low calcium?

Calcium in water is expensive to have measured through a commercial laboratory. On a regional, if not locality basis, Agriculture Western Australia can give you an idea of how your farm rates for soil calcium. Calcium levels recorded from farm dams in WA range from 2 - 35 mg/L.

For differences between dams on your farm, you can get a good indication from the fairly close relationship between salinity and calcium from measurements of water conductivity in springtime. Very fresh, turbid dams, well up the valley slope with salinity as mg/L in the low hundreds, also usually have low calcium.

If you see many noticeably lighter/softer shelled yabbies trapped from particular dams, these may indicate a calcium problem, particularly if your processor notices the same incidence amongst many batches. However, some caution is needed in becoming unduly concerned; crayfish are normally softer shelled over the gill covers just after moulting in moult stage early C, when they are most catchable in traps.

How do I increase the calcium in a dam?

Regular liming is a well-recognised aquaculture practice for earthen fish ponds elsewhere in the world and there is a good deal of information on its benefits. While a number of materials can be used to

Our yabby study dam at Pingelly received an enormous inflow from a downpour on March 19, 1993. Although the dam immediately went clear (dark with dissolved organic matter which flocculates clay particles) and trap catchability was virtually zero in April, the yabby stock survived. Clay turbidity and catchability were back to normal in September 1993, though spawning was depressed in the spring.

What can I do about pollution of my dams by summer floods?

For many years, farmers have placed a small silt-trap dam above a main dam that they especially want to keep clean. Some farmers have placed a low chicken wire fence across the front of the dam to hold back the larger debris in a flood runoff. More recently, a prominent yabby farmer has used a fish net which can be drawn across a dam to remove floating debris from a flood. As a last resort, farmers siphon drain a polluted dam and dragline out the black organic bottom ooze before winter. Recently, we used calcium nitrate in ponds to oxidise the organic pollution from summer floods.

lime ponds, agricultural limestone (calcium carbonate $CaCO_3$) is the safest, cheapest and most effective option. Adding powdered agricultural limestone to a dam if you suspect a problem won't hurt the yabbies.

However, adding calcium will decrease clay turbidity, so stick to very turbid dams, as these are the most likely to be very low in calcium. To raise the calcium concentration of what farmers traditionally refer to as a 2,000 cubic yard dam by 10 mg/L, you'll need to add at least 50 kg of powdered agricultural limestone.

Some dams have green water over summer and go clear after autumn – why?

The green water or algal bloom is another form of water turbidity called algal turbidity. It is due to microscopic, single-celled, floating plants, called uni-cellular algae or phytoplankton. As with all plants, algae need strong sunlight (plus the nutrients phosphate, nitrate and carbon dioxide) to grow. In clay turbid/muddy dams, the algae are shaded out and grow unnoticed in lesser numbers at the surface.

Green water is characteristic of salinised dams that are cleared of clay turbidity and located near valley bottoms. These lower dams with larger catchments are often characterised by higher inputs of organic matter that leach to supply nutrients for algal growth. Nutrients are mainly stored in the dam bottom sediments during winter - so they don't get flushed out of the dam – and are released from the sediments during summer when the bottom water becomes deoxygenated. Algal blooms die off and these dams clear when daylight decreases in autumn. The rotting mass of a large dead bloom causes very poor oxygen conditions for a while.

What do algal blooms do?

Green algal blooms produce very large changes in oxygen concentration in the surface water over 24 hours. Plants produce oxygen by photosynthesis in excess of its use for their respiration (breathing, like us) during the daylight hours, but at night they just respire. So during mid-afternoon, dam surface water becomes supersaturated with oxygen from an algal bloom, but overnight the oxygen falls to a very low level by sunrise. Some algae are present in even the most turbid dams.

At very high nutrient levels (polluted dams), green algae give way to blue-green algae that produce toxins. Some blue-green algae can move up and down in the water with light change. At sunrise, they can momentarily be seen as a dense, dark mat at the surface, which rapidly disappears as the sun comes up. Excessive nutrient enrichment is also called eutrophication.

Should I try to kill off an algal bloom in a yabby dam?

Trying to kill an algal bloom (green water) is basically treating the symptom rather than the cause. The cause is too much nutrient, or fertiliser in the water, which can be caused by overfeeding but is usually due to pollution from a summer flood (as explained further on). As noted above, killing off the algal bloom will drastically reduce oxygen levels for a time and the nutrients (stored in the bottom mud) will soon be recycled to produce another bloom. A better approach is to prevent the algal bloom from occurring by limiting the influx of organic matter. This can be achieved by building a contour bank and silt trap at the mouth of the dam and managing feed rates.

What about using algicides?

Using chemicals to kill off algae requires some caution, as previously noted. Copper sulphate (blue crystals 'bluestone') should never be used, as it is found in algae blocks that are used to treat stock water troughs. Copper is extremely toxic to yabbies and other crustacea and is non-biodegradable (i.e. accumulates in the environment). House-drinking water dams can be treated with
a chemical called simazine, which is not toxic to yabbies at the dose recommended by Agriculture WA (1-2 mg per litre).

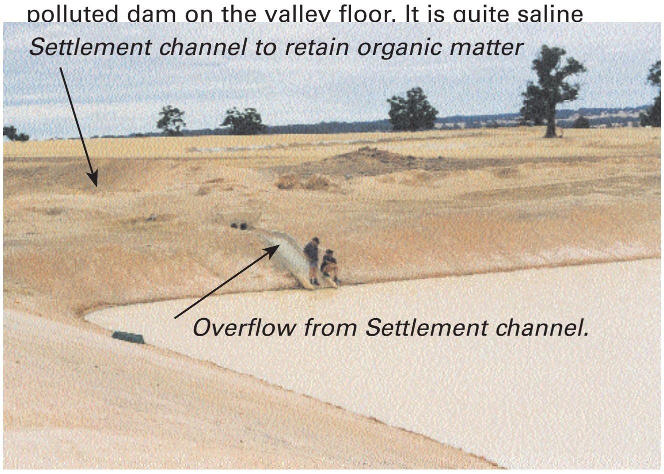
Do water conditions in dams affect yabby production?

There are large physical and chemical differences between farm dams and in the amount of crayfish they produce. We could measure many factors - and there are a lot - over a large number of yabby dams for several years and hope that at the end there is some pattern.

The more scientific method used in our experimental research program on yabbies over the past few years is to test and improve a theory developed some years ago from marron research in dams in the Kojonup area. This theory related marron production to dam conditions, but obviously needs to be extended into more enriched dams for yabbies. Some important factors need to be considered separately - clay type, rainfall, evaporation, air temperatures, catchment calcium, as well as regional variations.

Simple design to allow soil and organic solids to settle prior to runoff water flowing into main dam.

One extreme type of dams is the highly organically polluted dam on the valley floor. It is quite saline



More sophisticated design to restrict entry of organic matter and soil (commonly called 'silt' by farmers).

What about the summer floods that turn sheep off drinking dam water?

Dams with larger catchments and inflows along gully lines seem to be more at risk from the organic pollution following heavy summer rainfall. Summer floods that move large amounts of organic matter into dams can have a devastating effect on crayfish populations. Marron are particularly susceptible. Yabbies appear to fare better.

Breeding Yabbies 5

Do I need to build a hatchery to keep my dams stocked?

No. Yabbies breed so well that the problem tends to be too many juveniles in dams, even when the stock is harvested frequently. In the unlikely event that your farm dams have never been stocked with yabbies, it's not difficult to find other licensed farmers or harvesters who will sell you some bags of spare juveniles from their dams. However, as regulations regarding the movement of yabbies vary between states, and even between regions within states, contact your local fisheries office before obtaining any yabbies for stocking your dams.

How do you tell male from female?

In females, the third or centre pair of legs each has a round egg opening at the base, connected to an ovary. The remaining two pairs of non-clawed (non-chelate) legs are used for walking, cleaning and spawning. On the bases of the last pair of legs, the male has twin papillae, connected to his testes, used to fix a sperm packet (spermatophore) on the female at mating.

Female *Male*

How do yabbies breed (spawn)?

The male turns the female on her back and deposits a sperm packet (spermatophore) on her shell between the last two pairs of legs. In rock lobsters this packet is black and called a tarspot. We often incorrectly call the marron and yabby packet a tarspot, although it is whitish in these species. The female then curls her tail under to form a chamber and picks open the male's spermspot to mix sperm with her eggs extruded from the openings on her middle pair of legs. She attaches the fertilised eggs onto the long fine setae on her abdominal pleopods with a glue called glair.

Females carrying external embryos are said to be 'in berry' or 'berried'. The eggs are grey at first and surrounded by glair, then they turn olive and finally black just before hatching.

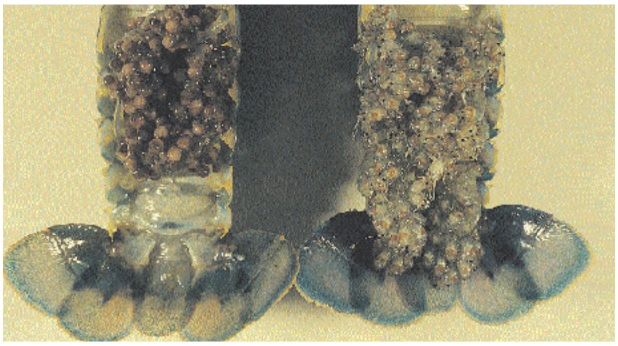
In the later stages, the developing baby yabby (embryo) can be seen as a yellowish spot near the egg surface. When the eggs hatch, the first stage baby yabby is still undeveloped and remains attached, but has a large amount of yellow yolk in its oversized cephalothorax to feed on. After a moult, the next stage is more developed with less yolk left.

The well-developed third stage, now definitely yabby-like in appearance, remains attached but can walk off the female to learn to feed. The attached young hang onto their mother's pleopods head down, using special snap-hooks in these stages on their back pairs of legs. After a third moult, the juveniles are truly independent of their mother, who often spawns again within a short time.

Spawning females don't feed much and, of course, can't shed their shells to grow (i.e. ecdyse).

tags attached to the shell are lost during moulting. An external tag planted in the flesh at the join between cephlothorax and abdomen, and not lost during moulting, is used for large rock lobsters, but is not successful for small crayfish. Crayfish have to be killed to retrieve magnetic internal tags or to use a new microscopic chemical ageing method on brains.

We follow growth of yabbies in our study dam, and



Two female yabbies, one with eggs (left) and one with juveniles (right).

estimate their total numbers, by punching marks on their tails which correspond to weight grade category and month of capture. These marks last through several moults. At Christmas, you need a mosquito net to catch the tiny, newly released young-of-the-year from the spring spawning. Most of the yabbies caught in traps are from the two spawnings in the previous year (one year olds) and range from 10 g (tail-enders of the summer spawning) to 40 or 50 g (males from the spring spawning). There are relatively few two-year-old yabbies (mostly very large males, easily identified by their much darker colour and our punch marks from the previous year).

How many eggs do females have?

The number of eggs increases with size of female crayfish. If the numbers of eggs in the ovaries are counted, this potential fecundity can be related to female size by an equation. However, the actual fecundity, or number of eggs, or hatched young, on the tail of a female is always less than the potential fecundity. For yabbies, the number is extremely variable for females of a given size.

Some researchers have found no relationship to female size; we do have an equation with rather wide limits. Most berried females have from 200 to 400 eggs in a single clutch, but can produce multiple clutches over spring-summer so that the total fecundity for the season could exceed 1,000 eggs per female.

Females in one of my dams have only a few, dead looking eggs under their tails; what does this mean?

Dead eggs look orange and often have a whitish coating over them. If most females have a large, healthy (shiny green or black) bunch of eggs, we would not worry about the occasional poor mother. However, if many females in a dam are poorly berried, this often means that oxygen levels in the dam water are very low.

They have been described as shy and retiring when nursing their eggs and recently hatched juveniles. The female spawners you catch in baited traps are a low proportion of what's in a dam. Fair numbers with early green eggs are caught, fewer with black eggs and very few with attached young. Some recent mothers we've re-caught (last caught and marked as newly berried) after release of young are shell-stained, indicating they've been hiding in burrows.

When do they spawn?

Yabby (*Cherax destructor*) spawning has been studied in a laboratory in South Australia where they spawned repeatedly under controlled summer conditions of long day length (14 or more hours of day length or photoperiod) and high water temperature (20°C or higher). WA yabbies (*Cherax albidus*) in our laboratory also spawn with increased photoperiod and temperature. Field observations in the east indicate spring to autumn spawning, depending on the locality's temperatures. *Cherax albidus* spawning in WA dams starts in September as the temperature in shallow water rises to about 18-20°C; spawning may start earlier further north and later in the Great Southern. Young from the spring spawning are released by December and many females then repeat spawning with a shorter incubation time, due to higher water temperatures, and release young by February.

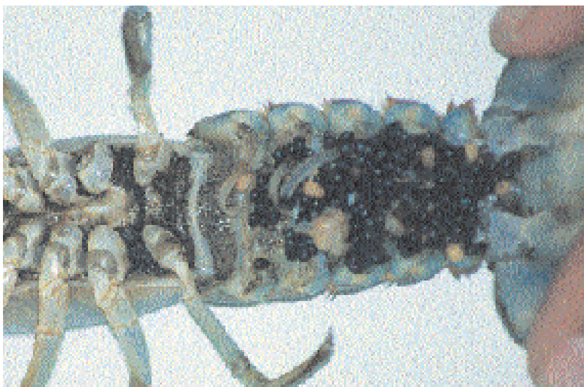
What sizes are mature males and females?

Size at maturity is not fixed in fish or crustacea and usually varies between individuals and under different growth conditions. Spawning females are predominantly in the 20-40 g weight range, with very few below 20 g. The smallest size recorded for a berried WA female yabby is 10 g and only 10 months old.

Females examined in late winter-early spring have well developed eggs in their ovaries, but can't spawn until they undergo a moult that widens their tail shell (see previous answer on external body parts). Many measurements have shown that tail broadening occurs in females at around 20 g. Mating trials at our laboratory have confirmed that mature females can be reliably identified by this easily seen external characteristic.

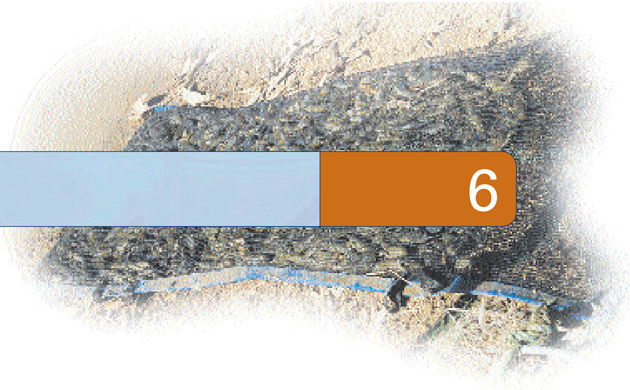
Males appear to mature at a larger size than females. But which size males actually mate with females may be more a question of behavioural size dominance, like bulls and rams, than potential ability. Since females spend most of the growing season spawning, and therefore not growing, males of the same age grow on to much larger sizes (50 g and larger).

In adult males over 40 g, the claws start to become disproportionately larger than those of females and smaller males, and this change continues to exaggerate the claws to a relatively



don't have any permanent hard parts (scales, otoliths, spines, bones) to form growth rings. External

Female with some dead (orange) eggs.



How fast do yabbies grow?

Crayfish and fish don't have fixed growth rates, so there's no single, simple answer. Given that spawning females don't grow, if a group of yabbies is placed in a tank of water at their optimum temperature for growth and fed a highly nutritional diet to excess, growth and survival will still depend very much on their density, as they interact behaviourally, with larger ones dominating smaller ones. In addition, temperature can affect growth markedly. Yabbies grow slower in winter and faster in summer.

The growth rates of different yabby strains from around Australia varies considerably. The faster growing strains grow over nine times faster than the slower growing strains. The average growth of the WA yabby strain in aquaria is around 0.018 g/day. The fastest growth recorded for the WA yabby strain in ponds during summer is 0.6 g/day.

Probably the best practical measure of growth and survival in a particular dam is the annual total weight of marketable yabbies a farmer can harvest. We know that this quantity varies considerably from dam to dam. Our research has shown that a poor dam may only produce around $60 of yabbies per year, while our best dam produced over $2,000 worth of yabbies in one year. An average dam produces around $600 worth of yabbies per year.

How many times do they have to moult to get to, for example, 50 g?

About 20 times. Yabbies put on up to 50 per cent of their weight at each moult. Small ones moult at weekly or shorter intervals and the interval becomes longer, a month or more, as they get to 50 g, but it only takes them about four moults to get from 10 to 50 g. Slow growth means longer intervals between moults, so if you don't see many freshly moulted (very clean shells) yabbies in your traps, the stock isn't growing much. The reasons could be time of year/water temperature, crowding and/or lack of food.

What stock management methods are there?

The most obvious method is frequent, heavy harvesting to relieve the population pressure. Most farmers probably don't harvest enough. Of course, the effort of frequent harvesting needs to be balanced against diminishing catch. Most farmers harvest dams at monthly to six-weekly intervals. The other harvesting factor is the sizes removed. Although the value of crayfish per kilogram increases with their individual size, markets have been found for yabbies as small as 30 g.

What are the main things I can do to increase the size of my yabbies?

The two major factors limiting growth of yabbies are high densities and not enough feed. The best way to increase production of large yabbies is to lower density by trapping more often and feeding the yabbies more.

What is monosex culture and how does it work?

Monosex culture is hand-sorting yabbies and placing them into dams or ponds that contain either only males or only females. When you separate male and female yabbies, they grow faster than they would if spreadsheet, or to a ruled ledger book with a double page for each numbered dam. Column headings could be: date, number of traps set, times of trap setting and hauling, total catch removed in kilograms, catch for each weight grade category, feed type, feed rate, Secchi depth (turbidity), water colour (muddy or green), water level (see below) and observations (on newly moulted yabbies, female spawners, bugs in the water etc.).

Since dams differ in size, yabby production needs to be related to dam size to compare dams. The easiest measurement of dam size is the nearly square surface area of water. From a front corner, measure the width of water, in metres, as a straight line across the front of the dam and, then at right angles, the length of water down a side, averaging over bends in the shoreline. You only need to measure the maximum surface area once, when the dam is just full. The minimum surface area, at low water, can be measured each year in late autumn.

Water level can be read from a pole driven into the clay bed, as the height of the pole above the water surface; if you measure the corresponding maximum depth of the dam at the centre once, this depth of the dam at any time can be calculated from the water level easily read on the post.

Records kept over a number of years can be analysed for differences between dams, good or bad trends with time and the effects of management practices.

Researchers at Fisheries WA have been using a logbook system to record yabby dam conditions and production for a number of years. A copy of the logbook sheets we have been using is provided at the end of this book (Appendix 1).

What is integrated aquaculture?

Integrated aquaculture is where aquaculture is incorporated with other farming practices. It often results in increased efficient use of resources and decreased production costs by utilising otherwise non-productive resources. Examples found in other countries include hydroponics and fish, fish and warm water effluent from power stations, *Artemia* and salt production. Producing yabbies in farm dams built for watering stock is a very good example of successful integrated aquaculture.

What is polyculture?

Polyculture is farming two or more species in the same water body. Polyculture usually involves farming a couple of fish species, but in a few instances, people farm fish and crustaceans. The principle of polyculture is that the species should eat different foods and not eat each other (predation) or otherwise harm one another, for example, through disease. If these favourable relationships exist, more production can be harvested from a body of water than if only one of the species is farmed there.

Can I stock fish in a yabby dam?

The problem is finding a suitable combination of species. Many fish can't see to feed in muddy water. Some farmers are stocking eastern states Murray-Darling fish (i.e. silver perch *Bidyanus bidyanus*) or native black bream (*Acanthopagrus butcheri*) in their dams. These fish eat small yabbies (which may not be bad where the yabby stock tends to be crowded and stunted), but they can grow to large sizes and eat big yabbies as well. This can be expensive when fish are eating yabbies that are worth $5 - 10 kg.

kept together. Males in monosex culture grow 17 per cent faster than males in mixed-sex populations, and females in monosex culture grow 31 per cent faster than females in mixed sex populations.

This is because in normal mixed sex populations yabbies put a lot of effort into reproducing, but if you separate the males from the females, they divert this energy into growth. The improved growth obtained from this simple stock management technique results in a 70 per cent greater gross value of yabbies produced than from normal mixed sex populations.

I have heard of a new hybrid yabby, what is it?

Scientists in WA have discovered that mating a female yabby from NSW called *Cherax rotundus*, with a male from WA called *Cherax albidus* results in only male progeny. This is a very important breakthrough for farmers, as by growing these male hybrids in their dams, they can control density, as the male hybrids will not reproduce. In addition, as male yabbies grow 68 per cent faster than female yabbies, the hybrids should also result in more large valuable yabbies.

In a recent experiment, we compared the growth rate of the hybrid and *C. albidus* yabbies in our research ponds. The hybrids grew twice as fast as the *C. albidus* yabbies. A large number of farmers already manually sex yabbies to stock their monosex ponds or dams. The farming of this new hybrid will save a great deal of labour and be more reliable than hand-sexing.

OK, this hybrid sounds great, but can farmers use this technology?

Yes, this simple technique is currently being prepared for commercialisation by farmers. The plan is for farmers to obtain stocks of NSW *Cherax rotundus* and WA *Cherax albidus*, then all they have to do is have a couple of dams or ponds that contain no yabbies. The farmers can use these ponds for maintaining their own breeding populations of the two species.

To produce the hybrids, the farmers simply trap some females from their *Cherax rotundus* pond and males from their *Cherax albidus* pond. These animals can then be placed directly into a breeding pond or into a cage in a dam. The yabbies mate in this breeding pond or dam and all the juveniles will be male. They can then be trapped and distributed to growout ponds without having to laboriously hand-sex them.

Is there a chance that my yabbies are inbred?

We have compared the growth of WA yabbies with animals from the ancestral population from Merwyn Swamp. Yabbies from both locations grew at the same rate. Therefore, although the WA yabbies came from a very small gene pool, they do not show any decreased growth due to inbreeding.

I want to keep records of my catches, dam conditions, and so on. Do you have any advice?

The golden rule is to write everything down at the time and not rely on memory. Use a notebook on the dams and later transfer the notes to a PC mincer with a 3 mm die plate attached to form long strands of pellets. Dry the strands of pellets in an oven at 50°C for 24 hours. Remove from oven and break strands into manageable lengths using a grister to produce yabby pellets approximately 3 mm in diameter by 5 mm long.

Black bream and silver perch.

Feed is usually cast by hand in the shallow water while walking around the dam. As a general rule in aquaculture, it is best to feed little and often. Large one-shot feeding tends to cause oxygen depletion as the uneaten feed rots. To make this easier for farmers we have recently used some simple low cost automatic feeders with good results.

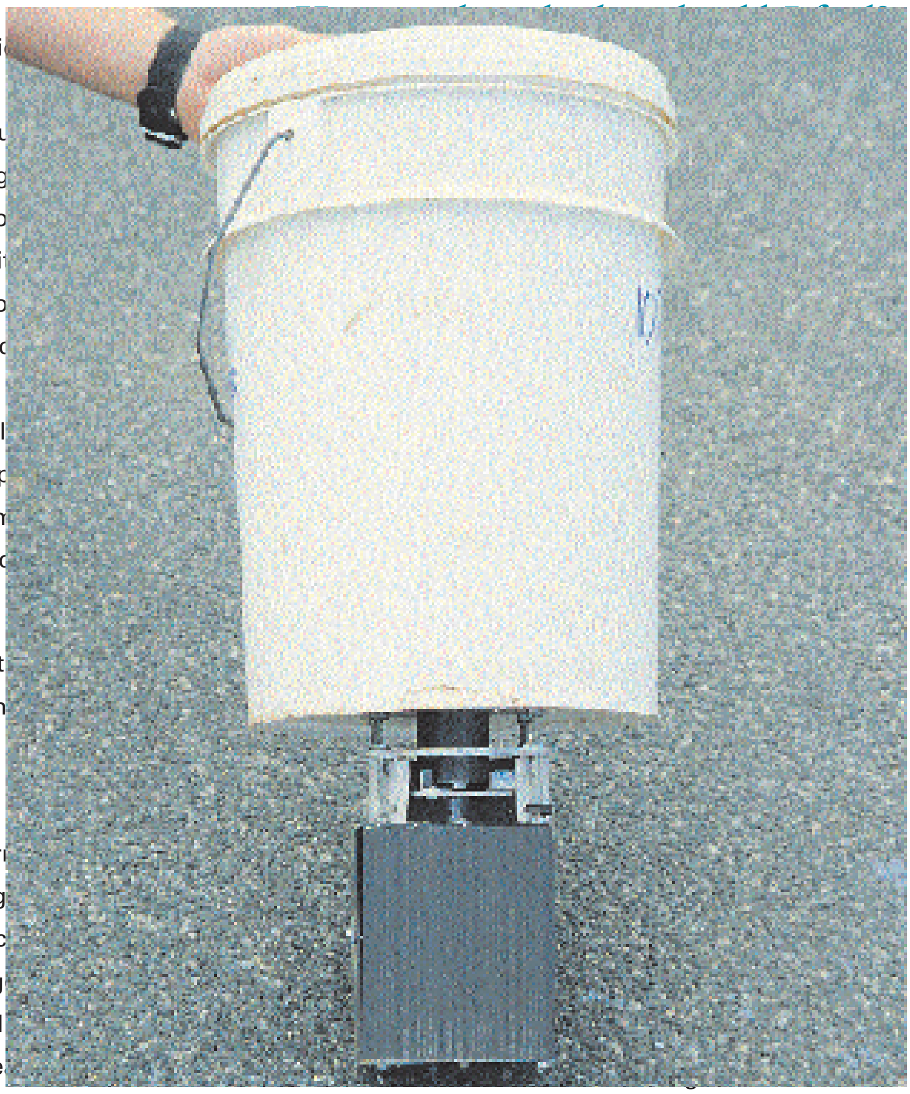
It may be more economical to grow fish in a separate dam and feed them a pelleted diet for around $1.20/kg. Recently, researchers have grown fish in cages within freshwater crayfish ponds.

Feed pellets (left) and lupins (right).

your yabbies, but be careful you don't overfeed!

Do the yabbies get any natural food in dams?

The first winter rains each year provi
food for yabbies in the next growing
The runoff carries crop stubble, pastu
sheep droppings into a dam. This org
outside the dam can often be seen fo
in the corners of a dam. Eventually, i
gradually decomposed by bacteria to
protein-rich feed for crayfish. Organic
produced in a dam, from sunlight
and nutrients by plant growth, usuall
blooms of minute single cells of susp
algae. Various small animals, many m
feed on the algae and detritus, provic
food chains for yabbies.



Automatic feeder.

Our research has shown that this nat
very important as yabbies can obtain
cent of their food from these natural
farm dam without any feeding.

On these natural feeds, the richer far
maintain a total biomass (living weig
of up to 1,500 kg per hectare of surfac
of water. However, most dams averag
400 kg per hectare, without additional
The productivity of dams can be incre

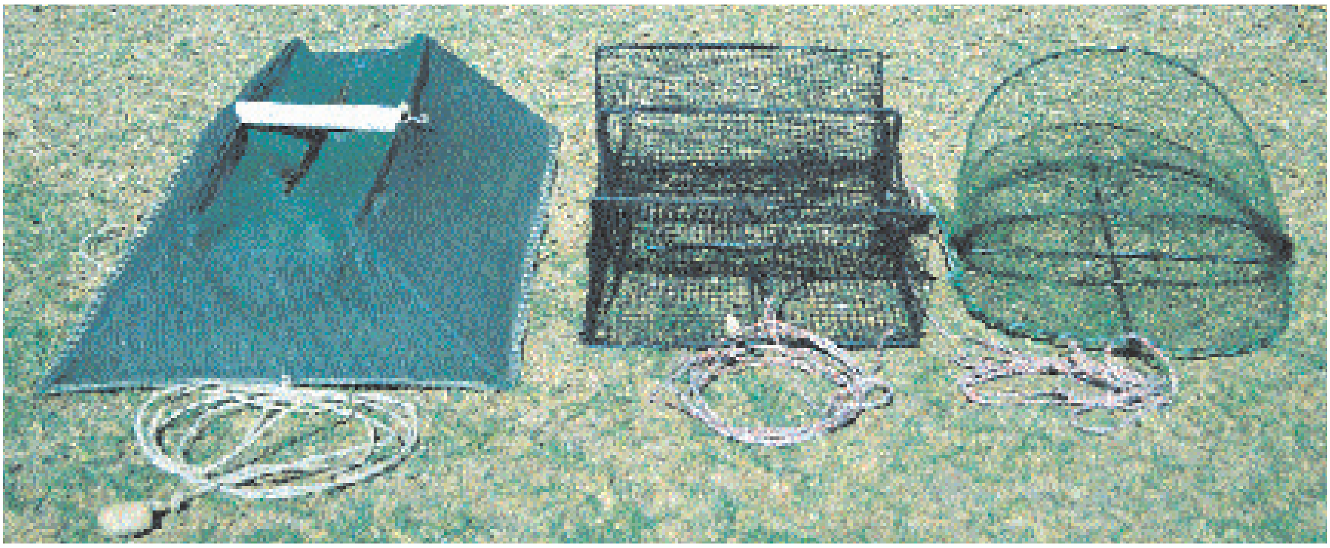
on stands holding the yabbies off the bottom. Bore water is deoxygenated, so aerate the tanks for a while before introducing yabbies. Bore water has the advantage of being sterile, that is, free of bacteria and fouling organisms.

What if I want to purge my yabbies but water is scarce?

If you have no bore water, and scheme water is too expensive to replace each week, then you'll need to re-use water by cleaning it. The main cleaning that needs to be done is on the nitrogen excretion product from yabbies, called ammonia. Ammonia is very toxic in very small concentrations. A re-use system circulates the yabby tank water through a physical filter that removes organic waste particles and an aerobic biological filter (biofilter), containing good bacteria that remove toxic dissolved ammonia. These good bacteria oxidise the ammonia to less toxic nitrite and then nitrate.

Some types of biofilters can also act as physical filters, for example large sandbed filters. However, a large surface area and plenty of oxygen are needed to grow these bacteria. Fine sand can be used but it tends to clog quickly. Instead, more efficient biofilters use rings or complex balls with a high surface area, and water is trickled over these to provide good aeration. Some guidelines for these water reuse systems are:

- Don't use one if you have good bore water.
- The simpler the re-use system, the better (and less costly). There are a number of very expensive, specialised add-ons: carbon filters, ion exchange resins, UV sterilisers, ozone, micron filters.
- Keep excessive amounts of organic matter out of the biofilter by pre-filtering.
- Exclude all natural sunlight, otherwise you'll be battling green water due to algal growth on the accumulating dissolved phosphate and nitrate. Even the best re-use systems need the addition of, at least, 10 per cent fresh water (makeup water) a



Folding Traps

increases with higher water temperature and oxygen levels, trapping during late afternoon is more effective than in the early morning.

How do I separate the marketable sizes from the undersize on the dam bank?

A quick method is to use a grader, which you can make. To make a grader, you need a plastic bin with the bottom cut out, some 25 mm diameter PVC pipe for the gap bars and some threaded rod to put at right angles through the PVC bars, every 200 mm, and the sides of the bin for gap spacing and rigidity. Graders can also be made from plastic trays by cutting gaps lengthways in the bottom.

The gap between the bars is set at the carapace width corresponding to the selected yabby weight, say 30 g (see table on Page 38). Since the weight of yabbies for a given carapace width varies, a grader does not give precise or knife-edge selection. Some of the yabbies retained will be just under 30 g and some that fall through will be just over 30 g. If yabbies lose legs or are dehydrated, they'll weigh less.

To make sure that the grader retains only yabbies that are over a selected weight, add a millimetre to the following true carapace width values:

weight (g)	carapace width (millimetres)	grader gap (millimetres)
20	18.2	19.2
30	21.2	22.2
40	23.5	24.5
50	25.5	26.5

Most of the underweight yabbies will fall through the grader bars easily, but those close to the selection weight need to be put on their backs in a gap.

For packing for market, processors prefer to put yabbies into grades more precisely by weighing each yabby on an electronic balance.

What does gill-washing mean and why should I bother?

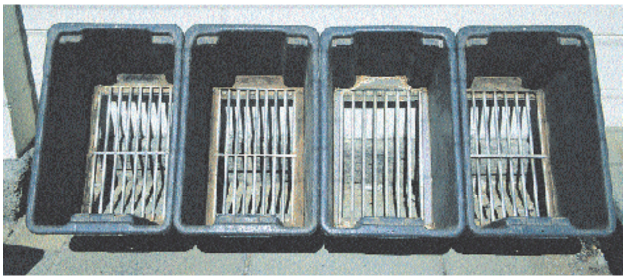
This is one of the most crucial steps in yabby farming. When you haul a trap it disturbs the bottom, stirring up the black, oxygen deficient (anaerobic) mud, so the yabbies in the trap are pulled through this bacterial-laden water. As the trap is pulled out of the water, the yabbies in it stop pumping water through their gill chambers and close the chambers at the bottom to stop the water running out. As a result, their gills are surrounded by bacterial-laden water. If you keep the yabbies out of water for some time, they become infected internally by bacteria. Over the next few days, the bacteria multiply in the yabbies, no matter how clean their subsequent tank holding conditions (purging tanks) may be, and then the yabbies die.

The remedy is to have a small tank or large bucket on the bank with some clean dam water from an undisturbed part of the dam and put the yabbies into it immediately when the trap is hauled. The yabbies then open their gill chambers and pump clean water over their gills. This essential practice is known as gill washing.

What type of trap and bait do most farmers use?

Most farmers use one of several variations of commercially available folding traps of much the same design. We'll keep out of the argument about which brand is best, but we have found that top-entry traps catch more yabbies than traditional side entry traps. Traps are rather expensive ($30 - 40 each) but robust. Being hand-made, they are built for a long life with rough use. Bait is generally dog cubes, sometimes with pieces of pilchards (mulies). Pilchards are the most effective bait we have tested so far.

Some companies are now producing artificial rock lobster baits that may also be useful for catching yabbies. Recently a substance called Betaine has been tested and was found to attract yabbies. For this reason, we have used it in our yabby diet (Fisheries WA FRDC Yabby Diet No.2) and anticipate in the future that it may also be included in specially formulated baits for yabby traps.



Graders.

Are traps a good method for catching yabbies?

Traps are a very efficient method of catching yabbies, but they are selective. Traps tend to catch more males than females, with berried females less likely to enter traps. Over a period of time, this can have a negative effect upon the gene pool of yabbies in your dam. If farmers remove the largest fastest-growing yabbies and return the smaller stunted yabbies, they are favouring genetic selection of slower-growing yabbies.

Furthermore, as traps remove more males than females, trapping can result in a skewed sex distribution of yabbies in the dam with many more females than males. This increase in the proportion of females results in an increase in the number of

Gill washing yabbies.

juveniles produced and population density, with a corresponding decrease in growth.

One method to avoid this is to manage your yabby stock as you manage other livestock on your farm. We recommend that when you pull your traps, remove small animals, particularly small females, and send these to market, while also regularly returning some larger stud animals to breed. Alternatively, the smaller yabbies can be moved to a heavily trapped dam that has few yabbies.

Why can't I use a Swan River prawn drag net?

This method is not used by the yabby farming industry. It stirs up the bottom sediment in the dam greatly (see section on gill washing) and is not recommended for commercial producers. Drag netting catches and damages yabbies that have just moulted or are about to moult, and these have little chance of surviving. Consequently, drag netting is a bad harvesting method during the growing season, particularly when dams are low.

My catches vary a lot from month to month and dam to dam; why?

Sock.

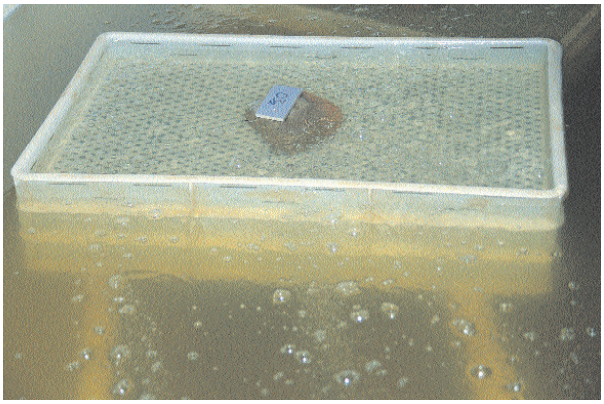
Foam box for moving yabbies.

The proportion of yabbies in a dam that you'll catch on any occasion (called catchability) depends on many factors: the number of yabbies present, type of bait, type of traps, number of traps, water temperature, oxygen level, light (water turbidity), recent feeding, moult stage, sex, spawning stage of females and the size of yabbies. In the past, many farmers have thought that they couldn't catch yabbies during winter. A recent experiment at our research station has shown that it is possible to trap yabbies all year round. This may vary from region to region according to water temperatures, but try it next winter as yabbies are in short supply in the market during the cooler months of the year.

How many traps should I use in a dam and where should I place them?

Place about one trap every 10 m of bank at a maximum, which is 15 in a full (spring) 2,000 cubic yard dam and 10 at low water in autumn. Most farmers use fewer than these numbers of traps in a dam. During summer, as the water level recedes, traps should be set close to the bank to avoid the oxygen-depleted, deeper water. Since catchability

How do I store catches until I've got enough for a trip to sell them?



Purging tank.

For the unlicensed farmer who delivers to a depot or processing shed operated by a licensed farmer or processor, the industry has developed a dam sock to store yabbies between deliveries. A sock is a flat bag of shade cloth, and some are floated at the dam surface by a rectangular frame of PVC pipe to keep yabbies away from the poorly oxygenated dam sediments. Oxygen is high at the surface and, with a loosely moored sock, some wind-driven movement of the bag circulates water through it.

To ensure that your yabbies have sufficient oxygen, you should never hold yabbies in sugar, wheat or other close woven mesh bags in a dam, particularly lying on the bottom, even in shallow water. Never store or transport yabbies in water in a bucket. If all you've got is bags, it's better to store yabbies out of water. Keep the bags damp and out of the sun, and protect them from any drying wind (hot or cold).

Experienced farmers and harvesters use foam boxes or eskies, often with ice packs in hot weather, to move yabbies. Water or air temperatures over 36°C kill yabbies and they are stressed increasingly by temperatures over 28°C. Large rapid changes in temperature, up or down, can kill them too. When out of the water, they must be kept in a moist atmosphere. Crustacea don't have wax in their shells like insects and can dry out rapidly by evaporation in a dry breeze. Even more importantly, their gills must not be allowed to dry out. For crayfish to be able to breathe in air, some water must be kept around their gills. Gills that dry out are permanently damaged, and damaged yabbies suffocate when they are put back into water, since water contains only a small amount of oxygen (compared with air).

What about holding and purging tanks?

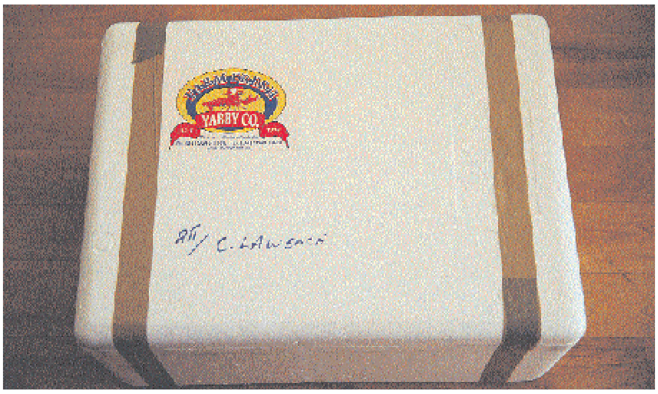
If you intend to direct market yabbies, then you'll need to build a packing shed with holding-purging tanks and have a licence. The tanks should be well shaded from sunlight by a tin roof rather than shade cloth. Sunlight encourages growth of algae (green water) and yabbies are stressed by strong light.

A major problem is the quality of the water supply. If you have a supply of bore water that does not contain iron (but it can be, beneficially, somewhat brackish), use it. Simply refill tanks with fresh bore water between weekly batches of yabbies. You don't need to pump (circulate) the water through filters, but the tanks should be well aerated by an air blower (large volume, low pressure), under crates

- Keep all metal fittings out of a re-use system. Copper and zinc (brass) dissolve in the water (worst in acid water below pH 7.3) and are very toxic to crustacea. This rule also applies to algae control blocks (copper sulphate used in stock drinking troughs), if you have green water in your tanks.
- Do not use any domestic insecticides anywhere in the shed (such as fly sprays or cockroach baits). Insecticides are extremely toxic in tiny amounts to crustacea as well as insects.
  Be careful of sprays as they may drift.

How do I transport yabbies to market?

Purged yabbies (and marron) are usually packed as a particular weight range or grade category in a polystyrene (foam) carton with layering material and a cold pack. Successful shipment overseas is now routine for experienced exporters, though some improvements in materials and cost savings may be possible. Crayfish lose weight in air, so some allowance must be made in packing.
The yabby code of practice provides additional information on packing and transporting yabbies (see Recommended Reading).



Packed box of yabbies.

My dam is full of tadpoles, what can I do?

Tadpoles are the offspring of frogs and are found in nearly every fresh water body in early spring and are gone again by late summer to early winter when they turn into frogs. In most natural situations, they do not cause any problems. However, when they get into yabby dams or ponds, in large numbers, they will compete with the yabbies for food. When this happens, with large numbers of tadpoles, it causes a problem as the yabbies miss out on their food. Consequently, they will probably not grow as well, along with experiencing other food depletion problems.

Below is a diagram of how to build a tadpole trap that will help reduce the number of tadpoles in yabby ponds. Please note that the trap will not eradicate the tadpoles, it will only assist in reducing their numbers.

Tadpoles need to have air to breathe as they do not have gills. The tadpole swims up the funnel shape to eat the pellets and then continues up to the surface to get air. After breathing they will try to swim back down into deeper water at an angle and then get caught in the trap. (Note: the tadpoles can still return to the surface and breathe while in the trap). Once the tadpoles have been trapped they can be removed from the pond and relocated, therefore allowing the yabbies to obtain the full benefit of the food they are being fed.

For the best results the trap should be set with the top just above the surface of the pond, to ensure that the tadpoles do not swim over the top of the trap and escape back into the pond.

To catch the tadpoles use marron, trout or chook pellets as bait placed into the bait basket to attract them.

I washed my hands in a yabby dam after dipping the sheep. The next day, we found that the yabbies had walked out and died. Is there any connection?

Since crustacea (crayfish) are the same group of animals (Arthropods) as insects, any insect poison like sheep dip is very deadly for them. Phosphorous -based and synthetic pyrethroid (sheep dip) poisons are biodegradable within a day or so, but fresh from the tin are extremely toxic in very small amounts to crayfish.

We've done research on using sheep dip (esfenvalerate) to clear a dam of a crowded, stunted yabby stock to properly restock it. This |has shown that a single application at 1 µg/L completely eradicated the yabby population in a pond (there are 1000µg in a mg). The acutely toxic conditions in the pond were temporary, lasting between 5 - 12 days. Small yabbies introduced to the pond 49 days post treatment showed good growth, with some animals reaching greater than 50 g within five months. Esfenvalerate has recently been registered for the purpose of eradicating yabbies in WA. However, farmers should contact their local Fisheries office as regulations vary between states.

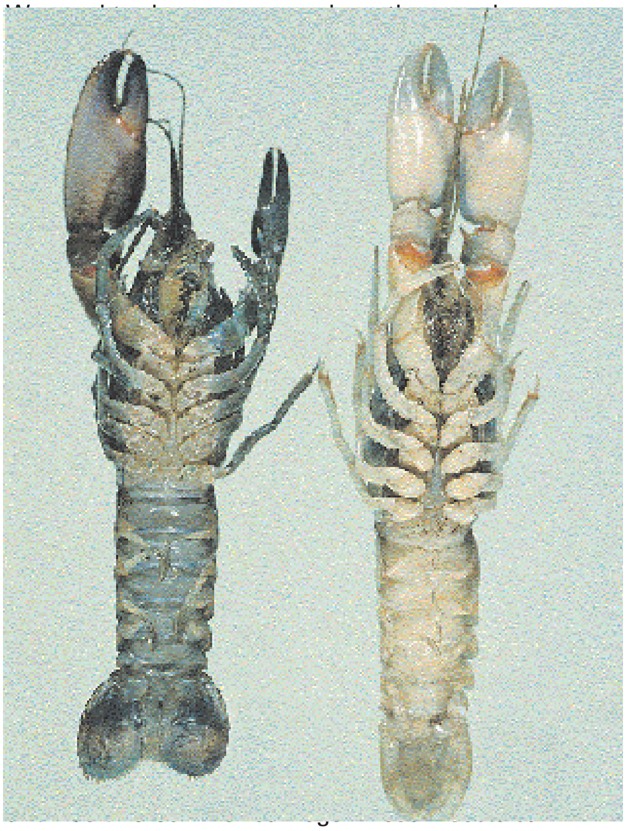
as regulations vary between states.

How do I tell if my yabbies have Thelohania?

It is often difficult to tell if a yabby is infected by *Thelohania* as the tiny spores can be present in the muscle of the crayfish and can only be detected by a microscopic examination. In advanced infections, the tail muscle of the yabby turns white and takes on a cooked appearance, which is why the disease is often called porcelain disease. It should be noted, however, that there are a number of other afflictions of crayfish that cause the muscle to turn white and confirmation of the presence of *Thelohania* must be undertaken in a laboratory by a qualified fish health expert.

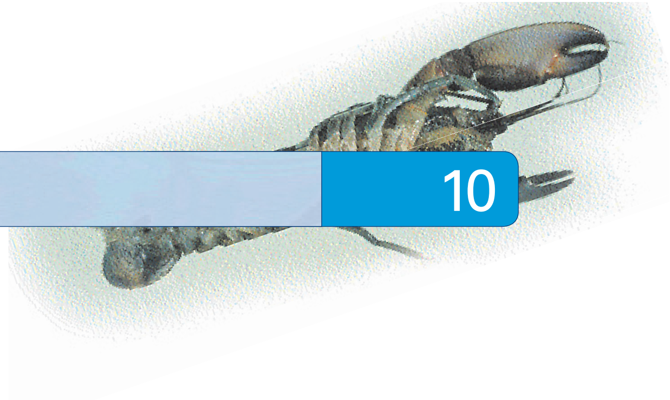
My yabbies have tiny crawling, leech-like animals and pinhead-size eggs under their tails. What are these?

These are called temnos (temnocephalids) by farmers and occur naturally on all crayfish. They are not a disease organism, but what is called an ectocommensal. They feed on the bacteria and algae (epiphytes) growing on the crayfish shell, so they tend to be a symptom of a slow-growing stock and larger crayfish (which don't cast of their shells frequently) and rich, clearer water conditions.



Healthy *Infected with Thelohania*

be seen darting very quickly back and forth to the surface of the dam in shallow water to breath air.



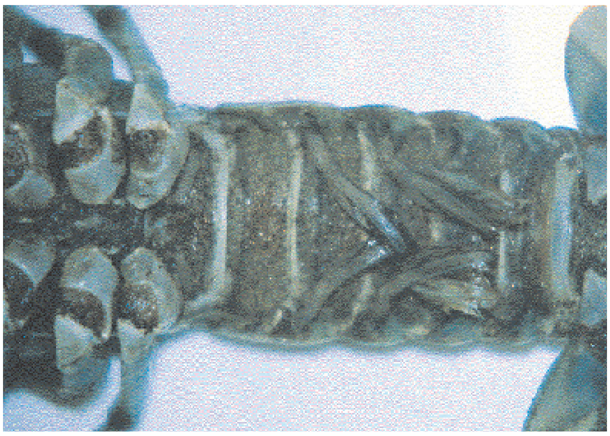
What can I do to ensure that I protect native fish species?

To protect native fish and crayfish, farmers should never allow introduced yabbies to escape into natural water ways. In particular, farmers should never release any surplus yabbies they may produce into local waters. This is particularly important in WA where the 'yabby line' exists to protect the native marron populations in the south west of the state.

Will yabby burrows damage my dam?

We have had no reports of any farm dams in WA being compromised by yabby burrows. However, overseas countries have expressed concern that yabby burrows may damage dams, rice paddies or canals. We recently completed a survey of yabby burrows in WA, and our results showed that the average burrow length was 25.8 cm. The maximum distance a burrow penetrated directly into a dam was 64.5 cm, while the longest burrow recorded was 148 cm.

The majority of burrows (64 per cent) had only



Temnocephalids.

one entrance to a simple tunnel (mean width 6.4 cm) leading to a terminal cavern (mean width 12.5 cm). Channels and large dams tended to have longer (22 - 40 cm) and more complex burrows than small dams or ponds (8 - 21 cm).

The burrows were generally much shorter than those described in published reports for crawfish (*Procambarus clarkii*) and in anecdotal reports for *C. destructor*, the commonly farmed yabby from south-eastern and central Australia.

The burrowing habits of yabbies vary between locations, but appear to be influenced by sex ratio and feed availability. While the water chemistry results were inconclusive, it is possible that burrowing is prompted by increasing ionic concentration due to evaporation. This could provide a signal of impending drought to crayfish and promote burrowing.

Are there any environmental issues I should be aware of?

Corixid.

Farming yabbies in dams requires relatively little input of nutrients as most of their food comes from natural runoff from the surrounding catchment.

Nonetheless, farmers should not discharge waters from farm dams into local creek systems. Dams are naturally flushed during heavy winter rains, which fortunately dilute nutrient outflow when this occurs.

If yc

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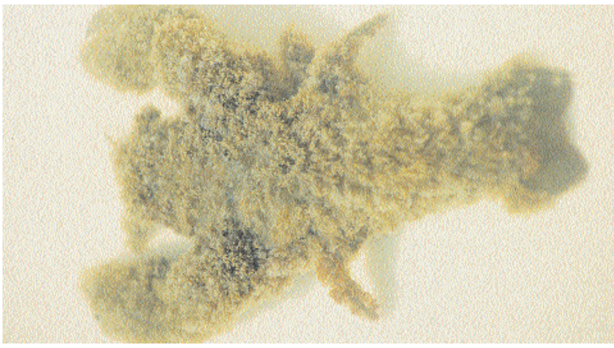
well

Scud. (amphipod)



Epistylis growing on the shell of a yabby.

I've heard that there is a disease that could kill yabbies. How do I prevent my yabbies from catching it ?

Epistylis organisms as they appear under the microscope.

Yabbies can be affected by a muscle-wasting disease (*Thelohania*) that is caused by a microscopic parasite. The disease is widespread in eastern states yabbies, but the original stock of yabbies introduced to WA were thought to be free of *Thelohania* (this is a good reason for no one being foolish enough to smuggle in yabbies or other crayfish from the east or, much worse, from overseas where there are much worse diseases that could destroy our export markets and potentially the whole industry).

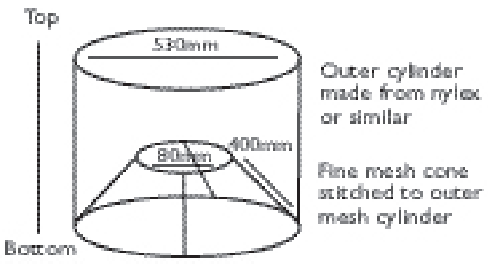
Segmented blood worm.

gin

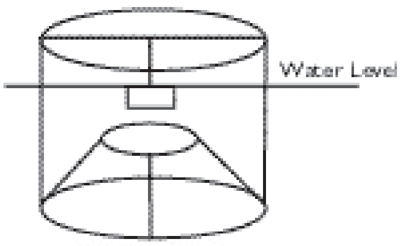
that the disease was introduced by a farmer bringing in yabbies from the eastern states and then spreading the diseased animals around to other properties. This is a good reason not to bring in any yabbies to your farm unless you know they are free of disease.

In WA, it is possible that *Thelohania*-free stocks of yabbies may be found north of Great Eastern Highway and at the Fisheries WA research facility at Avondale. Because of this, yabbies in WA cannot be shifted from south of the Great Eastern Highway to dams north of that highway. A zoning system has been established in WA to control the spread of *Thelohania* (Thorne, 1995). Esfenvalerate has recently been registered for the purpose of eradicating yabbies with Thelohania in WA. However, farmers should contact their local Fisheries WA office

Large numbers of these insects mean that a dam is highly organically polluted with very little oxygen, even in shallow water (summer floods are a common cause, but overfeeding can cause this condition, too).



Tadpole trap dimensions



Tadpole trap with bait basket

The corixids lay eggs on any stationary object (such as a stick) or slow moving crayfish. Marron are badly affected in polluted dams, but we've had no reports for yabbies, which are less slowed down by low oxygen. Large numbers of corixids are a good indication of a dam which is too rich in decomposing organic matter and microscopic algae.

On the other hand, a good indication of a dam with well-oxygenated shallow water is the presence of a small crustacean called a scud (amphipod). These get their oxygen from the water, not the air. Sometimes, scuds are mistaken for baby yabbies. When taken out of the water and placed on your hand, yabbies can crawl upright while scuds have curved, side-flattened bodies and lie or spin helplessly on their sides.

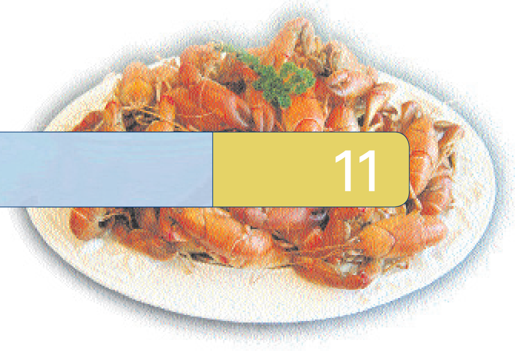
My crayfish are covered in fur. What is this?

The fur is one of a number of microscopic colonial protozoans (stalked peritrichs, usually *Epistylis*). This organism is symptomatic of dam conditions described above for corixids and again is usually found on a few surviving yabbies suffering in a polluted dam.

I can see a lot of small red worms near the edge of my dam. What are they?

These 'segmented blood' worms are the aquatic larvae of an insect and eventually hatch into a fly, the non-biting midge (chironimid). The red colour is an oxygen carrying blood pigment, since these larvae live on organic matter in the mud under stagnant water where oxygen is very low. Many larvae can be seen after pollution from a summer rain. Otherwise, they indicate over feeding. However, they are a good natural source of food for yabbies.

Glossary



AERATION Mixing air and water to facilitate the transfer of oxygen into the water.

ALGAL BLOOMS A rapid increase in unicellular algae.

ALLOCHTHONOUS Originating from outside a system, such as paddock run-off, or the leaves of a tree that fall into a dam.

ANAEROBIC Oxygen is very low or absent from the environment.

ARTHROPODS Phylum of segmented animals, frequently with a hard protective skin or cuticle; typically with jointed appendages.

BERRIED Egg-carrying, usually refers to crayfish which are carrying eggs beneath their tails.

BIRAMOUS Two branched or two jointed, usually refers to appendages e.g. swimmerets, chelipeds.

BRANCHIAE Gills or organs for breathing in water.

BRANCHIAL Pertaining to gills or Branchiae.

BRANCHIOSTEGITES The expanded sides of the carapace which form the gill cover.

CARAPACE The hard upper shell of a crustacean.

CEPHALOTHORAX The body region created by the joining of thoracic segments with the head in some arthropods, especially crustaceans.

CHELIPEDS Claw-bearing jointed appendage.

CHIRONOMID Non-biting midges which inhabit permanent and temporary, fresh and saline waters in larval form. They are especially abundant in nutrient enriched waters.

COLLOIDAL Particles, often clay, that can stay suspended in water indefinitely because they are small and negatively charged.

CORIXID Aquatic invertebrate commonly known as water boatmen, often present in large numbers in nutrient-enriched water bodies.

DETRITUS Broken-down organic and inorganic matter that has settled on the bottom of a dam or pond.

ECDYSIS The shedding of the exoskeleton in crustaceans.

ECTOCOMMENSAL An organism that lives on the outside of another organism (the host) but is not deleterious to the health of the host.

ENDOPODITE The inner (medial) branch of a crustacean appendage.

EPIBIONTS Organisms, usually fungal, living on the surface of plants or animals.

EPIPHYTES Plants which live on the surface of other plants and animals but are not parasitic.

EPISTYLIS A microscopic protozoan on fine stalks 5 -10 mm long and visible as an off-white to brown cotton wool fuzz on the shell.

EUTROPHICATION Nutrient enrichment of a body of water.

EXOPODITE The outer (lateral) branch of a crustacean appendage.

FRDC Fisheries Research and Development Corporation.

GASTROLITHS Small, white, hard, calcium deposits generally located within the stomach wall. They are the place where crustaceans store calcium before moulting. The size is dependent upon the moult stage of the animal.

GLAIR A clear-white cement produced by female crayfish which attaches newly extruded fertilised eggs to the pleopods underneath their abdomen.

HEPATOPANCREAS Midgut-gland. Organ found in decapods that releases digestive enzymes.

MANDIBLES Mouthparts and third appendages of crustacea which crush and chew food externally.

MAXILLAE Jaws which are a paired appendage that forms part of the mouthpart complex.

MAXILLIPEDS The paired appendages (or mouthparts) immediately behind the maxillae (jaws).

MONOSEX Culturing males and females in separate ponds in order to avoid uncontrolled reproduction.

OTOLITHS Small bones of the inner ear. The growth rings of the otoliths are used to determine the age of fish.

OXIDISING To combine or cause to combine with oxygen.

PAPILLAE A small nipple-shaped projection.

PHOTOSYNTHESIS (oxygenic) The process by which green plants convert light energy into chemical energy to synthesise carbohydrates from carbon dioxide and water, with the release of oxygen.

PLEOPODS An abdominal appendage or swimming leg of crustaceans.

PLEURA Gills attached to the lateral body wall above some appendages.

POIKILOTHERMS Animals that are unable to control their body temperature, that is cold-blooded animals.

POLYCULTURE The culture of a number of types of organisms in the same water body.

SCAPHOGNAPHITE Plate-like appendage in the branchial chamber which circulates water forward through the gills.

SECCHI DISC A disc 30 cm in diameter painted black and white in alternate quadrants and used to measure the turbidity of water.

SETAE Small, hair-like spines on the surface or appendages of an animal.

SOMITE Each body division of a crustacean.

SPERMATOPHORE A packet or capsule enclosing spermatozoa that is extruded by the male and deposited between the female's fifth walking legs during mating.

STERNUM Ventral, transverse bar of cuticular material between segmental appendages.

STRATIFICATION Layering, often used to refer to the layers of water formed with different temperatures and/or differing salinities.

TELSON The last central segment in the tail of crustaceans.

TEMNOCEPHALIDS An ectocommensal Platyhelminth (flat worm) often found on freshwater crustacea.

TERGUM Upper, cuticular plate covering somites that are not enclosed by the carapace.

THERMOCLINE The layer of water between the epilimnion and the hypolimnion; the layer where there is a great change in temperature per unit of depth.

TURBIDITY A cloudy condition of water, usually caused by particles such as clay, phytoplankton, bacteria or impurities, which limits the penetration of light.

UROPODS Extension of last abdominal somite either side of the telson.

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Additional useful sources of information are:

Yabby Code of Practice, Video and book available from: Simon Bennison, ACWA. PO Box 55, Mt Hawthorn, WA 6016

Australian Crayfish Aquaculture e-group

http://www.egroups.com/subscribe/AustralianCrayfishAquaculture

Fisheries WA web site (http://www.wa.gov.au/westfish/)

Aquaculturalists in WA can borrow items from the Fisheries WA library at Waterman, or through their local libraries. Visits to the Fisheries WA library can be arranged by appointment (08) 9246 8444.

YABBY FARM DAM CONDITIONS LOG BOOK – FISHERIES WA

Dam code	
Dam name	
Latitude	
Longitude	
Position in catchment	
Catchment size	
Maximum dam depth	
Dam length	

Photo ref
Water Sample
Mud sample
Benthos sample
Invertebrate trawl
Specimens collected
Silt trap present
Clay colour

VARIABLE PARAMETERS

Date						
Current dam depth						
Turbidity (Secchi disc reading)						
Salinity						
Bank height						
Wind direction						
Catchment use						
Water colour						
Temperature (ambient/water)						
Dissolved oxygen						

FISHERIES W.A. - YABBY FARM DAM PRODUCTION LOG BOOK

NAME ______________________

Please note the portion of yabbies returned to dam (as seconds or juveniles), or added from other dams, in each size category.

			kg. yabbies caught in each size class									
Dam	Harvest Date	Harvest techniques	less than 20g	20g-30g	30-40g	40-50g	50-60g	60-100g	100g+	Amount of food added (kg.)	Date feed was added	Type of feed/comments (ie good or bad harvest, water quality etc.)
		yabbies caught										
		kg. yabbies returned										
		kg. yabbies caught										
		kg. yabbies returned										
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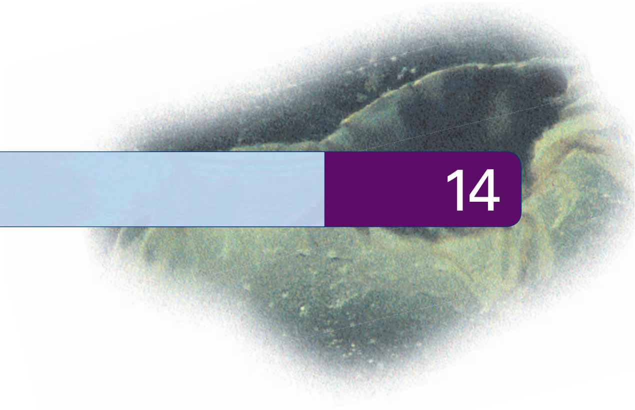

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