

Eulo springs super-group

The Eulo springs super-group is a group of Great Artesian Basin (GAB) springs formed in and around the Eulo township in south-western Queensland. The springs have very high conservation value as they contain specialised plants and animals that are found only in GAB springs and nowhere else in the world. Springs continue to perform an important role as a permanent water source in this semi-arid region, for plants and animals, Traditional Owners and graziers.



Eulo springs super-group is habitat for specialised plants like the spring milfoil that only grow in GAB springs.



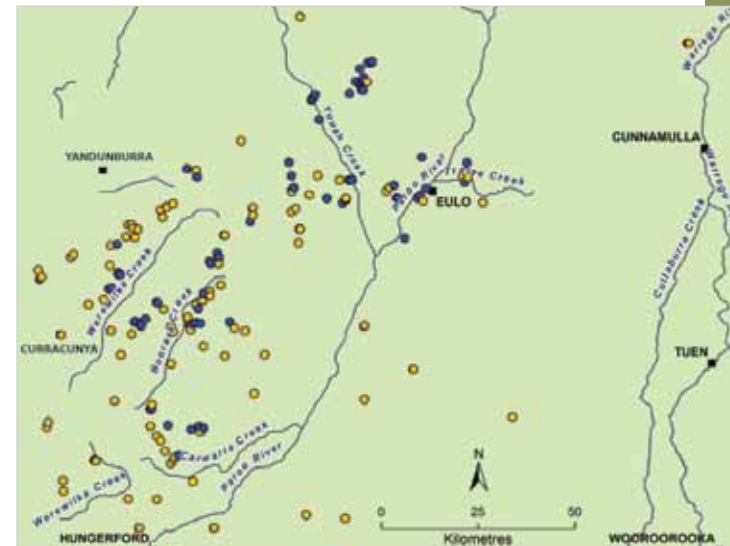
White mineral deposits are evidence artesian water has flowed over or reached the surface.



Mound spring in the Eulo springs super-group



Open water spring in Currawinya National Park, within the Eulo springs super-group.



About this case study:

This case study was created by the DERM Aquatic Ecosystem Health Science Integration and Capacity Building Team as part of the Queensland Wetlands Program.

The purpose of this conceptual modelling case study is to synthesise and present information on the values of and threats to the Eulo springs super-group.

Map of the Eulo springs super-group

Blue circles indicate active springs, yellow circles indicate inactive springs.

The Great Artesian Basin

The Great Artesian Basin underlies approximately one-fifth of the Australian continent (over 1.7 million km²), from Cape York in the north to Dubbo in the south and Oodnadatta in the west. Its impressive size and volume make it one of the largest artesian groundwater basins in the world. Most water enters the GAB where sandstone formations are exposed or buried beneath porous sand sheets on the northern and eastern margins of the Basin (generally located on the western slopes of the Great Dividing Range) where rainfall is high. Some recharge may occur in the western margins of the GAB when desert channels occasionally fill with floodwater. Upon entering the GAB the water is confined and pressurised in an underground layer of porous and permeable material (generally sandstone).



Location of the Great Artesian Basin spring super-groups



This is an inactive mound spring that has collapsed in on itself, revealing its internal structure. The white soil shows where groundwater has flowed.

Springs, spring-complexes and super-groups?

A spring is a discrete, groundwater-fed wetland that may be fed by multiple vents.

A spring-complex is a group of springs, all within a consistent landscape setting, usually with less than 6 km distance between neighboring springs; however the total area of the complex may extend much further. The GAB spring-complexes are concentrated into broad, regional clusters that have some consistent hydrogeological characteristics: these are the super-groups (see adjacent map).

Spring-complexes and super-groups can contain both active and inactive springs. In fact the complexity of the aquifer and overlying geology are such that an active spring may lie only a few metres away from an inactive one.

What is artesian water?

Artesian water is groundwater that flows to the surface.

Springs over time



Springs often form close to each other. These features pictured are potentially new mound springs forming at Currawinya National Park, near the series of inactive mound springs shown below.



This mound spring is now inactive, eroding and collapsing in on itself. The water collected in the middle is run-off from recent rains, not spring water.

Spring formation in the Great Artesian Basin

What are springs and how do they form?

Springs occur where groundwater is able to reach the surface:

- in recharge areas where the GAB sandstone is exposed at the ground surface, rainfall entering the outcropping formations may overflow as springs, particularly in low-lying areas;
- where the water-bearing sediments (the sandstone aquifer) approach the surface near the margins of the GAB;
- where water flows from the buried aquifers up to the surface, through faults or unconformities in the overlying sediments;
- where a conduit is provided at the contact surface between the aquifer and the outcropping of rock (e.g. granite).

In many instances springs occur as a result of combinations of these factors.

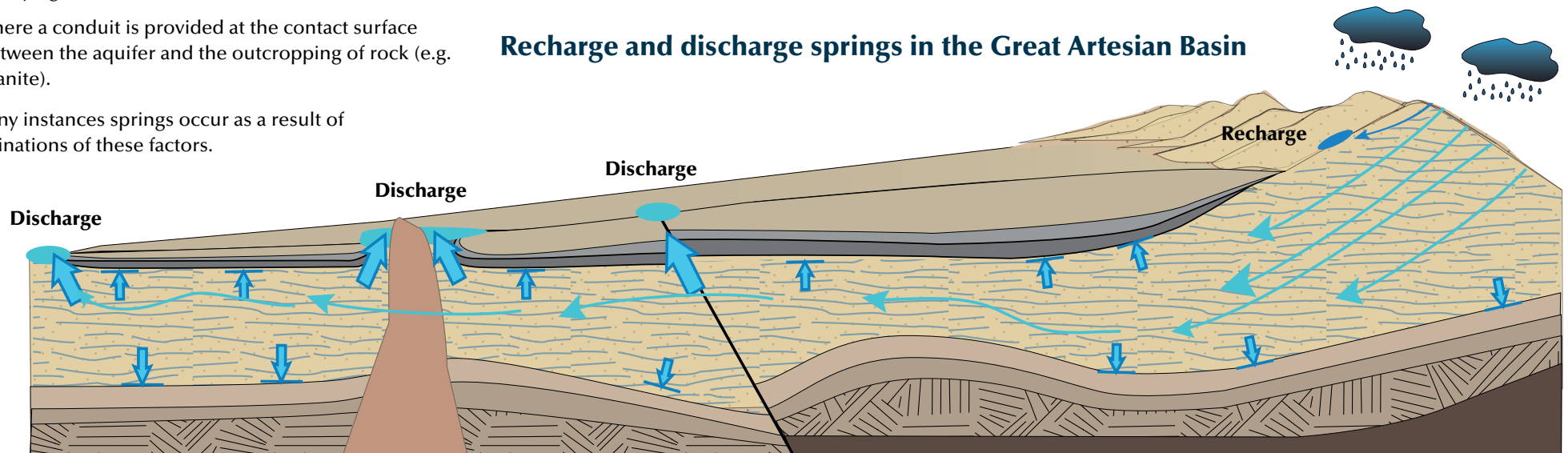


Some discharge springs, such as Massy Springs, form around rocky outcrops that provide a conduit for pressurised GAB water to flow.



Other discharge springs, like Jubilee Springs, are formed by pressurised artesian water reaching the surface through a thin confining layer or a fault line.

Recharge and discharge springs in the Great Artesian Basin



Rainfall



Artesian water



Outcrop



Aquifer



Confining layers (Aquiclude)



Artesian water is pressurised in the confined aquifer.



Artesian water flows through the Great Artesian Basin aquifer and may remain underground for millions of years.

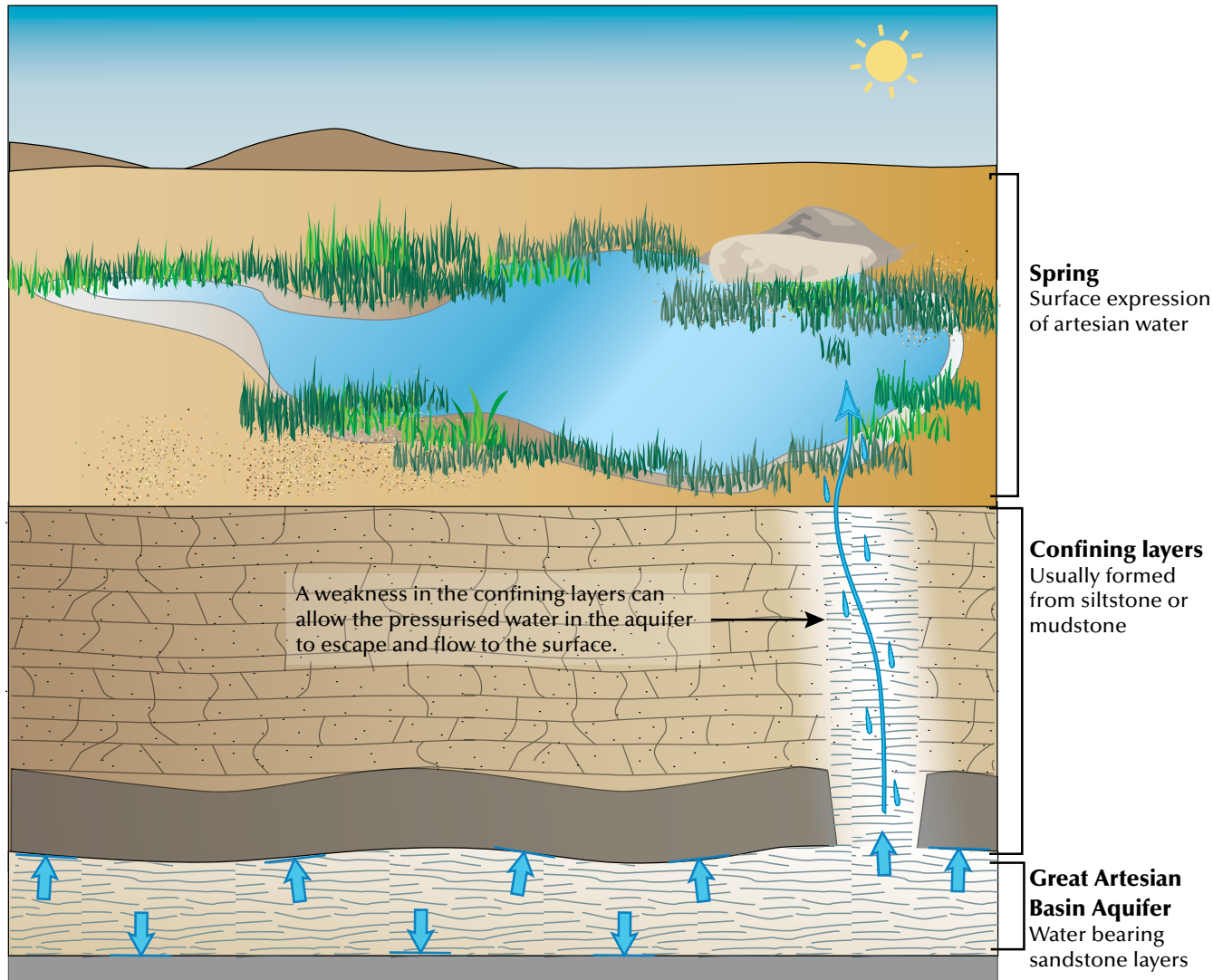


Discharge springs occur where artesian water under pressure is able to be released at the surface. This may occur a significant distance away from where water enters the aquifer. More information about the range of ways in which this can happen can be found on page 5.



Recharge springs occur close to where rainfall enters the aquifer, in lower-lying areas where water is still percolating downwards.

Anatomy of a spring



This is a generalised model, showing just one aquifer, in many parts of the basin there are several aquifer layers, created during different time periods and overlaying each other.

Springs – surface expressions

Springs in the GAB including the Eulo springs super-group are formed by a range of underground geological and hydrological processes. Upon reaching the surface, these underground features combine with surface features (eg. topography, evaporation rate) and a spectrum of springs result. Mound springs (sometimes referred to as mud springs) may form, or the spring may be an open pool of free water in a depression. The spring water may join a stream or river, and/or may feed a vegetated swamp (palustrine). There are examples of all of these 'surface expressions of groundwater' within the Eulo springs super-group.

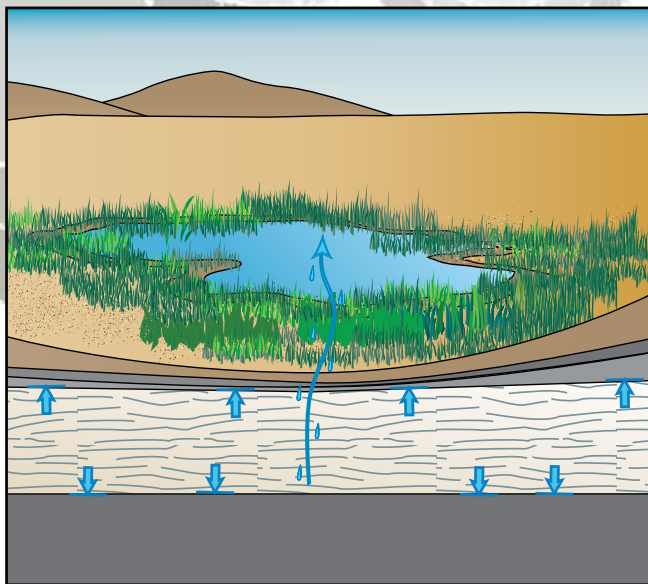


Springs diversity in the Eulo super-group:
A. Open pool of free water
B. Mound (mud) spring
C. Vegetated spring

Water flow

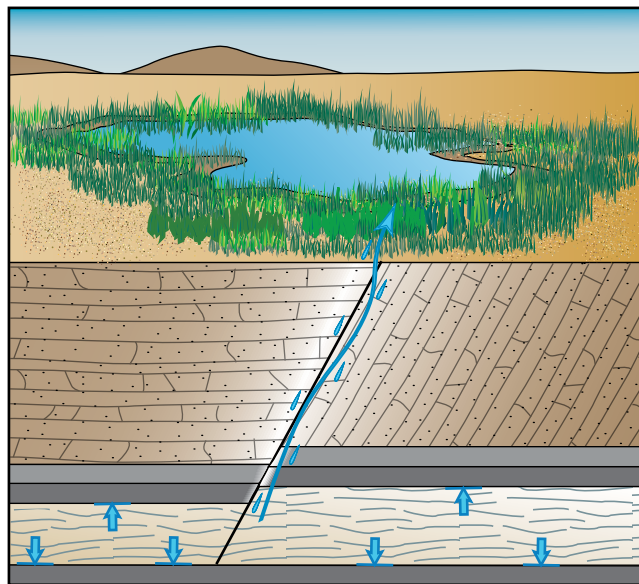
Water flow is usually regular and gentle. Spring water levels vary naturally with groundwater pressure, differences in hydraulic conductivities, opening or closing of sub-surface fractures, atmospheric pressure, sedimentation, seasonal evaporation rates, vegetation presence and type and possibly lunar cycles. A range of man-made changes and impacts to spring wetlands and the GAB aquifer also affect water flow.

Underground causes of discharge spring flow in the Great Artesian Basin



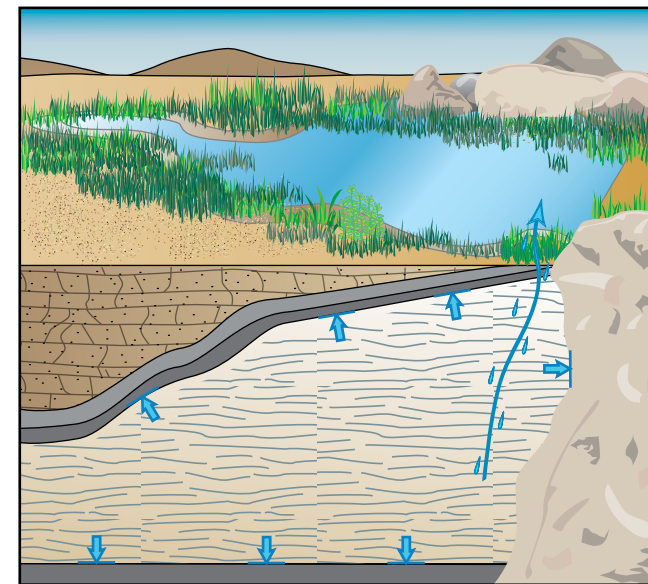
Pressurised water breaking through thin confining layers

In the Eulo springs super-group there are areas where the artesian water can break through the relatively thin and fine-grained confining layers of the overlaying sediments that lie above water-bearing aquifer sediments. This cause of spring formation is more common at the margins of the Great Artesian Basin.



Faults where pressurised water can flow upwards

A fault line through the layers of rock above the aquifer creates a passageway for water to travel upwards if pressure in the aquifer is sufficiently high. This is a common cause of spring formation in the GAB and is a common cause of the mound and vegetated springs in the Eulo springs super-group.



Abutment of aquifers against an outcrop

In some places water-bearing aquifer sediments were laid down around erosion-resistant volcanic outcrops that had formed earlier. Confining layers have subsequently formed over the aquifer; the outcrops provide an interruption to these overbearing layers where the pressurised water in the aquifer is able to reach the surface. Some examples of granite outcrop springs in the Eulo spring super-group are 'The Granites' at Currawinya National Park and the springs at Tarko.

Artesian water is 'fossil water'

Artesian water can take millions of years to travel from the recharge areas to where it is discharged. Artesian water chemistry is different to rainwater and surface water due to this immense aging process and the long-term exposure to the high pressure and high temperature conditions within the aquifer layers.

Mound springs

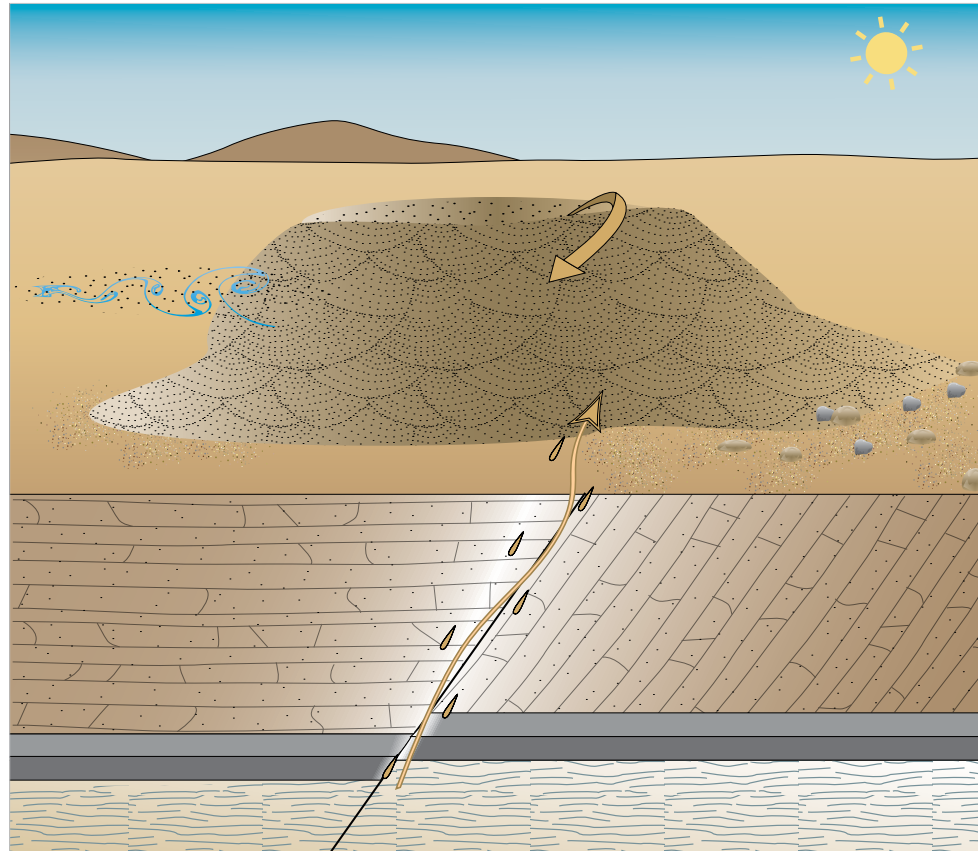
Though mound springs (sometimes called mud springs) are considered to be very rare in Queensland, the Eulo region is famous for its mound springs and they are more common in this super-group than in any other area in Queensland.

A range of processes can also be involved in mound spring development, including:

- the accretion of calcium carbonate as travertine
- the accumulation of wind-blown sand and other particles sticking to the muddy surface
- the swelling of surface clays due to the presence of water
- through the development of peat.

However, the mound springs in the Eulo region are composed of mineral-rich clay-mud that has been slowly transported to the surface by the pressurised artesian water from the sandstone aquifer. Most are roughly conical in shape and some have artesian water pools in and around them, which indicates they are still active. Another indicator that groundwater is still flowing is a 'wobbly' mud surface, particularly in the centre of the cone. The mound springs do not usually support vegetation.

There have been recordings of mound springs reaching 6 m high. There have also been records of pressure within some mounds building up to the extent that they occasionally (and surprisingly!) burst into life and emit mud.



Mound spring formation



Artesian water carries a mineral-rich clay-mud slurry to surface



Particles of sand and dirt carried in the wind can stick onto moist surfaces of mound springs, aiding their growth



Mud accumulates, hardens and forms a mound around and over the spring water source

Please note: mound springs can form over a range of underground formations, not just fault lines, as depicted here.



Examples of mound springs in the Eulo region (above and below)



Eulo's mound springs provide a popular point of interest for tourists



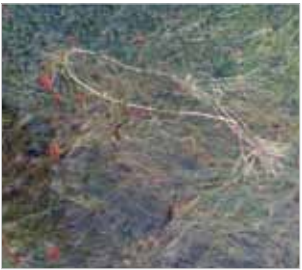
An active mound spring

Vegetated springs

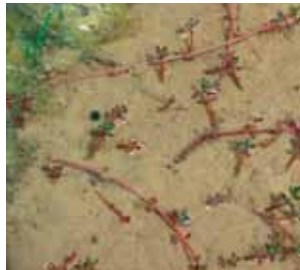
Aquatic plants



Fairy aprons (*Utricularia dichotoma*), a **carnivorous bladderwort**, far away from its typical home.



Aquatic vegetation can thrive in the permanently wet environment of springs.



Grasses and sedges



Native sedges, rushes and grasses commonly emerge from and surround vegetated springs.

Vegetated springs provide habitat, shelter, structure, shade, food and materials for a variety of animals so these springs tend to be more biodiverse than mound springs or unvegetated pools of open water. Vegetated springs also provide potential habitat and nesting sites for small insectivorous and grain-eating birds.

A range of plants can be found in association with springs, including trees, shrubs, grasses, sedges, forbs, algae and submerged aquatic plants.

Perennial wetland plants are found in the permanently wet areas because these plants require a fairly constant water flow. Endemic species such as spring milfoil occur here.

Groundwater runs over the surface and evaporates at the margins of springs, or leaks up in these areas under lower pressure and evaporates on the surface. These processes result in salt accumulation and create a drier habitat where salt-loving plants are found.

Typical plant species in the Eulo springs super-group include native grasses and sedges like the smooth flatsedge (*Cyperus laevigatus*), the branching rush (*Juncus polyanthemus*), smooth bluerod (*Stemodia glabella*), beetle grass (*Leptochloa fusca*) and Bermuda grass (*Cynodon dactylon*).

The Eulo springs super-group also contains GAB endemic plants (species that are found nowhere else in the world but in GAB springs) and endangered species. Examples include *Eragrostis fenshamii*, *Eriocaulon carsonii* (salt pipewort), *Hydrocotyle dippleura*, *Isotoma* sp. (R.J. Fensham 3883), *Myriophyllum artesium* (spring milfoil), *Sporobolus pamela*, *Plantago* sp. (R. Fensham 3677).

Some plants found in springs are interesting, not because they are rare, but because the permanently wet spring environment has allowed them to flourish great distances away from their typical (often coastal) habitats. The carnivorous bladderwort *Utricularia dichotoma*, commonly called fairy aprons, is an example.

Endemic and endangered plants



Spring milfoil (*Myriophyllum artesium*), a GAB springs endemic plant found in the Eulo springs super-group.



Hydrocotyle dippleura, a GAB springs endemic plant, found at Bundoona Springs (Yowah), in the Eulo springs super-group.



Salt pipewort (*Eriocaulon carsonii*), an endangered plant, also at Bundoona Springs (Yowah) in the Eulo springs super-group.

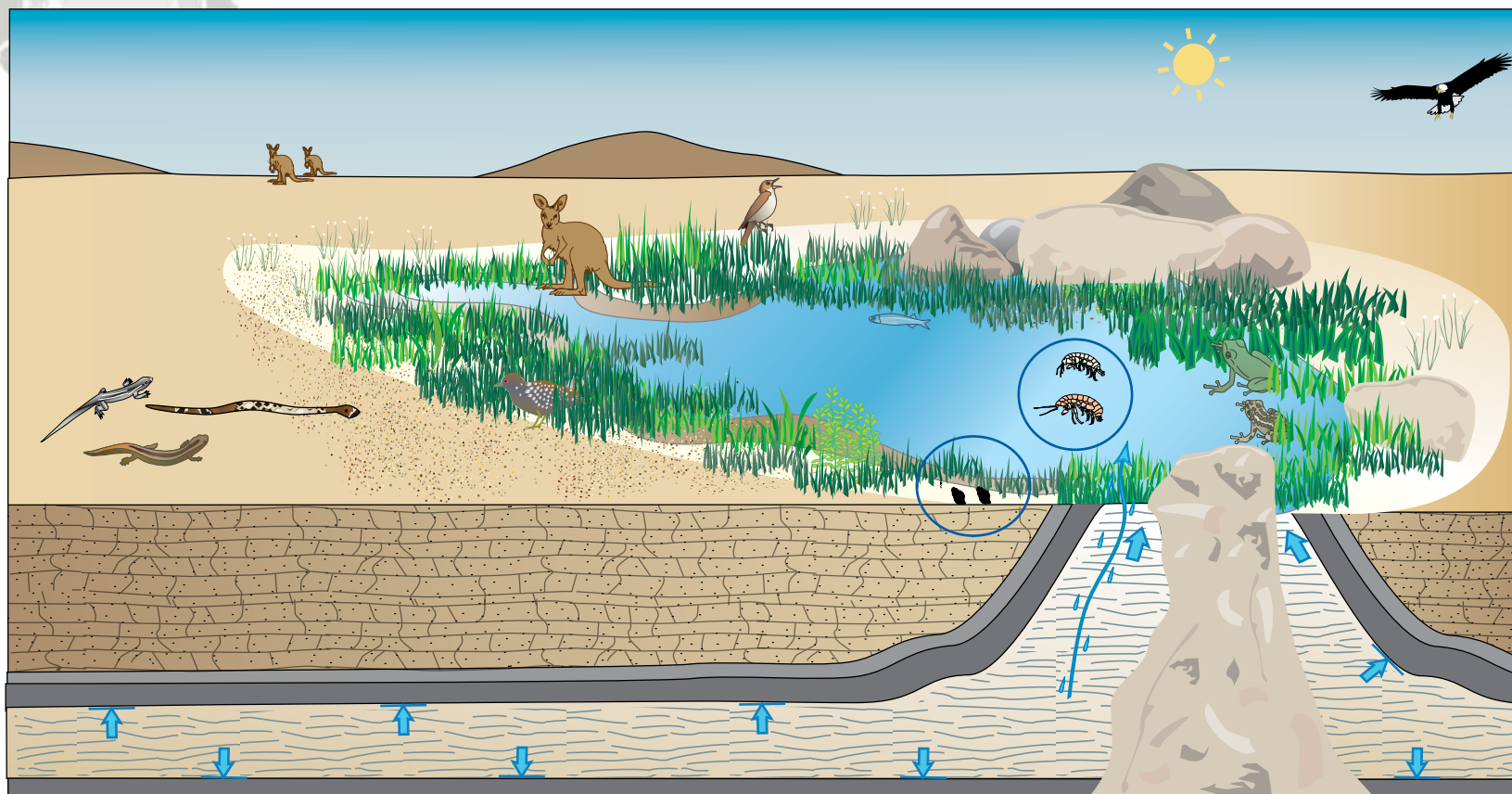
Values of springs

Plants and animals value springs

Many GAB springs provide a relatively clean source of water that flows regardless of local rainfall or drought. So in the semi-arid landscape of the Eulo region, springs are an important feature to many animals, not only for aquatic and semi-aquatic animals like fish and frogs. Birds (like the Australian spotted crake and the clamorous reed warbler favour sedges and reeds for habitat and can be found at springs) reptiles and mammals (like wallabies and kangaroos) also rely on the artesian water, that springs naturally provide, to sustain their populations during drought.

The isolated nature of these springs has allowed **endemic** species to evolve — animals and plants that are found nowhere else, except in GAB springs.

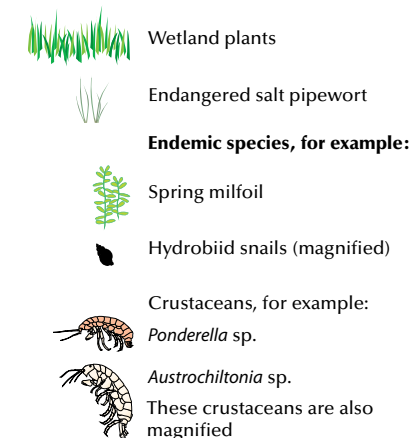
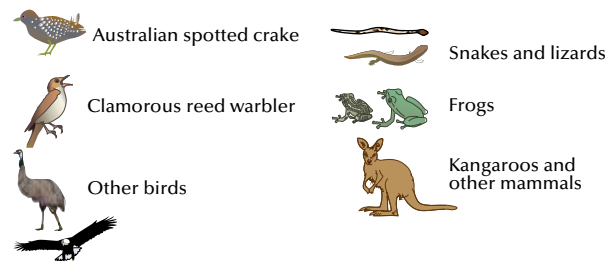
The endemic animals in some GAB springs include fish, spiders, insects, a wide variety of crustaceans, molluscs, and worms.



The Eulo springs super-group is home to at least one endemic hydrobiid snail *Jardinella eulo* and four other snail species yet to be described by science: two endemic isopods (small crustaceans) *Ponderella bundoona* and *P. eromanufactia*, one endemic flatworm *Weissun capacidudus* and one endemic amphipod (another type of small crustacean) *Austrochiltonia sp.*

The spring communities of plants and animals that depend on GAB spring flow, are listed federally as endangered and are protected by law.

Springs are important for plants and animals



Values of springs

People value springs

Great Artesian Basin water, sourced from natural springs and man-made bores, has been an important water source for practically all groups of people who have lived in the region.

The Aboriginal peoples of inland Queensland have strong cultural connections with GAB springs dating back many thousands of years, evidenced by the presence of tools, fire hearths, songs and oral history. GAB springs have been important to the survival of Aboriginal peoples of these arid and semi-arid regions, providing a source of water, food and other material resources, as well as having ceremonial and spiritual values. A recently rediscovered survey from 1911 conducted in the Eulo region contains the Aboriginal names for many of the springs in the area, including inactive ones, a vital piece of the region's cultural heritage. More information about the Aboriginal cultural associations can be found in the 'Great Artesian Basin Spring wetlands – cultural heritage values' factsheet.

GAB springs have also been utilised by others living in or passing through the region, including colonial explorers, camel herders and Chinese market gardeners. There are even records of short-lived inns established at Tego and Curracunya springs that seem to have used the spring water in brewing their beer! Springs have supported the growth of agriculture in the region, though this has often been through stock access, the development of bores or excavation, all of which have had a range of impacts on the spring's ability to continue to provide water or to support other natural values. Nonetheless springs have been seen as vital for life and development of grazing in the region and there are many examples of homesteads, shearing sheds and other gathering places that were intentionally located near a property's spring. Water from GAB bores continues to provide a water source for many pastoral properties and town water in the region.



Springs provide a permanent water source in a dry landscape.



Carved tools, found around many spring in the Eulo region are evidence of long-standing Aboriginal connections.



These tiny hydrobiid snails, photographed close up on a hand, are found only in GAB springs.



Springs are an important water source for the region's pastoral industry.



Springs provide water, habitat and access to other resources for aquatic animals, such as frogs, and for many other species, including birds, mammals and reptiles.

Threats to springs

Water extraction, through the sinking of thousands of bores across the GAB, has caused a substantial decrease in GAB water pressure and has resulted in decrease in spring flow, to the point where some springs have become inactive. It is estimated that approximately 40 per cent of discharge spring complexes in the GAB have become inactive due to this water draw down. Studies have found that the Eulo spring super-group is one of the most severely affected, with half its 61 spring complexes now completely inactive and a further 22 only partially active. A mere eight spring complexes remain entirely active, and their discharge rate is about a third of the volume they discharged in the early 1900s.

Feral pigs, goats and domestic stock access springs in the Eulo spring super-group and can severely reduce their habitat. These introduced animals have hard hooves that damage the soft ground and trample vegetation. Sheep, cattle and goats can place increased grazing pressure on springs and pigs remove vegetation by its roots – reducing its ability to grow back. Pigs and cattle tend to wallow in the water, disturbing aquatic vegetation, stirring up bottom sediments and reducing water quality. Sheep and goats can become trapped in the mud and die, causing similar declines in water quality. Defecation in springs introduces a substantial amount of nutrients to these sensitive ecosystems and this also reduces water quality, which impacts on the plants and animals that rely on springs as a water source.

Introduced plant species (particularly ponded pasture grasses) can invade springs and choke out native habitats.



Unmanaged stock grazing a spring.



Animal defecation puts nutrients into springs.



Introduced grasses can choke springs.



Excavation destroys spring habitat and can reduce flow.



Water extraction reduces pressure across the GAB.



Stock and feral animals such as goats and pigs damage the banks and beds of springs with their hard hooves, reducing water quality and native vegetation growth.

Threats to springs

In the past it was common practice for springs to be 'dug out' – excavated, dredged and converted to dams or wells in an attempt to increase flow or provide easier water access for stock or humans. There are even reports of explosives being used in an attempt to achieve these outcomes. Due to the fragility of the underground structures that allow artesian water to reach the surface these heavy-handed attempts to increase stream flow often had the reverse effect and destroyed the surface connection with water-bearing layers, resulting in a cessation of flow. A profound loss of local spring habitats and species is a common side effect of these measures.

While the figures for the Eulo spring super-group are not available, it is estimated that 11 per cent of all active spring complexes have suffered total or partial damage by excavation.

Threats to springs



Animals such as feral goats and pigs and even unmanaged stock can uproot and trample spring vegetation, and may cause:



- erosion and pugging of spring banks and beds with their hooves;



- higher levels of sediment in the water, and resuspension of settled sediment due to disturbance, reducing water clarity;



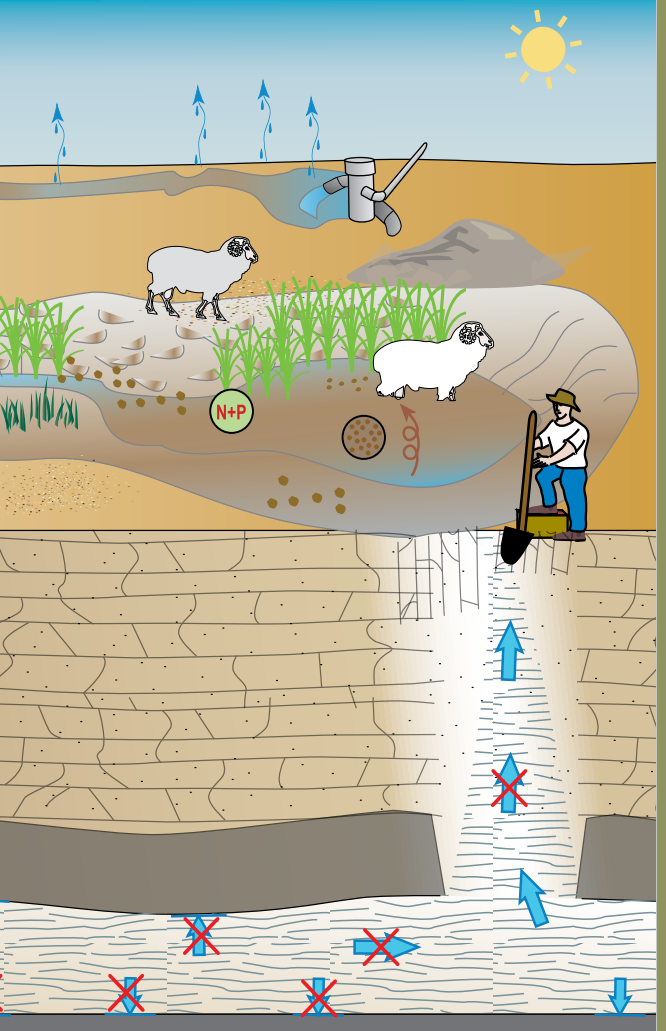
- defecation by feral animal and stock is likely to result in higher levels of nutrients in the water and a subsequent decline in water quality.



Water extraction through bore drilling has resulted in a drop in water pressure across the Great Artesian Basin, resulting in many springs becoming inactive, and others becoming partially inactive.



Aquifer draw down resulting from water extraction causes a drop in water pressure and therefore reduced spring discharge.



Weedy introduced plants like the ponded pasture grass hymenachne can invade springs and have the potential to outcompete native vegetation, dominating the spring and reducing biodiversity and habitat value for native animals.



Excavation of springs through digging out, or other means, can destroy habitat, disrupt the connectivity of water-bearing sediments and result in a cessation or lowering of spring flow.

Management of springs



Free-flowing bores allow substantial amounts of artesian water to be lost to evaporation. This unmanaged water extraction causes a drop in GAB water pressure and reduced spring and bore flow rates.



A bore in the Eulo springs super-group that has ceased to flow due to the drop in GAB water pressure.

Bore capping and rehabilitation

The most effective way to limit draw down is capping and rehabilitating uncontrolled bores and restricting future bore construction. Limiting discharge through bore rehabilitation has resulted in increased water flows to springs in the local area. However, there have been no recorded spring recoveries in the Eulo springs super-group, where the loss of pressure has been great.

The pastoral industry accounts for about 90 per cent of water extracted from the GAB so management actions that target property-level use of artesian water are important in managing this threat. Under the Great Artesian Basin Sustainability Initiative (GABSI) the state and federal governments are providing support for the repair of uncontrolled artesian bores and the replacement of open earthen bore drains with piped water reticulation systems.

Case studies of bore rehabilitation on private properties have found a range of benefits to the landholder including:

- the elimination of all costs associated with bore drain maintenance and repairs, such as delving, repairing breakouts and bore drain inspections
- reduced mustering times and simplified mustering processes
- reduced stock mortality due to the better reliability and improved quality of water supply
- increased ability to control feral animals, thereby reducing control costs

- reduced weed growth and spread along bore drains and thereby reduced weed control costs
- increased pressure and water quality at the homestead
- increased security of water supply , and improved scope to manage during drought
- reduced likelihood of draw down of bores that would then require pumping, and accrue establishment and maintenance costs.

Productivity improvements and increased carrying capacity are also common following bore rehabilitation. For more information see the reading list at the back of this document.



Piping bore water rather than letting it flow through open drains has a variety of benefits, including dramatically reducing evaporation losses and preserving water quality.

Management of springs

Sustainable grazing management

Stocking rates based on grass availability and removal of stock during dry periods are crucial steps for reducing grazing pressure on springs and their vegetation. High goat numbers also contribute to the grazing pressure on springs and therefore also require management. Fencing-off springs and providing off-spring water sources aids in reducing stock impacts.

Grazing has been used as a tool in managing spring vegetation, and strategic grazing has proved to be effective at inhibiting the dominance of the perennial reed *Phragmites australis*. *P. australis* is a highly palatable fodder and provides habitat for several animal species; however an overabundance reduces the overall diversity of plant species in a spring, obstructs spring discharge, and decreases water levels due to its high transpiration rate (water use).

Feral control

Most landowners have a feral pig control program in place, usually a combination of shooting, trapping and baiting. In warm and dry climates, feral pigs require water daily so their distribution is centred around natural or artificial water sources. Preventing access to water, for example by fencing or replacing open bores with pipe, may reduce pig numbers in the semi-arid regions where springs occur, reducing disturbance to these sensitive habitats. Control programs may be most effective when considered as a part of a cooperative approach across a local area.

Habitat rehabilitation

Very little research has been done on rehabilitation of excavated springs, either in terms of reforming natural structure or native revegetation. This is an emerging area of research that will no doubt provide insights into spring function, values and management requirements.

Weed control

Weeds are not an issue for the Eulo springs super-group but introduced species, like the exotic perennial pasture grasses para grass (*Brachiaria mutica*), aleman grass (*Echinochloa polystachya*) and hymenachne (*Hymenachne acutiglumis*) have the potential to invade spring wetlands. Once established these species can dominate and even eliminate virtually all other wetland species. Prevention of weed invasion will preserve endangered and endemic spring wetland species, which are difficult to re-establish once eliminated from an area. Further research is needed to understand how to successfully manage weed invasion in springs.

Fire management

Fires need to be carefully planned around conditions, and the risk that a fire might spread to and destroy an underground peat layer (if present) needs to be considered. More research is required in order to better understand the interaction between fire and spring plant and animal communities and to be able to develop site-appropriate management plans and actions for fire.



Unmanaged sheep, cattle, goat and pig access to springs can cause declines in water quality.



Fencing in Currawinya National Park has reduced feral animal grazing pressure on springs, and resulted in greater, more diverse vegetation growth.



An example of an excavated spring

Key references and further reading



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