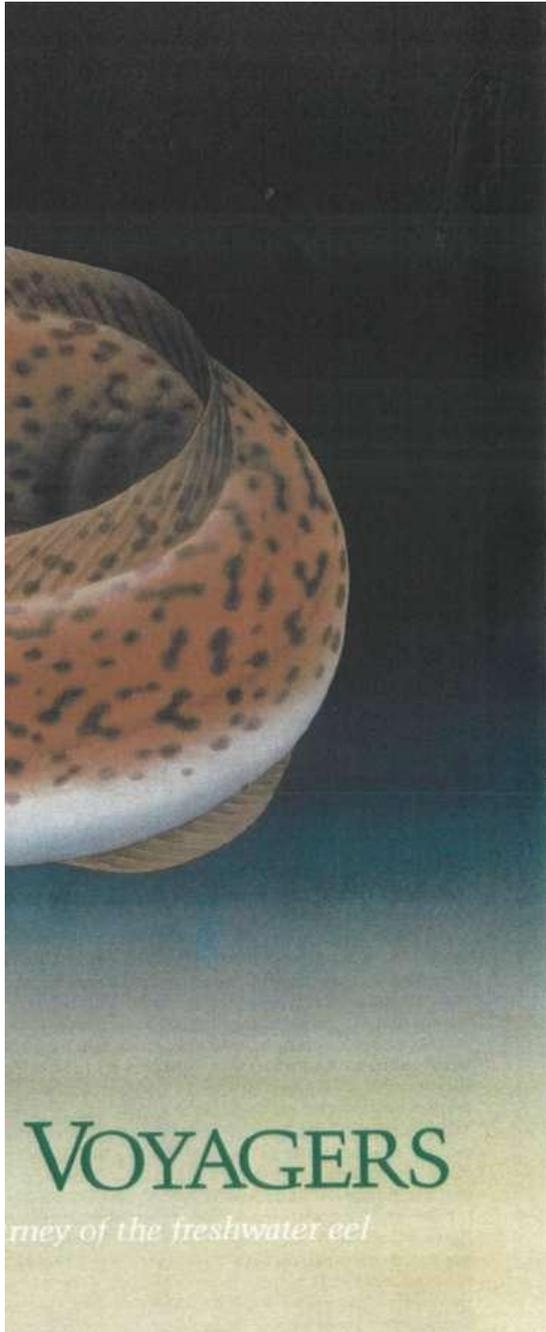


# Incredible Voyagers

TEXT BY ANDY PARK ILLUSTRATIONS BY ROD SCOTT

WARRAGAMBA DAM, 70 kilometres west of Sydney, is the imposing structure you would expect, considering it was built to contain much of that city's water supply. Ninety metres thick at the base and 110 m high, this concrete monolith should be the end of the line for any fish moving upstream, particularly one averaging a mere 12 centimetres in length.



But the mighty walls of Warragamba Dam are merely another obstacle for a creature with one of the most extraordinary migratory journeys in nature - the freshwater eel. Beyond the walls these young eels grow into adults in the placid waters of Lake Burratorang, having swum more than 4000 km after hatching in spawning grounds believed to be off Vanuatu. And when they have grown to maturity, they tumble over the spillway to begin the tortuous journey downstream to return to their spawning grounds.

When I read of this strange phenomenon I considered eels for the first time in 25 years, having successfully driven them from my mind. They are not pretty and my first encounter with one was not pleasant.

I was walking with my father in Melbourne's Royal Botanic Gardens when he handed me a crust of bread and suggested in his matter-of-fact way that I feed the eels. I took the bread and knelt at the edge of the pond. For a long time nothing happened. Suddenly, the green water swirled beneath my hand and a huge slimy snout appeared, followed by beady little eyes. I recoiled in horror, dropping the bread, and the slimy green-brown monster seized the crust and disappeared into the murk.

"But they'll take it right out of your hand," my father said.

Eels are like that. The word genteel has nothing to do with them. And yet here they were scaling this Everest for eels at Warragamba at the end of the most remarkable journey imaginable. Having blocked the slimy things from my mind for so long, I decided, belatedly, to investigate the case for the defence.

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At Warragamba Dam, Alan Varlow, the chief guide and unofficial monitor of eel migrations, showed me the intricate detour the baby eels (properly known as elvers) use to reach the safety of Lake Burragorang. We traced the route from the mouth of an old stream bed about 100 m downstream from the stilling pool, up the rock-strewn slope of the Warragamba River chasm, through dense bush to a box drain, then under an access road to a drainage ditch. But at the end of the ditch was a two metre cement wall, then a traffic roundabout!

I was slack-jawed and Mr Varlow sensed my disbelief.

"Seriously," he said, laughing, "with a good rain the elvers climb the wet walls and cross the roundabout. After that it's all downhill to the lake. See that grate?" He pointed to a metal drain in the middle of the bitumen roundabout.

"If they slide down there, it's straight back to the stilling pool."

I studied the innocuous grate, just 50 m from the safety of the lake, and thought this must be the cruellest game of snakes and ladders ever conceived.

### **Mystery of Migration**

THOSE tenacious elvers (infant eels) wriggling around Warragamba Dam are driven by a migratory instinct which is part of one of the most obscure life cycles in nature. In fact the definitive studies of eel biology were conducted only 80 years ago by Johannes Schmidt of Copenhagen's Carlsberg Laboratory, who began studying eels as a valuable commercial food resource. Schmidt's investigations eventually brought him to Australasia in the 1920s where he began to unravel the mysteries of eel migration in the Southern Hemisphere.

Two types of freshwater eels are found in Australia: short-finned and long-finned. Most of the elvers at Warragamba grow into the latter. Longfins range over the entire east coast of Australia, from the tip of Cape York south to Tasmania and west to the Tarwin River in Victoria. The three species of shortfins are distributed throughout separate areas of Australia: the first is limited to the north-west coast, the second to the north-east coast and the third to the south-east coast and Tasmania.

Longfins are big - 20 kg in weight and two metres long is not unheard of - while the shortfins average only 2 kg. Both are quite edible but the convenient size and attractive colouring of the shortfins give them the commercial advantage.

The seaward migration of eels begins with the massing of mature adults in their freshwater habitats which can vary from large water-catchment areas like Lake Burragorang or the Gippsland Lakes, to ponds, lagoons or even waterholes.

Alan Varlow recalled the huge congregation of eels in Lake Burragorang in March and April 1984: "I saw a few around the dam gates in mid-March, but by April there were hundreds of giant eels - most of them nudging two metres long - just swimming back and forth. I've been watching since 1964 and they mass like this every three years."

These eels were mature and ready to begin the migration, but because of low water, the gates weren't opened until August by which time many of the eels had returned to their home territories in different parts of the lake.

"When the gates finally opened," Mr Varlow continued, "the local eels swam into the current, turned upstream and slipped through the gates tail-first. I watched them tumble down the spillway into the stilling pool. You know, in all those years of watching them, I've only ever seen three hurt by the fall."

In this way, tail-first over the abyss (the dam spillway), the eels begin a journey which will take months or years to complete. By the time they reach the lower estuaries their colour fades and they become silver eels, but little is known of their fate once they enter the ocean.

It is the depth of the open ocean which confounds scientists in their attempts to understand eel migration. Silver eels are only rarely caught at sea, usually by fishing trawlers trying to catch something else. These isolated catches have confirmed the eels are approaching spawning condition, but trawlers mostly are confined to the Continental Shelf - once the silver eels enter deep ocean they disappear completely. Scientists only know eels have spawned at all because eel larvae, called leptocephali, are occasionally netted as they drift back to the mainland in ocean currents or are discovered in the stomachs of predatory fish.

Until more research is undertaken the mystery will remain, but it is not difficult to see why Australia has been reluctant to become involved. What Dr Sloane describes as "basic larval work" would be quite an undertaking. Trawlers would ply (travel) the East Australian Current collecting constant samples of plankton which sometime contain eel larvae. In addition, larger fish would have to be taken and their stomachs examined for signs of eel larvae. The transparent leptocephali are almost jelly-like in substance so the presence of remains shows they were caught by the fish just hours before.

The trawlers would move slowly against the current and, presumably, would catch smaller and smaller larvae as they approached the Coral Sea, eventually collecting sufficient samples to pinpoint the spawning grounds.

If eels were big business in Australia this research would already be completed, but our commercial eel fishing contributes less than one per cent to the world catch. To put this amount into perspective, Des Harrington, of the Arthur Rylah Institute for Environmental Research in Victoria, gave an example: "There was a recent study of a cormorant rookery in Holland. The number (of eels) the birds took in a year was equivalent to the annual Australian catch!"

Little eel research is being conducted in Australia at present, but the Tasmanian Inland Fisheries Commission is encouraging its eel industry and commercial prospects have begun to improve.

### **Eel Farming**

I was surprised to learn, considering the increasingly cosmopolitan nature of Australia's population, that eating eels is not more popular here. In Europe and Asia, eels have great economic importance and in New Zealand there is a thriving export market, but only a few eel-processing companies operate in Australia.

Eels Pty Ltd in Skipton, Victoria, is our largest single exporter of eels. Small eels are caught and transferred to local water-catchment areas where they grow to market size in about five years.

"Most eels are frozen and shipped to Germany," the company's marketing director, Alan Kaufmann, explained. "The rest are either smoked or live-shipped to Hong Kong. Live eels are cooled to two to three degrees centigrade and packed in damp, oxygen-charged boxes. They leave the plant at 9 a.m. and are on Hong Kong restaurant tables in time for dinner."

At present, eels cannot be hatchery-raised, as is so common with trout. While egg and sperm production can be artificially induced with hormones, and these can be successfully combined in the laboratory to produce fertile eggs, the larvae die within five days of hatching. This mortality is due to an unsuitable environment, but because so little is known about the larvae's natural, deep sea nursery, efforts to provide correct laboratory conditions are ineffective or too expensive.

But progress is being made in some areas. The Japanese have developed a highly successful technique for the intensive culture of their native freshwater eel which is similar to the Australian shortfin, but slightly smaller. Other countries notably Taiwan, Britain and Italy, are using similar techniques, but Japan leads the field. Japanese workers begin with glass eels, the second stage of the eel growth cycle after larvae. (Glass eels are transparent. Skin, skeleton and organs are all present, yet you can see right through.)

They are trapped in marine estuaries and transferred to concrete-lined, freshwater holding ponds at the eel farm. After a few days' quarantine the glass eels are moved to other holding ponds where they develop into brown elvers. At this stage they are placed into one-eighth hectare, mud-lined maturing ponds complete with heating and aeration systems, where they grow to market size.

Why not trap brown elvers to begin with? I asked Dr John Beumer, fisheries biologist for Queensland's Department of Primary Industries.

"Disease control," Dr Beumer answered. "Brown elvers already have freshwater parasites, but any saltwater parasites the glass eels have will be killed by the sudden change to fresh water - while the eels easily adapt. Disease is a major concern in intensive culture and this is a simple, inexpensive way of introducing disease-free stock."

But eel farming is not a 'get-rich-quick' scheme. Establishment costs are high, and even with every precaution, disease can spell ruin. Moreover, supplies of glass eels or brown elvers, required every year as culture stock, can be very difficult to obtain.

The technology of eel farming is very new, but of course silver eels have swarmed down rivers toward the sea for eons and man's efforts to catch them date back thousands of years. Certainly, early Aborigines had regular spring banquets, catching their prey in traps woven of cumbungi (bulrushes), by spearing, or even by hand. In Lake Condah in south-western Victoria, the local tribes built a complicated system of channels, weirs and traps for migrating eels.

Eels have always fascinated people. They were idolised by the Egyptians, pampered by the Romans, ineptly studied by the Greeks and fricasseed by almost everyone else. Eels just soldier on, from salt water to fresh water and back again, surmounting incredible physical obstacles to fulfil their role in nature.

Infant eels on their way to Lake Burragorang – which is the water storage behind the dam

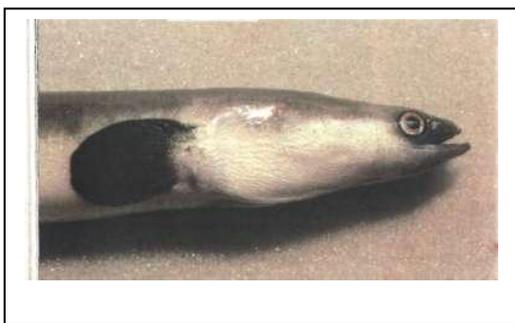


**Above:** Like a river of black spaghetti, brown elvers mass in preparation for the next stage of the journey.  
For centuries these mass migrations have been called 'eel fares' which gave rise to the word 'elvers'.

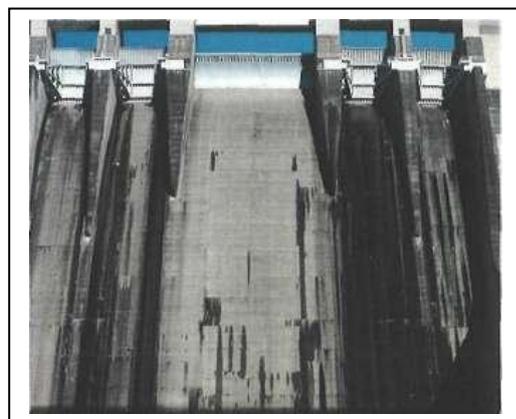


**Above:** Glass eels caught at the beginning of their freshwater upstream migration. It is a mystery how creatures with hearts, backbones, stomachs and livers can be so transparent (see-through), but it is a short-lived state

Mature female eels are ready to spawn in the ocean begin their journey by sliding tail-first down the spillway (not spilled since 1998)

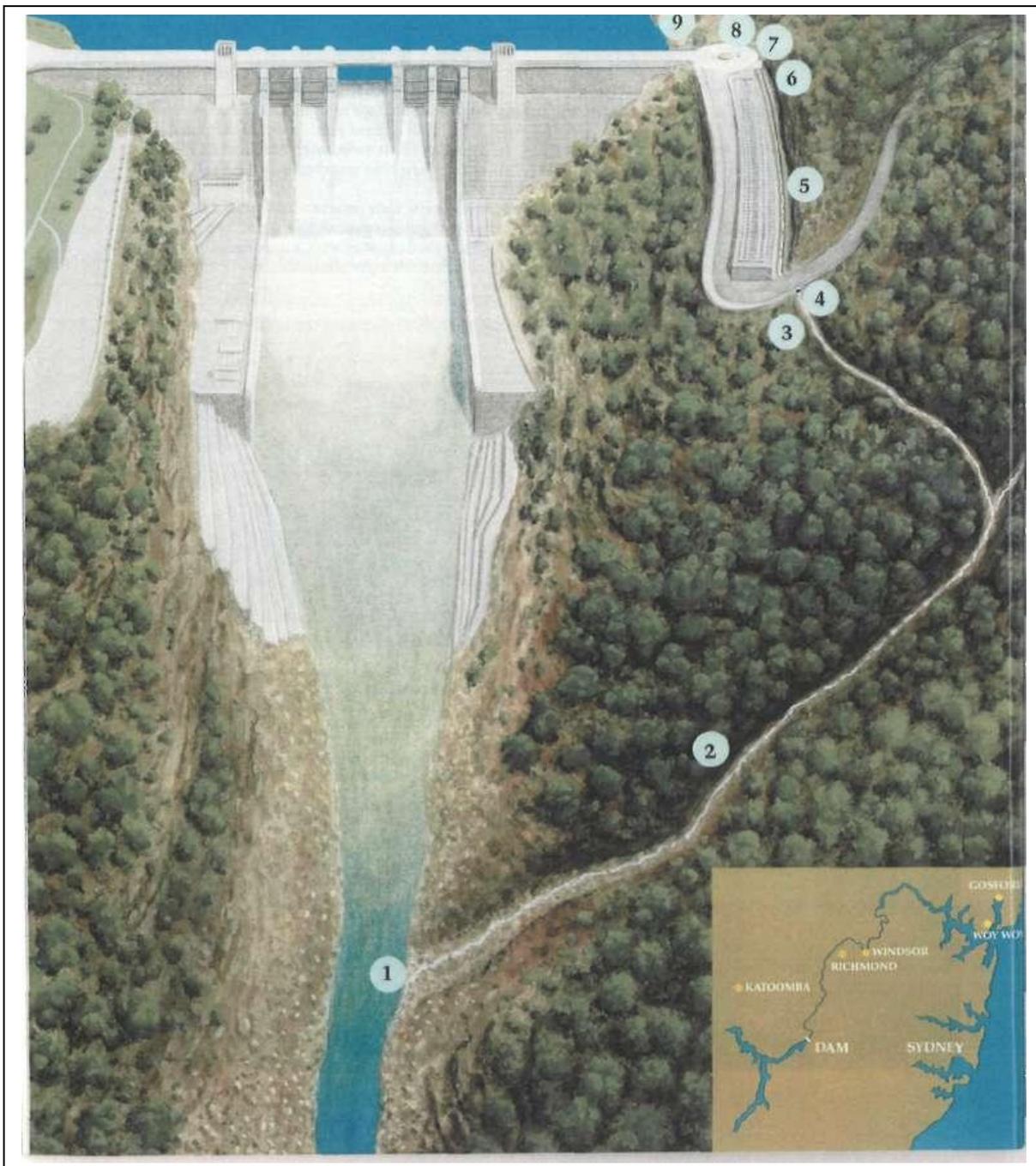


A mature silver (female) eel with the enlarged eyes typical of a migrating eel approaching spawning condition.



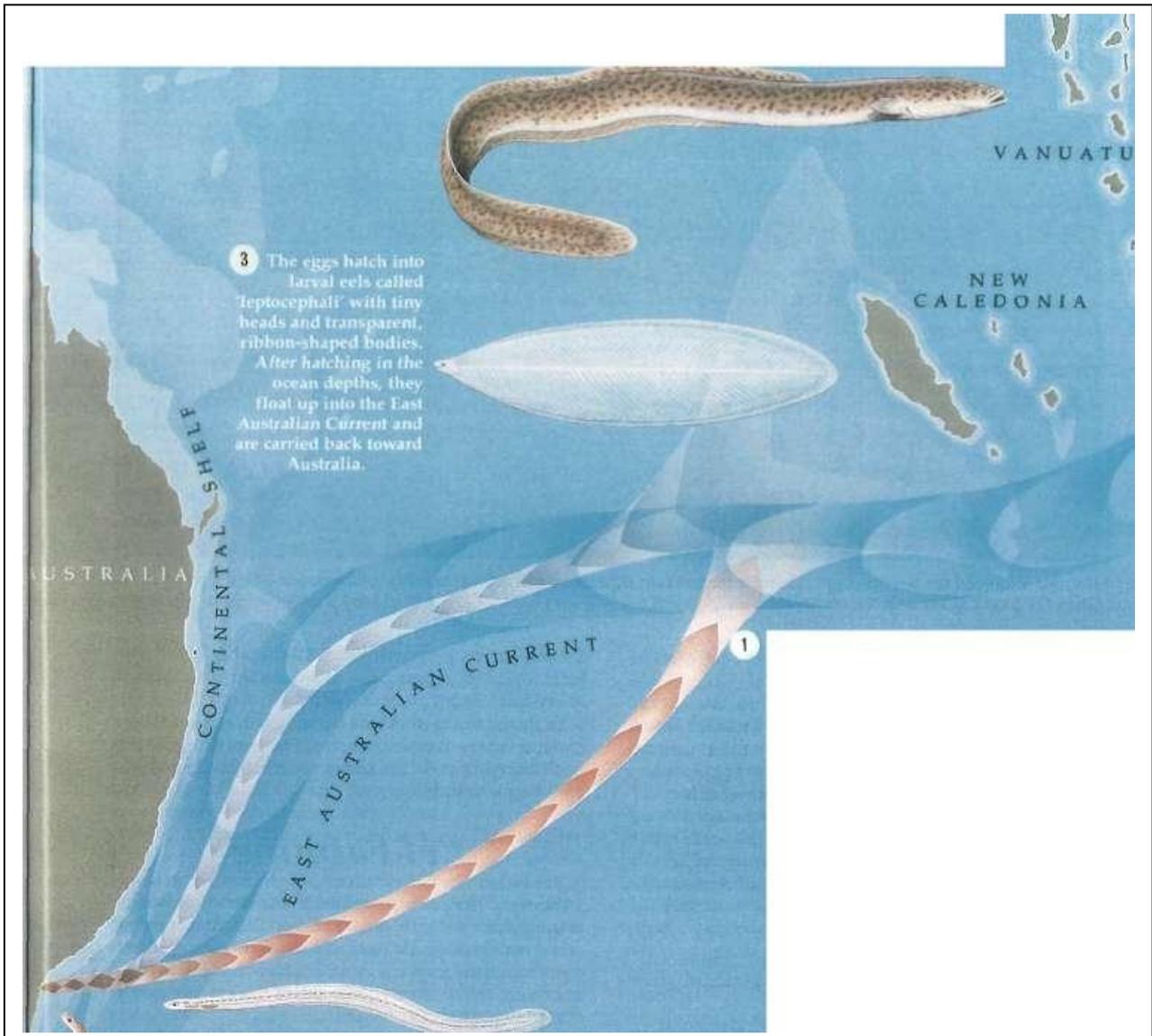
Mature female eels are ready to spawn in the ocean begin their journey by sliding tail-first down the spillway (Warragamba Dam has not spilled since 1998-the female eels are waiting)

The detour around the dam for the infants (elvers) on their way from the ocean



Elvers cannot climb the face of the dam. If they try, they are quickly eaten by birds such as hungry cormorants or herons.

- (1) About 300m downstream from the spillway, a small stream joins the Warragamba River
- (2) At this point the elvers begin their detour, wriggling their way up the rocky stream-bed for some 300 m and climbing about 90 m to the top
- (3) where there is a drain
- (4) leading to a ditch
- (5) the ditch runs about 100 m beside a rail-line leading to the road crossing the dam.

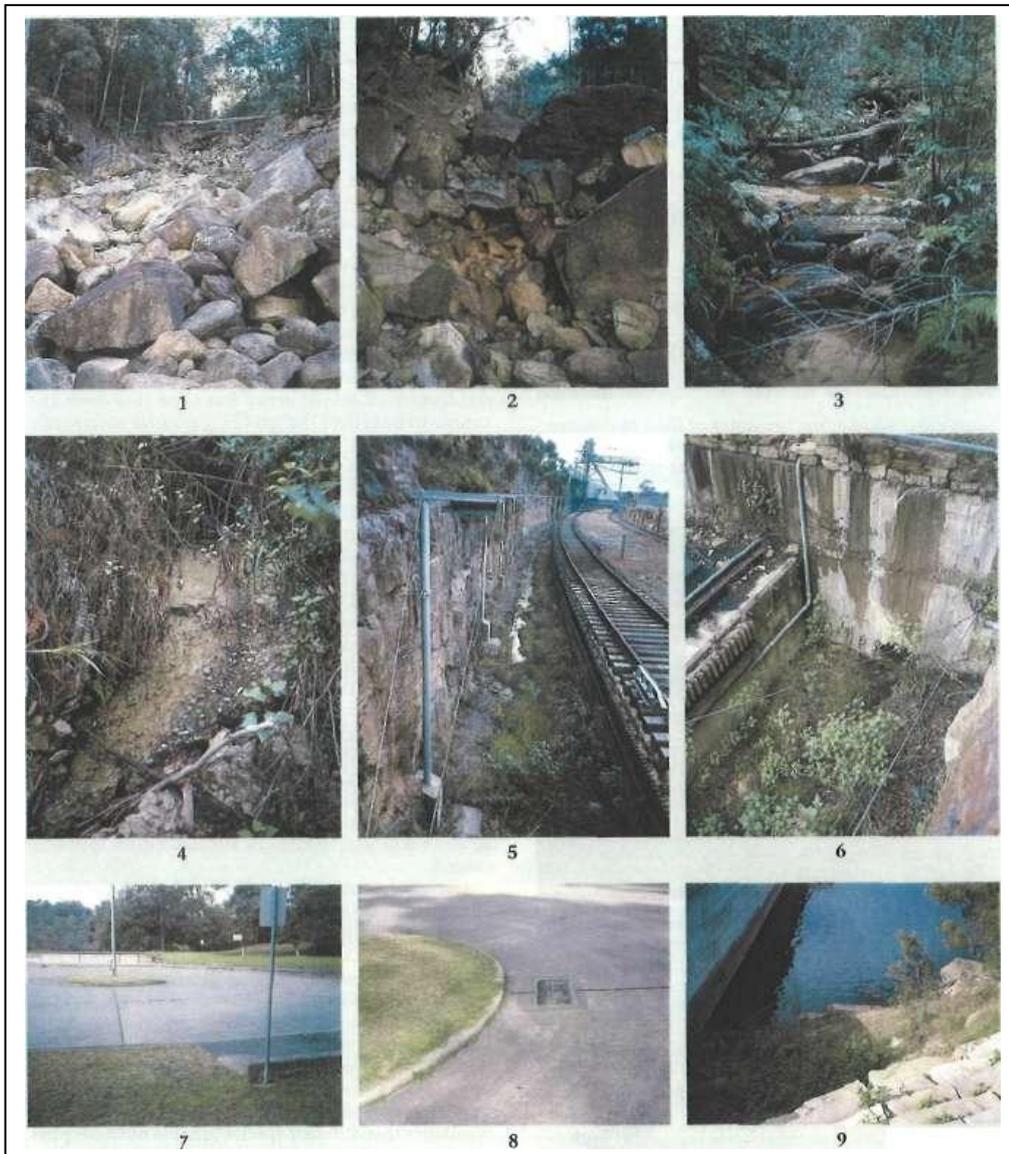


The East Australian Current (**think of the movie Nemo**) takes the larvae to the edge of the Continental Shelf.

Here, they metamorphose (change) into tiny glass eels with fully developed skeletons and organs, but are totally transparent. The glass eels slowly swim toward the coast where they enter an estuary system. As they head upstream they adapt to fresh water and develop the dark brown pigmentation of eelers.

It is estimated that the return journey takes one to three years.

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**(THERE IS NOW A PIPE SO THE EELS DO NOT HAVE TO CROSS THE ROAD AND CLIMB UP THE WALL AS SHOWN IN PICTURES 6, 7 AND 8)**

(6), the road is some 2 m lower than the level of the road, so the elvers must wait for heavy rains to wet the walls, then climb) two vertical cement walls (7) cross the traffic roundabout at the end of the dam road AND, (8), avoid the grate

**<they still do this>>** (9) slither to safety another 50 m downhill to Lake Burragorang.

The detour is almost half a kilometre long and in that distance the elvers climb almost 120 m.